



Town of Port Hedland

Port Hedland Townsite CHRMAP

Coastal Hazard Risk Management and Adaptation Plan

DRAFT

October 2018

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Executive summary

The Port Hedland Townsite is situated on a narrow headland, exposed to erosion hazards, with low-lying areas subject to tidal influences and storm surge. The physical context and shape of the townsite – including its urban land and infrastructure – makes it highly vulnerable to risk of coastal hazards. Port Hedland Townsite and its coastal reserve supports a diversity of important infrastructure and land use assets, including transport, services and community infrastructure, urban land, and the coastal foreshore reserve. These are assets strongly valued by the community:

- for recreation opportunities
- as a social space to meet and interact
- for its cultural value
- for its character, sense of place and scenic landscape
- as an ecosystem and place of biodiversity
- for education, science and learning
- as a commercial economic resource
- as a personal economic resource

This Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) identifies and considers coastal hazards and risks for the Port Hedland Townsite culminating in a recommended adaptation pathway with actions to assist in adapting to immediate coastal inundation and erosion risks, and undertaking appropriate planning to address increasing risk over time. This CHRMAP considers hazards and risks in the immediate term (2010), the current planning horizon (to 2060) and the long-term (to 2120).

The areas of the Port Hedland townsite that are vulnerable to coastal erosion and flooding have been identified by a hazard assessment. This assessment provides a representation of the areas within the townsite expected to be vulnerable to erosion and/or coastal flooding based on coastal modelling for the timeframes of 2010, 2060 and 2120. In assessing vulnerability, GHD have also considered the specific variability in geotechnical conditions along the Port Hedland townsite. The geotechnical variability is not generally represented in the results of coastal modelling studies and hazard mapping.

The hazard assessment considers erosion and flooding risk associated with different storm scenarios. In the context of coastal hazard assessments, likelihood is defined as the chance of a coastal hazard occurring and how often it may impact an asset, land use or value. In the coastal hazard assessment, for each planning horizon, the CHRMAP considers three scenarios with relative levels of likelihood – almost certain, possible and rare. The distances of the erosion allowances for the immediate period for the almost certain, possible and rare likelihoods, consider the shoreline retreat likely to occur as the result of a 1, 10 and 100-year Average Recurrence Interval (ARI) erosion event, respectively. Because the occurrence of these events is not likely to be evenly spaced in time, considering their Annual Exceedance Probabilities (AEP), which indicates the probability of an event occurring within any given year, can assist in understanding the likelihood of each event. The immediate likelihoods of almost certain, possible and rare translate to a 63%, 9.5% and 1% annual exceedance probability, respectively.

Based on the hazard assessment, coastal erosion and flooding present an immediate level of risk to assets and values that is intolerable, particularly:

- Coastal residential properties in the West End (vulnerable to erosion in a possible and rare event)
- Public infrastructure (playgrounds) within the Cemetery Beach foreshore (vulnerable to erosion in a rare event)
- Public beaches, roads, and residential properties at the western end of Sutherland Street (vulnerable to erosion in the rare event)
- Public beaches, roads, and residential properties on Barker Court, near Goode Street (vulnerable to erosion in the rare event)
- The existing Port Hedland town centre within the West End (vulnerable to coastal flooding in all events)

In the current planning horizon (to 2060), the risk of erosion to public foreshore, roads, and residential properties along Sutherland Street and in the East End of Port Hedland (Goode Street and properties that back onto the existing coastal reserve) is likely to increase to a point that it is intolerable.

Whilst in the immediate term the Spoilbank offers protection against erosion to assets in the area, in the current planning period to 2060 the persistence of this sedimentary geomorphological feature is less certain because this study did not include a detailed sediment transport assessment in relation to the Spoilbank. In addition, the State Government is planning a substantial investment of capital funding for the Port Hedland Spoilbank Marina which represents a strategic decision to protect this part of the Port Hedland coast. Either separately or as part of the design process for the marina, a detailed investigation of coastal processes and geotechnical stability of the Spoilbank over the current planning horizon (to 2060) should be undertaken to understand the localised risk of erosion and wider impacts.

It will be important for the Town of Port Hedland, in conjunction with State Government, industry and the community, to proactively engage and implement coastal adaptation in Port Hedland. If not managed, then over time residential properties and social and environmental values of the public coastal foreshore (including access to a public beach for recreation, and environmental assets such as turtle nesting habitat) will be lost as a result of erosion.

Investment into coastal adaptation is recommended to deliver the following adaptation pathway, and proactively manage risk of erosion and inundation to maintain social, environmental and economic values across Port Hedland:

Planning Area	Immediate actions (2018 to 2030)	Current planning (2018 up to 2060)	Long-Term planning (2060-2120)
1. West End (erosion)	Interim protection via sand replenishment and dune stabilisation or rock armour seawall		Managed retreat or further interim protection
2. Kingsmill Street (erosion)	Interim protection via rock groynes and sand replenishment or rock armour seawall		Managed retreat or further interim protection
3. Spoilbank (erosion)	Undertake localised hazard and geotechnical investigations to understand localised risk of erosion. Managed retreat and/or interim protection of localised areas (for example marina)		Managed retreat and/or interim protection of localised areas (for example marina)
4. Cemetery Beach (erosion)	Monitor		
5. Spinifex Hill/Cooke Point (erosion)	Interim protection via sand replenishment	Managed retreat or hard passive protection, depending on the outcomes of further community engagement, informed by detailed coastal processes assessment.	
6. East End (erosion)	Interim protection via sand replenishment	Managed retreat or hard passive protection, depending on the outcomes of further community engagement, informed by detailed coastal processes assessment.	
7. Pretty Pool (erosion)	Monitor and avoid new development in long-term hazard area		
8. West Townsite (inundation)	Accommodate		Managed retreat and/or further accommodation
9. East Townsite (inundation)	Monitor	Interim protection and accommodate	

The recommended adaptation pathway is consistent with schedule 1 of the State Coastal Planning Policy (SPP2.6) in considering the 100-year ARI erosion event for the rare scenario. Based on the results of the coastal hazard assessment, there is very little difference between the almost certain, possible and rare erosion hazard areas by 2060, and even less by 2120. Therefore, the adaptation and implementation pathway of this CHRMAP plans for the rare event. Development of more detailed adaptation responses will require further investigation into coastal hazards and this may allow a less conservative approach to be taken during implementation.

Further information and community engagement is required to guide decision making to manage increasing erosion risk between now and 2060 for the planning areas of Spinifex Hill/Cooke Point and East End. The evaluation of adaptation options for these areas did not strongly discriminate between the costs and benefits of managed retreat versus interim protection (which would delay the need for retreat for 50 years). Significant costs considerably influence the viability of interim protection in these locations. The acceptability of managed retreat requires prioritisation of the social impacts of land acquisition against the high costs of interim protection that will manage risks only for a 50-year timeframe. The community should be engaged in considering the costs and benefits of managed retreat versus interim protection to determine the most feasible response.

Because so much of the Port Hedland townsite is at risk of coastal hazards, the cost of proactive coastal adaptation will be high, and requires substantial investment by government and the private beneficiaries of adaptation action. Many adaptation recommendations to manage increasing risk to 2060 have a high cost and will require a considerable investment at the time that implementation is required. The high cost of proactive coastal adaptation in Port Hedland cannot be delivered by the Town of Port Hedland alone at the time of these trigger points.

It is important that appropriate funding options and relationships are identified, and a long-term funding strategy is put in place. This may include a long-term funding plan that allocates and sets aside an annual contribution for coastal adaptation in Port Hedland, so that sufficient funding is available prior to triggers for implementation. The proactive budgeting of smaller amounts over time is far more likely to be successful than attracting a significant grant (of \$40 million or more) at the time that a strategic implementation action is required, and therefore provides greater certainty to the community that strategic, effective coastal adaptation will occur. If funding cannot be secured and planned for over time, it is possible that unmanaged retreat will occur, which will result in the loss of important social and environmental values along the coast as well as the loss of private land, without any compensation to property owners.

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1. Introduction

Port Hedland is a major regional centre in Western Australia's Pilbara Region. This coupled with its port activities cements the town's major role in the Western Australian economy, particularly in relation to mining exports.

The strong role of Port Hedland in the state's economy supports ongoing population growth in the town. However, Port Hedland is highly constrained in its ability to support sustained population growth. The town's location on a narrow headland surrounded by tidal flats results in limited land for urban expansion. The historic West End of Port Hedland is influenced by dust pollution from mining exports, which is placing pressure on the release of residential land toward the east of the town.

The growth of Port Hedland is strongly influenced by its coastal context. Coastal erosion and inundation risks are a key influence on future urban growth and settlement patterns in Port Hedland. Inundation has previously affected areas of the West End and Wilson Street and erosion pressures are impacting coastal areas along Goode Street. Managing coastal risks is vital in order to enable the community of Port Hedland to continue to enjoy the coastal lifestyle in their town.

In response to State Planning Policy (SPP) 2.6, the Town of Port Hedland has identified coastal erosion and inundation risks and produced a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP). This CHRMAP builds on a Coastal Vulnerability Report completed in 2011 (Cardno) that identified long-term erosion and inundation hazards, but this document focuses specifically on the Port Hedland Townsite.

1.1 Purpose of this plan

This CHRMAP considers the coastal hazard risk assessment for the Town of Port Hedland culminating in a decision-making framework with recommended adaptation actions to assist in adapting to immediate coastal inundation and erosion risks, and planning to address increasing risk over time. The purpose of this plan is to assist with coastal management decision making and is not to provide recommendations on coastal setbacks for development purposes.

This CHRMAP is the beginning of the conversation and journey with the community and stakeholders to understand and respond to the changing coast and townsite. The plan has a very long-term planning horizon, considering the decisions that will need to be made from now until 2120. This plan recommends priority coastal management options to inform appropriate investment in coastal reserves and the town for future management, with a focus on the implementation and management of short-term measures in the next five years.

The plan has been prepared as the first iteration of an evolving, long-term planning and decision-making process for the community and key stakeholders to adapt the Port Hedland settlement and infrastructure to coastal erosion and inundation. As the Town of Port Hedland, stakeholders and the community learn more about how the coast and townsite will change in the future, this plan and recommended adaptation responses will evolve to reflect and respond to the values, aspirations, and learnings of the community and stakeholders.

This plan applies to the study area identified in Figure 1-1. It assesses the coastal hazards and proposes coastal adaptation measures that consider the overall coastal dynamics within the secondary and tertiary sediment cells of the Pilbara Region. The study area is the Port Hedland Townsite, including all existing and future urban areas.

This plan has been prepared for implementation through the Town of Port Hedland planning framework and capital works programs. There are a number of major assets and locations in and around Port Hedland Townsite where the local planning scheme does not control development. This includes the Port of Port Hedland (within which port works and port facilities are exempt from the local scheme) and major industries operating under state agreements, which also become exempt from the local scheme. This plan does not make any recommendations for land outside the planning control of the Town of Port Hedland, or land that is managed by the Port of Port Hedland.



Figure 1-1 Study area for the project

In the short-term, this plan provides recommendations of management actions to conserve the functional and natural values of the coast and provide for sustainable land use and development. Where possible, the development of the short-term management actions should not limit future management options unless there is justification based on conserving functional and natural values.

In the long-term, this plan provides a road map for incorporation of adaptation planning into the Town of Port Hedland's land use planning framework and long-term financial plan. -

1.2 Objectives

The objectives of the CHRMAP are to:

- Improve understanding of coastal features, processes and hazards in the Port Hedland Townsite;
- Gain an understanding of the vulnerability of the Port Hedland Townsite to coastal processes;
- Identify vulnerability trigger points and respective timeframes for each sediment cell to mark the need for immediate or medium term risk management and adaptation;
- Identify assets (natural and man-made) which are situated in the coastal zone and the services and functions they provide;

- Identify the value of at-risk assets that are vulnerable to adverse impacts from coastal hazards;
- Determine the likelihood and consequence of the adverse impacts of coastal hazards on the assets, and assign a level of risk;
- Identify possible (effective) management and adaptation measures (or ‘actions’) and how these can be incorporated into short and longer-term decision-making; and
- Engage stakeholders and the community in the planning and decision-making process.

1.3 Planning context

This CHRMAP sits within the local and regional planning framework, and provides guidance for the Town of Port Hedland to develop a planning framework that will adequately respond to coastal vulnerability over time. The key elements of the strategic planning framework that inform and/or are informed by this CHRMAP are illustrated in Figure 1-2.

1.3.1 State Planning Policy 2.6 State Coastal Planning Policy

State Planning Policies (SPPs) are prepared by the Western Australian Planning Commission and guide all local planning strategies, schemes and decisions. SPP2.6 provides a range of policy measures that require planning authorities to consider the long-term nature of coastal processes into decision-making and sets the framework for coastal adaptation and risk management to inform decision-making. This CHRMAP, informed by SPP2.6 and associated policy guidelines, will provide a blueprint for local planning frameworks in Port Hedland to deliver the requirements of the policy.

1.3.2 Local Planning Strategy - Pilbara’s Port City Growth Plan

The purpose of local planning strategies is to set out the local government’s objectives for future planning and development and includes a broad framework by which to pursue those objectives. The strategy is therefore the appropriate document to articulate the longer-term nature of the challenges arising from sea level rise and its associated effects on the coastline, and the Town of Port Hedland’s response to those challenges.

Pilbara’s Port City Growth Plan is the Town of Port Hedland’s current Local Planning Strategy. As part of the preferred scenario for growth, the East End of Port Hedland was identified as a high amenity coastal community, with a new retail centre. The growth plan predicted 5,643 new dwellings in Port Hedland, focused around the East End unconstrained by dust and industrial influences. The growth predicted for the East End of Port Hedland requires careful management of coastal processes to enable the townsite to grow as planned by the Port City Growth Plan.

The Port City Growth Plan was approved in 2012, and is scheduled for review. This CHRMAP will review the coastal hazards associated with the urban growth areas identified in the Port City Growth Plan to identify the most appropriate locations and form of future urban growth, with respect to coastal hazards, for Port Hedland.

1.3.3 Town of Port Hedland Local Planning Scheme

The local planning scheme provides the statutory framework for land use in Port Hedland. Informed by the local planning strategy, the local planning scheme (and any associated local planning policy) will be a key tool to deliver land use change necessary to implement the recommendations of the CHRMAP.

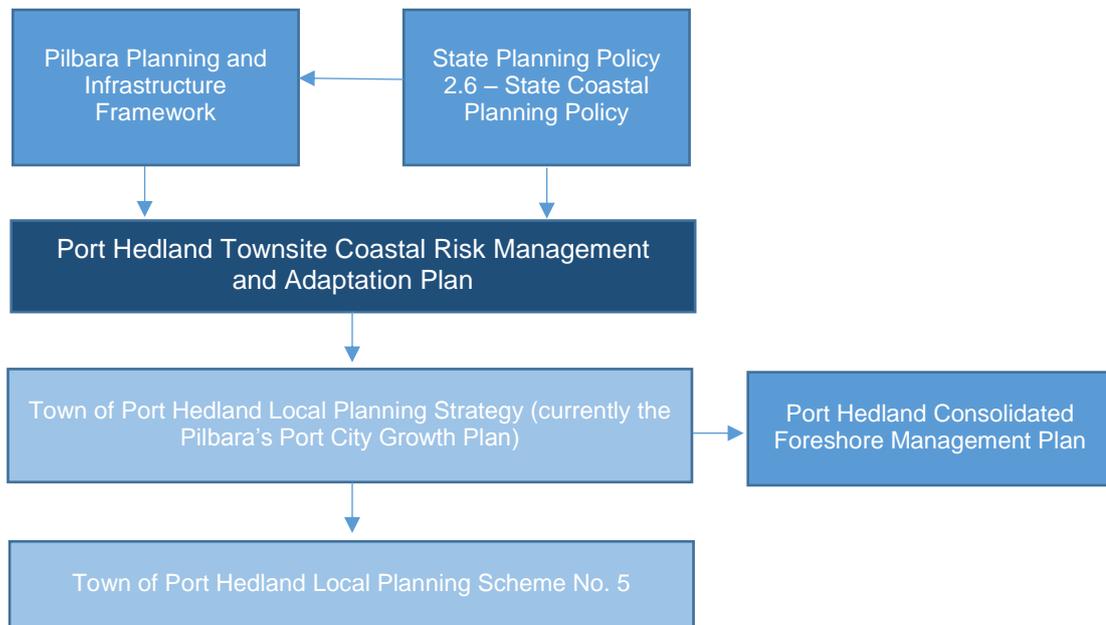


Figure 1-2 Local planning context

Other relevant policy and strategic planning documents shown in Figure 1-2 include the Pilbara Planning and Infrastructure Framework and the Port Hedland Consolidated Foreshore Management Plan. The recommendations of this CHRMAP will guide future iterations of these documents to provide a consistent approach to urban growth and infrastructure planning in the context of coastal risks in the Port Hedland Townsite.

1.4 Planning horizons

The three planning horizons used for this study to assess coastal hazards, risks and develop adaptation plans follow the horizons in the Coastal Vulnerability Assessment (Cardno 2011):

Immediate risk: Actions recommended to address the existing locations of intolerable risks at 2010 between now (2018) and 2030.

Current planning horizon: Planning decisions, additional investigations and decision-making recommended to address risks that will become intolerable between now (2018) and 2060.

Long-term planning horizon: Planning approaches to help Port Hedland prepare for long-term risks by 2120.

The long-term planning period is comparable with the 100-year planning horizon recommended in State Planning Policy 2.6.

The structure of this CHRMAP is based upon these three planning horizons.

2. Coastal risk management and adaptation

2.1 An evolving coast

The Port Hedland Townsite and its beaches are vulnerable to coastal processes, including erosion and inundation. Over time, the town and the coast will become increasingly vulnerable to the impacts of sea level rise, storm surges and changes in sediment transport and natural sediment stores.

The two main processes for consideration in Port Hedland are erosion and inundation.

Erosion is the loss of sand. An eroding coastline refers to shoreline movement where the shoreline shifts landwards, potentially reducing the width of the coastal foreshore reserve or reducing the distance to fixed features on the land. Erosion is the result of either sediment moving offshore or along the shore by waves and currents. Erosion can be a slow seasonal process, such as sand moving from one end of a beach to the other and back over a year as a result of change in seasonal wind and wave directions, or it can be sudden, resulting in sudden changes in the shape of the beach or vertical drops in the sand level such as after storm events. Erosion is a natural process that is balanced by the opposite process of accretion, the accumulation of sand, which allows beaches to replenish and rebuild over time in some instances, dependent on the nature and severity of the erosive event.

Inundation is the flow of water onto previously dry land. It may be either permanent (for example due to sea level rise) or a temporary occurrence during a storm (such as flooding in the town during a cyclonic event). Other than the regular short-term variations in water levels caused by tides, other temporary effects on water level include falling barometric pressure which allows water surfaces to rise (inverse barometric effect), the action of wind and waves that can cause water to pile up against the coastline (setup) and waves breaking and pushing water up the beach face (wave run-up).

Our coastline is reacting and responding to changes in sea levels. In the short to medium term, sea level rise is expected to continue to be slow and linear, but by the latter half of this century, sea level rise rates are expected to increase (IPCC 2014). Increases in mean sea level will result in loss of land in low-lying areas such as adjacent tidal creek areas and along the Spoilbank. These changes will be most noticeable on beaches and tidal planes with gentle gradients. Increases in sea level will also contribute to higher water levels during extreme events, increasing greatly the areas affected during significant storm events to areas previously not impacted by inundation, and increasing the potential frequency of inundation in areas already affected.

The potential for inundation and the frequency of inundation will increasingly affect areas of Port Hedland such as the West End Commercial area, Tjalka Boorda and the low-lying land between Wilson St and Anderson St, including the Boulevard shops. Pretty Pool tidal creek floodplain is one of the major undeveloped areas likely to be impacted by inundation. The risk with areas affected by inundation is that with rising sea levels, the ability to drain inundated areas with drainage infrastructure will also reduce as tail water levels will be higher in the future. So the impacts of the combination of high rainfall events with coastal inundation and high tail waters is likely to increase although this study focuses only on flooding from the marine environment and not rainfall.

As mean and extreme water levels increase as a result of sea level rise, the areas of beaches that wave and tidal energy act upon will change and may result in increased rates of shoreline

erosion in response. Areas that will respond most noticeably to erosion will be sandy beaches such as Cemetery Beach, Cooke Point, the Goode St Foreshore, Spoilbank and Town Beach.

2.2 What do we mean by risk?

A hazard is a source or event, such as erosion or inundation, with the potential to cause damage to or loss of assets or land and their associated values or result in injury to people. Risk is the likelihood of a hazardous situation or event occurring and the negative impacts that may result from it. Risk is therefore dependent on the likelihood of a hazardous event or situation occurring and the consequence of the event or situation.

In the context of coastal hazard assessments, likelihood is defined as the chance of a coastal hazard occurring and how often it may impact an asset, land use or value. In the coastal hazard assessment, for each planning horizon, we have looked at three scenarios with relative levels of likelihood – almost certain, possible and rare.

Immediate coastal hazard likelihoods (2010) only consider discrete events with a random probability of occurrence such as storms or cyclonic events. The distances of the erosion allowances for the immediate period for the almost certain, possible and rare likelihoods, consider the shoreline retreat likely to occur as the result of a 1, 10 and 100 year Average Recurrence Interval (ARI) erosion event, respectively. These events are discrete, meaning that they can happen at any time, thus the terminology ARI can be somewhat confusing, indicating that the occurrence of these events is likely to be evenly spaced in time. Instead, it is perhaps best to refer to likelihoods by their Annual Exceedance Probabilities (AEP), indicating the probability of an event occurring within any given year. The immediate likelihoods of almost certain, possible and rare are associated 63%, 9.5% and 1% annual exceedance probability, respectively.

Current (up to 2060) and long-term (up to 2120) coastal hazard likelihoods are considerate of both discrete events, with a random probability of occurrence of such as storms or cyclonic events, as well as time dependent processes that will increase with the passing of time, such as historical trends in erosion and increasing impacts due to sea level rise. Assigning a probability to these almost certain, possible and rare scenarios is therefore nonsensical as they are time dependent, so the probabilities will change with time. For further details on the hazard likelihood for erosion and inundation including the technical inputs, refer to the Coastal Hazards Assessment in Appendix E.

The risk assessment is consistent with state policy in considering the 100-year ARI erosion event for the rare scenario. Based on the results of the Coastal Hazard Assessment, there is very little difference between the almost certain, possible and rare erosion hazard areas by 2060, and even less by 2120. Therefore, for 2060, the implementation pathway plans for the rare event. Development of more detailed adaptation responses will require further investigation into coastal hazards and this may allow a less conservative approach during implementation.

Consequence is the impact of coastal hazards on assets and their values. Consequences relate not only to the direct impact or damage to an asset but also the effect on related social, economic and environment values (WAPC 2014).

2.3 What is adaptation planning?

The Port Hedland Townsite and its coastline has always been a dynamic, changing environment. Continued coastal processes combined with impacts of climate change (including stronger storm events and sea level rise) will present increasing risk and impacts to the townsite – including social, environmental, and economic assets and values. Adaptation planning is about being ready to manage the risks and impacts of erosion and inundation, by planning for the most appropriate decisions and options to implement over time.

A risk management approach is being used increasingly, nationally and internationally, to deal with potential adverse impacts of coastal hazards. A risk management and adaptation planning approach is a systematic way to identify and understand coastal hazard risks, and implement controls and measures to manage those risks in consultation with the community and stakeholders.

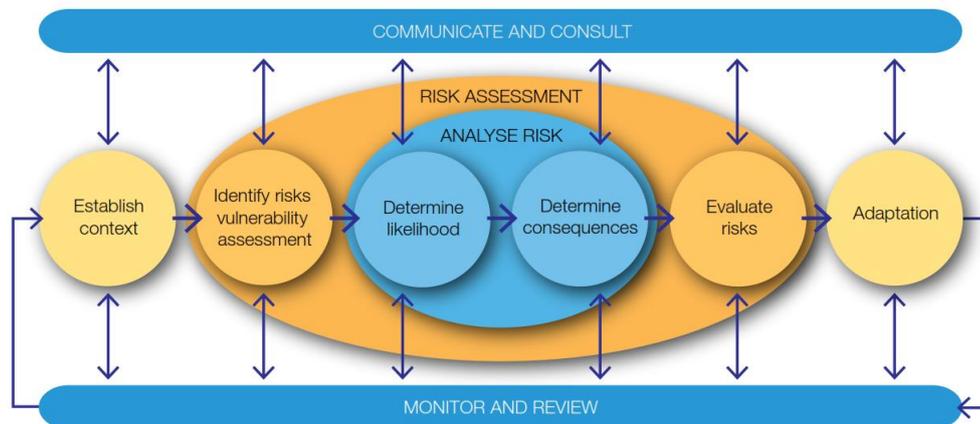


Figure 2-1 Risk management and adaptation process from Coastal hazard risk management and adaptation guidelines (WAPC, 2014)

State Coastal Planning Policy No 2.6 (SPP2.6) includes a requirement for 'responsible management authorities' to prepare coastal hazard risk management and adaptation plans, where existing or proposed development is located in an area at risk of being affected by coastal hazards over a 100-year planning horizon. For many areas of the coast, local government is the land manager. Therefore, local government in Western Australia has been leading the development of CHRMAPs.

Irrespective of the lead for preparing adaptation plans, successful adaptation planning requires cooperation from all stakeholders and decision makers involved. Key stakeholders and responsibilities for adaptation planning are shown in Table 2-1.

Table 2-1 Adaptation planning - roles and responsibilities

Role	Responsibility	Key Stakeholders
Planners and decision makers	Strategic planning responsibilities: Prepare adaptation plan for coastal land within their management. Inform asset owners and users about risk and decision-making. Decision-making responsibilities Make adaptation decisions on land and assets within their management/jurisdiction.	Western Australian Planning Commission Department of Planning, Lands and Heritage Town of Port Hedland Department of Transport
Asset owners	Manage assets in the context of coastal risk. Undertake accommodation measures, where consistent with government decisions. Decommission and relocate assets where required by government decisions to retreat.	Private land owners Business owners and operators Town of Port Hedland Infrastructure agencies Department of Transport Pilbara Port Authority
Other coastal users	Engage with decision makers regarding the values of the coast to inform decision-making.	Community

2.4 Adaptation measures

There are four key options available when making decisions about managing erosion and inundation. These are:

- **Avoid** locating future development in an area that would experience intolerable risk at some stage during the planning timeframe.
- **Retreat** (relocate) assets and development away from the risk to allow land at risk to naturally experience erosion and/or inundation. Large-scale strategic retreat will require coordination and partnership across state and local government and private landowners whose landholdings are likely be affected by retreat decisions.
- **Accommodate** the risks (e.g. occasional flooding) through asset specific design or retrofitting that enable an asset to continue to operate whilst being affected by coastal impacts. In relation to inundation, this includes measures to enable an asset to manage occasional flooding, such as raising of habitable floor levels and emergency management plans.
- **Protect** assets through coastal engineering works to reduce the risks associated with the coastal hazards of erosion and inundation to land and assets. Interim protection measures are detailed in Table 2-2.

Table 2-2 Coastal interim protection works

Approach	Description	Examples
Soft – Passive	Foreshore interim protection works that offer benefits to mitigate against erosion and inundation but do not involve construction of structures and do not directly affect coastal processes.	Sand replenishment, dune stabilisation and revegetation/planting
Hard – Passive	Foreshore interim protection works that involve the construction of structures which alter the coastal processes that act on the land/beach with the intention to maintain or improve beach amenity through retention of sand.	Groynes and intertidal breakwaters
Hard – Active	Works that involve the construction of structures which offer a source of interim protection to landside assets in proximity to the foreshore. The construction of hard active engineering measures can alter the way coastal processes act on the land/beach interface. These changes to the shape of the land (e.g. erosion of a beach in front of a seawall) can have implications on land use (e.g. loss of beach amenity).	Seawalls and levees

The most appropriate adaptation option may differ based on the values to be protected in a certain location, and the social, environmental and economic costs of the options. The Coastal Hazard Risk Management and Adaptation Planning Guidelines (WAPC, 2014) explain that the adaptation options should be considered as a hierarchy – the further down the hierarchy, the less flexibility there is to consider alternative adaptation measures. Effectively, these options become decisions for government and the community to make when planning for the future of coastal assets and land.



Figure 2-2 Hierarchy of risk management and adaptation options (WAPC, 2014)

2.5 Adaptation principles and strategic pathway

Adaptation planning is a very long-term process, and it is important to agree a long-term decision-making pathway to provide context and benchmarks for shorter term decision-making.

The following principles underpin the adaptation planning process, and guide the decision-making process set out in this adaptation plan. These are described in more detail in Appendix A.

- Principle 1** **Adaptation planning in the current planning horizon does not impede the ability of future generations to respond to increasing risk beyond current planning horizons.**
- Principle 2** **Adaptation requires a decision-making framework that enables the right decision to be made at the right time, in line with the values and circumstances of the time.**
- Principle 3** **Adaptation planning reflects the public's interest in the social, environmental, and economic value of the coast.**
- Principle 4** **Alternative adaptation measures should consider the full range of land uses and values.**
- Principle 5** **The full life-cycle benefits, costs and impacts of coastal interim protection works should be evaluated when considering adaptation options.**

In-line with these adaptation principles, the most appropriate adaptation pathway to adapt to erosion and inundation in the Port Hedland Townsite is one that enables decision-making on adaptation measures to be made at the right time, in line with the values of that time. The pathway is shown in Figure 2-3.

The 'right times' for decision-making are called triggers. The trigger for a decision about erosion and inundation (avoid, retreat, accommodate, interim protection) is the time when the risk to assets and values increases from tolerable to intolerable. These triggers are shown and defined in the strategic pathway in Figure 2-3.

Successful long-term adaptation is achieved when decisions made now, in 20 years or in 50 years do not prevent other measures being chosen later, retaining ongoing flexibility in decision-making consistent with the hierarchy of options. For example, at the end of the design life of interim protection structures, the full suite of adaptation options are re-assessed, and the most appropriate measure for the values of that time is implemented. There may be a point in future when interim protection or accommodation are no longer viable due to social, environmental or economic costs. Therefore, even if we choose to accommodate or protect in the shorter-term, we need to undertake longer term strategic planning to enable retreat in the long term.

The adaptation pathway provides a framework to strategically plan for retreat measures on the most vulnerable coastal land in the long-term. The pathway also recognises the role of responsible interim adaptation measures to continue land uses where those measures are justified on social, economic and environmental grounds.

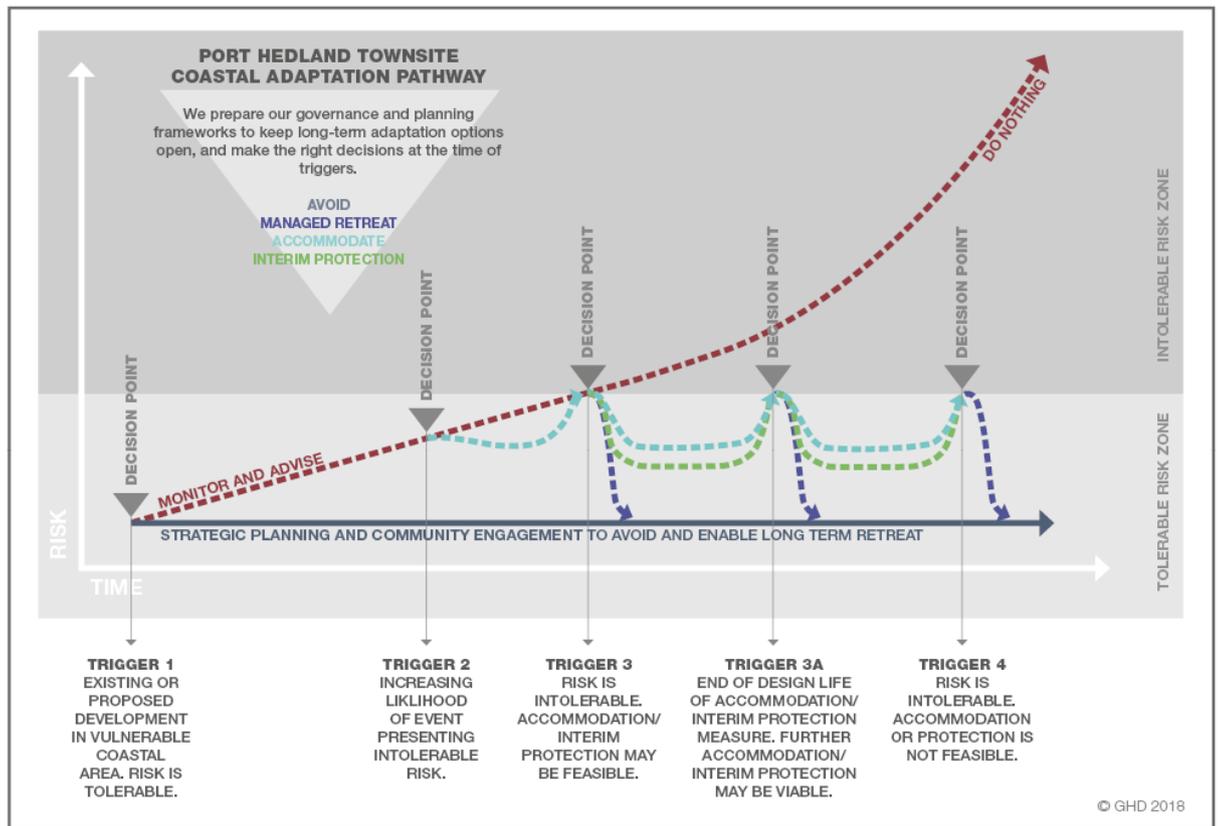


Figure 2-3 Port Hedland Townsite strategic coastal adaptation pathway

In line with the strategic adaptation pathway, this adaptation plan focuses on the two strategic areas of adaptation actions:

- Implement appropriate adaptation actions in response to immediate term triggers:
- Develop strategic planning frameworks for flexibility in the medium and long-term.

This adaptation plan presents strategic planning measures to incorporate a flexible pathway into the medium (2060) and long-term (2120) planning horizons in the Town of Port Hedland. The plan identifies triggers for adaptation in the immediate (15 year) term and recommends adaptation measures for further investigation and implementation.

3. Values of the Port Hedland Townsite and Beaches

The coastal and port setting of the Port Hedland Townsite is key to its character and community. Determining the risk of coastal hazards, identifying triggers for adaptation and selecting the most appropriate adaptation responses are informed by the assets at risk, and the values of the Port Hedland Townsite and the coastal area.

Understanding the value of assets at risk alongside broader coastal values are important in coastal risk management and adaptation planning. Managing risk to particular assets has to consider how risk management relates to broader coastal values. The most appropriate approach may need to balance the value of specific assets against broader coastal values.

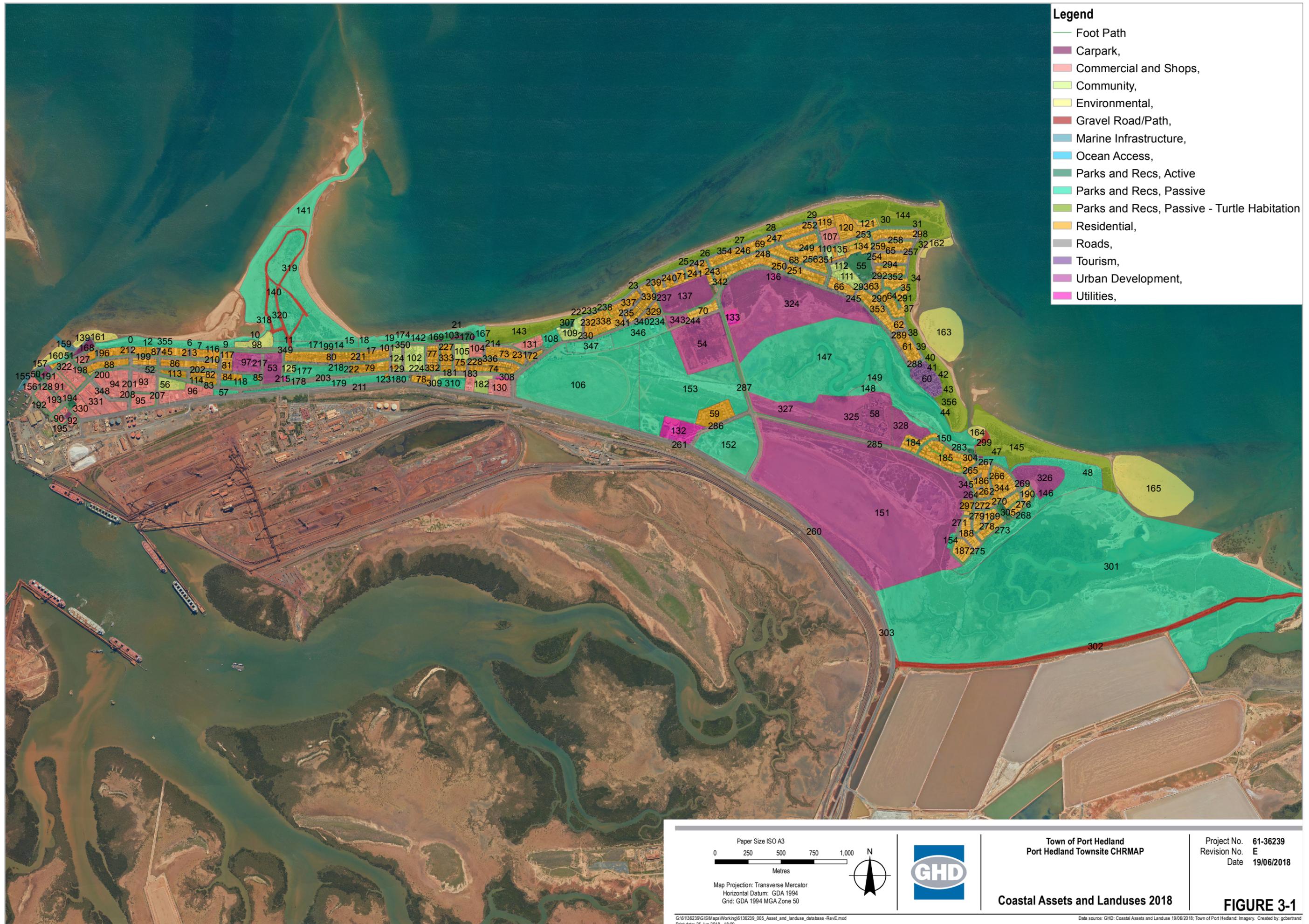
3.1 Assets at risk

The Port Hedland Townsite is situated on a narrow headland, exposed to erosion hazards, with low-lying areas subject to tidal influences and storm surge. The physical context and shape of the townsite – including its urban land and infrastructure – makes it the key asset at risk of coastal hazards.

Port Hedland Townsite and its coastal reserve supports a diversity of important infrastructure and land use assets. This CHRMAP focusses on public assets and infrastructure, including transport infrastructure, services infrastructure, community infrastructure, urban land, and the coastal foreshore reserve. The number of built and land assets within the Port Hedland Townsite are substantial; a database of assets is provided in Appendix B and the nature of the assets and their value is described in this section. Figure 3-1 illustrates the location of key assets and land uses across the Port Hedland Townsite.

From the community's perspective, the value of an asset relates to the experience it supports, more so than the cost or financial value of that asset. The financial value of assets depreciates over time based on their design life, although the functional value endures. Because the depreciation of an asset can occur prior to long-term coastal risks being realised and it is not feasible to determine the current financial value of all assets in Port Hedland, this CHRMAP focusses on the functional value of assets/areas of the Port Hedland Townsite in decision-making. The functional value of assets throughout the townsite relate to broader environmental, social and economic values of the town.

The following section describes the key assets and infrastructure within the study area; the specific value the community places on them relates to their function in supporting the coastal values described in section 3.2.



- Legend**
- Foot Path
 - Carpark,
 - Commercial and Shops,
 - Community,
 - Environmental,
 - Gravel Road/Path,
 - Marine Infrastructure,
 - Ocean Access,
 - Parks and Recs, Active
 - Parks and Recs, Passive
 - Parks and Recs, Passive - Turtle Habitation
 - Residential,
 - Roads,
 - Tourism,
 - Urban Development,
 - Utilities,

Paper Size ISO A3

0 250 500 750 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50



Town of Port Hedland
Port Hedland Townsite CHRMAP

Coastal Assets and Landuses 2018

Project No. 61-36239
Revision No. E
Date 19/06/2018

FIGURE 3-1

G:\6136239\GIS\Map\Working\6136239_005_Asset_and_landuse_database-RevE.mxd
Print date: 25 Jun 2018 - 18:00

Data source: GHD: Coastal Assets and Landuse 19/06/2018; Town of Port Hedland; Imagery. Created by: gcberrand

3.1.1 Transport infrastructure

Transport infrastructure facilitates the movement of people and freight, which is vital for economic, cultural, and social exchange and activity. Key transport infrastructure within the area includes:

- Port Hedland Port – which has significant value in transport and economic development (see section 3.2.7);
- Regional road links – connecting Port Hedland to South Hedland and the broader Pilbara region; and
- Local roads – providing access within and across the townsite.

Transport infrastructure within Port Hedland Townsite and the coastal zone is strongly valued by the community. Transport infrastructure provides the community access to the places they live, work, play and do business and provides pathways for evacuating from coastal hazards during extreme events.

3.1.2 Services infrastructure

Services infrastructure provides essential services to land use and development. Key services infrastructure within the area includes water, electrical, and telecommunications supply and distribution infrastructure.

Services infrastructure is generally located within road reserves, with key utilities sites shown on the asset map in Figure 3-1.

Services infrastructure assets within the Port Hedland Townsite and the coastal zone are strongly valued by the community. These are essential services for the operation of the town.

3.1.3 Community infrastructure

Community infrastructure is essential for community wellbeing and provides opportunities for community interaction.

The coastal foreshore reserve of Port Hedland is a key piece of community infrastructure, however supports values beyond simply community and social values. The coastal foreshore provides important community infrastructure that facilitate community use and enjoyment of the area including:

- Footpaths
- Street furniture
- Shaded pergolas
- Signage
- Playground and recreation equipment
- Change rooms and toilets
- Car parks

Community infrastructure within the coastal foreshore reserve is strongly valued by the community, as it provides access for the community to enjoy the values of the coast. Specific coastal values (including environmental values) that are supported by the coastal foreshore reserve are provided in the next section.

Outside the public foreshore reserve, other important community infrastructure is located within urban land of the Port Hedland Townsite, including:

- Health and medical services;
- Schools;
- Civic buildings and local government administration;
- Swimming pool and recreation centre; and
- Local parks and active playing fields.

3.1.4 Urban land

Urban land facilitates all forms of infrastructure, services, and land use to support a community. Because it supports all aspects of community (including housing, employment, community infrastructure, other infrastructure) urban land is a key input to this CHRMAP in terms of considering impact of coastal hazards on assets.

Within Port Hedland, urban land includes the existing residential, commercial, and industrial areas of the townsite and future urban growth areas. Urban areas are highly valued – without sufficient urban land, there would be no opportunity for the community to live in Port Hedland with the services they require located in their neighbourhood. With residential constraints in the West End of Port Hedland due to health implications of dust, additional land supply is essential to enable community members to continue to live in the townsite. Over time, the importance of additional urban land within the Port Hedland Townsite will increase if/when retreat from areas of intolerable coastal risk is required. Land supply is also necessary to support a growing community.

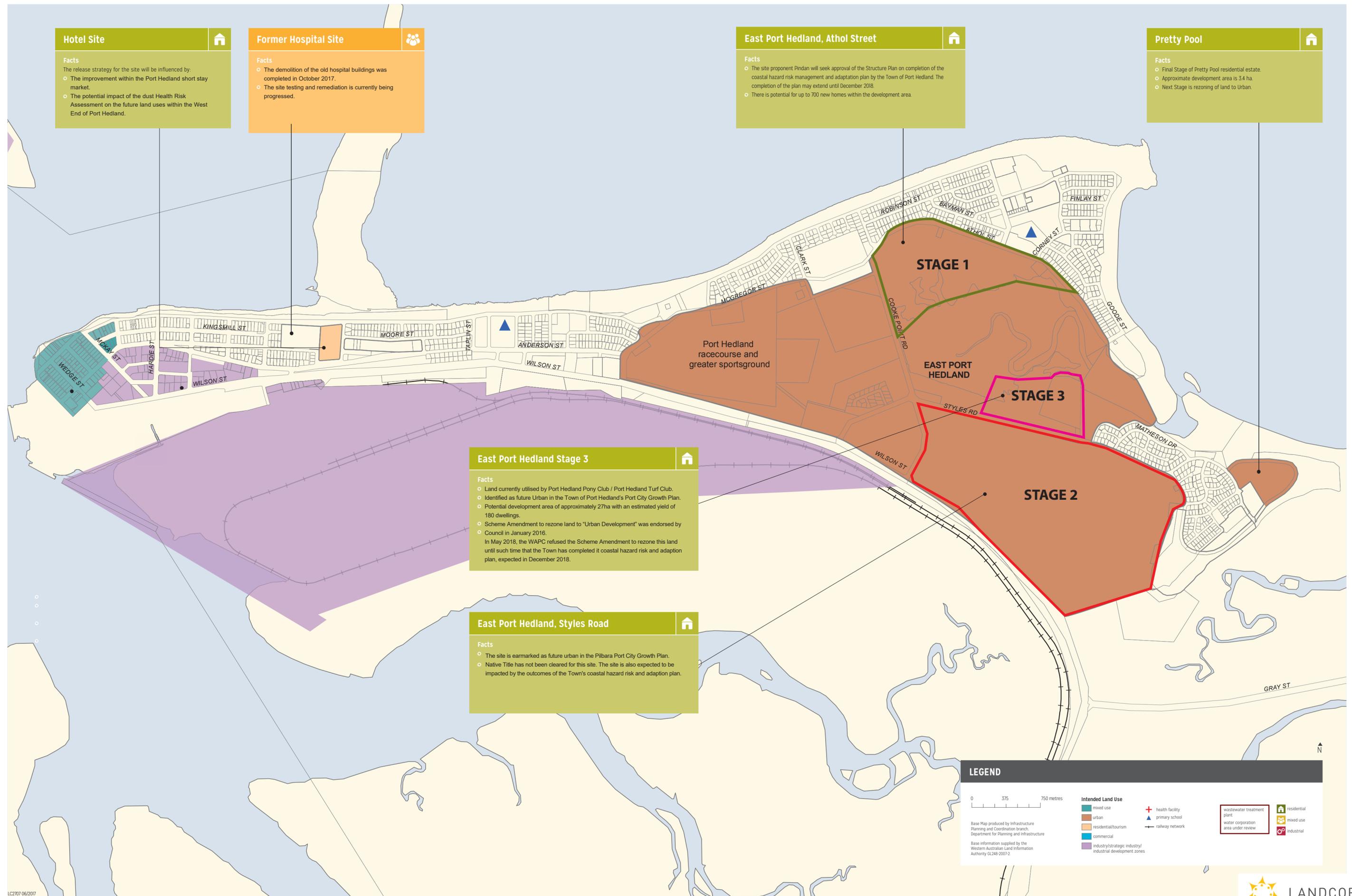
Key areas identified for future urban development by Landcorp are shown in Figure 3-2. Key sites include:

- Former Port Hedland hospital site;
- East Port Hedland, Athol Street;
- East Port Hedland, The Stables;
- East Port Hedland, Styles Road (South); and
- Pretty Pool (Stage 3).

Opportunity for urban development associated with decommissioned wastewater treatment plant has also been identified.

The Spoilbank Marina is a potential future urban asset that presents potential economic development value to the local community. The concept includes development areas for commercial and tourist uses, provides recreational value through enhanced marine and boating recreation, and proposes events space for social interaction. The future asset will require a project level CHRMAP and associated assessment of coastal management requirements as part of further steps to demonstrate its viability, and is not further planned for by this CHRMAP.

Tjalka Boorda is currently a residential community within the Port Hedland area. Tjalka Boorda has high cultural value to the Aboriginal community. The land is also valued for its future development potential by Traditional Owners.



Hotel Site

Facts

- The release strategy for the site will be influenced by:
 - The improvement within the Port Hedland short stay market.
 - The potential impact of the dust Health Risk Assessment on the future land uses within the West End of Port Hedland.

Former Hospital Site

Facts

- The demolition of the old hospital buildings was completed in October 2017.
- The site testing and remediation is currently being progressed.

East Port Hedland, Athol Street

Facts

- The site proponent Pindan will seek approval of the Structure Plan on completion of the coastal hazard risk management and adaptation plan by the Town of Port Hedland. The completion of the plan may extend until December 2018.
- There is potential for up to 700 new homes within the development area.

Pretty Pool

Facts

- Final Stage of Pretty Pool residential estate.
- Approximate development area is 3.4 ha.
- Next Stage is rezoning of land to Urban.

East Port Hedland Stage 3

Facts

- Land currently utilised by Port Hedland Pony Club / Port Hedland Turf Club.
- Identified as future Urban in the Town of Port Hedland's Port City Growth Plan.
- Potential development area of approximately 27ha with an estimated yield of 180 dwellings.
- Scheme Amendment to rezone land to "Urban Development" was endorsed by Council in January 2016.
- In May 2018, the WAPC refused the Scheme Amendment to rezone this land until such time that the Town has completed its coastal hazard risk and adaption plan, expected in December 2018.

East Port Hedland, Styles Road

Facts

- The site is earmarked as future urban in the Pilbara Port City Growth Plan.
- Native Title has not been cleared for this site. The site is also expected to be impacted by the outcomes of the Town's coastal hazard risk and adaption plan.

LEGEND

0 375 750 metres

Intended Land Use

- mixed use
- urban
- residential/tourism
- commercial
- industry/strategic industry/ industrial development zones

+ health facility
 ▲ primary school
 — railway network

wastewater treatment plant
 water corporation area under review

residential
 mixed use
 industrial

Base Map produced by Infrastructure Planning and Coordination branch, Department for Planning and Infrastructure

Base information supplied by the Western Australian Land Information Authority GL248-2007-2

3.2 Coastal values

Values considered in the risk assessment and adaptation plan are the elements of the environment – both physical and intangible – that bring benefit to the community.

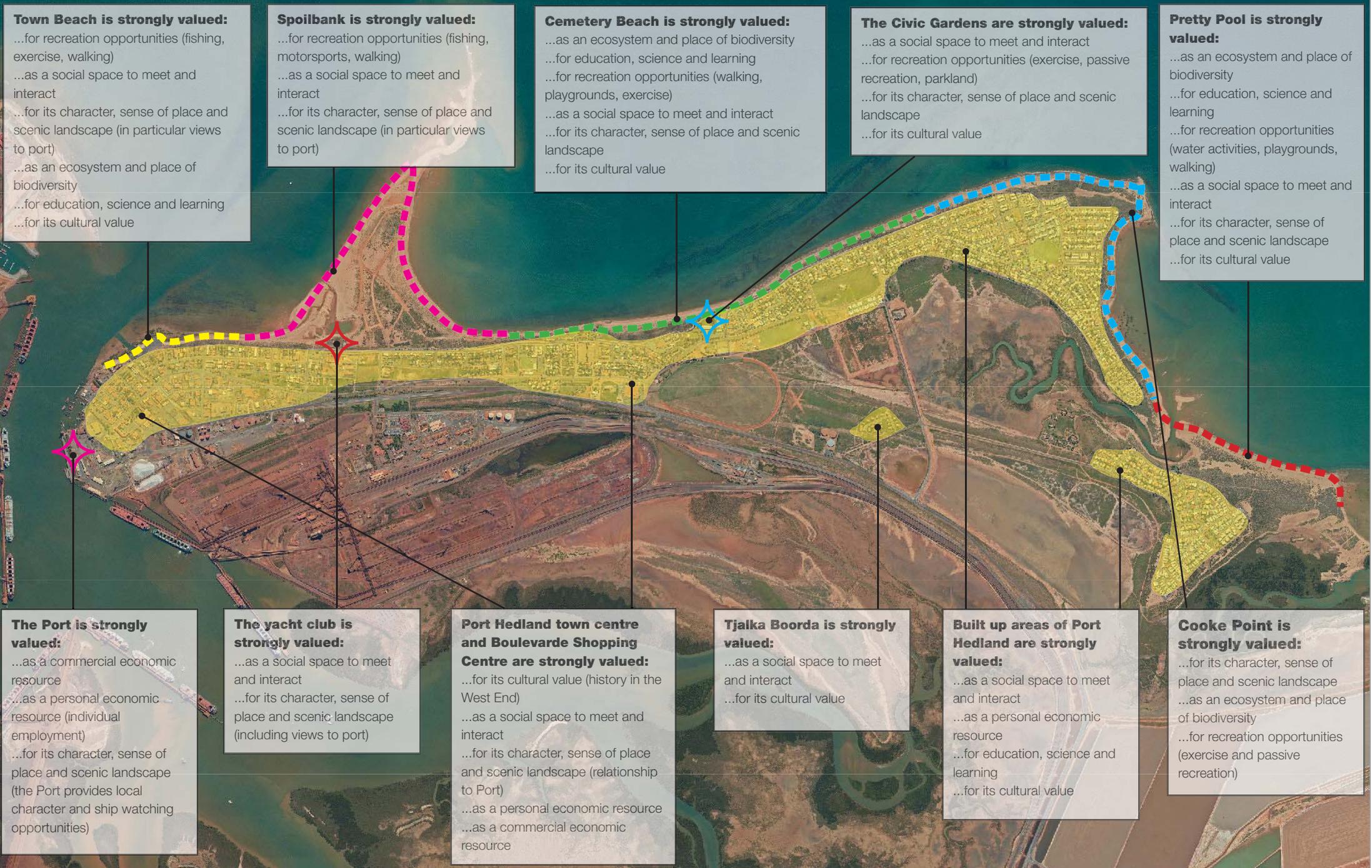
Community engagement was undertaken from October to December 2017 to understand the values of the Port Hedland Townsite. Appendix B provides information about the consultation, and detailed results from the coastal values survey that asked about use and values of particular locations.

Port Hedland's coastal areas are used and valued for a diversity of purposes and reasons. The overall value of the Port Hedland Townsite and its coast are summarised in the following value statements:

The community values the coast and Port Hedland Townsite:

- **for recreation opportunities**
- **a social space to meet and interact**
- **for its cultural value**
- **for its character, sense of place and scenic landscape**
- **as an ecosystem and place of biodiversity**
- **for education, science and learning**
- **as a commercial economic resource**
- **as a personal economic resource**

Figure 3-3 illustrates the locations in Port Hedland that most strongly reflect the identified coastal values from the perspective of the community.



The nodes shown on this map are the areas of Port Hedland that most strongly reflect local coastal values. Other areas are also valued and frequently used by the community, including:
 ...intertidal zones and magroves valued as an ecosystem and place of biodiversity...boat ramp for recreation...4 mile beach for recreation and fishing...6 mile fishing sport for recreation...Koombana lookout for scenic landscape... Marapikurrinya Park for recreation and social activities...

<p>Paper Size ISO A3 0 250 500 750 1,000 Metres</p> <p>Map Projection: Transverse Mercator Horizontal Datum: GDA 1994 Grid: GDA 1994 MGA Zone 50</p>			<p>Town of Port Hedland Port Hedland Townsite CHRMAP</p> <p>Port Hedland Coastal Values</p>	<p>Project No. 61-36239 Revision No. 0 Date 19/01/2018</p> <p>FIGURE 3-3</p>
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3.2.1 Recreation opportunities

“There aren’t many places the grandchildren can go in Port so luckily they all love water and outdoor activities” - survey participant

Recreation on the coast is one of the strongest social values in Port Hedland. The water around Port Hedland and the recreational opportunity it presents is central to the lifestyle of people in town.

Passive recreation – including walking, dog walking, photography, sun bathing – is the key recreational activity enjoyed by the community (based on survey participants, focus groups, and inputs at information stalls in Port and South Hedland). Pretty Pool, Cemetery Beach, Cooke Point, Spoilbank and Town Beach are key locations for people to engage in casual recreational opportunities.

Exercise and sports are another recreational opportunity enjoyed by community members, particularly at Cemetery Beach, Spoilbank and Pretty Pool.

Fishing is a major coastal recreational activity, particularly on the Spoilbank and at 6 Mile.

Pretty Pool is valued for the opportunity to undertake water sports – the safety of the water at Pretty Pool is a major attractor for users of the area.

Boating and motorsports are recreational opportunities valued by the community, focused on the Spoilbank, boat ramp (for boating), 6 Mile and 4 Mile (motorsports)

Different recreational opportunities are afforded by the specific characteristics of different coastal areas – for example tidal flats and sandy areas at Pretty Pool and Spoilbank are key assets that enable recreational use. Parkland and facilities at Cemetery Beach, Civic Gardens, Marapikurrinya Park and Town Beach are key attractors for the community to recreate in these areas.

3.2.2 Social space to meet and interact

“The sun sets, sitting on the beach having drinks with friends” - survey participant

The coastal environment – as well as the Port Hedland town centre – are key areas for social interactions. Social interactions and community participation are vital to a healthy community, and contribute to mental health and lifestyle.

On the beach, Pretty Pool, Cemetery Beach, the Yacht Club, Civic Gardens, Marapikurrinya Park and the Spoilbank were identified by the community as key places to socialise and interact, through barbecues, picnics, and community events.

In the town centre, socialising and visiting restaurants are key activities that the community engages in.

The Port Hedland Townsite supports a number of community facilities that provide a hub for community spirit. This includes sporting grounds and clubs, local schools, and community facilities for groups.

3.2.3 Cultural value

“This is the Historical part of town and needs to be preserved for future generations to understand our long history” - survey participant

The cultural value of the Port Hedland Townsite includes Aboriginal and European heritage, spiritual connections, and historical value.

The history of the Port Hedland Townsite is highly valued, and it is a key element of the character of the settlement area.

The Port Hedland Townsite and coastal area is significant to the culture and identity of the Kariyarra, Ngarla, and Njamal People, the traditional owners and custodians of this area.

Numerous specific sites across the townsite have been recognised for their significant importance to Aboriginal culture having been listed as Aboriginal Sites under the *Aboriginal Heritage Act 1972*. These are shown in Figure 3-4. It is important to note, however, that places of significance may not be registered, and there are additional areas valued and used by the Aboriginal community beyond formally protected sites.

3.2.4 Character, sense of place, and scenic landscape

“The way industry and community are so close to each other and share the beach is wonderful, a world treat!” - survey participant

The Port Hedland Townsite and coastline is a very unique place. The character of the area is influenced by its coastal setting and its relationship to the port.

Community engagement outcomes told numerous stories of ship watching from Town Beach or Dome, and this is a key value that is unique to Port Hedland and something valued by the community.

The beauty of the coastal environment, the scenic value, and the sense of place are the key attractors for people using Port Hedland’s beaches, and are strongly valued by the community.

3.2.5 Ecosystem and place of biodiversity

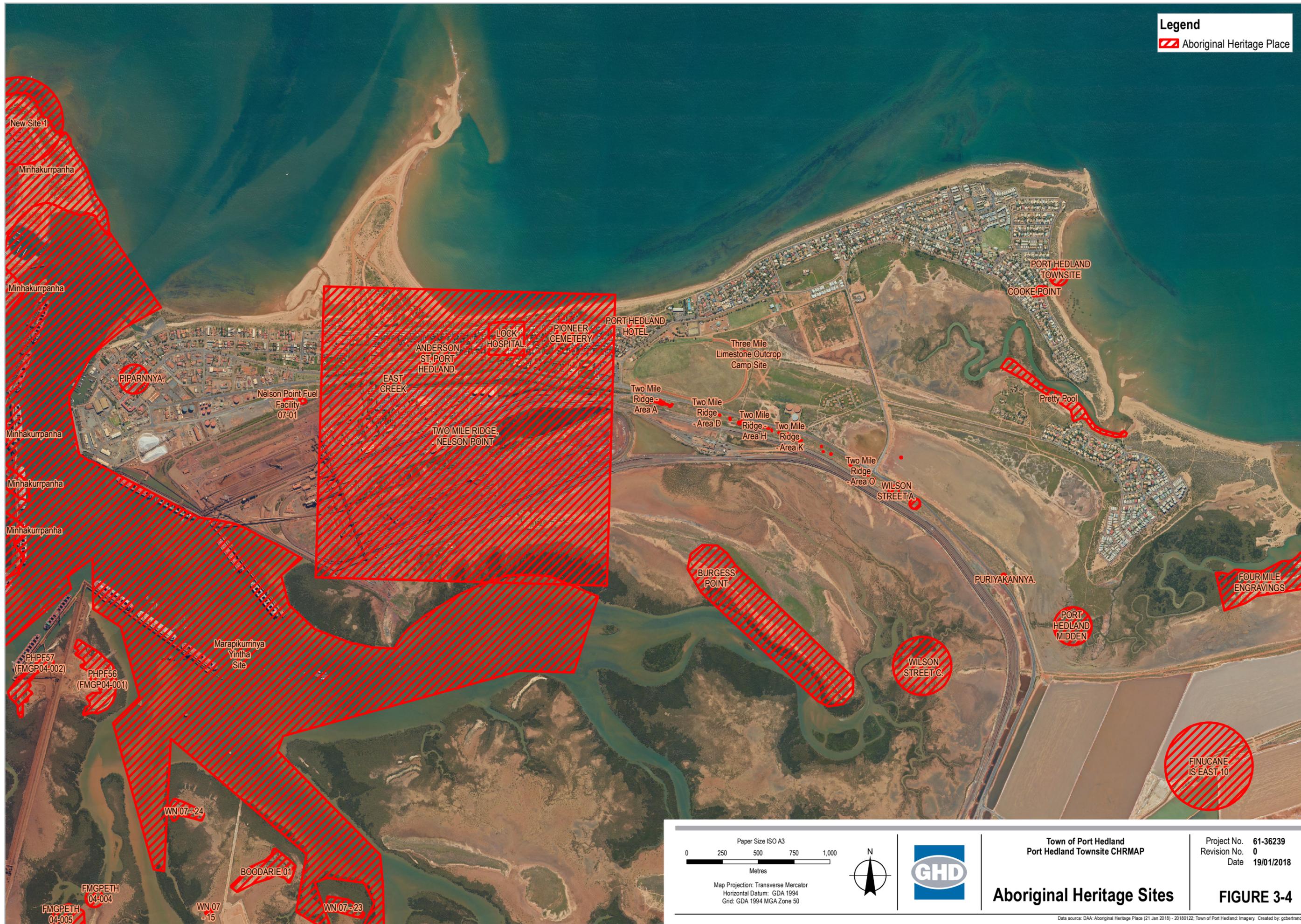
“The beaches and the habitat of the turtles and the reef.” - survey participant

The environmental value of Port Hedland’s coastal areas is a key attractor for beach users. In particular, close to 60 percent of survey respondents that use Cemetery Beach and park are attracted to this area because of its environmental value.

The study area supports a range of environmental values. The coastal foreshore, which is reserved for Parks and Recreation under Town’s local Planning Scheme No. 5, includes some stands of natural vegetation that provide habitat for coastal fauna. The habitat value of the area is continually being improved by revegetation works carried out by community groups, volunteers and the Town of Port Hedland.

The Port Hedland coastline provides vital habitat for the flatback sea turtle, which is a threatened species. Cemetery and Pretty Pool beaches are key nesting sites. The turtle-nesting season is a significant environmental and tourism event. The ability to experience and observe turtle nesting behaviours is a key social value identified during early community engagement. Community members raised the importance of turtle nesting to the identity of Port Hedland, suggesting this key value changes the perception that Port Hedland is simply an industrial hub. It is also a beautiful environment.

Legend
 Aboriginal Heritage Place



Paper Size ISO A3
 0 250 500 750 1,000
 Metres

Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 50




Town of Port Hedland
 Port Hedland Townsite CHRMAP

Aboriginal Heritage Sites

Project No. 61-36239
 Revision No. 0
 Date 19/01/2018

FIGURE 3-4

Data source: DAA: Aboriginal Heritage Place (21 Jan 2018) - 20180122; Town of Port Hedland: Imagery. Created by: gcbstrand

There are a number of contaminated sites of varying classifications within the Port Hedland Townsite some of which require remediation and some which are contaminated with restricted use. Restricted use relates predominantly to sites on Dowding Way and Jakarli Close, where residential development is permitted with restrictions to groundwater access. There is one other site on Wilson St where use as a church and single dwelling has been permitted but any land use change will require additional contamination assessment and/or remediation.

Areas at risk from contamination where remediation is required are generally located to the west of the study area. Any remediation plans for these sites should consider the long-term CHRMAP.

3.2.6 Education, science and learning

“The reef walks ... are so educational and very good way to unwind from work stress” - survey participant

The Port Hedland coast provides opportunity for education, science and learning. This is an important value identified by community members.

Sea turtle nesting habitat provides important scientific value, with researchers undertaking population and breeding studies on the flatback turtle during the nesting season.

Care for Hedland conduct an intertidal reef monitoring program. In 2016, scientists from the WA Museum were engaged to assist with baseline biodiversity surveys. Monitoring of Finucane Island, Cemetery Beach and Cooke Point occurs on a seasonal basis with the aim to monitor ongoing trends in coral health and biodiversity.

The Port Hedland Townsite includes educational facilities, including local schools, which have a vital education purpose for the local community.

3.2.7 Commercial economic resource

“We came here in 1961 so have always had the love of watching the state ships go past while sitting down on the town foreshore” - survey participant

Central to the character of Port Hedland, the Port of Port Hedland – the largest bulk minerals port in the world - is the key economic resource in the town. Over the coming years, growth in iron ore exports from BHP, FMG, Roy Hill and other smaller operators will be the primary driver to development in the region. These businesses together with the Pilbara Port Authority support the local, regional and state economy.

The Port and mining operations are economic assets of state significance, and are major employers in the Port Hedland area. The port assets have significant economic value for the Port Hedland community.

The two major business enterprises within the town are BHP, which operates a significant iron ore shipping facility exporting iron ore and Dampier Salt, which produces over 3 million tonnes of industrial salt annually for export from solar salt ponds. Various companies also export other minerals, including manganese, copper and tantalum.

In addition to the state significance of the Port, the Port Hedland Townsite and coastal areas support local economic values. The town centre includes numerous businesses that provide retail, hospitality and services to the community, and support local employment. Eating at local restaurants and cafes was the top response for survey participants that visit the Port Hedland Townsite, followed by shopping at local retail outlets.

The townsite and the coastal areas host the key tourist attractions for the Port Hedland area. Tourist investment is a key economic value for the local community. Visits from cruise ships are a key tourism input.

3.2.8 Personal economic resource

“Our business is located here” – survey participant

Personal economic value is important to community members. Local businesses and private property owners in Port Hedland gain economic value and security from their property and business holdings. The scenic landscape and proximity of the coast to coastal lands can often lead to increased property values in these locations, although coastal private land can be at risk of hazards of coastal erosion and inundation.

3.3 Risk management and adaptation based on values and assets

Determining the relative importance of coastal values is essential in coastal risk management and adaptation, as the value assets hold inform the risk assessment and identification of triggers, guiding which adaptation option will be most appropriate for a given location. It is important to understand that assets are not only built structures. Assets considered in the CHRMAP also include land, foreshore areas, commercial areas, and urban development areas.

All the values that the coast (including the foreshore and built assets) and townsite present are important to the Port Hedland community, with many seeing the values as equally weighted. In particular, the ability to experience coastal character, scenery, and recreation in Port Hedland is important as it is not possible or it is highly inconvenient for the community to access these assets and enjoy these values elsewhere. Conservation values are important, as they are specific to the Port Hedland coastline. These values are an important input into the risk assessment of coastal hazards, and identifying trigger points. An adaptation response will be triggered when the risk of coastal erosion or inundation to the assets and the social or environmental values they hold becomes intolerable. The adaptation response will ensure the asset can continue to support its associated values.

This relative importance of values is a necessary input into the adaptation planning process, as adaptation measures respond differently to different values placed upon assets and land within Port Hedland. The most appropriate adaptation response will be based on the most important values to retain. Whilst it is difficult to identify the relative importance of values when the community gives them all a similar weighting, the values survey provided a path to determining this.

To inform the options evaluation process, the survey asked respondents to identify the top and bottom three factors in decision-making. These related to coastal values and feasibility of delivering coastal adaptation, the key things that inform decision-making. A number of participants noted that, despite the survey being designed to force prioritisation of three values, all are equally important. The project team appreciates and respects this concern. It is the key challenge in making decisions about coastal adaptation.

It is noted that it is often difficult to find the right balance, however in coastal adaptation planning, decision-makers and the community will need to make decisions on adaptation options that do not treat all values equally, even if all values are important.

Overall, the most prioritised factors in decisions making from the perspective of the survey participants are the environmental qualities of the area, coastal amenity and scenery. The factors of least priority were foreshore access and housing/properties.

More detailed prioritisation of values and adaptation feasibility factors (e.g. cost) for specific areas is part of evaluating the available adaptation options for Port Hedland.

DRAFT

4. Implementation plan

The following implementation plan provides immediate risks actions, current and long-term planning considerations for coastal adaptation.

Immediate risk actions are recommended to address intolerable risks that are currently affecting parts of the Port Hedland Townsite. The recommended immediate risk actions must be considerate of the strategic recommendations of the current planning horizon (between now and 2060). In this section we present the current strategic planning recommendations first, followed by the immediate actions that are to be implemented and are consistent with the strategic intent of the current planning horizon.

4.1 Coastal planning units

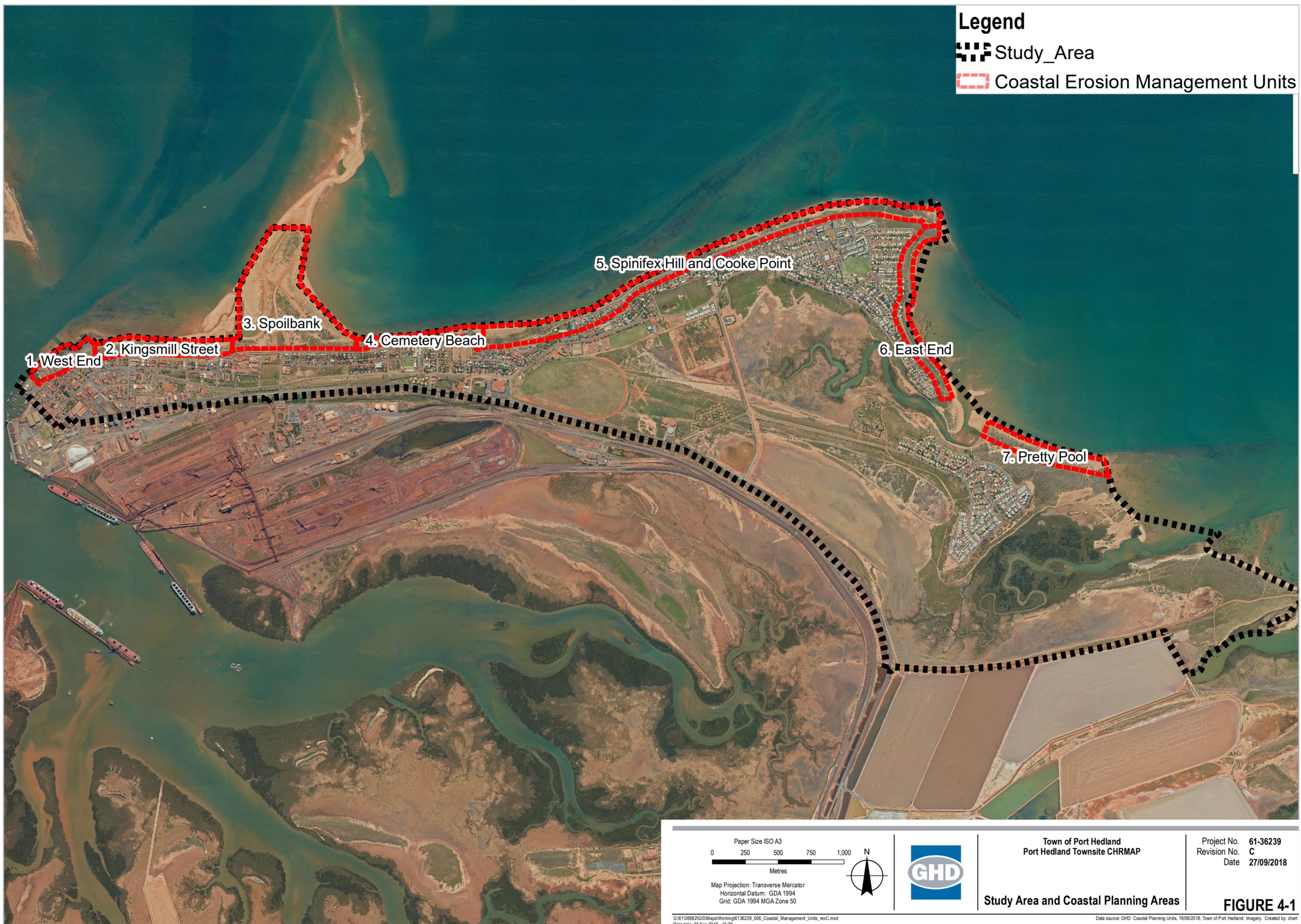
The nature of coastal values – particularly in relation to land use – change across the Port Hedland Townsite, although some key values occur across the entire area. The different values, assets and land uses that various parts of Port Hedland support and the varied coastal processes that impact on those assets and land uses result in different approaches to risk management and adaptation responses. To reflect this, the Port Hedland study area was divided into a number of coastal planning areas (refer to Figure 4-1):

1. West End (erosion);
2. Kingsmill Street (erosion);
3. Spoilbank (erosion);
4. Cemetery Beach (erosion);
5. Spinifex Hill/Cooke Point (erosion);
6. East End (erosion);
7. Pretty Pool (erosion);
8. West townsite (inundation); and
9. East townsite (inundation).

Legend

 Study_Area

 Coastal Erosion Management Units



1. West End

2. Kingsmill Street

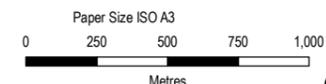
3. Spoilbank

4. Cemetery Beach

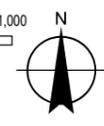
5. Spinifex Hill and Cooke Point

6. East End

7. Pretty Pool



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50



Town of Port Hedland
Port Hedland Townsite CHRMAP

Project No. 61-36239
Revision No. C
Date 27/09/2018

Study Area and Coastal Planning Areas

FIGURE 4-1

G:\6136239\GIS\Map\Working\6136239_06_Coastal_Management_Units_revC.mxd
Print date: 27 Sep 2018 - 16:20

Data source: GHD: Coastal Planning Units, 19/06/2018; Town of Port Hedland: Imagery. Created by: chm

4.2 Risk tolerance

Immediate coastal hazard risks to the Port Hedland Townsite are likely to result from the occurrence of a significant storm or cyclonic event. Immediate coastal hazards requiring action are mostly erosion related, due to the potential for the loss of land to result in permanent asset and value impacts. Inundation risks, at present, are more likely to be temporary and not result in the permanent loss of land and assets.

The coastal hazard assessment undertaken, refer to Appendix D and Appendix E, was used to assess risk tolerance to assets and values and to identify the required urgency of actions. This coastal hazard assessment was a high-level assessment to identify large scale patterns, and did not take into account:

- Highly localised variations in shoreline type (such as presence of small areas of intertidal rock),
- Changes in orientation of the shoreline and therefore exposure to wave energy, or
- Consider secondary risks, which may occur after an erosion or inundation event has occurred and have further impact on assets or values.

In particular, in areas where there are high sandy dunes, event-based erosion may result in geotechnical instability of the dune which could result in additional erosion of land and impact further upon assets and values. Therefore, some of the immediate risk actions recommended are based on existing site knowledge and we have recommended further investigations in areas where hazards are potentially amplified due to unknown geotechnical dune stability.

The risk assessment evaluated the risk to individual assets, based on the values that each asset supports as reported in the preceding section. Groupings of assets at similar levels of risk enabled the determination of coastal planning areas. The coastal hazard risk levels and tolerability ratings from the risk assessment, detailed in Appendix F, have been used to establish the tolerance profile and trigger point for each coastal planning area in the immediate, current and long-term and are shown in Table 4-1.

Table 4-1 Summary of coastal hazard risk tolerance levels and trigger points

Coastal Planning Unit	Immediate (2010 risk)	Current (up to 2060 risk)	Long-Term (2060-2120)
1. West End (erosion)	Intolerable Trigger 3A	Intolerable Trigger 3A	Intolerable Trigger 3A or 4
2. Kingsmill Street (erosion)	Intolerable Trigger 3A	Intolerable Trigger 3A	Intolerable Trigger 3A or 4
3. Spoilbank (erosion)	Risk is uncertain as the stability of the Spoilbank structure is unknown therefore it could not be assessed in modelling.		
4. Cemetery Beach (erosion)	Tolerable Trigger 2	Intolerable Trigger 3	
5. Spinifex Hill/Cooke Point (erosion)	Intolerable Trigger 3	Intolerable Trigger 3	Intolerable Trigger 3A or 4
6. East End (erosion)	Intolerable Trigger 3	Intolerable Trigger 3	Intolerable Trigger 3A or 4
7. Pretty Pool (erosion)	Tolerable Trigger 1	Tolerable Trigger 1	Intolerable Trigger 3 or 4
8. West Townsite (inundation)	Intolerable Trigger 3	Intolerable Trigger 3 or 4	Intolerable Trigger 3A or 4
9. East Townsite (inundation)	Tolerable Trigger 1	Intolerable Trigger 3	Intolerable Trigger 3

The triggers in Table 4-1 and the adaptation pathway are risk-based triggers, rather than physical triggers. Triggers 3 and 4 are considered to be reached when the values of an asset within a coastal planning unit are subject to intolerable risk in a specified erosion or inundation event. For erosion, this is based on an asset's location within the erosion risk area. For inundation, this is based on an asset's elevation relative to an inundation event water level.

For the majority of erosion areas, intolerable risk is a result of the loss of social and environmental values within the public foreshore reserve. Therefore, Triggers 3, 3A and 4 are reached when the width of the public foreshore reserve is less than the storm erosion (S1) allowance at that point in time. For other infrastructure and private assets affected by erosion hazards, Triggers 3, 3A and 4 (risk is intolerable) are reached when that asset is located within the storm erosion (S1) allowance of the HSD (defined as the active limit of the shoreline under storm activity (WAPC 2013)), and the likelihood and consequence of that event would cause an intolerable risk to the asset. This is the point in time at which adaptation is recommended to be implemented.

For inundation hazards, the risk assessment defines which likelihood event at which timeframe presents an intolerable risk for each asset. The trigger is reached when the water level of that inundation likelihood event at that time exceeds the elevation of the asset/site, i.e. when the elevation of the site becomes lower than the S4 level for the specified inundation event.

The risk of erosion to the West End, Kingsmill Street, Spinifex Hill/Cooke Point, and East End is intolerable and immediate adaptation action is recommended. Risk associated with inundation in the West Townsite is intolerable, and immediate adaptation action is recommended.

In the current planning horizon, decision-making is recommended to address risk of erosion at Cemetery Beach and risk of inundation in the East Townsite, which will become intolerable between now and 2060.

4.3 Adaptation Pathway

To recommend appropriate adaptation measures, this plan has developed, assessed, and prioritised appropriate adaptation options where intolerable risk is expected in the current planning horizon (see Appendix H). Adaptation measures were tested for immediate to short-term suitability on a coastal management unit scale to develop a list of preferred measures. For immediate-term intolerable risk, adaptation responses are recommended consistent with the strategic approach for that coastal planning unit in the current planning horizon.

The current state coastal planning policy (WAPC 2013) supports maintaining flexibility of options and accepting some level of risk as it only allows for protection when all other options for a section of a coast have been explored. Using the outcomes of the adaptation measures evaluation, measures were matched to the coastal management unit trigger points requiring risk mitigation for each planning period. The whole-of-coast plan was developed to consider only complementary adaptation measures between coastal management units. The recommended adaptation measures for implementation in the trigger-based flexible adaptation pathway, which manages the risk at a tolerable level is shown in Table 4-2.

4.3.1 Adaptation pathway timeframes

The recommended timeframes for implementation of the flexible adaptation pathways varies from the timeframes of the risk tolerance levels that were used to define the trigger points. Implementation of immediate risk actions are to be undertaken between now (2018) and 2030. Undertaking of current planning is required to be undertaken between now (2018) and 2060 and the implementation of adaptation solutions recommended as a result of the outcomes of the current planning are anticipated to occur between 2030 and 2060.

The overlap between the immediate risk actions and the current planning is because planning is an ongoing process that will inform future adaptation actions, whereas immediate actions are generally actions focussing on informing or undertaking the implementation of specific coastal engineering adaptation protection options.

In some cases, for example Spinifex Hill/Cooke Point (erosion) and East End (erosion), immediate actions have been recommended based on the need to investigate further the feasibility of the current planning recommendation. Where these planning decisions can be made sooner than anticipated, immediate actions in line with the current planning recommendations may also be able to be implemented sooner.

4.3.2 Flexible adaptation pathway

Table 4-2 Flexible adaptation pathway for Port Hedland

Planning Area	Immediate actions (2018 to 2030)	Current planning (2018 up to 2060)	Long-Term planning (2060-2120)
1. West End (erosion)	Interim protection via sand replenishment and dune stabilisation or rock armour seawall		Managed retreat or further interim protection
2. Kingsmill Street (erosion)	Interim protection via rock groynes and sand replenishment or rock armour seawall		Managed retreat or further interim protection
3. Spoilbank (erosion)	Undertake localised hazard and geotechnical investigations to understand localised risk of erosion. Managed retreat and/or interim protection of localised areas (for example marina)		Managed retreat and/or interim protection of localised areas (for example marina)
4. Cemetery Beach (erosion)	Monitor		
5. Spinifex Hill/Cooke Point (erosion)	Interim protection via sand replenishment	Managed retreat or hard passive protection, depending on the outcomes of further community engagement, informed by detailed coastal processes assessment.	
6. East End (erosion)	Interim protection via sand replenishment	Managed retreat or hard passive protection, depending on the outcomes of further community engagement, informed by detailed coastal processes assessment.	
7. Pretty Pool (erosion)	Monitor and avoid new development in long-term hazard area		
8. West Townsite (inundation)	Accommodate		Managed retreat and/or further accommodation
9. East Townsite (inundation)	Monitor	Interim protection and accommodate	

The flexible adaptation pathway in the immediate term recommends a combination of monitoring, interim protection and accommodation measures to maintain tolerable risks and to lower intolerable risks to a tolerable level.

Evaluation of adaptation options to manage immediate risk of erosion in unit 1 West End and unit 2 Kingsmill Street, (Appendix H) identifies that interim protection in these locations is justified on social, environmental and economic grounds. Evaluation of adaptation options to manage inundation hazards in unit 9 East Townsite (which includes the major urban expansion area of Port Hedland) identifies that protection with potential for some accommodation is justified on social, environmental and economic grounds. This will effectively manage risk into the long-term planning horizon.

Further information and community engagement is required to guide decision making for the current planning horizon for erosion risks for unit 5 Spinifex Hill/Cooke Point and unit 6 East End. The evaluation of adaptation options identifies a potential preference for managed retreat in these areas, however at the high level of this CHRMAP, could not adequately discriminate

between the costs and suitability of retreat versus interim protection (which would delay the need for retreat for 50 years). The appropriate decision will require further investigation into local coastal processes and geotechnical conditions to better understand risk. The viability of protection in these locations is considerably influenced by significant costs. The acceptability of managed retreat requires prioritisation of the social impacts of land acquisition against the high costs of interim protection that will manage risks only for a 50-year timeframe.

Further details on the analysis and scoring of the adaptation measures is provided in the Adaptation Options Evaluation Report in Appendix H. Further information regarding the specific adaptation recommendations that support the pathways follows in this section.

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4.4 Localised adaptation recommendations

4.4.1 West End – erosion

The West End – erosion coastal planning unit is subject to erosion hazards (Figure 4-2), resulting in immediate intolerable risk based on the social and economic values of land and businesses in the area, with the number of assets affected by intolerable risk increasing to 2060.

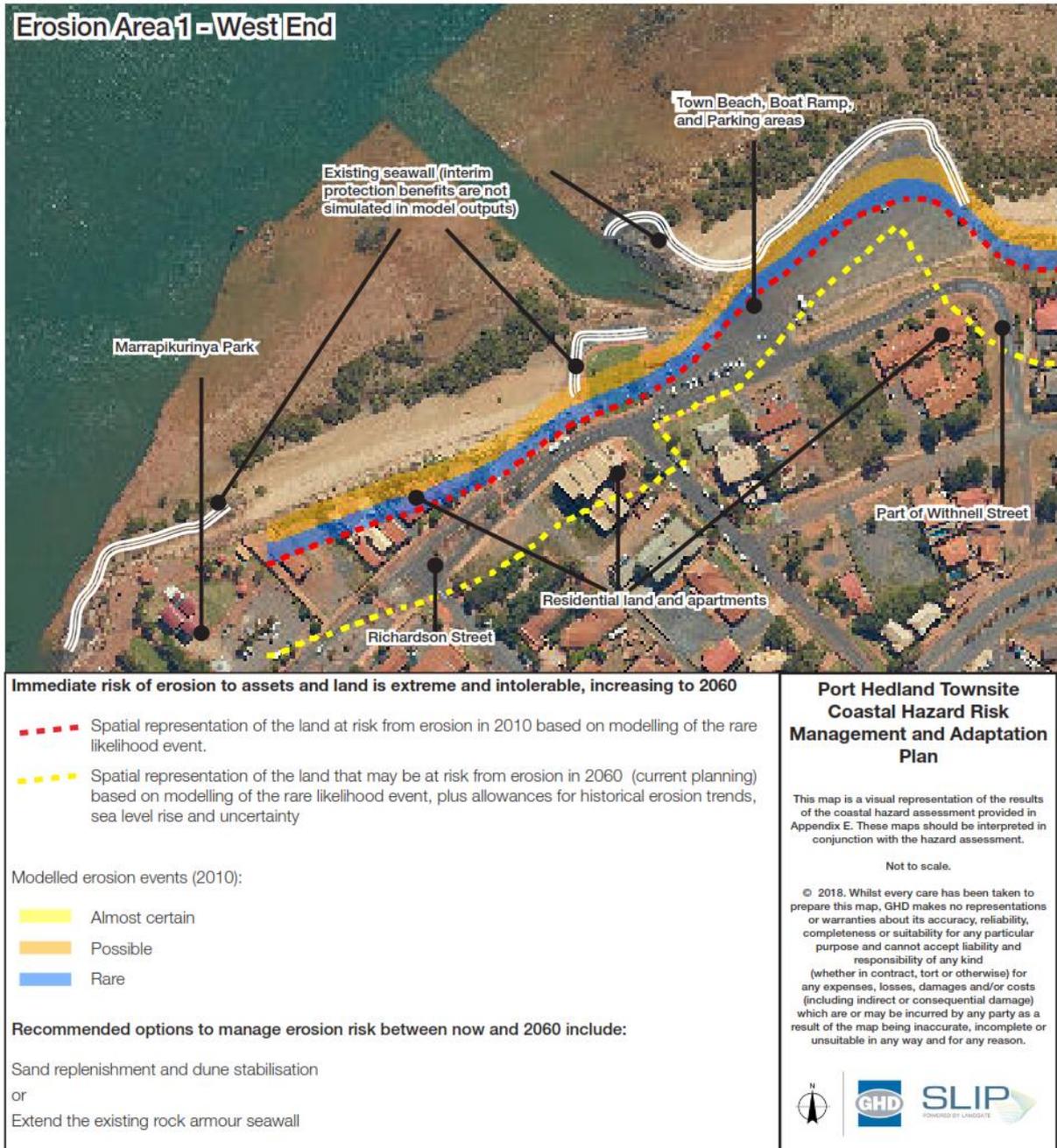


Figure 4-2 West End erosion hazard and recommended adaptation

The West End foreshore is protected by two lengths of seawall, one extending from the Nelson Point Tug harbour to Marrapikurinya Park and the other protecting the boat ramp and boat trailer carpark adjacent to Richardson Street. At present the section of foreshore between these two seawalls is vulnerable from erosion during significant storm events as there is minimal dune buffer between assets and the area of the beach face that coastal processes will act on during a

storm event, refer to Figure 4-2. This section of the foreshore, and the assets behind it, are also at risk of inundation at present during a rare storm event, refer to section 4.4.8.

Risk of erosion in this area is considered intolerable in the immediate term. This is due to the risk of coastal processes on the social values of the foreshore reserve and assets, and the economic and social values of residential assets impacted by erosion hazards.

The immediate risk action recommended for this section of foreshore is interim protection. The presence of hard active measures on each side of this section of foreshore may act to limit the effectiveness of passive solutions such as sand replenishment, although replenishment may be a suitable temporary buffer against event-based coastal processes. It is recommended that PPA and ToPH undertake an investigation into potential stabilisation options for this area considering options such as:

- Sand replenishment and dune stabilisation; and
- Rock armour seawall – to top of dune.

Table 4-3 provides a summary of the likely costs for the available adaptation options for the West End in the immediate and current planning periods. The potential costs for implementing interim protection in the immediate planning period are likely to be in the order of \$5 million.

Table 4-3 Comparison of interim protection measures and order of magnitude budget estimate for the West End

Period	Description	Capital Costs (\$M)	Maintenance Costs (\$M)#	Decommissioning Costs (\$M)*	Total (\$M)
Immediate term (2018 to 2030)	Dune stabilisation and sand nourishment	2.2	0.9	n/a	5.0
Current Planning (2018 to 2060)		n/a	1.9	n/a	
Immediate term (2018 to 2030)	Rock armour seawall	4.4	0.2	n/a	5.7
Current Planning (2018 to 2060)		n/a	0.4	0.7	

*Note: Decommissioning costs will be incurred at the end of the design life approximately 50 years after implementation.

#Note: Maintenance costs are total over the relevant period.

It should be noted that due to the levels of adjacent structures and the level of the land behind Town Beach and the West End, implementation of interim protection at the West End would be to stabilise the land and not to protect against the risk of inundation.

Actions

- Investigate geotechnical stability of dunes and site specific coastal processes, refer to 4.5.2;
- Investigate feasibility of hard active versus hard or soft passive protection options; and
- Implement interim protection, refer to 4.5.4.

4.4.2 Kingsmill Street

The Kingsmill Street coastal planning unit is subject to erosion hazards (). Whilst the present day coastal erosion hazard modelling (refer to) does not highlight erosion as an immediate risk to property, there is a limited buffer zone between the area of active coastal processes and adjacent assets. Therefore secondary risks of geotechnical dune instability trigger this area to an immediate intolerable risk, based on the social and economic values of residential properties in the area. The number of properties affected by intolerable risk increases to 2060.



Figure 4-3 Kingsmill Street erosion hazard and recommended adaptation

Interim protection in this area is considered to be viable, compared to implementation of immediate managed retreat, as the cost of interim protection is considerably less than land acquisition. A number of protection options are available that perform well in relation to social and environmental values.

It is recommended that the Town of Port Hedland investigates the geotechnical stability of these dunes to better understand the potential erosion risk to adjacent residential properties. Interim protection options suitable to this section of the foreshore include continuation of the rock armour seawall (hard active), or sand replenishment with groynes (hard passive).

Table 4-4 provides a summary of the likely costs for the available adaptation options for Kingsmill Street in the immediate and current planning periods. The potential costs for implementing interim protection in the immediate planning period are likely to be in the order of \$5 to \$8 million.

Table 4-4 Comparison of interim protection measures and order of magnitude budget estimate for Kingsmill Street

Period	Description	Capital Costs (\$M)	Maintenance Costs (\$M) [#]	Decommissioning Costs (\$M) [*]	Total (\$M)
Immediate term (2018 to 2030)	Groynes and sand replenishment	7.0	1.0	n/a	21.0
Current Planning (2018 to 2060)		8.9	1.8	2.3	
Immediate term (2018 to 2030)	Rock armour seawall	4.5	0.6	n/a	13.3
Current Planning (2018 to 2060)		5.7	1.1	1.4	

*Note: Decommissioning costs will be incurred at the end of the design life approximately 50 years after implementation.

#Note: Maintenance costs are total over the relevant period.

Actions

- Investigate geotechnical stability of dunes and site-specific coastal processes, refer to 4.5.2; and
- Implement interim protection, refer to 4.5.4, investigating feasibility of hard active versus hard or soft passive protection options.

4.4.3 Spoilbank

The erosion modelling for the Port Hedland Townsite is a high-level study that considers general trends in erosion processes. Whilst in the immediate term the Spoilbank offers protection against erosion to assets in this area, in the current planning period to 2060 the persistence of this sedimentary geomorphological feature is less certain because this study did not include a detailed sediment transport assessment in relation to the persistence of the Spoilbank. The approach to assessing erosion hazards in the long term has therefore been a conservative approach connecting the hazard lines from either side of this sedimentary feature, refer to Figure 4-4. Whilst the Spoilbank has existed for over 50 years, it has changed considerably and so its persistence to 2060 and beyond is uncertain, particularly if it is considered as a suitable source of sand for use elsewhere.

The Western Australian Government is investing a significant amount of capital funding for the Port Hedland Spoilbank Marina. The investment in the marina is a strategic decision to protect this part of the Port Hedland coast, as breakwaters associated with the marina will provide for protection of land based values and assets.

Detailed design for the marina should be based on detailed coastal processes investigations to ensure that breakwaters associated with the project provide sufficient protection for the marina and development behind it for a 100-year planning horizon. Investigation of the geotechnical stability of the Spoilbank should be undertaken to understand how erosion will affect the broader Spoilbank feature, and understand how much of the feature is anticipated to be affected by erosion in the current planning horizon (to 2060).

Availability of materials – in particular sand - for interim protection of other areas of Port Hedland is uncertain. Future decision-making may consider the future use of the Spoilbank as a resource for protection and retention of the Port Hedland Townsite rather than a resource for recreational purposes. If materials for coastal protection (including sand replenishment) are not readily available, mining sand from the Spoilbank (outside of the marina development) would provide a local source of sand for erosion management to facilitate continued protection of the Port Hedland Townsite.

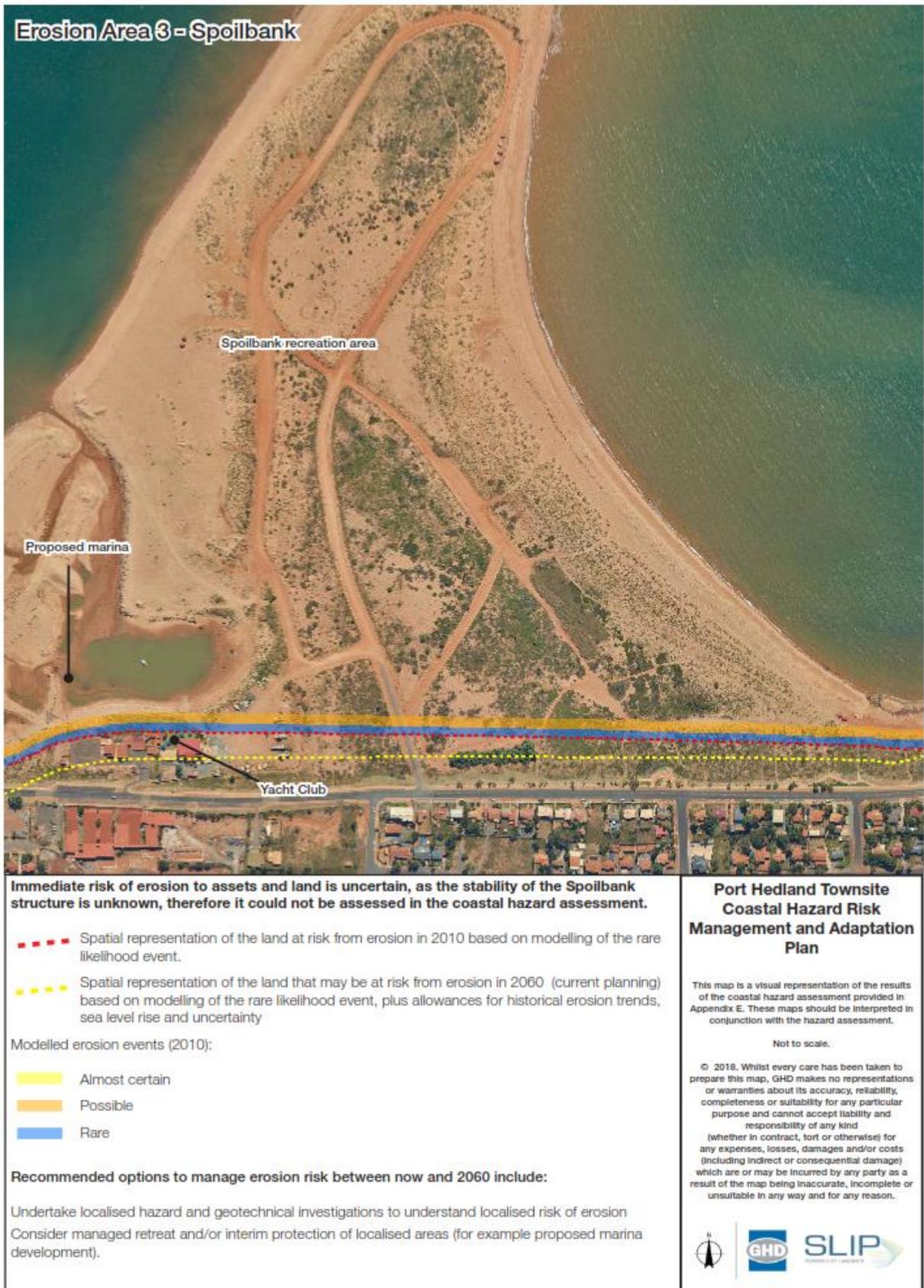


Figure 4-4 Spoilbank erosion hazard and recommended adaptation

4.4.4 Cemetery Beach

The foreshore of Cemetery beach has remained stable over the long-term due to the presence of the rocky cliffs along the foreshore. The erosion hazard for Cemetery Beach is caused by the potential storm erosion and an allowance for sea level rise. The rock cliffs act to reduce the potential erosion during storm events; however, due to the levels, during an extreme event some overtopping may be experienced which may result in erosion of the land behind it.

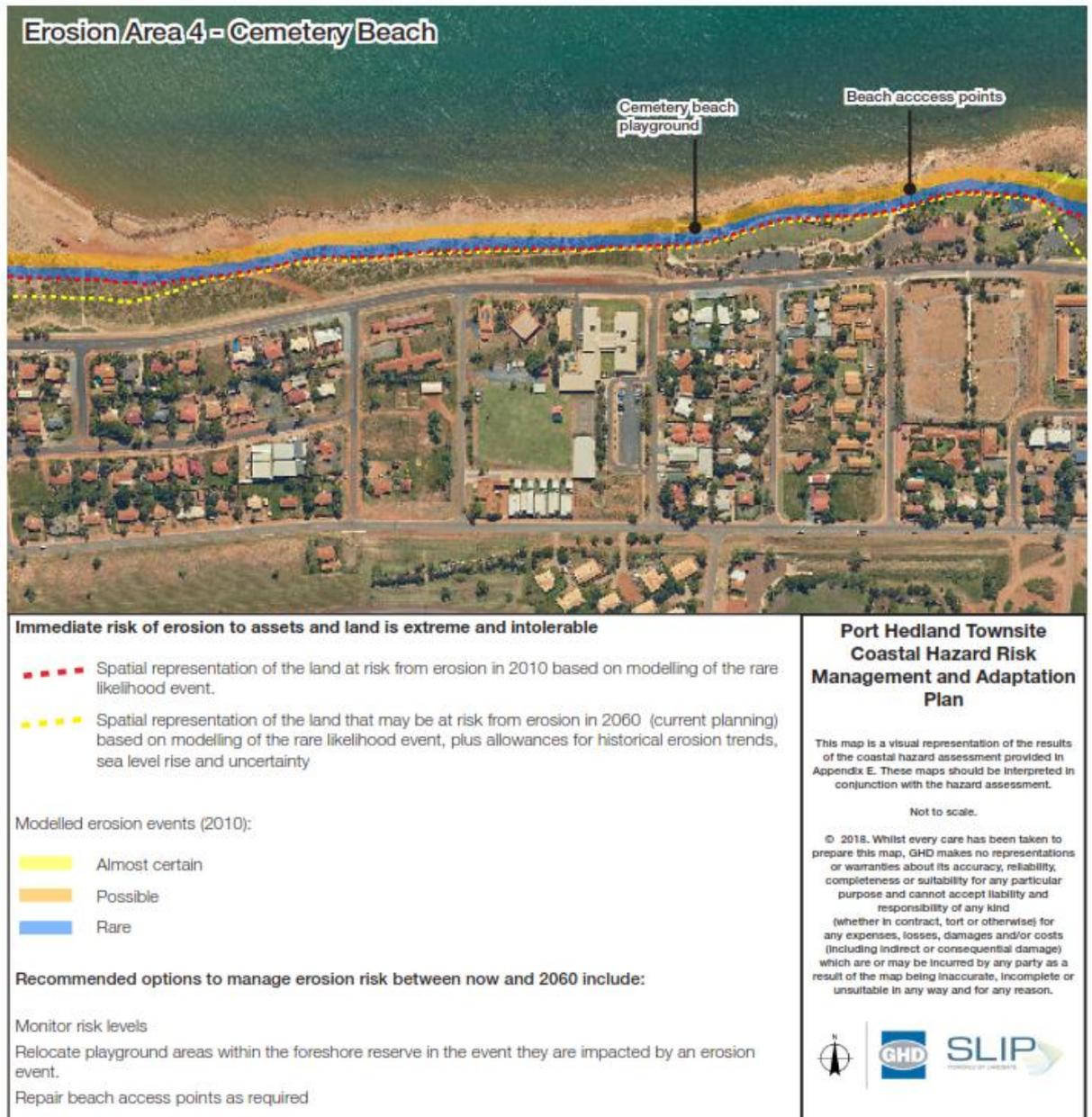


Figure 4-5 Cemetery Beach erosion hazard and recommended adaptation

The foreshore area of Cemetery Beach is also at risk of temporary inundation associated with storm events in the immediate period. The immediate areas of inundation risk affect the playground, lookouts and beach access routes (possible) risk with the rare hazard area connecting this section of the coast to Wilson Street. The area of possible risk increases slightly to encompass more of the playground by 2060, and the rare risk zone also increases, but does not have a significant impact on the risk tolerance to assets and values. Inundation risks are therefore considered to be tolerable and no mitigation actions are required.

The only assets and values at risk of erosion in the immediate term are the Cemetery Beach Playground and the high social values associated with it. Due to the magnitude of protection costs versus the costs of the assets and values it would be protecting, protection of this area is not recommended. Given risks to this section of the coast are event based, and the moderate costs of repair or replacement of the assets, it is not necessary to mitigate these risks until they are realised.

The primary action for managing coastal risks at Cemetery Beach is foreshore monitoring, refer to 4.5.5, and the repair or relocation of the Cemetery Beach Playground once erosion occurs.

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4.4.5 Spinifex Hill / Cooke Point

The Spinifex Hill/Cooke Point coastal planning unit is subject to erosion hazards. At present the key assets and values that are vulnerable to erosion in the Spinifex Hill/Cooke Point area are a portion of Sutherland Street and the parks and recreation reserve between Crawford Street and Wodgina Street, refer to Figure 4-6. Whilst the present day coastal erosion hazard modelling does not highlight erosion as an immediate risk to property, there is a limited buffer zone between the area of active coastal processes and adjacent assets. Therefore, secondary risks of geotechnical dune instability trigger this area to an immediate intolerable risk, based on the social and economic values of residential properties in the area. The number of properties affected by intolerable risk increases to 2060.

Adaptation options to manage immediate risk

There are two appropriate interim options for the ToPH to manage risk in the immediate term. The first is implementing soft passive measures including sand replenishment and dune maintenance to increase and maintain the buffer zone. The second is that the Town could employ a more reactive approach, and not implement any protection but respond to an erosion event that triggers the need for road or dune remediation since erosion of these dunes and foreshore will only result from a significant storm event. If this latter approach is taken, it is recommended that the Town, in conjunction with State Government, identify alternate access routes for properties, particularly those in Padbury Place, and identify potential impacts to services in this area, as disruption to services may have the potential to affect local properties.

The estimated cost for implementing beach monitoring, dune maintenance and sand replenishment by establishing a 30 m wide buffer zone in front of the 600 m of highest risk foreshore is approximately \$6.5 million with an ongoing maintenance cost estimated to be in the order of \$350,000 per annum.

Adaptation options to manage risk to 2060

Between now and 2060, the risk of erosion becomes intolerable to coastal roads and residential properties. With the road providing a hard edge, the dune system loses its ability to recover, and therefore the risk of erosion to the public beach, dunes, and turtle nesting habitat is also extreme and intolerable.

A number of options were explored to recommend the most appropriate adaptation pathway for Spinifex Hill and Cooke Point. The most appropriate options to respond to erosion risk in the area include:

- Managed retreat through expansion of the foreshore reserve, with compensation paid to property owners;
- Interim protection (50-year design life) through groynes with sand replenishment; and
- Interim protection (50-year design life) through an intertidal rocky platform with sand replenishment.

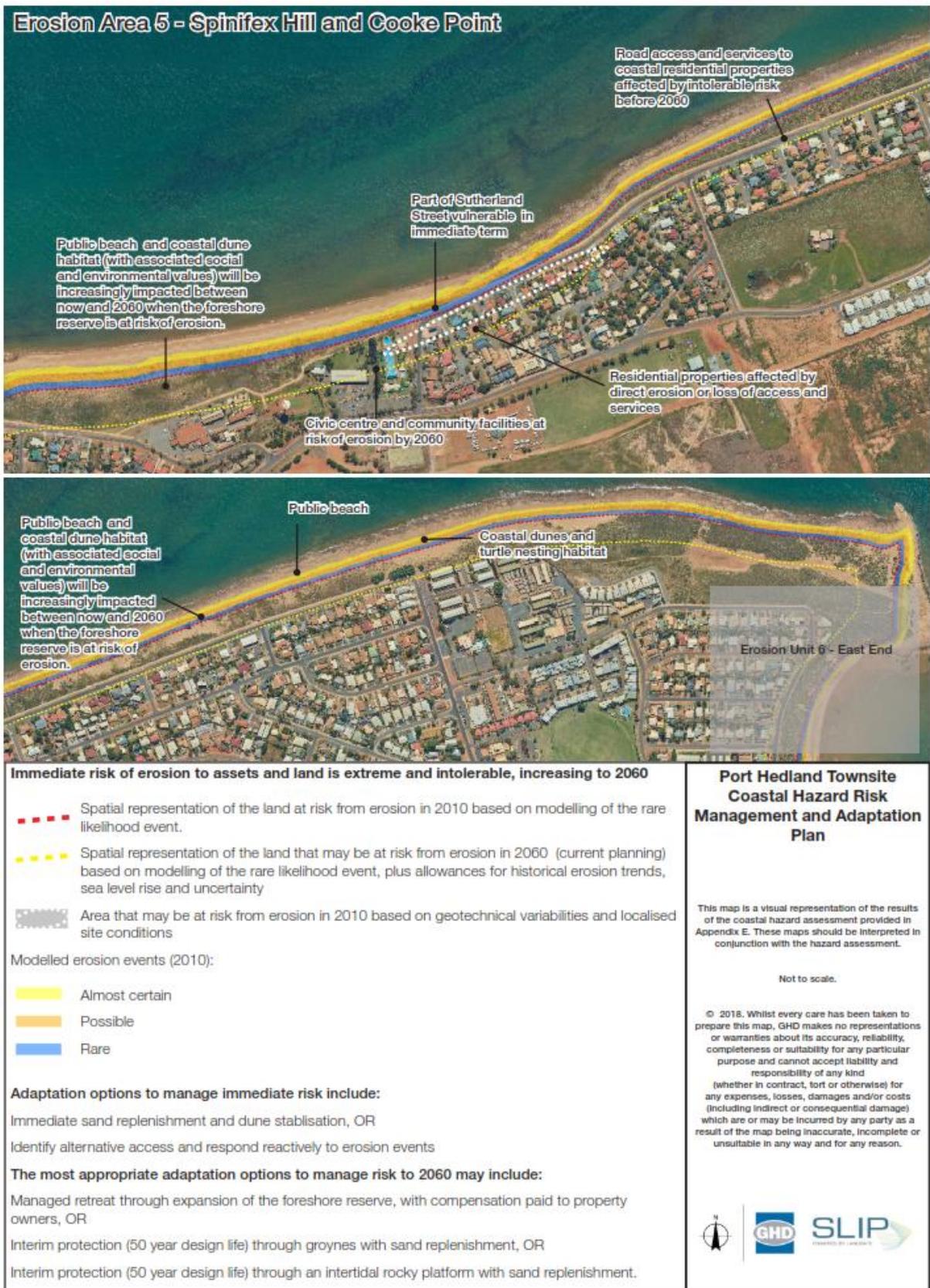


Figure 4-6 Spinifex Hill/Cooke Point erosion hazard and recommended adaptation

There are other adaptation options but these are considered unviable based on the values of the community. Hard active protection measures to manage erosion in this area, such as seawalls, are incompatible with the values of the area due to the importance of the turtle nesting habitat. This is because seawalls accelerate erosion of the beach and dunes in front of them and only protect the land behind them, which would promote the loss of turtle dune nesting habitat. Unmanaged retreat (which involves no government intervention or expenditure, with loss of the foreshore reserve occurring before houses at risk are abandoned due to safety) was also deemed incompatible with the values of the area as it would involve the loss of the public beach and turtle nesting habitat as the beach and dune area would be lost, and would not provide support or compensation to affected property owners.

The multi-criteria analysis used to evaluate and compare the adaptation options was highly sensitive to cost and management of residual risk in ranking the options, and did not adequately differentiate between managed retreat compared to interim protection (designed for 50 years, after which further investment into either managed retreat or further interim protection) through groyne installation. Whilst managed retreat was preferred in the multi-criteria analysis (which considered cost along with social, environmental and economic values), the differentiation was not particularly strong, therefore making a judgement regarding the feasibility of managed retreat versus interim protection for the current planning horizon requires further engagement with the community to further explore and differentiate between the most viable options.

Table 4-5 Comparison of interim protection measures and estimate for Spinifex Hill / Cooke Point

Period	Description	Capital Costs (\$M)	Maintenance Costs (\$M) [#]	Decommissioning Costs (\$M) [*]	Total (\$M)
Current Planning (2018 to 2060)	Partial groyne field and sand replenishment	32.0	4.3	5.1	41.4
Current Planning (2018 to 2060)	Complete groyne field and sand replenishment	71.1	8.8	11.2	91.1
Current Planning (2018 to 2060)	Intertidal rock platform with sand replenishment	29.9	26.2	1.1	57.2
Current Planning (2030 to 2045)	Managed Retreat	45.5 (Land acquisition of 91 residential properties)	n/a	n/a	45.5

*Note: Decommissioning costs will be incurred at the end of the design life approximately 50 years after implementation. Land acquisition/compensation costs would occur opportunistically and sporadically until such a time that retreat is implemented.

#Note: Maintenance costs are total over the relevant period.

It is possible that the cost of coastal engineering works in this locality is too high to justify providing interim (50-year) protection for residential properties, and is therefore considered unfeasible. If that is the result of further community engagement, then the appropriate adaptation trigger for this locality in the current planning horizon is Trigger 4 – risk is intolerable, interim protection is unviable. This would require retreat in the current planning horizon. In this

case, managed retreat is considered the most appropriate response based on the significant social, economic and environmental values of the locality however, land acquisition costs require funding. Unmanaged retreat does not require public funding however, shifts the cost onto coastal property owners and will result in the loss of social and environmental values associated with the coastal foreshore reserve.

This will be a significant decision for the Town of Port Hedland and State Government, and it requires considerable strategic consultation and further investigations, including:

- Engaging with the community and affected landowners to determine which response is most aligned with the community's current values, and therefore ascertain whether interim protection is justified on social, environmental, and economic grounds;
- Undertaking further investigation into local coastal processes and geotechnical conditions to better understand risk levels and prioritise implementation on a localised scale to enable staging of investment; and
- Identifying and gaining commitment to funding appropriate adaptation through interim protection or managed retreat, because the costs are considerable and are unable to be funded by the Town of Port Hedland or affected landowners.

Actions

These actions are required for immediate implementation to manage immediate intolerable risk, and effectively plan for strategic adaptation to manage intolerable risk between now and 2060. Common actions to multiple coastal planning areas are described in section 0.

- Undertake immediate sand replenishment and dune stabilisation;
- Investigate geotechnical stability of dunes;
- Engage with the community in decision-making between managed retreat or interim protection, considering the high financial costs of interim protection;
- Engage with state government, private industry, and the community to prepare a long-term funding strategy for strategic, appropriate coastal adaptation;
- If interim protection is determined as the most appropriate approach, investigate feasibility of hard and soft passive protection concept options; and
- If managed retreat is determined for implementation, develop a managed retreat plan to provide a coordinated, staged approach to land acquisition and decommissioning of assets in the areas of intolerable risk.

4.4.6 East End

The Goode Street foreshore is a known erosion risk area and the ToPH has previously engaged coastal engineers to investigate options to stabilise the eroding dunes. At this site hard active protection options (a seawall (built of either rock, sand bags or old tyres)), hard passive protection options (groynes with sand replenishment) and soft passive protection options (sand replenishment) have been investigated (Cardno 2013, MPR 2017).

The risks to assets and values in this area are the result of the limited buffer zone between the area of active coastal processes and adjacent assets. The present day coastal erosion hazard maps do not highlight erosion as an immediate risk in this area because it is the secondary risks as a result of the potential geotechnical instability of the sand dunes which trigger this area to an intolerable risk, refer to Figure 4-7.

Adaptation options to manage immediate risk

The most appropriate interim option for the ToPH to manage risk in the immediate term is to implement soft passive measures including sand replenishment and dune maintenance to increase and maintain the buffer zone.

The estimated cost for implementing beach monitoring, dune maintenance and sand replenishment by establishing a 30 m wide buffer zone in front of the 160 m length of highest risk foreshore is approximately \$1.7 million with an ongoing maintenance cost in the order of \$90,000 per annum.

Adaptation options to manage risk to 2060

Between now and 2060, the risk of erosion is intolerable to coastal roads and residential properties. With the road providing a hard edge, the dune system loses its ability to recover, and therefore the risk of erosion to the public beach, dunes, and turtle-nesting habitat is also extreme and intolerable.

The options previously investigated for this area are still applicable but GHD recommends that the ToPH consider additional passive options that complement the environmental and social values of this section of the coastline as the most appropriate for implementation. Passive coastal protection options assist to increase and maintain the buffer zone between the area of active coastal processes and coastal assets by reducing incident wave energy at the base of the dune during normal tidal conditions. Passive coastal protection options include groynes and nourishment or an intertidal rock platform.

Unmanaged retreat (which involves no government intervention or expenditure, with loss of the foreshore reserve occurring before houses at risk are abandoned due to safety), was also deemed incompatible with the values of the area. This is because it would involve the loss of the public beach and turtle-nesting habitat as the beach and dune area would be lost, and would not provide support or compensation to affected property owners.

The most appropriate options to respond to erosion risk in the area include:

- Managed retreat through expansion of the foreshore reserve, with compensation paid to property owners;
- Interim protection (50-year design life) through groynes with sand replenishment; and
- Interim protection (50-year design life) through an intertidal rocky platform with sand replenishment.

Table 4-6 provides a summary of the likely costs for the available adaptation options for East End in the current planning period.

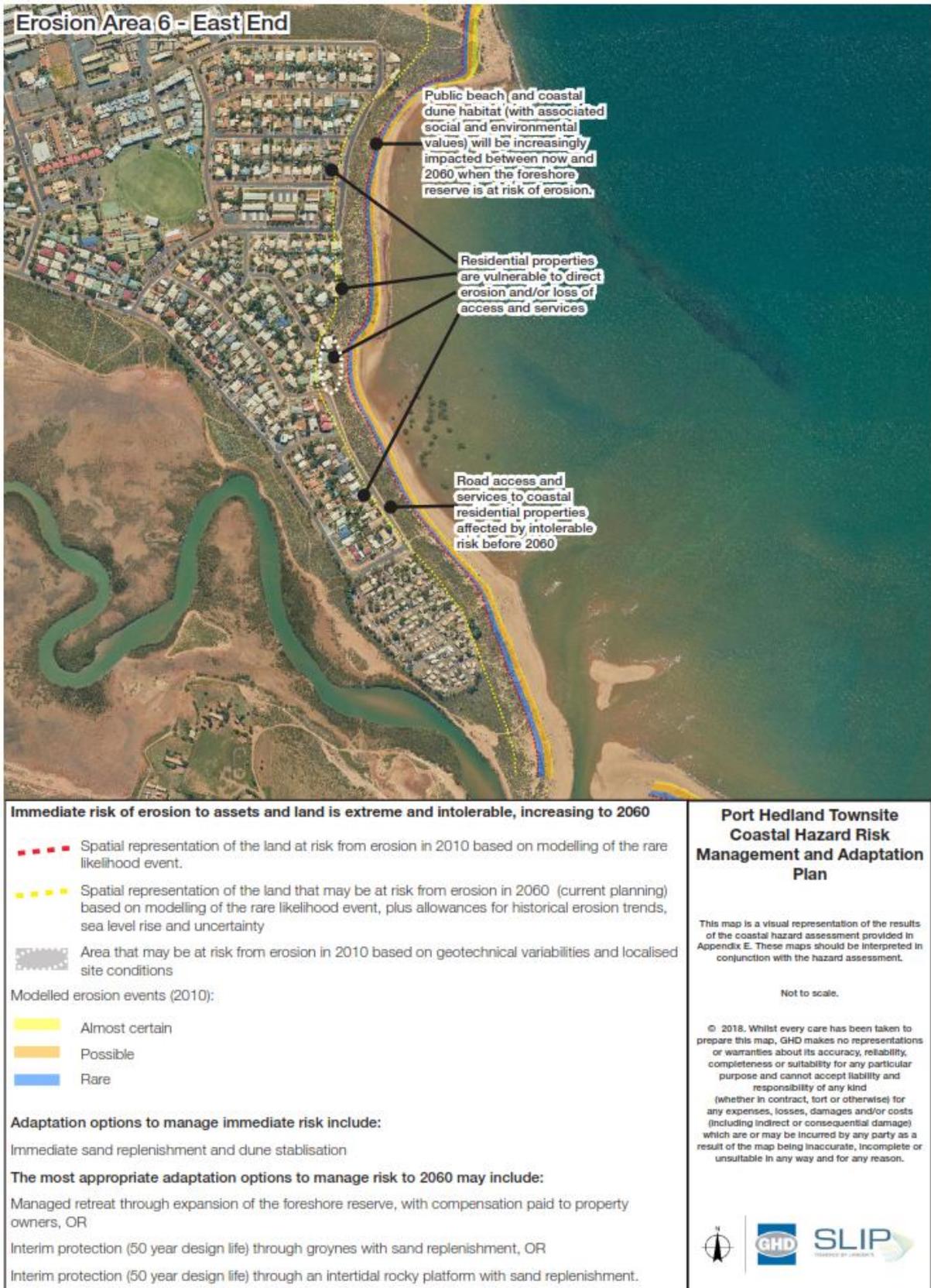


Figure 4-7 East End erosion hazard and recommended adaptation

The multi-criteria analysis used to evaluate and compare the adaptation options was highly sensitive to cost and management of residual risk in ranking the options, and did not adequately differentiate between managed retreat compared to interim protection (designed for 50 years, after which further investment into either managed retreat or further interim protection) through groyne installation. The cost of all interim protection options (Table 4-6) is very high and exceeds the estimated cost of land acquisition and compensation required to deliver managed retreat (Appendix H) in the same 50-year effective timeframe. Therefore, the most appropriate decision for this area requires balancing the cost of implementation against the impact on property owners that would occur with the implementation of managed retreat.

Table 4-6 Comparison of interim protection measures and order of magnitude budget estimate for East End

Period	Description	Capital Costs (\$M)	Maintenance Costs (\$M) [#]	Decommissioning Costs (\$M) [*]	Total (\$M)
Current Planning (2030 to 2060)	Groyne field and sand replenishment	31.1	3.6	4.9	39.6
Current Planning (2030 to 2060)	Intertidal rock platform with sand replenishment	17.0	12.4	1.0	30.4
Current Planning (2030 to 2045)	Managed Retreat	17.5 (Land acquisition of 35 residential properties)	n/a	n/a	17.5

*Note: Decommissioning costs will be incurred at the end of the design life approximately 50 years after implementation. Land acquisition/compensation costs would occur opportunistically and sporadically until such a time that retreat is implemented.

#Note: Maintenance costs are total over the relevant period.

It is possible that the cost of coastal engineering works in this locality is too high to justify providing interim protection for residential properties, and is therefore unfeasible. If that is the result of further community engagement, then the appropriate adaptation trigger for this locality in the current planning horizon is Trigger 4 – risk is intolerable, interim protection is unviable. This requires retreat in the current planning horizon. In this case, managed retreat is considered the most appropriate response based on the significant environmental values of the locality; however, land acquisition costs require funding. Unmanaged retreat does not require public funding, however shifts the cost onto coastal property owners and will result in the loss of social and environmental values associated with the coastal foreshore reserve.

This will be a significant decision for the Town of Port Hedland, and it requires considerable strategic consultation and further investigations, including:

- Engaging with the community and affected landowners to determine which response is most aligned with the community's current values, and therefore ascertain whether interim protection is justified on social, environmental, and economic grounds;
- Undertaking further investigation into local coastal processes and geotechnical conditions to better understand risk levels and prioritise implementation on a localised scale to enable staging of investment; and

- Identifying and gaining commitment to funding appropriate adaptation through interim protection or managed retreat, because the costs are considerable and are unable to be funded by the Town of Port Hedland or affected landowners.

Actions

These actions are required for immediate implementation to manage immediate intolerable risk, and effectively plan for strategic adaptation to manage intolerable risk between now and 2060. Common actions to multiple coastal planning areas are described in section 0.

- Undertake immediate sand replenishment and dune stabilisation;
- Investigate geotechnical stability of dunes;
- Engage with the community in decision-making between managed retreat or interim protection, considering the high financial costs of interim protection;
- Engage with state government, private industry, and the community to prepare a long-term funding strategy for strategic, appropriate coastal adaptation;
- If interim protection is determined as the most appropriate approach, investigate feasibility of hard and soft passive protection concept options; and
- If managed retreat is determined for implementation, develop a managed retreat plan to provide a coordinated, staged approach to land acquisition and decommissioning of assets in the areas of intolerable risk.

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4.4.7 Pretty Pool

Pretty Pool is a comparatively recent urban area with development aligned with SPP2.6. Therefore, the erosion hazard is maintained within the existing foreshore reserve, with sufficient land available to maintain values as physical processes change the shape and width of the foreshore area, refer to Figure 4-8.

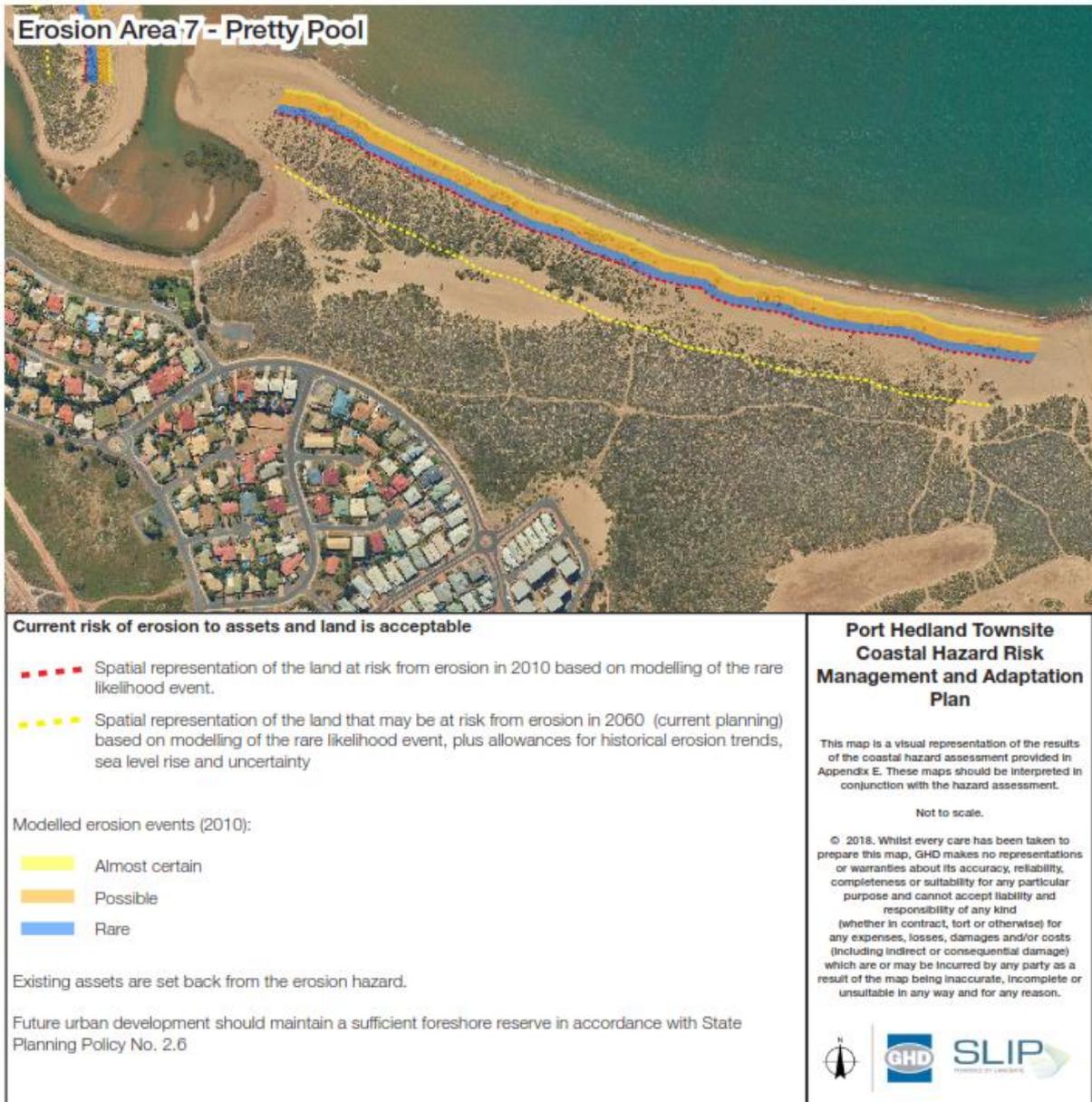


Figure 4-8 Pretty Pool erosion hazard and recommended adaptation

Land identified for future urban development does include some land within the modelled erosion hazard area. The detailed planning for this area should comply with SPP2.6 by providing a coastal foreshore reserve that provides for the physical processes allowance plus sufficient land for recreational, environmental and social values and assets. This will effectively mean that some land identified as urban development will be reserved, and is not suitable for development.

4.4.8 West Townsite Inundation

Much of the Port Hedland town centre within the West End is subject to inundation hazards (), resulting in intolerable risk based on the social and economic values of land and businesses in the area.



Protection from inundation is not considered viable in the West End of Port Hedland. Therefore, inundation hazards should be accommodated for the immediate term and current planning horizon. To deliver this outcome, the following actions are required:

- Undertake a Stormwater Drainage Assessment;
- Undertake Emergency Preparation and Response Management;
- Prepare a short-term inundation accommodation planning policy

This document is in draft form. The contents, including any opinions, conclusions or recommendations contained in, or which may be implied from, this draft document must not be relied upon. GHD reserves the right, at any time, without notice, to modify or retract any part or all of the draft document. To the maximum extent permitted by law, GHD disclaims any responsibility or liability arising from or in connection with this draft document.

Action - Stormwater Drainage Assessment

The almost certain inundation area within the West End does not have direct linkages to the ocean. Due to the lack of connection to the ocean, these areas are likely to be slow to drain and this is supported by the large drainage pumps that exist between Gilbert St and Wilson St to help manage inundation risks. It should be noted that the inundation maps do not consider the joint probability of marine inundation and overland flooding as a result of rainfall events and investigation of overland flow to complement the findings of this study is recommended. It is also recommended that ongoing maintenance of the Wilson Street pump system is undertaken and review of the pumping capacity and future capacity requirements is undertaken as part of a larger west end drainage investigation. This is critical because in the future, as sea levels rise, the hydraulic gradient between the head and tail water levels will decrease, and drainage infrastructure in this area may become less effective.

To minimise the effects of marine water pushing up through the drainage network, ToPH should also consider if installation of one way valves on ocean / tidal creek outfalls is required.

Action - Emergency Preparation and Response Management

For all areas of the townsite subject to immediate term inundation risk, it will be necessary for the Town of Port Hedland to undertake emergency preparation and response management.

The Town currently provides useful information to the community in relation to emergency preparation and response. This includes an annually updated tropical cyclone information booklet for community members and 'flood safe tips' on the Town's website.

It is recommended that the Town develops more coastal inundation specific materials for residents, businesses, and landowners in the areas at risk of inundation hazards. In addition to emergency response (which is addressed by current information), the Town should provide advice and encouragement for preparation, in particular property management (sandbags prior to storm events) and retrofitting (flood gates etc.) to accommodate inundation events. It is important that any floodfencing is cyclone proof and well maintained. An education campaign would be a suitable tool to encourage landowners in inundation risk areas to proactively prepare to accommodate inundation as a result of coastal storm surge.



Above – The Town of Port Hedland should encourage local businesses and residents to consider proactive installation of cyclone proof flood fencing, flood gates and responsive use of sandbags to prepare for flood events. (Final two images source - Radbournes.co.uk and <http://www.waterloowellingtonblogs.org>)

Action - Short-term inundation accommodation policy

The Port Hedland Townsite requires an immediate planning response in the form of planning policy to guide development in areas of inundation risk. This will complement the community education campaign for residents and businesses to retrofit their properties to manage inundation by specifically requiring upgrades for development subject to development approval.

A local planning policy for areas of coastal inundation should be prepared as a matter of urgency to provide design guidance for new development and redevelopment in areas subject to inundation risk – including the almost certain, possible and rare events.

Development of the local planning policy will require more detailed, localised modelling than has been undertaken to inform the CHRMAP to identify the spatial extent and depth of inundation expected in a storm event, taking into account local drainage and inundation pathways. This will enable the preparation of a storm surge map that is suitable for use for development design and assessment, and provide a more informed basis for decision-making.

Once appropriate modelling is undertaken, the local planning policy should be prepared, considering the following policy and design principles for new development in the inundation risk area:

- Locate development on a portion of the site that would not be vulnerable to inundation;
- Raise the height of the finished floor level for all habitable rooms (dwellings) or net lettable area for a commercial/community building above the identified inundation level through filling of the land and/or structural / building design response (i.e. elevated housing on ‘stilts’);

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- Provide a storm surge protection wall or barrier;
- Section 70A notifications on title advising prospective purchasers that the land is identified as being vulnerable to inundation;
- Inclusion of emergency evacuation plans;
- Appropriate footing design to prevent undermining by scour;
- Building and footing design to handle structural loads associated with storm surge flow, waves and debris impact, and undermining by scour; and
- Location of electrical infrastructure, permanent fixtures and plumbing above the modelled inundation level.

The local planning policy will only apply to development subject to development approval. With the preparation of a new scheme for the Town of Port Hedland, or in the interim via a scheme amendment, a special control area should be incorporated into the scheme to subject all development that would otherwise be exempt to the requirement to obtain development approval. The special control area could refer to the local planning policy for more detailed design requirements.

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4.4.9 East Townsite Inundation

Much of the East Townsite of Port Hedland is subject to inundation hazards (Figure 4-9). Whilst the majority of this area is currently undeveloped, the inundation hazard presents intolerable risk to future urban development if the hazard is not addressed in planning and design.

The importance of maintaining residential and commercial land in Port Hedland, particularly with land use in the West End being constrained by dust, makes avoiding development in the East Townsite unviable and inconsistent with the values of the community to continue to live and work in Port Hedland.

The evaluation of options to enable development of the East Townsite considered strategic protection (tidal gates and levees) against protection at the development scale (through raising land levels) against accommodation at the lot level (through housing design, such as stilt development). Strategic protection via tidal gates and levees have a significant cost and considerable complexity of construction that impact on their feasibility for use in Port Hedland. Therefore, the most feasible protection options relate to raising land levels to support urban development.

The multi-criteria analysis used to assess options was unable to effectively measure the cost of accommodation versus protection on a site-by-site basis. The options of accommodation and protection respond similarly to local environmental and social values, therefore financial feasibility is the key differentiator to determine the most appropriate adaptation response. Therefore, future urban development undertaken by Landcorp and others in the East Townsite should include feasibility investigations that compare protection through raised land levels with accommodation, with an appropriate decision made at the time of development. All urban development must be undertaken in accordance with SPP2.6, with floor levels above the required inundation event through protection (fill) or accommodation (building design).

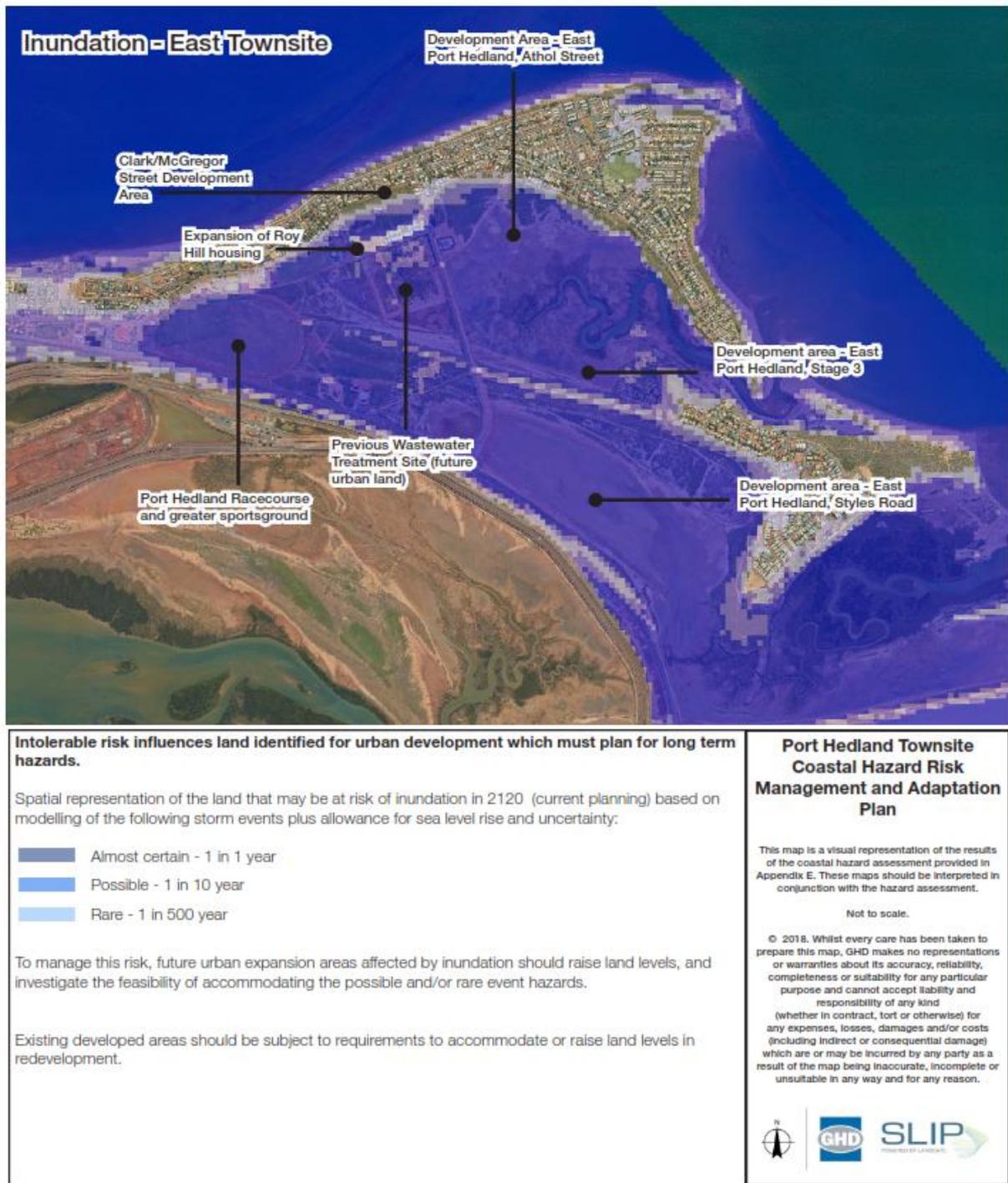


Figure 4-9 East Townsite inundation hazard and recommended adaptation

4.5 Common adaptation options

4.5.1 Immediate and responsive sand replenishment

In some areas, a strategic decision needs to be made between managed retreat and interim protection in the current planning period. Of these areas, some have intolerable risks in the immediate term. Until decisions have been made on the current planning term strategy there is opportunity to implement sand nourishment to provide a storm buffer against erosion processes, assisting the ToPH and the community to “buy time” to make an informed decision.

The estimated cost to establish a 30 m wide, 4 m high buffer zone with sand nourishment are in the order of \$10,000 per m length of foreshore, but are dependent upon the distance that sediment would need to be transported e.g. implementing nourishment along 100 m of foreshore would cost ~\$1 million. In some areas, a 30 m buffer zone may be too wide, and only a smaller buffer zone may be required and in some areas the existing dunes may only need to be supplemented, so a smaller volume may be able to be placed.

Sand nourishment is a temporary solution to immediate risks that the ToPH may consider implementing in the immediate term to ‘buy time’ before a strategic decision on the adaptation pathways is required to be made for the current planning term.

4.5.2 Additional investigations

The appropriate decisions will require further investigation into local coastal processes and geotechnical conditions to better understand risk.

The recommendations made in this CHRMAP are based on a high-level coastal hazard assessment. Assessing and developing localised adaptation options will require greater understanding of localised coastal processes (e.g. alongshore sediment transport rates) and the influence of local site conditions (e.g. geotechnical stability of sand dunes and alongshore changes in presence of rocky or sandy features). Finding out more is a critical item to the successful implementation of localised adaptation pathways.

4.5.3 Engage the community in decision-making

Further information and community engagement is required to guide decision-making for the current planning horizon for erosion risks at Spinifex Hill/Cooke Point and the East End and inundation risks to the West Townsite. The viability of protection in these locations is considerably influenced by significant costs. The acceptability of managed retreat requires prioritisation of the social impacts of land acquisition against the high costs of interim protection that will manage risks only for a 50 year timeframe.

4.5.4 Implementation of Interim Protection

SPP2.6 sets clear policy expectations for the use of coastal protection works. First, and foremost, coastal protection works are to be considered only after all other options have been explored through a coastal hazard risk management process.

Prior to the construction of coastal engineering protection structures, there are several steps that should be undertaken to develop the basis of design and confirm that the proposed interim protection methods are the most suitable approach from a performance and financial viability perspective.

The following steps (as a minimum) are proposed:

1. Undertake a gap assessment to identify datasets required to inform coastal processes assessment and concept option development;

2. Undertake the required investigations to fill any gaps in the data. This may require installation of data recording devices, survey work, geotechnical investigation or numerical coastal processes modelling such as sediment transport modelling. It is also recommended that investigations into suitable sources of supply of materials is undertaken, including considering the feasibility of using the Spoilbank as a source of sand replenishment;
3. Develop a basis of design with available information;
4. Develop several concept designs based on the preferred approach to be optimised to confirm the most suitable design;
5. Obtain required environmental approvals for the preferred design, including consideration of impacts on turtle nesting habitat; and
6. Once a final design option has been selected, additional investigations and detailed design can be undertaken.

The earlier that steps 1 and 2 can be undertaken in advance of any design works the better informed the design work will be. To be compliant with the SPP, the planning of coastal protection works will need to demonstrate adequate funding for construction and maintenance in addition to the above design elements.

4.5.5 Foreshore Monitoring

Management of the Port Hedland Beaches would benefit from the development of an annual monitoring program. A list of monitoring and data acquisition/analysis that would be beneficial for coastal management of Town of Port Hedland is summarised below:

- DoT and PPA currently undertake monitoring and data collection in Port Hedland. Long-term historic wave and water levels are available, as well as LiDAR data and vegetation line mapping. Regular review of this data by the ToPH is recommended to identify trends that may be affecting the coastline and to ensure that the information required for the design of coastal structures is readily available;
- Installation of nearshore hydrodynamic instrumentation to collect wave and water level conditions at locations where interim protection is planned to be implemented will enable better calibration and validation of any numerical coastal processes modelling required; and
- Photo monitoring should be undertaken at key erosion spots at a minimum of biannually (winter/summer) and during/post significant storm events, in accordance with the methodology recommended by Department of Transport (DaSilva 2012). Visual comparison of site photos provides context for interpretation of the measured profile, vegetation line and bathymetric changes. Opportunities for citizen participation in science may be used to assist in photo monitoring in combination with ToPH staff.

LiDAR survey and aerial photography of the entire Port Hedland coastline should be repeated on a regular basis (~5 to 10 years). When undertaken, it should be compared with previous datasets to identify coastal trends and interpret coastal management pressures.

4.5.6 Identify sources of construction materials

Interim protection options are highly dependent upon the suitable supply of materials of rock armour and sand for sand replenishment. Due to the number of areas recommended for interim protection, it is recommended that investigations into suitable sources of materials are undertaken. In particular, it is recommended that the feasibility of using the Spoilbank as a source of sand replenishment is considered. Factors to consider include the quantities and properties of sediment required, the local sediment transport rates, and potential for the

sediments of the Spoilbank to have contamination as a result of dust, shipping or dredging activities.

4.5.7 Implementing managed retreat

The Western Australian Planning Commission (WAPC) recently released draft Planned and Managed Retreat Guidelines (WAPC, 2017). The guidelines provide a framework for triggering acquisition of private land affected by erosion; recommended triggers for acquisition effectively results in the erosion of the entirety of the public foreshore prior to acquisition of properties. These triggers are not appropriate for Erosion Units 5 (Spinifex Hill and Cooke Point) and 6 (East End) and would result in the loss of important social, environmental and economic values that the foreshore reserve provides, as described in Section 3.2. To deliver managed retreat in a way that retains these values over time, a more strategic approach is recommended with an earlier trigger for expansion of the foreshore reserve to maintain those social, environmental and economic values. Recommended triggers are described later in this section.

The acquisition process recommended in retreat guidelines supports compensation paid to property owners under provisions in the *Land Administration Act (1997)*. This would require government to provide funding to acquire property. However, there is no obligation for government to adopt a policy that effectively forces government to compensate. There is also no legal responsibility for government to provide protection of private property from natural hazards, nor compensation where private land is lost to erosion. Government has the ability to intervene and enforce eviction if private property becomes uninhabitable or if property presents a public risk. Without strategic investment into managed retreat through land acquisition, the cost of erosion and sea-level rise is paid for by property owners and users and beneficiaries of the coastal environment.

There is a risk to the community of Port Hedland if sufficient investment is not allocated by government to deliver strategic, proactive coastal adaptation. In order to maintain social, environmental and economic values of the Port Hedland coastal environment, strategic managed retreat should be funded and delivered. This includes expansion of the foreshore reserve to plan for retreat. Over time, to implement retreat, reserved land would be acquired using public funds, just as it is for infrastructure projects such as major highways.

Implementation of retreat involves two key, separate roles for coordinated action by government:

1. Coordinating land use zoning and policy changes, and coordination between multiple infrastructure owners and managers to cooperate in relocating and retreating assets; and
2. Establishing funding arrangements, including the responsibilities of government, public and private land and asset owners to finance the necessary collective action.

The coastal foreshore is a vital piece of infrastructure. It provides an important coastal protection measure that protects public and private land and associated assets from coastal risk as well as serving important social and environmental functions as outlined in SPP2.6. It is important that the public foreshore is retained and managed in Port Hedland.

Where managed retreat is a preferred decision (or trigger 4 is reached – particularly in Erosion Units 5 and 6) an appropriate model for implementing retreat might be one that is similar to how the State Government delivers traditional infrastructure. For example, planning and delivering the coastal foreshore reserve in a manner similar to other vital infrastructure in Western Australia, such as highways. This includes planning for and acquisition of the land necessary for public reserve, then budgeting/obtaining funding for a major capital project that delivers the on-ground infrastructure. In the case of managed retreat, that capital project would include

relocation of remaining infrastructure and assets, and remediation of the public foreshore reserve. This model is shown in Figure 4-10.

In Erosion Units 5 and 6, the risk of erosion to the foreshore reserve becomes intolerable sometime between now and 2060. It is recommended that implementation of managed retreat commences around 2030, to enable establishment of a sufficient foreshore reserve prior to the anticipated loss of values before 2060. This would result in full implementation of retreat around 2045. An indicative future foreshore reserve may be the physical processes allowance (are vulnerable to erosion) plus 20 metres to provide infrastructure, such as car parking, access, etc. A more detailed retreat zone should be identified based on a more detailed and localised understanding of erosion hazard.

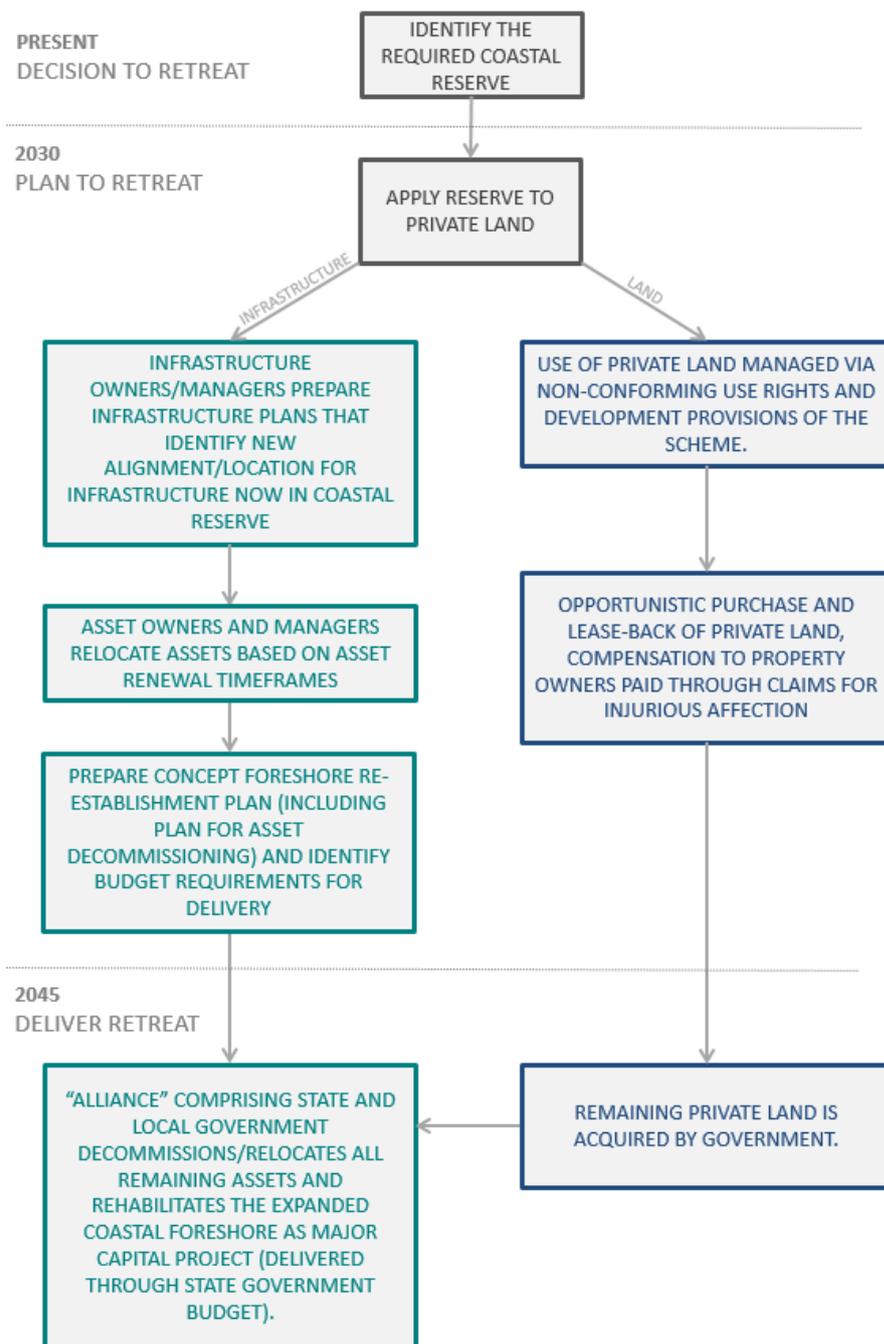


Figure 4-10 Model for strategic retreat delivery

4.6 Community awareness campaign

The local community places a great deal of value on the coastal foreshore and environment, and areas of Port Hedland affected by inundation hazards – in particular the West End. Many community members have high expectations for quality assets and experiences in the foreshore reserve. Facilities and development within the vulnerable coastal area are not permanent. The adaptation plan recognises that the coastal environment will change considerably into the future, just as the coastal vulnerable area will change over time. It is important to engage the community in regards to the dynamic nature of coastal processes, how these influence the Port Hedland settlement, and manage expectations for future development and use.

A key component of ongoing coastal adaptation planning is to consider and test the core values of the community in relation to the impacts of sea level rise on the Port Hedland Townsite. The trigger-based adaptation pathway articulates the need to do this frequently as trigger points are reached, to ensure the right decision is made. Over time, as sea level rise occurs and we see changes in the Western Australian coast, it is likely that what the community values and how the community prioritises different values will change. Ongoing community engagement is important to inform future decision-making.

A longer-term awareness drive and community dialogue would be a beneficial way in which to engage the community and engage them in testing values over time. Greater levels of awareness will bring together broader views on the issue, and enable a more informed discourse of the often competing, values of the coast and coastal land. Alongside general awareness of coastal planning and values, it will be important to inform the community of the CHRMAP and its recommendations.

It is recommended that the Town of Port Hedland continue with awareness raising via a number of methods, including specific information on the website, fact sheets and through an ongoing interaction with the broader community. Incorporation of community education and awareness into future projects, such as foreshore management plans, and coastal projects, such as interpretive signage, provides excellent opportunities to continue the conversation with the community. The ongoing engagement strategy needs to be a process of regular and repeated opportunities to inform and engage with the community so that the values of the community can be properly assessed. This will be important for long-term decision-making, which will need to test the values of the community in relation to the coast at each decision-making point.

4.7 Funding

The Town of Port Hedland alone cannot deliver the high cost of proactive coastal adaptation in Port Hedland.

It is important that appropriate funding options and relationships are identified, and a long-term funding strategy is put in place. This may include a long-term funding plan that allocates and sets aside an annual contribution for coastal adaptation in Port Hedland, so that sufficient funding is available prior to triggers for implementation. The proactive budgeting of smaller amounts over time is far more likely to be successful than attracting a significant grant (of \$40 million or more) at the time that a strategic implementation action is required, and therefore provides greater certainty to the community that strategic, effective coastal adaptation will occur.

If funding cannot be secured, it is likely that a policy of unmanaged retreat will occur, which will result in the loss of important social and environmental values as well as the loss of private land, without any compensation to property owners.

Because Port Hedland currently has a public foreshore between the high water mark and private land, “unmanaged retreat” would result in a loss of significant environmental and social values, therefore there is a strong public benefit for government to be involved in managed

retreat or interim protection where that investment is linked to maintaining social, environmental and broader economic values.

Funding will be a key issue for the implementation of adaptation planning. The responsibility for paying for coastal adaptation lies with the beneficiaries of those actions. This includes land and asset owners that benefit from protection strategies, and coastal users that benefit from coastal management approaches. Where public funds are used for coastal adaptation works, there should be a direct public benefit as a result of that investment. Ongoing cooperation between local and state government and key asset owners will be required to consider and address these funding issues and responsibilities.

Some options for managing and covering the costs of coastal adaptation options include:

- Funding through State Government budgets;
- Funding through local government budgets;
- Funding through Federal Government budgets;
- Special area rates within the coastal risk area;
- Developer contributions plans to recoup costs where the need and obligation is clearly defined;
- Coastal Adaptation and Protection grants through the Department of Transport;
- Coastal Management Plan Assistance Program through the Department of Planning, Lands and Heritage;
- Ceding of private land for the coastal foreshore reserve; and
- Inclusion of coastal management/protection levy within lease agreements within the coastal reserve.

The appropriate funding option for coastal adaptation options will depend on the beneficiaries of the measures taken and the values being protected. Direct beneficiaries should directly contribute to coastal management and adaptation costs. Indirect beneficiaries also contribute through public funding investment (contribution through rates and taxes into public funds).

Funding options that seek to raise funds from immediate coastal landowners (such as special area rates for coastal areas) are suitable when coastal management works provide protection of privately owned assets. Because private land is identified as being at risk and recommended for protection to manage immediate risk (units 1 and 2 West End and Kingsmill Street), cost contributions from those landowners would be an appropriate component of the overall funding strategy for coastal adaptation in Port Hedland. Future development of the Port Hedland marina development should also consider funding mechanisms for landowners that directly benefit from the marina infrastructure to contribute to the ongoing maintenance and upgrades of coastal protection works constructed as part of the development.

4.8 Short-term action plan

Table 4-7 provides a consolidated list of all recommended actions from across the implementation plan for delivery by relevant stakeholders to manage immediate risk and commence planning to adapt to increasing risk to 2060.

Table 4-7 Consolidated short-term action plan

Action	Commencement date	Lead stakeholder	Supporting stakeholders
All areas			
Investigate geotechnical stability of dunes and site specific coastal processes to prioritise adaptation planning and investment for the current planning horizon (to 2060).	Within 5 years	Town of Port Hedland	Department of Transport. Department of Planning, Lands and Heritage. Pilbara Ports Authority.
Develop and implement a foreshore and coastal hazard monitoring program	Within 1-2 years	Town of Port Hedland	Department of Transport. Department of Planning, Lands and Heritage. Pilbara Ports Authority.
Engage with state government, private industry, and the community to prepare a long-term funding strategy for strategic, appropriate coastal adaptation	Immediate	Town of Port Hedland	Department of Transport. Department of Planning, Lands and Heritage. Pilbara Ports Authority. Private industry.
Identify sources of construction materials for interim protection options	Within 5 years	Town of Port Hedland	Landcorp.
Develop and deliver a community awareness campaign on coastal hazards and risk	Within 1-2 years	Town of Port Hedland	Department of Transport. Department of Planning, Lands and Heritage. Pilbara Ports Authority.
Erosion Areas 1 and 2 – West End and Kingsmill Street			
Investigate feasibility of hard active versus hard or soft passive protection options within Erosion Area 1 – West End and 2 – Kingsmill Street and implement preferred interim protection.	Within 1-2 years	Town of Port Hedland	Department of Transport. Department of Planning, Lands and Heritage. Pilbara Ports Authority.

Action	Commencement date	Lead stakeholder	Supporting stakeholders
Erosion Area 3 - Spoilbank			
Undertake localised coastal hazard and geotechnical investigations to understand localised risk of erosion	Within 5 years or as part of Marina planning	Town of Port Hedland	Department of Transport. Department of Planning, Lands and Heritage. Pilbara Ports Authority. Landcorp.
Erosion Area 4 – Cemetery Beach			
Repair/relocate beach access points and structures within Cemetery Beach if damaged by erosion	As required	Town of Port Hedland	
Erosion Areas 5 and 6			
Undertake immediate sand replenishment and dune stabilisation at acute erosion points to provide a buffer from the immediate erosion hazard.	Immediate	Town of Port Hedland	Department of Transport. Department of Planning, Lands and Heritage. Pilbara Ports Authority.
Engage with the community in decision-making between managed retreat or interim protection to manage increasing risk to 2060.	Within 5 years	Town of Port Hedland	
If interim protection is determined as the most appropriate approach, investigate feasibility of hard and soft passive protection concept options	10-15 years	Town of Port Hedland	Department of Transport. Department of Planning, Lands and Heritage. Pilbara Ports Authority.
If managed retreat is determined for implementation, develop a managed retreat plan to provide a coordinated, staged approach to land acquisition and decommissioning of assets in the areas of intolerable risk.	10-15 years	Town of Port Hedland	Department of Planning, Lands and Heritage.
Inundation – West Townsite			
Undertake a Stormwater Drainage Assessment	Immediate	Town of Port Hedland	Pilbara Ports Authority.
Undertake Emergency Preparation and Response Management	Immediate	Town of Port Hedland	Pilbara Ports Authority.
Prepare a short-term inundation accommodation planning policy	Immediate	Town of Port Hedland	Department of Planning, Lands and Heritage.

5. Long-term planning

The risk of coastal erosion and inundation will increase between 2060 and 2120. In the lead up to 2060, future iterations of coastal adaptation plans will engage with the community to understand the values and assets at risk, confirm risk levels, and make appropriate adaptation decisions.

To enable all options being available for future decisions on coastal risk beyond 2060, it is important that strategic planning for the growth of Port Hedland maintains the future opportunity to retreat from areas of intolerable risk without increasing the cost to the future community of doing so. Changes to the planning framework are required to achieve two key adaptation outcomes:

1. Build resilience and flexibility into coastal planning frameworks to enable long-term retreat; and
2. Facilitate land use change to implement retreat when required.

5.1 Future settlement pattern

Coastal processes will strongly influence the future shape of Port Hedland. Urban development cannot be designed to withstand or accommodate erosion pressures, and this will influence coastal urban areas of Port Hedland. Suitable protection options for erosion have a discrete design life and require continuous maintenance and materials for sand replenishment. Over time, the cost of interim protection to manage erosion pressures may become unviable, and retreat may become inevitable.

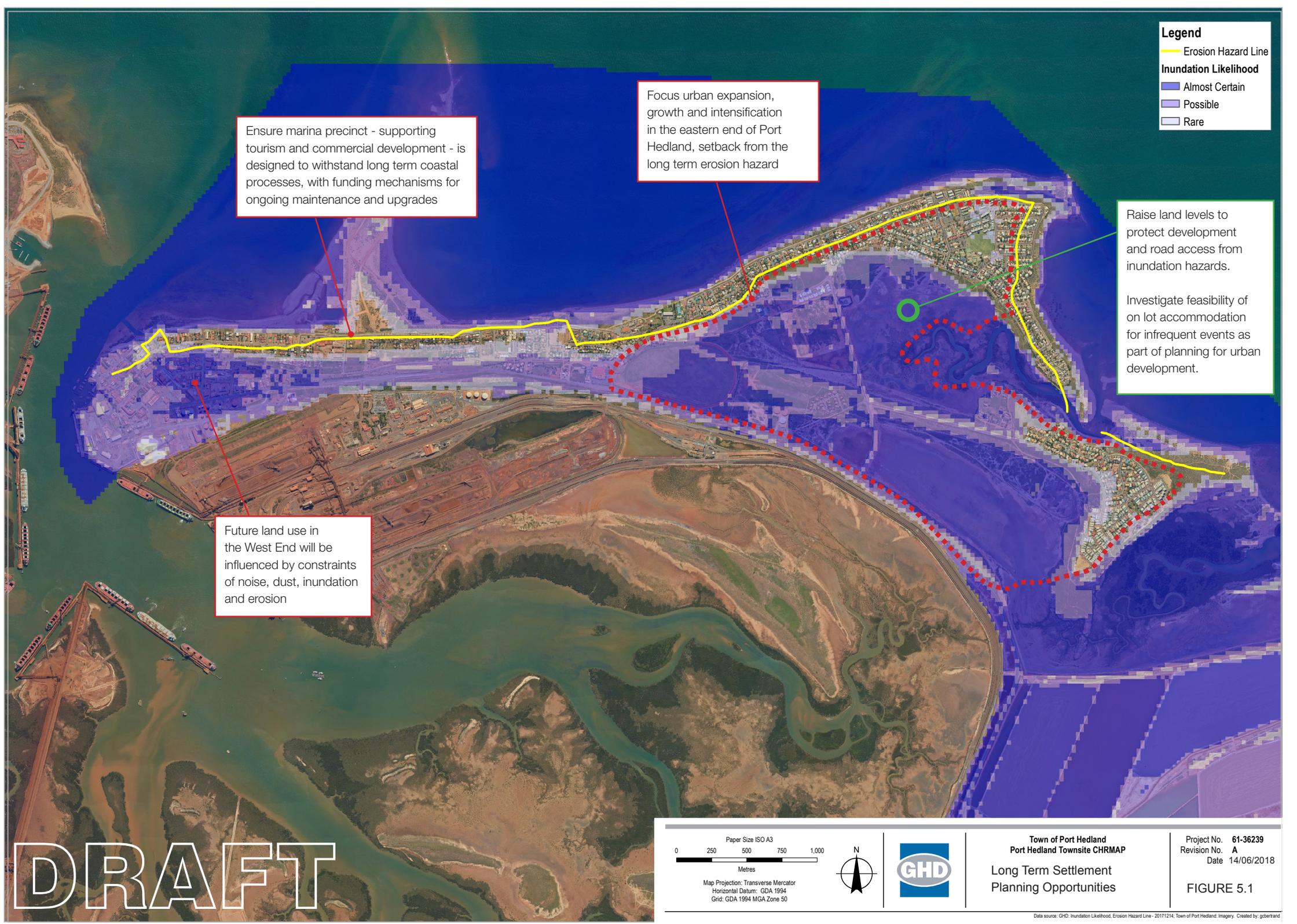
While development design is able to better respond to inundation hazards, inundation will also influence the future shape of Port Hedland through building design and or increased land levels.

The Port Hedland Townsite is a long, narrow settlement and this significantly affects the feasibility of protection options. It is far more cost effective to focus on smaller, consolidated areas of protection.

The West End of Port Hedland is already under pressure for residential retreat as a result of dust and associated health impacts. The justification for protecting this area in the long term may be limited when compared to the cost benefits of investing in protection of the eastern part of Port Hedland.

A strategic spatial plan for long-term coastal adaptation in Port Hedland is provided in Figure 5-1. This plan is achieved by focussing growth, urban expansion and increased development potential in the eastern part of the existing townsite. The long-term settlement plan would avoid growth and expansion in the West End subject to inundation, and the coastal strip affected by erosion, ultimately resulting in managed retreat from these areas. This enables long-term investment into feasible protection of inundation in the east end that is not constrained by dust etc and enables the full suite of urban uses that could not otherwise be supported in the West End.

Reshaping the Port Hedland Townsite makes protection more feasible for a longer term thereby delaying the need for large-scale retreat across the entirety of Port Hedland. This builds long-term resilience into the Port Hedland Townsite.



Legend

- Erosion Hazard Line
- Inundation Likelihood**
- Almost Certain
- Possible
- Rare

Ensure marina precinct - supporting tourism and commercial development - is designed to withstand long term coastal processes, with funding mechanisms for ongoing maintenance and upgrades

Focus urban expansion, growth and intensification in the eastern end of Port Hedland, setback from the long term erosion hazard

Raise land levels to protect development and road access from inundation hazards.

Investigate feasibility of on lot accommodation for infrequent events as part of planning for urban development.

Future land use in the West End will be influenced by constraints of noise, dust, inundation and erosion

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<p>Paper Size ISO A3</p> <p>0 250 500 750 1,000</p> <p>Metres</p> <p>Map Projection: Transverse Mercator Horizontal Datum: GDA 1994 Grid: GDA 1994 MGA Zone 50</p>			<p>Town of Port Hedland Port Hedland Townsite CHRMAP</p> <p>Long Term Settlement Planning Opportunities</p>	<p>Project No. 61-36239 Revision No. A Date 14/06/2018</p>
<p>FIGURE 5.1</p>				

Data source: GHD; Inundation Likelihood, Erosion Hazard Line - 20171214; Town of Port Hedland; Imagery - Created by: gcb@rand

Managed retreat, particularly along the coastal strip, requires a strategic approach to ensure that the values of the coastal foreshore are retained over time, even as land is lost to erosion. SPP2.6 provides guidance for determining an appropriate coastal foreshore reserve that is wide enough to accommodate coastal processes, and provides sufficient additional land to maintain the values, functions and equitable use of the coastal area in the long term, as shown in Figure 5-2.

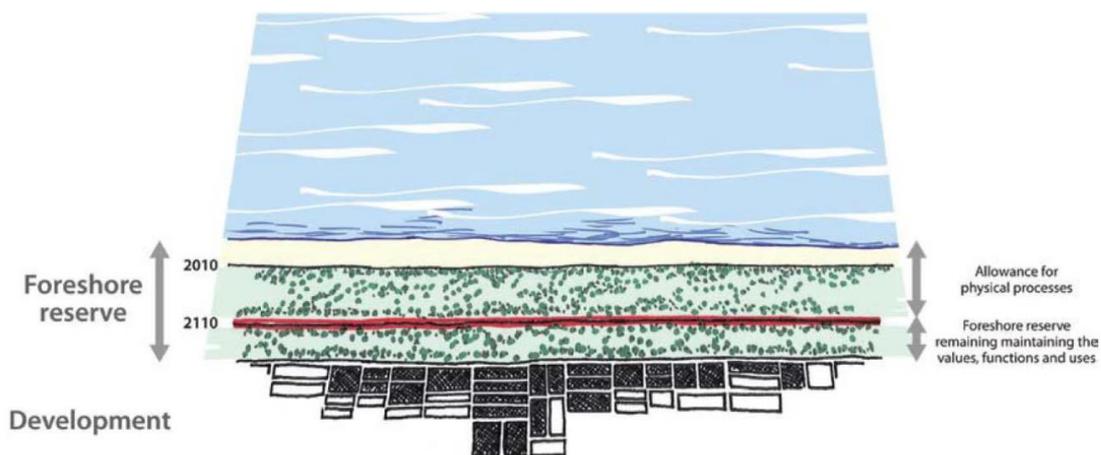


Figure 5-2 A coastal foreshore reserve accommodates physical processes and land to maintain values, functions and uses. (WAPC, 2013)

The coastal foreshore along Port Hedland supports very important environmental and social values, however is not sufficiently wide to maintain those values whilst allowing for erosion hazards. Therefore, managed retreat is necessary to extend the coastal foreshore. Nominally, the long-term retreat zone for areas of Port Hedland influenced by erosion risk should include the physical processes (erosion) allowance, with 20 metres to provide space for additional facilities.

Immediate retreat from the retreat zone may not be necessary as short-term adaptation options and other strategic decisions may enable the continued use of some areas. For example, erosion protection associated with the Port and the proposed marina will provide interim erosion protection to private land and assets, therefore delaying the need to retreat from these locations. However, these areas should not be identified for urban infill or intensification. In future planning horizons, in line with the trigger based adaptation pathway in Section 2.4, a decision for retreat should be made. There are several planning instruments available to plan for the retreat decision, and then to deliver the retreat decision. These are discussed in the next section.

5.2 Planning instruments

It is important that the local planning framework builds resilience into the Port Hedland settlement to address coastal risks beyond 2060. The following sections provide recommendations for the local planning framework to support the long-term transition of the Port Hedland Townsite in line with the strategic spatial recommendation presented in section 5.1, and build long term resilience into the townsite.

5.2.1 Appropriate instruments

Planning decisions are made at both state and local government levels. For example, rezoning proposals are approved by the Minister for Planning, subdivision is determined by the Western Australian Planning Commission, and development applications are determined either by the Town of Port Hedland or a Development Assessment Panel. It is important that policy instruments used to deliver the CHRMAP are those that will be considered by all decision makers.

Local planning documents that have received state level endorsement, including the local planning strategy and scheme, carry the most weight and are considered in all levels of planning decisions. The local planning scheme is a statutory document, therefore carries the most weight in decision-making. Local planning policies are not reviewed or endorsed at the state level, therefore carry less weight in decision making and are only given due regard in determination of development applications at the local level, with very limited applicability to strategic planning decisions and subdivision.

To successfully implement the CHRMAP, it is important that planning responses carry sufficient weight in decision-making and can be adequately defended in the event of appeals. Therefore, the CHRMAP focusses on the local planning strategy and local planning scheme as the most appropriate instruments to deliver planning recommendations as they are endorsed at the state level and carry the most weight in decision-making.

5.2.2 Special control area – retreat zone

The local planning strategy should include the long term coastal strategy presented in section 5.1 – which includes a long-term intent to protect the eastern end of the Port Hedland Townsite from inundation, and gradually retreat land use and development from intolerable erosion risks along the coastal edge and from inundation risks in the West End. A key planning mechanism to deliver the coastal strategy is a special control area applied to the identified retreat zone, which provides additional planning controls to support long-term retreat, ahead of formal reservation and acquisition of land at the time of intolerable risk.

In developing a special control area for the retreat zone, the following elements should be considered in the local planning strategy review:

- Determination of an appropriate special control area for the long-term “retreat zone”. This includes the area required for an extended foreshore reserve (including the 100 year erosion hazard plus 20 to 50 metres to facilitate coastal recreation facilities), and areas affected by the almost certain and possible inundation events in the West End of Port Hedland as recommended in section 5.1;
- Investigation of necessary development controls for the special control area, and the timing or trigger points for inclusion of those controls in the scheme. This would include consideration of:
 - Notifications on title for properties within the special control area, placed on as a condition of development approval or subdivision, which are reviewed and updated over time

- Mandate that all development requires approval, thereby providing the power to regulate development that may otherwise be exempt from development control
- Policy provisions requiring all new land use and development to be located outside of the retreat zone, which would facilitate incremental and opportunistic relocation (retreat) of private development over time
- Policy provisions that facilitate granting of temporary approval (e.g. for 10 years) for development and land use deemed appropriate for short term, which facilitates continued land use whilst taking into account future risk and a policy of eventual retreat.

The local planning strategy should clearly identify at what point the scheme should incorporate controls on development or redevelopment in vulnerable areas. CHRMAP guidelines stipulate regular review of the CHRMAP. When this is done, the extent and level of the SCA, and the nature of development controls included in the scheme should be reviewed in the light of updated understanding of trigger points (e.g. monitoring versus the need for action).

The local planning scheme, informed by the strategy, should incorporate the special control area to advise landowners and planners that the area is in a vulnerable coastal area and retreat zone for the long-term (100 year) planning horizon. Development controls incorporated into the scheme through the special control area will manage future land acquisition costs by controlling the scale of development and capital investment in the area. The operation of the special control area will direct private investment into land use and development into locations that will not be subject to future risk or acquisition, whilst enabling ongoing use of land in the interim.

The special control area provides an interim planning instrument to manage land use in the retreat zone prior to a decision to implement retreat. Once a decision to retreat is made, the area subject to the special control area should be transferred to a coastal foreshore reserve as a trigger for land use change and acquisition (see section 5.2.4) to implement managed retreat.

5.2.3 Coastal policy within Local Planning Strategy

The local planning strategy should provide clear expectations to manage development across Port Hedland, and avoid proliferation of high value development in the retreat zone, which would considerably increase the cost of future retreat to the community.

Including coastal policy statements within the local planning strategy will enable the policy to apply to all planning proposals, including subdivision and rezoning which are approved at the state level.

Whilst SPP 2.6 requires that infill development consider the adaptation planning hierarchy, some infill development may not be subject to the same requirement for the physical processes allowance and ceding of foreshore reserves as new development and settlements, particularly where it is not contiguous with the current foreshore reserve. The local planning strategy review should consider the long-term implications of this, and investigate policy measures to provide a consistent approach to new and infill development.

In particular, the local planning strategy review should:

- Introduce policy measures that require strategic planning proposals and rezoning proposals to be assessed against SPP2.6 as if it were new development, including ceding of coastal foreshore reserve (i.e. avoiding any new development within the retreat zone, with the exception of temporary development)
- Avoid density increases or intensification of land uses (including subdivision) within the retreat zone

- Consider sites of high density in the retreat zone that might be appropriate for a reduction in density and development potential
- Plan for infrastructure provision in a way that avoids placing future infrastructure within or immediately adjacent to the physical processes allowance, and avoids permanent linear servicing infrastructure (including roads) parallel to the coast, therefore potentially becoming a threatened asset in longer-term planning horizons.
- Identify urban expansion and intensification outside of the retreat zone as shown in Section 5.1.

5.2.4 Coastal foreshore reserve

A primary planning response to enable retreat from the vulnerable coastal area is through expansion of the coastal foreshore reserve. The current foreshore reserve in Port Hedland, with the exception of Pretty Pool, is insufficient in width to maintain the social and environmental functions of the reserve once erosion risk has been allowed for. Therefore, managed retreat cannot occur in Port Hedland without impacting on land use outside the current foreshore reserve.

The retreat zone identified in Section 5.1 nominally recommends a long-term (100 year) erosion hazard area plus an additional 20 metres as a future foreshore reserve. This takes into account that there is adaptive capacity within the foreshore for restabilisation following a rare event to maintain environmental values, and 20 metres is generally sufficient for public facilities, including playgrounds, access and parking, outside of the hazard area. The long-term coastal foreshore reserve should be identified in the local planning strategy, with triggers for implementation based on the recommendations of the CHRMAP.

If interim protection is implemented in the current planning horizon (for example, associated with the proposed marina development), then immediate expansion of the coastal foreshore will not be required with interim land use and development managed in accordance with the recommended special control area for the retreat zone. However when, following the design life of interim protection, risk again becomes intolerable, the coastal foreshore reserve should be extended as a trigger for managed retreat, including land acquisition. Following acquisition of land within the foreshore reserve, capital investment will be required for decommissioning assets and re-establishing the area for coastal foreshore purposes.

Port Hedland's coastal foreshore reserve is currently a 'Parks and Recreation' reserve in the local planning scheme. Future iterations of the Town's local planning scheme will be required to be consistent with model scheme provisions set out in the *Planning and Development (Local Planning Schemes) Regulations 2015*. None of the model reserve types set out in the model scheme provisions include objectives that articulate the importance of coastal risk management within foreshore reserves along the coast. In preparing the local planning strategy, the Town should consider the use of a special purpose reserve for the coastal foreshore area alongside the Port Hedland Townsite or include additional reserve objectives that recognise the importance of coastal hazard risk management to guide use and development of these areas.

5.2.5 Compensation and injurious affection

With the future implementation of managed retreat, the reservation of land to secure an appropriate foreshore or other reserve will provide a trigger for compensation (at the time of sale, a refused development application, or a development approval subject to unacceptable conditions) payable by the local government. Alternatively, land can be acquired by Local or State government. This is the appropriate trigger and mechanism to compensate loss of property values where private land is required to expand the foreshore reserve to address erosion issues. To ensure that acquisition or compensation costs are not increased over time

due to increased development potential, the CHRMAP recommends maintaining and not increasing density within the long-term retreat zone.

It is likely that support of the state and federal government will be required to fund land acquisition and capital works associated with managed retreat in the vulnerable coastal zone.

5.2.6 Foreshore management plans

Foreshore management plans can provide an implementation plan to deliver the strategic recommendations of the CHRMAP for particular foreshore reserves in Port Hedland. Foreshore management plans can be a key tool for communication and engagement with the community as they include detailed planning for community places and facilities.

To provide site-specific implementation guides for each coastal management unit in Port Hedland, the Town should prepare foreshore management plans that include:

- Identification, prioritisation, and funding of natural coastal and dune management techniques to enhance the ability of the natural system to buffer coastal processes;
- Consideration of sea level rise and coastal risk, defining relevant coastal planning triggers for the reserve and whether there is a need for the relocation or decommissioning of existing assets as required;
- Identification of appropriate, impermanent community facilities to meet demand for coastal infrastructure in the short-term;
- Policy requirements for development in the reserve, including:
 - Design life for assets to reflect risk timeframes;
 - Architectural and construction requirements for development to portray a temporary aesthetic, thereby communicating to the community the impermanent nature of facilities.
- Coastal interim protection works required in the short-term planning horizon, where recommended by this adaptation plan, including:
 - a plan detailing the location of protective structures;
 - estimated costs, maintenance responsibility, and impacts on the reserve; and
 - consideration of the requirements of SPP2.6, in particular clause 5.7 regarding coastal protection works.
- A long-term plan for the relocation of impermanent structures
- Recommended lease conditions for appropriate low-scale, temporary private use and development approved in accordance with SPP2.6 that:
 - Define lease duration in relation to risk levels and likely timeframe of triggers;
 - Clarify that lease renewals will be contingent on adaptation decisions at future trigger;
 - Require decommissioning of private assets at the expiry of a lease.

6. Review framework

6.1 Adaptation plan review

This plan should be reviewed regularly, alongside the review of the ToPH strategic plans and/or five-yearly reviews of local planning strategies.

Review processes should include targeted community and industry consultation to update values and views about coastal development and assets that will be at risk both within a 15-year planning horizon and beyond. Revised values and new learnings should be used to test recommendations of this adaptation plan, and determine whether adaptation strategies for the 15-year planning horizon require modification as a result of changing values.

The regular testing of values and adaptation measures will involve the following actions incorporated into the review of future strategic plans, for land and assets identified as being at risk within 15-years of the strategic plan review:

- Identification of any new or alternative adaptation options based on greater information and new technology;
- Review of criteria used in the multi-criteria assessment;
- Community, stakeholder and industry consultation on the weighting of criteria;
- Review of the weighted scoring of adaptation options;
- Confirmation of adaptation options for a 15-year planning horizon.

6.2 Future hazard assessment

It will be necessary to update the hazard mapping from time to time to reflect actual sea level rise, updated projections of future sea level rise and the response of the coast to changing conditions. These updates should occur as new information becomes available.

It is recommended that the erosion and inundation hazard assessment is updated following the release of the next IPCC assessment report which is expected in 2020/21.

7. References

Cardno (2011) Port Hedland Coastal Vulnerability Study: Final Report, Prepared for Landcorp.

Cardno (2013) Port Hedland Coastal Geomorphological, prepared for Town of Port Hedland.

MPR (2017) Goode St Dune Erosion Concept Management Options Study, prepared for Town of Port Hedland.

International Panel on Climate Change (2014) Fifth Assessment Report, New York USA.

Western Australian Planning Commission (2013) State Planning Policy No. 2.6 State Coastal Planning Policy.

Western Australian Planning Commission and Department of Planning (2014) Coastal hazard risk management and adaptation planning guidelines, Perth Australia.

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Limitations

This report: has been prepared by GHD for the Town of Port Hedland and may only be used and relied on by Town of Port Hedland for the purpose agreed between GHD and the Town of Port Hedland.

GHD otherwise disclaims responsibility to any person other than Town of Port Hedland arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by the Town of Port Hedland and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The purpose of estimating the coastal hazards of erosion and inundation in this study is to assess the risks to coastal assets and values to assist in the analysis of coastal adaptation solutions and is not to be used for the purpose of determining coastal setback distances for new development.

Climate change is a significant current and future issue and effects, such as sea level rise, are at this stage difficult to quantify to a high degree of certainty. The following assumptions have been made during the preparation of this report:

- *The sole purpose of the reports are for evaluating coastal hazard risks and developing adaptation plans associated with coastal hazards and sea level rise for the Town of Port Hedland.*
- *The reports are produced for use by the Town of Port Hedland, and are not for use by any third party person or organisation. The information and recommendations are to be read and considered holistically, and content is not to be used selectively for purposes other than coastal hazard risk management (e.g. design) as this may misrepresent the data and processes herein and provide erroneous project or decision outcomes.*
- *The data and processes herein are to be used for coastal hazard risk assessment and adaptation planning purposes, approved by the Town of Port Hedland, and based on Australian and state government guidelines:*
 - *Western Australian Planning Commission and Department of Planning (2014). Coastal hazard risk management and adaptation planning guidelines, Perth, Australia.*
 - *Western Australian Planning Commission (2013). State Planning Policy No. 2.6 State Coastal Planning Policy.*
 - *Western Australian Planning Commission (2013), State Coastal Planning Policy Guidelines.*

These guidelines have been considered as per the requirements of the brief. This information has not been independently verified. Assumptions and recommendations that need further testing are noted in the text of the report.

- *The establishment of the sea level rise aspects of the project uses data and scenarios based on publicly available information by the International Panel on Climate Change, summarised by the Western Australian Department of Transport:*
 - *Bicknell (2010). Sea Level Change in Western Australia: Application to Coastal Planning, prepared by the Department of Transport, Fremantle, WA.*
- *Climate change and coastal hazard assessment by its nature is a dynamic and ongoing process. As the sea level rise projections used are uncertain by nature, it is possible that the effects that actually occur may not be as assumed and stated in this exercise. Therefore, it is recommended that Town of Port Hedland routinely incorporate the latest climate change science and sea level rise cause and effect knowledge into all future planning.*

GHD has prepared the indicative order of magnitude costs set out in section 0 of this report using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD based on capital and maintenance costs of similar foreshore stabilisation projects in Western Australia.

The Cost Estimate has been prepared for the purpose of comparing the feasibility of the different adaptation options in the Multi Criteria Analysis and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the works can or will be undertaken at a cost which is the same or less than the Cost Estimate.

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<https://projects.ghd.com/oc/WesternAustralia/porthedlandchrmap/Delivery/Documents/6136239-REP-F-Draft CHRMAP.docx>

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Revision	Author	Reviewer		Approved for Issue		
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C	G Bertrand C Thompson	H O'Keeffe	On file	C Thompson	On file	18/05/2018
D	G Bertrand C Thompson	C Hart	On file	C Thompson	On file	13/07/2018
E		N Hoey	On file	C Thompson	On file	27/07/2018
F	J Lee C Hart C Thompson	H O'Keeffe		S Hosseini		01/10/2018

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