



Cossack Coastal Hazard Risk Management Adaptation Plan

November 2017



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Contents

1. Introduction	1	8. Key Elements (Assets)	27
2. Purpose of the CHRMAP	3	9. Success Criteria	29
3. Objectives	5	10. Coastal Hazard Summary	31
4. Scope	7	11. Risk Analysis and Evaluation	33
5. Study Area	9	11.1 Risk Analysis	33
6. Community and Stakeholder Engagement Strategy and Outcomes	15	11.2 Risk Evaluation	37
6.1 Policy Context for Stakeholder and Community Engagement	15	11.3 Risk Evaluation by Precinct	38
6.2 Purpose and Objectives	15	12. Adaptation Options	39
6.3 Stakeholder Identification and Analysis	15	12.1 Risk Management and Adaptation	39
6.4 Overview Approach to Communications and Engagement	16	13. Implementation Plan	45
6.5 Engagement Outcomes	17	Modification to Scheme Maps	47
7. Existing Planning Framework and Controls	21	14. Monitoring and Review	49
7.1 Planning and Development (Local Planning Schemes) Regulations 2015	21	14.1 Aerial Photography	49
7.2 State Planning Policy 2.6 – State Coastal Planning Policy	22	14.2 Beach Profile Data	49
7.3 Pilbara Planning and Infrastructure Framework	23	14.3 Beach Photography	50
7.4 City of Karratha Local Planning Strategy	23	14.4 Geotechnical Assessment	50
7.5 Local Planning Scheme No. 8	23	14.5 Emergency Response Planning	50
7.6 DP19 Storm Surge Risk Local Planning Policy	24	14.6 Requirements for Review	50
7.7 Conclusions	25	Appendix A	51
		Site Photography	51
		Appendix B	71
		Coastal Hazard Mapping	71
		Appendix C	75
		GHD Geotechnical	75

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1. Introduction

Cossack is an historic settlement located approximately 15km north-east of Roebourne within the City of Karratha. The nearest town to Cossack is Wickham, located approximately 4 km to the West. Cossack is now a recreation and tourism attraction, popular for fishing and heritage tourism attraction. Backpacker accommodation and a café operate from Cossack for parts of the year. Cossack also hosts events including the annual Cossack Art Awards, which is the largest art awards event in regional Western Australia.

Refer to Figure 1 – Location Plan

The historic settlement of Cossack is primarily located on Crown land leased to the City of Karratha, with a number of freehold lots owned by private landowners and a portion of Unallocated Crown Land (UCL).

The State government has leased land within the Cossack locality to the City of Karratha. The City has recently agreed to a three year lease extension to provide the City with additional time to assess whether it can progress plans to rejuvenate Cossack. To implement this, this City's Local Planning Scheme No.8 (the Scheme) needs to be amended to remove restrictions to development while also establishing agreed coastal adaptation measures to respond to the risk of coastal processes. The Department of Planning, Lands, and Heritage (DLPH) have advised the City that a Coastal Hazard Risk Management Adaptation Plan (CHRMAP) is required to support any proposal to amend the Scheme to provide for future development at Cossack.

The City of Karratha has recently completed a Coastal Hazard Study for the Cossack coastline, which was prepared in accordance with State Planning Policy 2.6 – State Coastal Planning Policy (SPP 2.6).

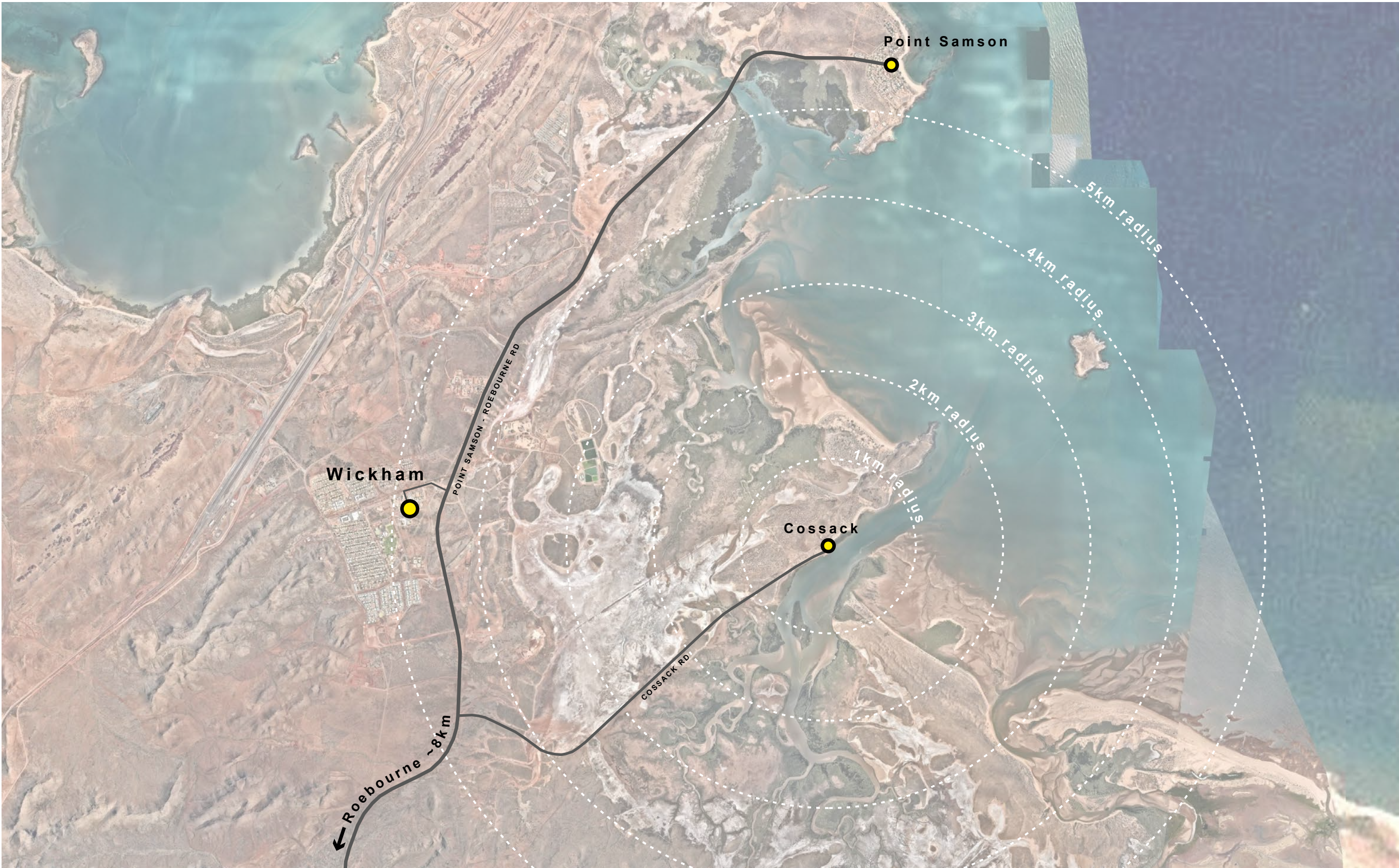
SPP2.6 identifies that there are a variety of coastal landforms and typologies along the coastline. This includes typical sandy coastlines as well as rocky coasts and estuarine environments. However, whilst different landforms are acknowledged, the assessment

methodology for coastal erosion hazards is limited to the assessment of the shoreline as either a sandy or rocky coastline.

The coastline fronting Cossack sits within Butchers Inlet and therefore does not meet the classification of a sandy coastline. Furthermore, sections of rock are evident along the shoreline, however the extent of this rock is not consistent enough to meet the definition of a rocky shoreline within SPP2.6. The exception to this is the northern portion of the site, which is consistent rock and has been assessed as such.

The absence of a specific methodology for the assessment of coastal erosion hazards on a shoreline such as that fronting Cossack means that the shoreline needs to be assessed as a sandy shoreline under the policy, despite the expected coastal response being markedly different to a true sandy shoreline. The outcomes of the coastal hazard assessment are therefore likely to be conservative and may lead to areas being identified as vulnerable to coastal erosion when in reality they are not.

Figure 1. Location Plan



2. Purpose of the CHRMAP

The City of Karratha (the City) Council adopted the Cossack Visioning Study in 2015. This visioning study illustrates a preferred development concept for tourism related facilities in and around the historic Cossack townsite. This vision promotes the establishment of a range of tourist accommodation options; from a camp ground / caravan park to concealed campsites, glamping sites and shack like cabins.

The Cossack Visioning Study is supported by Cossack Development Guidelines, which broadly recognises the development potential and property interests of freehold lot owners.

The City commissioned MP Rogers and Associates to prepare storm surge modelling and mapping for Cossack to understand the risk and how it should be featured into future planning for Cossack.

At the request of the DLPH and the Western Australian Planning Commission (WAPC) Chairman, the City commissioned TPG+Place Match and MP Rogers and Associates to prepare a CHRMAP to consider how the risk of Coastal processes can be managed.

The City has been managing Cossack since 1996 when a 21 year lease agreement was entered into with the State. This lease agreement has recently been extended on a short term basis. Further extension to the City managing Cossack on behalf of the State is pending the outcome of this and other strategic documents.

It is necessary to define the likelihood and consequence of storm surge and coastal erosion on the Cossack townsite in order to better inform future management and adaptation approaches for the existing townsite and future development opportunities.

Depending on the ability of the City to implement the vision for Cossack and the support available to maintain Cossack's heritage values, the City will determine whether it will continue to play a role in managing Cossack when the current lease expires.

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3. Objectives

The following objectives have been developed to guide the preparation of the CHRMAP for Cossack:

1. To ensure that any future tourism development and associated infrastructure is not exposed to an unacceptable level of risk of impact by coastal processes.
2. Involve key stakeholders in the process of developing a CHRMAP for Cossack.
3. Identify community, cultural, environmental and economic values and assets within the coastal zone.
4. Determine the likelihood and consequence of the adverse impacts of coastal hazards on the identified assets, and assign a level of risk.
5. Identify a comprehensive range of adaptation measures that address the risk of coastal processes and subject these adaptation measures to a multi-criteria analysis to define those adaptation measures that are most desirable and appropriate for identified assets within the coastal zone.
6. Develop appropriate adaptation responses to generally facilitate the preferred development concept within the Cossack Visioning Study and Development Guidelines.
7. Provide guidance for the preparation of statutory planning controls.
8. Prepare an implementation and monitoring framework to support delivery of the CHRMAP recommendations.

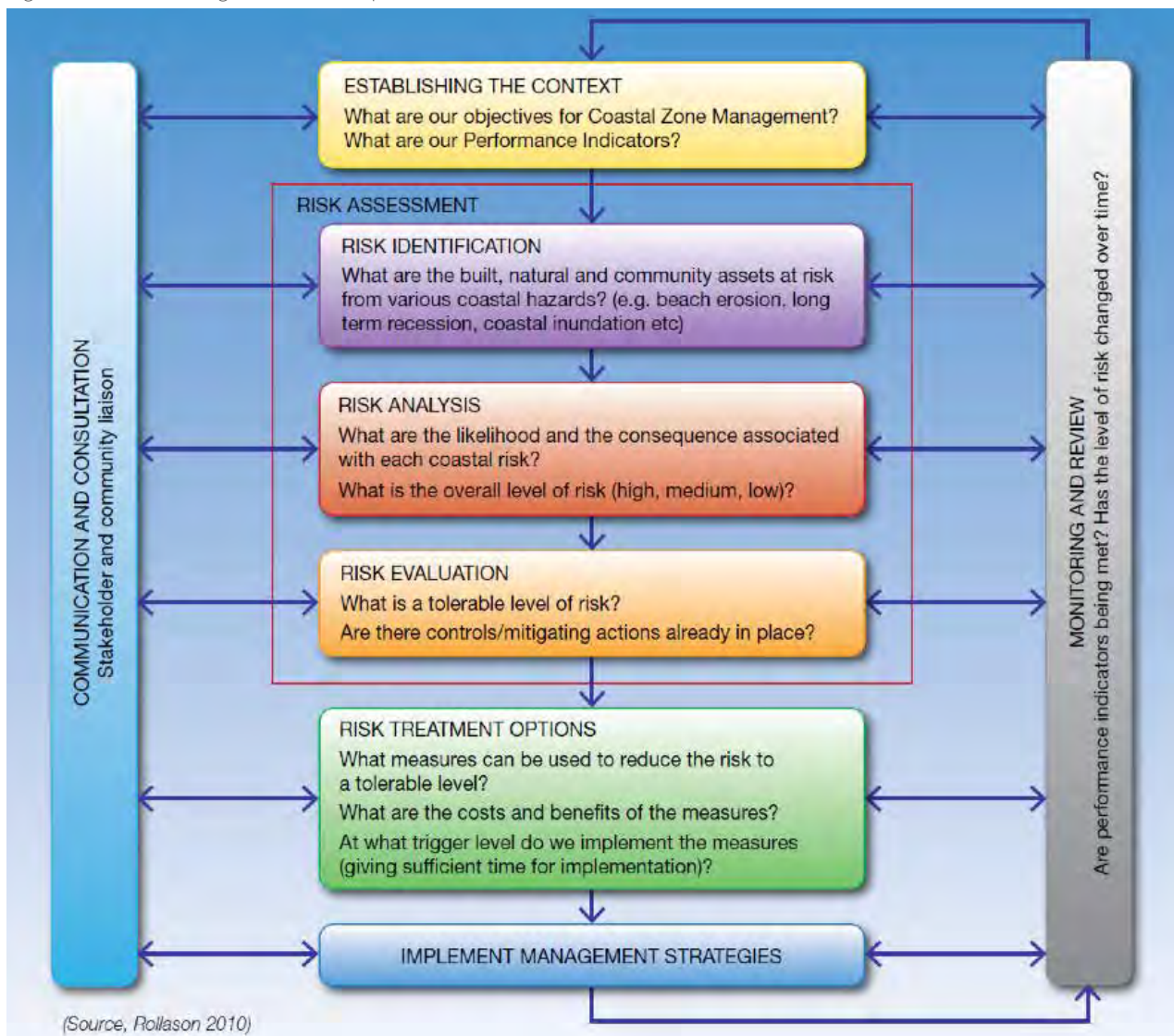
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4. Scope

The CHRMAP Guidelines (WAPC, 2014) provide a specific framework for the preparation of a CHRMAP. This is outlined in the flowchart presented in Figure 2 which shows the risk management and adaptation process.

Refer to Figure 2 - Risk Management and Adaptation Process

Figure 2. Risk Management and Adaptation Process



The development of the CHRMAP has been informed by the assessment of the coastal erosion and inundation hazards. The CHRMAP specifically applies to the coastal zone as defined by the inundation and coastal erosion hazard mapping prepared by MP Rogers for the study area. The Coastal Hazard Mapping is continued at Appendix B.

This CHRMAP considers the potential risks posed by coastal inundation and erosion over a range of timeframes covering a 100 year planning horizon to the year 2117.

Intermediate planning horizons will also be considered in order to assess how risk profiles may change in the future and to inform the requirement for adaptation strategies. Intermediate planning horizons that have been considered are outlined below.

- 25 years to 2042.
- 50 years to 2067.
- 75 years to 2092.
- 100 years to 2117.

The present day risks and adaptation requirements have also been considered.

Based on the results of the risk assessment, risk mitigation and adaptation strategies will be developed, where required, to provide a framework for future management. However, it is important to realise that the risk assessment will be based on the outcomes of the coastal hazard study which, by their nature, are justifiably conservative. In this particular instance, the level of conservatism is expected to be even higher than usual given the requirement to assess the coastal erosion hazards using a methodology that is applicable to a sandy coastline, not a predominately riverine shoreline such as that present within Butchers Inlet. The presence of rock, which through completion of a preliminary geotechnical assessment has been identified in some areas at a level sufficient to meet the classification of a rocky shoreline in SPP2.6, further reduces the risk profile in some areas. Moreover, it is expected that additional geotechnical assessments could identify further areas of competent rock which would further reduce the risk profile in these areas.

Given the high levels of uncertainty regarding the future coastal response as a result of coastal erosion hazards, due to the issues outlined above, the framework for

future risk management strategies should be considered to be a guide for future requirements.

The consideration of existing rock on the shoreline is particularly relevant in this regard, as even though the extent of visible rock is not sufficient for all of the shoreline to be classified as “rocky” under SPP2.6, the rock that is present will have an impact on future coastal movement. In this regard, the risk assessment has considered the impact of this rock on the potential for future shoreline movement. The risk assessment has given careful consideration of the likelihood of the coastal hazard lines being realised over the various planning horizons, given the presence of the rock.

The actual requirement for implementation of these management actions should ultimately be informed by a coastal monitoring regime. The purpose of this coastal monitoring regime would be to identify changes in the shoreline or sea level that could alter, either positively or negatively, the risk exposure of the key assets.

The scope of this CHRMAP has been developed to respond to two primary considerations:

1. To address potential impacts from coastal erosion and inundation hazards on existing assets (environmental, social, economic) within the study area; and
2. To inform future land use planning in relation to implementing the preferred development outcome for Cossack.

Due to the primarily vacant nature of the existing Cossack settlement within the Cossack Heritage Precinct, it is not considered necessary to undertake a comprehensive Cost Benefit Analysis of the proposed adaptation responses, instead, this study will rely on a multi-criteria analysis.

5. Study Area

The study area for this CHRMAP is illustrated in Figure 3 and generally includes the historic Cossack townsite, the banks of Butcher's inlet which bounds Cossack and includes Cossack Road up to its termination point with the intersection of Point Samson-Roebourne Road.

Cossack is located on an elevated land area which is surrounded by water during high water level events. The presence of Cape Lambert and Point Samson to its north provide protection to Cossack against wave attack from the north through west.

Figure 3. Study Area



The north eastern peninsular of the land area is predominantly rock, containing only a couple of small sandy beaches. The presence of non-erodible rock along this shoreline is evidenced by the long term stability of the peninsula. This section of shoreline is highlighted in Figure 4. The outlook from the rocky peninsula is shown in Figure 5.

Figure 4. Cossack Shoreline



Figure 5. Rocky Peninsula - North East Cossack



Sandy beaches and mudflats span the land area either side of the rocky peninsula. Mangroves and salt bush thrive on these sections of the shoreline due to the irregular inundation conditions. Access to Cossack is via Cossack Road, which is a causeway constructed over the intertidal flats. Figure 6 shows a portion of this causeway and partially inundated Salt Bush present at the southern end of the Cossack land area. Some small rock and rubble that provides protection to Cossack Road is also visible in this photo.

Figure 6. Cossack Road & Partially Inundated Salt Marsh – South Cossack



Adhoc rock protection is present closer to Cossack town site. This provides a level of protection against erosion. The extent and a photograph of the adhoc rock protection are shown in Figures 7 and 8 respectively.

Figure 7. Location of Adhoc Rock Protection South West of Cossack Townsite



Figure 8. Photograph of Adhoc Rock Protection South West of Cossack Townsite



The existing infrastructure in Cossack consists of heritage buildings, a lookout, wharf, roads and archaeological remains. Present day photographs of the wharf, constructed in 1894, are shown in the figures below. The photographs of the wharf show that some level of deterioration is occurring along the face of the wharf.

Figure 9. Cossack Wharf



Figure 10. Cossack Wharf



The figure below shows the wharf and remainder of the heritage buildings in the existing historic townsite.

Figure 11. Cossack's Existing Historic Townsite



The study area for this CHRMAP will cover the entire Cossack land area as presented in Figure 3, as well as Cossack Road which provides the only reliable means of land based access to the site.

A comprehensive record of site photography of the Cossack coastline and terrain is contained at Appendix A.

Refer to Appendix A – Site Photography

6. Community and Stakeholder Engagement Strategy and Outcomes

6.1 Policy Context for Stakeholder and Community Engagement

State Planning Policy 2.6: State Coastal Planning Policy (SPP2.6) provides guidance for coastal management and decision-making across the state as well as providing the policy requirement for stakeholder engagement when preparing coastal management documents.

Clause 5.8 of SPP2.6 requires public interests to be considered in coastal planning. This includes ensuring that adequate opportunity is provided to enable the community to participate in coastal planning and management; and that community consultation and engagement strategies are developed to encourage informed community input into the decision-making process.

The DPLH's Coastal Hazard Risk Management and Adaptation Planning Guidelines provide further guidance with respect to engagement and consultation expectations.

6.2 Purpose and Objectives

6.2.1 Purpose

Community and stakeholder engagement has a number of identifiable benefits that can be realised during the course of this project. In summary, the purpose of this engagement plan is:

- To ensure that the CHRMAP takes into account not only existing assets within the coastal zone but also examines implications in relation to delivery of the Cossack Vision.
- To provide the opportunity for the local community and stakeholders to contribute to the preparation of the CHRMAP.

This engagement strategy seeks to consult directly with Landowners of the freehold lots within Cossack, as it is their development rights and interests that have the potential to be the most greatly affected. The wider community is proposed to be consulted by way of Public Consultation of the draft CHRMAP report.

6.2.2 Objectives

- Community members and their representatives affected by coastal hazard processes in Cossack to be provided with the opportunity to influence adaptation responses to those identified risks.
- Different stakeholder perspectives to be considered during engagement. This includes engaging in a way that suits preferences and needs of stakeholders.
- Stakeholders to gain a clear understanding of the purpose of the engagement and be provided sufficient information and enough time to contribute effectively.
- To undertake ongoing and effective communication through the life of the project, including provision of follow-up feedback after engagement has concluded.

6.3 Stakeholder Identification and Analysis

6.3.1 Identification

Understanding who the project stakeholders are is a critical element of any project or programme. By understanding who these individuals and groups are, it is possible to understand what degree of influence and thus involvement they will and should have as part of the project.

Stakeholders have been identified and broadly grouped as follows:

- City of Karratha Council and Staff;
- Affected landowners and lessees;
- Government departments and service authorities;
- Ngarluma Aboriginal Corporation (NAC);
- Community interest groups (Cossack Advisory Group); and
- Local residents and the broader community (to have the opportunity for input during the public advertising of the CHRMAP report).

6.3.2 Analysis

Analysing the stakeholders is an essential part of developing an engagement plan. The following Stakeholder Matrix provides an assessment of the level of influence each group has, their recommended level of engagement and the most appropriate method to engage with them.

Stakeholder Matrix Diagram

High Influence	B Manage Closely	A Keep Satisfied
Low Influence	D Monitor (Minimum Effort)	C Keep Informed
	Low Interest	High Interest

A	High influence, highly interested people: these are the people you must fully engage and make the greatest efforts to satisfy.
B	High influence, less interested people: work in with these people to keep them informed and satisfied, but not so much that they become bored with your message.
C	Low influence, interested people: keep these people adequately informed and talk to them to ensure that no major issues are arising. These people can often be very helpful with the detail of your project.
D	Low influence, less interested people: again, monitor these people, but do not bore them with excessive communication.

6.3.3 Stakeholder Analysis

A detailed stakeholder analysis table has been undertaken by the City. A brief summary of this analysis is provided below:

Stakeholder Group	Level of Influence / Interest
Councillors	A
City Staff	B
Cossack Advisory Group	A
Government Department and Service Authorities	A - C
Affected Landowners	A
Affected Lessees	B
Ngarluma Aboriginal Corporation (NAC)	B
Broader Community	D

6.4 Overview Approach to Communications and Engagement

The stakeholder and community engagement activities are being delivered primarily by the City of Karratha, with support from TPG+Place Match. The engagement will inform the CHRMAP development through a program that engages the key stakeholders and community to:

- Identify the values of the coastal assets; and
- Identify the tolerance of the identified coastal hazard risks.

6.4.1 Cossack CHRMAP Engagement Tools

Landowner Information Pack: A Landowner Information Pack was prepared by TPG+Place Match and sent out to landowners of freehold land to raise awareness of the project and inform landowners of the issues, context and technical components of the CHRMAP.

Letter Mail Outs, Newspaper Notice, Website Notice and Facebook: These tools were used to raise general community awareness for the project and to seek feedback on the draft CHRMAP report during public advertising of the document. The CHRMAP will be available for review along with the associated scheme amendment.

Cossack Advisory Group and Workshop Session: A targeted information and workshop session was held with the Cossack Advisory Group. This session took participants through a logical process of understanding the issues, the context and the technical components of the Coastal Hazard Risk Management and Adaptation Plan and encourage the group to identify assets (social, economic, environmental) and to articulate risk tolerances and community values of assets. The range of adaptation options were also presented to this group to define preferred adaptation responses to the coastal risks.

Landowner Information Session: Landowners of freehold land were invited to attend an information session. This session took participants through a logical process of understanding the issues, the context and the technical components of the Coastal Hazard Risk Management and Adaptation Plan and encourage the group to identify assets (social, economic, environmental) and to articulate risk tolerances and community values of assets. The range of adaptation options were also presented to this group to define preferred adaptation responses to the coastal risks.

Email Based Survey: An email survey was used to obtain focused stakeholder input. The survey has used to identify key assets within the coastal zone and to obtain preferred development intentions for private land and to ascertain preferred adaptation responses.

Council Briefings: Communication materials will be prepared and provided to Council and the City's relevant staff at key milestones in the project based on the relevance of the information.

Government department and servicing authority communication: Written and/or verbal communication was undertaken with relevant government departments where deemed necessary to gain input and guidance into the preparation of the Cossack CHRMAP.

Council Meetings: The draft CHRMAP and Scheme Amendment will be put forward to Council for consideration to adopt the document for public advertising and again to finally adopt the documents following public consultation.

6.5 Engagement Outcomes

6.5.1 Cossack Advisory Group

The Cossack Advisory Group (CAG) was established by the Shire of Roebourne on 28th October 2013, under Council resolution number- 152640.

The overall aim of the Cossack Advisory Group is to enable elected members and officers to work together in setting and implementing a shared vision for the historical village of Cossack.

The CAG has met on seven (7) separate occasions since 16 April 2014, with the most recent meeting held on the 7 September 2017 to consider the coastal hazard mapping undertaken by MP Rogers.

6.5.2 Landowner Information Session

The City of Karratha organised invitations to be sent out to all landowners of freehold land and lessees to attend an information session so that these key stakeholders could be informed of the key issues relating to coastal hazards at Cossack prior to providing input and feedback into the adaptation process.

Landowners and lessees were sent an information pack ahead of the session so that they could review and inform themselves of the background material and information.

The information session was held via teleconference on the 12 September 2017, with a total of 10 landowners participating in the session. A record of attendance is provided below.

Attendees

Vikki Bull	Landowner
Shane Donovan	Landowner
James (Jim) Davies	Landowner
James Montesana	Landowner
Sarah Corr	Landowner
Stuart Otto	Landowner
Michelle Otto	Landowner
Terry Patterson	Landowner
Alan Wilson	Landowner
Geoffrey Van Waardenberg	Landowner

Bruce Jorgenson	Chief Executive Officer, NYFL
Bob Bongiorno	Manager, Hospitality & Tourism, NYFL
Jerom Hurley	Manager Planning Services (Chair), CoK
Chaz Roberts	Senior Planner, CoK
Anthony Wear	Manager Recreation Facilities, CoK
Mike Davis	Planning Consultant, TPG+Place Match
Clint Doak	Coastal Engineer, MP Rogers

Apologies

Jonathon Earnshaw	Landowner
Bronwen Markham	Trustee

The key objectives of the information session were:

- To inform landowners of Coastal Hazard Management Adaptation Planning and how it applies to their interests in Cossack.
- To inform landowners of the coastal hazard mapping undertaken for Cossack and how it applies to their property.
- To provide sufficient information to allow landowners to review their development intentions for their property and to consider proposed adaptation responses to the risk of coastal storm surge inundation and coastal erosion.

General Discussion Points

Much of the open discussion generated by the landowner participants centred around Cossack's geomorphology. Participants raised the point that most of Cossack is founded on hard rock and asked the question as to why Cossack was being treated as a sandy coastline when clearly it was a rocky coastline in their view.

Participants also noted that Cossack is a historical settlement with buildings remaining after being constructed 150 years ago. If the buildings have lasted 150 years, why is the modelling of storm surge and coastal erosion in particular showing removal of the Cossack settlement?

Participants were advised that the storm surge and erosion calculations are based on parameters set by State Planning Policy 2.6 and that further more detailed geotechnical analysis would be required to determine the extent of rock to determine whether Cossack could be classed as a rocky shoreline or not.

6.5.3 Landowner Survey

Following the landowner and lessee information session, landowners and lessees were sent a survey via email, which sought responses to the following questions:

1. What property/s do you own in Cossack?
2. What are your development intentions for this property / each property owned?
3. How do you intend on providing essential services (water, power, wastewater) to the property?
4. Recognising that the coastal erosion risk modelling has been prepared in accordance with guidance provided by the Department of Planning, Lands and Heritage, how would you address the modelled coastal erosion risk as it relates to your property in planning for its future use and development? (Please answer this in the context of the adaptation options discussed – Avoidance, Planned / Managed Retreat, Accommodation, Protection, and give examples of things you would do to manage risk).
5. How would you address the modelled storm surge risk as it relates to your property in planning for its future use and development? (Please answer this in the context of the adaptation options discussed – Avoidance, Planned / Managed Retreat, Accommodation, Protection, and give examples of things you would do to manage the risk).

A total of four surveys were completed and returned to the City. The landowners who completed these forms own a majority of the freehold land located within Cossack, and include ownership of the following properties.

Landowner Details	Lots under ownership
Terry Patterson	Lot 151 Perseverance Street, Cossack Lot 152 Perseverance Street, Cossack Lot 153 Perseverance Street, Cossack Lot 167 Cossack Road, Cossack Lot 144 Cossack Road, Cossack Lot 145 Cossack Road, Cossack Lot 20 Perseverance Street, Cossack Pt Lot 121 Cossack Road, Cossack
Stuart and Michelle Otto	Lot 149 Perseverance Street, Cossack
Geoff Van Waardengerg	Lot 150 Perseverance Street, Cossack
Alan Wilson (Executor of Estate of Helen Margaret Wilson)	Lot 112 Lot 116 Lot 117 Lot 165

All four submissions received acknowledged the risk of storm surge and coastal erosion on Cossack. In responding to this risk, the landowners have proposed a managed retreat option for all lots at risk of coastal erosion, which is summarised for the relevant properties as outlined in the following table:

Lot number	Proposed Development and Adaptation Response
Pt Lot 121	Adaptation Response: Accommodate <ul style="list-style-type: none"> Permanent commercial structure (i.e. micro brewery)
Lots 144,145,149, 150, 151-153 Perseverance Street	Adaptation Response: Planned and Managed Retreat <ul style="list-style-type: none"> Self contained transportable buildings, one for use as a dwelling and the others for short stay accommodation. Power: Solar panels and back up generator Sewer: Onsite Septic System Water: Rainwater tanks
Lot 165 and 167 Perseverance Street	Adaptation Response: Planned and Managed Retreat <ul style="list-style-type: none"> 'Glamping' tents and temporary service infrastructure
Lot 116 and 117	Adaptation Response: Planned and Managed Retreat <ul style="list-style-type: none"> Design of structures to accommodate storm surge events. Removable eco tents at rear of properties facing Perseverance Street. On-site services which may be decommissioned and removed once threat of coastal erosion is more imminent.
Lot 112	Adaptation Response: Accommodate <ul style="list-style-type: none"> Permanent dwelling structure proposed.

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7. Existing Planning Framework and Controls

7.1 Planning and Development (Local Planning Schemes) Regulations 2015

The *Planning and Development (Local Planning Schemes) Regulations 2015* (the Regulations) were gazetted in 2015 and contain both model provisions for local planning schemes (Schedule 1 of the regulations) and ‘deemed’ provisions (Schedule 2). These Regulations ensure that there is greater consistency for local planning schemes across the State with respect to structure, format and provisions.

The ‘deemed’ provisions of the Regulations automatically apply to all local government planning schemes throughout the State and supersede corresponding provisions of these schemes.

Schedule 2 of the Regulations establish planning mechanisms which may be used to control land use and development, and the applicability, including advantages and disadvantages of these mechanisms to coastal hazard and adaptation planning at Cossack is identified in Table 1.

Table 1: Statutory Mechanisms

Statutory Mechanism	Advantages	Disadvantages
Structure Plan / Activity Centre Plan	<ul style="list-style-type: none">• Can address location specific issues i.e. identification of coastal physical setbacks and areas affected by storm surge.• Can define the appropriate location for various land uses and development on the basis of the above.	<ul style="list-style-type: none">• Does not have the force and effect of the Scheme. Decision makers to have due regard only.• Would require a scheme amendment to appropriately zone Cossack to allow implementation of a Structure Plan.• Cannot vary R-Code requirements and is limited in its application to redefine building and development standards to respond to storm surge inundation.
Local Development Plan	<ul style="list-style-type: none">• Can specify built form requirements to address location specific coastal hazard issues i.e. increased setbacks, minimum habitable floor levels etc• Has statutory weight of the local planning scheme.• Can vary R-Code ‘deemed-to-comply’ development requirements to address particular design issues relating to storm surge inundation.	<ul style="list-style-type: none">• Location specific only and therefore cannot address coastal hazard issues on a broad scale.• Limited in its control over the location of specific land uses otherwise permitted by the Scheme.

Statutory Mechanism	Advantages	Disadvantages
Local Planning Policy	<ul style="list-style-type: none"> • Can address coastal hazard and risk issues at a district (broad) level and/or at a location specific level. • Can give statutory weight to mapping of coastal hazard issues with flexibility to update mapping as and when mapping is updated. • Has the statutory weight of the local planning scheme. • Can vary R-Code 'deemed-to-comply' development requirements to address particular design issues relating to storm surge inundation. • The City of Karratha has an existing storm surge local planning policy (DP19) which may be able to be adapted and modified to include requirements for Cossack. 	<ul style="list-style-type: none"> • Cannot define the location of specific land uses otherwise permitted by the Scheme and therefore a separate scheme amendment will be required to modify zoning following recommendations of the CHRMAP.
Special Control Area	<ul style="list-style-type: none"> • Special Control Areas (SCAs) may establish specific provisions to address a specific issue such as storm surge and coastal processes. • SCAs can broadly address unique issues that extend across multiple zones and / or reserves. • SCAs can be introduced to provide location specific planning controls. • Has statutory weight of the local planning scheme. • Can delineate a line on the map that corresponds with the extent of the coastal zone / identified coastal issue/s. 	<ul style="list-style-type: none"> • A scheme amendment would potentially need to be progressed every time mapping of the coastal issue is amended in response to new data.
General Development Provisions	<ul style="list-style-type: none"> • May establish development provisions relating to coastal hazard and risk issues. 	<ul style="list-style-type: none"> • Due to the unique nature of coastal hazard and risk issues and the varied locational extent of the issues, it is considered that development provisions would more effectively be dealt with by way of a SCA as opposed to a general development provision of the Scheme.

7.2 State Planning Policy 2.6 – State Coastal Planning Policy

State Planning Policy 2.6 – State Coastal Planning Policy (SPP 2.6) and associated guidelines have been prepared to guide decision making and policy in relation to planning along the State's coastline.

SPP2.6, provides policy on the determination of an appropriate foreshore reserve, which acts as a coastal buffer to accommodate coastal processes as a result of coastal erosion and risk or storm surge inundation in future planning periods.

SPP2.6 seeks to ensure coastal hazard risk management and adaptation planning is established to guide the location and form of development along the coast. The policy establishes a hierarchy for undertaking coastal hazard and risk adaptation planning. The adaptation measures of Avoid, Planned or Managed Retreat, Accommodate and Protect are to operate on a

sequential and preferential basis starting with avoid as part of the coastal hazard risk management adaptation planning process.

The State Coastal Planning Policy guidelines were introduced to support draft SPP 2.6. These guidelines identify a range of ongoing risk management and adaption planning measures that may be considered in the assessment of development proposals located within an area known to be subject to storm surge risk or coastal erosion hazard. The guidelines establish a process for undertaking CHRMAP, as follows:

1. Establish the context;
2. Undertake a risk vulnerability assessment;
3. Determine the likelihood of the hazard occurring;
4. Determine the consequences;
5. Evaluate the risks;
6. Set in place adaption management measures; and
7. Undertake monitoring and review.

Section 77 of the Planning and Development Act 2005 requires that local governments when preparing or amending a local planning scheme, to have due regard to relevant State policies and guidelines such as SPP 2.6.

In addition, SPP 2.6 provides for the identification of coastal nodes, whereby appropriate types of development and land use may be permitted within the coastal zone and foreshore reserve. Clause 7.5 of SPP 2.6 states:

‘The need for the provision of coastal nodes on the coast is recognised and should provide for a range of facilities to benefit the broader public. Such nodes may be developed within the coastal foreshore reserve but should only be located where identified in a strategic plan. Nodes should be located on stable areas; should have no negative impacts on the adjacent environment; and should avoid areas of high natural landscape or resource value.’

SPP 2.6 defines a coastal node as being:

‘a distinct and discrete built area that may be located within a coastal foreshore reserve. Excluding permanent residential development, it may vary in size from a grouping of recreational facilities to an area of commercial or tourism facilities or accommodation.’

It is considered that Cossack falls within the definition of a coastal node pursuant to SPP 2.6 on the basis that it has been identified in a planning strategy as a coastal settlement node for tourism purposes (City’s LPS and Pilbara Planning and Infrastructure Framework).

7.3 Pilbara Planning and Infrastructure Framework

The Pilbara Planning and Infrastructure Framework (the Framework) was prepared by the Western Australian Planning Commission in 2012. The Framework identifies a settlement hierarchy for the Pilbara and within this hierarchy, Cossack is acknowledged as a Village. This high level Framework supports the principle that Cossack is appropriate to be identified as a coastal node in accordance with SPP 2.6.

The Framework also recognises the need to maintain the region’s urban heritage, in particular Cossack and other historic settlements. As part of this objective, the Framework identifies an action to plan and develop Cossack as a ‘living’ heritage village.

7.4 City of Karratha Local Planning Strategy

The City of Karratha Local Planning Strategy (LPS) was adopted in June 2015 and provides the strategic planning direction for land use planning and development within the District over a 15 year planning horizon. While not a statutory document, it does establish strategic direction for planning of the various localities within the City.

It is important to note that the LPS identifies Cossack as a Tourist and Recreational Development Node, suitable for limited low impact tourist accommodation in accordance with the Cossack Visioning Study.

This is important as State Planning Policy 2.6 – State Coastal Planning Policy (SPP2.6) recognises that coastal nodes are appropriate in instances and may be developed within the coastal foreshore reserve where appropriately identified in a strategic plan.

7.5 Local Planning Scheme No. 8

The City’s Local Planning Scheme No. 8 (LPS 8) contains the following relevant provisions relevant to Cossack.

Zoning

The central portion of the Cossack Heritage Precinct is zoned for ‘Tourism’.

A number of lots located on Cossack Road and Perseverance Street are zoned ‘Development Area’ (DA 23), which has the following conditions attached to it:

1. *Development to be for residential and community purposes.*
2. *Development subject to the provision of adequate essential services and coastal vulnerability studies.*
3. *Further development of the Cossack townsite is restricted until such time as the above items are adequately addressed.*

This CHRMAP directly responds to item 2 above.

The remainder of the leasehold land within Cossack is reserved for ‘Conservation recreation and natural landscapes’.

Cossack Objectives

LPS 8 identifies the following objectives for Cossack:

- i. *Preserve the heritage values of Cossack.*
- ii. *Develop the Cossack Town Centre into a viable historic tourist centre with due regard to the natural and built environment.*
- iii. *Facilitate the return of Cossack into a “living” town offering an alternative residential setting based on its coastal and historic values.*
- iv. *Develop Settlers Beach into a tourist and recreational node.*

These development objectives are clearly impacted by the identified threat of coastal erosion and to a lesser extent storm surge to the historic Cossack townsite.

Cossack Historic Town Provisions

Clause 7.6 of LPS 8 establishes a Special Control Area over the Cossack Heritage Precinct. These provisions do not specifically relate to the issue of coastal hazards, however may need to be reviewed following the completion of the CHRMAP process for Cossack.

Storm Surge Risk Local Planning Policy

Clause 6.17 of LPS 8 establishes requirements in relation to land identified as being at risk of storm surge. The Clause requires the City to maintain a local planning policy that identifies land within the District that is vulnerable to storm surge inundation. The City has adopted DP 19 – Storm Surge Risk Local Planning Policy which contains mapping that identifies land the subject of this policy and establishes requirements for land use and development within the policy area.

The mapping contained within the local planning policy currently does not extend to the Cossack townsite, and therefore the policy does not apply to Cossack. However, following the CHRMAP process, it may be considered necessary to modify the policy so that it also applies to the Cossack locality.

7.6 DP19 Storm Surge Risk Local Planning Policy

DP 19 Storm Surge Risk Local Planning Policy was prepared in conjunction with the preparation of a CHRMAP for Karratha and nearby localities.

Key components and requirements of the policy are summarised as follows.

Schedule 1 of the policy will contain the most current storm surge mapping within the District, which may be updated by the City from time to time as more current and accurate information is prepared. All land that is identified as being vulnerable to the 500 year ARI storm surge event will be subject to the requirements of the policy.

The policy incorporates ‘as of right’ design mitigation measures which proposals may incorporate to sufficiently address the level of risk associated with storm surge inundation and therefore meet the minimum requirements of the policy. The ‘as of right’ design response includes raising the finished floor level of habitable rooms above the modelled 500 year ARI storm surge event level or locating the development on a portion of the site that is not vulnerable to storm surge inundation.

Alternatively, the policy provides a framework for applicants to take a performance approach to risk mitigation, where the proponent chooses to take an alternative approach to the ‘as of right’ design response and takes responsibility for consequences in the knowledge that finished floor levels are below the 500 year ARI storm surge level. In this regard, the policy contains a matrix and checklist for completion by applicants to assist in identifying and categorising the level of storm surge risk associated with the proposal. This risk assessment framework is a consolidated matrix based on the City’s broader risk assessment framework.

The policy outlines a clear process for assessment of applications for land vulnerable to storm surge.

The mapping contained within Schedule 1 of the draft policy includes the most up-to-date mapping of the 500 year storm surge event for the five (5) major development nodes along the coast within the City. These include:

- Dampier;
- Karratha;

- Point Samson;
- Roebourne; and
- Wickham.

The policy therefore does not directly apply to Cossack at this point in time as the policy does not contain mapping for Cossack within Schedule 1.

It is also noted that this policy only addresses the issue of storm surge and not coastal erosion.

7.7 Conclusions

A summary of the review of the existing planning framework and existing planning controls relating to coastal hazards is provided below:

1. The scheme provisions currently prohibit development until a coastal vulnerability study has been prepared and essential services adequately provided.
2. The City's Local Planning Strategy and the Pilbara Planning and Infrastructure Framework identify Cossack as a coastal node for tourism pursuant to the definitions provided in State Planning Policy 2.6.
3. The existing Clause 6.17 within LPS8 and associated DP19 Storm Surge Risk Local Planning Policy, do not specifically apply to Cossack. The LPP would need to be modified in order to become applicable to Cossack. It is noted that this policy only addresses the issue of storm surge and not coastal erosion.

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8. Key Elements (Assets)

Table 2 provides a preliminary assessment of the assets contained within the Cossack coastal zone.

Table 2: Cossack Coastal Zone Asset Audit

Assets	Functions / Services and Values
Environment	
Mangroves	Supports biodiversity and ecosystem integrity
Butcher Inlet	Environmental and social importance
Mangrove Island	Environmental and social importance
Salt Flats	Environmental importance
Social	
Galbraith's Store	Historical importance
Court House	Historical importance
Police Barrack	Historical importance
The Lock Up	Historical importance
Post and Telegraph Office	Historical importance
Customs House / Bond Store	Historical importance / Function Centre
School House	Historical importance
Cook House	Historical importance
Pearlers House	Historical importance
Union Bank	Historical importance
Pilot Street	Historical importance
Mr Pead's Boarding House	Historical importance
Workers' Hut	Historical importance
Market Gardens	Historical importance
Chinatown	Historical importance
Muramat's House	Historical importance
Path to Beach	Historical importance
Large Storehouse	Historical importance
Knight and Shenton's Store	Historical importance
Ruins	Historical importance
Cossack Cafe	Historical importance, Provides employment, tourist drawcard.
Foreshore Areas	Amenity Value
Freehold Lots	Key assets for owners

Assets	Functions / Services and Values
Glamping Sites	Proposed asset to improve tourism patronage
Camp sites and Associated Buildings	Proposed asset to improve tourism patronage
High End Cabins and Town Shacks	Proposed asset to improve tourism patronage
Economic	
Land backed wharf	Historical importance, provides for boating activities
Cossack Road	Main access into town from regional road network
Perseverance Street	Provides frontage access to existing leasehold land
Cossack Boat Ramp	Access for recreational boating
Private freehold and leasehold lots	Tourism income potential

Refer to Figure 12 which contains a map of the historical assets within the Cossack Townsite.

Figure 12. Cossack's Existing Historic Townsite



9. Success Criteria

The following success criteria have been identified for the Cossack CHRMAP. These success criteria have been shaped as a result of several inputs including the development intent articulated within the Cossack Visioning Study, the State Heritage and National Trust Listing of the Cossack townsite and the Coastal Vulnerability Study recently completed for Cossack.

1. New tourist and accommodation opportunities are provided for at Cossack.
2. Adopted adaptation approaches for Cossack are implemented.
3. Public safety is maintained.
4. The heritage integrity of the original Cossack heritage precinct, townsite and remaining buildings is maintained.
5. Additional tourism accommodation and activities within Cossack are located and designed to minimise the risk from Coastal processes.

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10. Coastal Hazard Summary

An assessment of the potential impacts of coastal hazards on the Cossack coastline is outlined within the *Cossack & Wickham Coastal Hazard Study* (M P Rogers & Associates, 2016). This study investigated the potential impacts of both coastal erosion and inundation hazards on Cossack in accordance with the requirements of SPP2.6.

As previously discussed, the requirement to assess the Cossack shoreline using a methodology that was developed for a sandy coast (given the lack of methodology for assessment of a riverine/estuarine shoreline within SPP2.6) introduces a higher level of conservatism into the assessment of potential coastal erosion hazards. Furthermore, in the absence of any detailed geological or geotechnical information, the majority of the shoreline surrounding Cossack was unable to be treated as a rocky coastline, despite there being sections of rock visible in some areas.

Rock is evident along much of the shoreline. SPP2.6 requires consistent and competent rock to be found at an elevation of at least 1 m above the peak steady water level during a storm event (often referred to as the 100 year ARI event) for the shoreline to be classified as rock. Based on the outcomes of the Coastal Hazard Study, this would require rock to be found at an elevation of around 6m AHD.

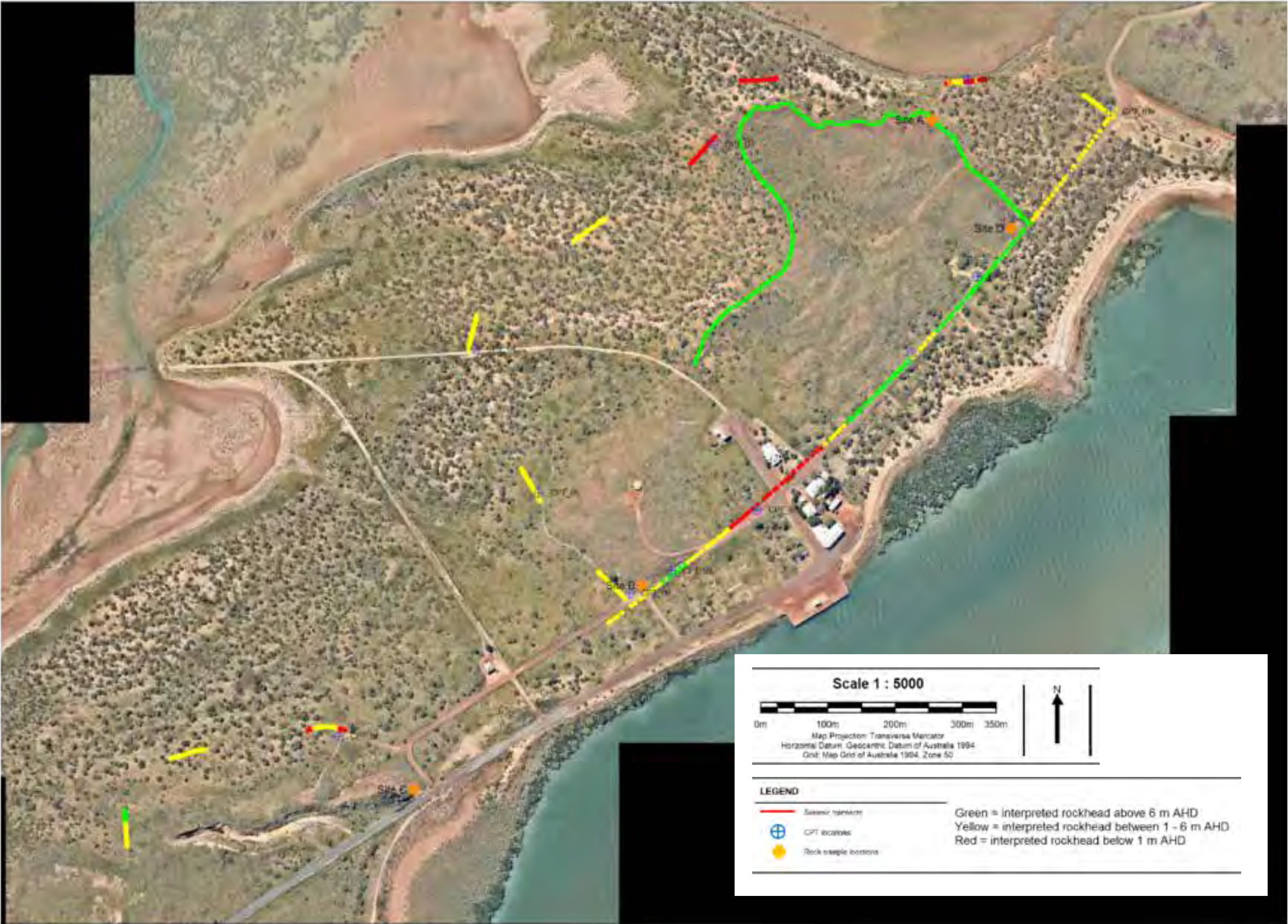
GHD were engaged to complete a site inspection and preliminary geophysical assessment. The results of this assessment were outlined in GHD (2017), however it should be noted that this was a preliminary assessment and was limited in terms of both available funds and areas that were easily accessible. Nonetheless, this assessment highlighted that rock is present in some areas at elevations that enable the shoreline to be classified as rock, as shown in Figure 13.

Refer to Figure 13 – Results from GHD Assessment of Rock Elevations

Given the extent of rock found by GHD, it follows that the results of the coastal erosion hazard assessment are no longer relevant across the northern portions of the site. The coastal erosion hazard lines have therefore been modified around the areas of competent rock above 6m AHD.

Mapping of the coastal erosion and inundation hazards, including details and locations of the Precincts are included in Appendix B.

Figure 13. Results from GHD Assessment of Rock Elevations



11. Risk Analysis and Evaluation

11.1 Risk Analysis

SPP2.6 requires the consideration of likelihood and consequence of coastal processes in order to define the overall risk.

The likelihood and consequences of coastal hazards are different for erosion and inundation. As a result, the likelihood and consequence of erosion and inundation should be considered separately. The likelihood of the coastal hazard impacts are discussed in the following sections.

11.1.1 Likelihood

Likelihood is defined as the chance of something happening (AS/NZS ISO 31000:2009). In relation to coastal hazard risk, the WAPC (2014) defines likelihood as the chance of erosion or storm surge inundation occurring or how often they impact on existing and future assets and values. This requires consideration of the frequency and probability of the event occurring over a given planning timeframe.

The probability of an event occurring is often related to the AEP or the Average Recurrence Interval (ARI). The use of the AEP to define impacts of coastal hazards over the planning timeframe assumes that events have the same probability of occurring each year. In the case of climate change and sea level rise, which have a large influence on the assessed coastal hazard risk, this is not true. In addition, there is insufficient data available to properly quantify the probability of occurrence. A scale of likelihood has therefore been developed, which follows the Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000:2009). This is presented in Table 3.

The risk analysis and evaluation has been undertaken on a Precinct basis, which groups areas of Cossack that have similar coastal features and issues. The Precincts are shown in Figure 14.

Table 3 - Likelihood Scale (Source: Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000:2009))

Designation	Rating	Annual exceedance probability (AEP)
A	Almost certain	There is a high possibility the event will occur as there is a history of frequent occurrence. 90-100% probability of occurring over the timeframe.
B	Likely	It is likely the event will occur as there is a history of casual occurrence 60-90% probability of occurring over the timeframe.
C	Possible	The event may occur 40-60% probability of occurring over the timeframe.
D	Unlikely	There is a low possibility that the event will occur 10-40% probability of occurring over the timeframe.
E	Rare	It is highly unlikely that the event will occur, except in extreme / exceptional circumstances. 0-10% probability of occurring over the timeframe.

Figure 14. The Precinct Plan



11.1.2 Coastal Erosion Likelihood Scale

An assessment of the relative likelihood of each of the identified key assets being impacted by coastal erosion hazards has been completed and is presented in Table 4.

It is important to note that the hazard lines reaching a particular asset at the end of the planning timeframe do not necessarily mean this will occur. This is due to the fact that it requires all of the following to occur.

- Consistent and accelerated erosion of the shoreline sufficient to also absorb the allowance for uncertainty.
- The upper limit of erosion caused by sea level rise.
- The severe storm event to be experienced at the end of the planning timeframe (i.e. when the other allowances have been lost).

Only if all of these occur will the erosion hazard lines be realised. This has been considered in the assessment of likelihood.

Table 4 – Assessment of Likelihood of Coastal Erosion Impact

Asset / Asset Group	Present Day	2041	2066	2091	2116
Precinct 1	Rare	Unlikely	Likely	Almost Certain	Almost Certain
Precinct 2	Rare	Unlikely	Likely	Almost Certain	Almost Certain
Precinct 3	Rare	Likely	Likely	Almost Certain	Almost Certain
Precinct 4	Rare	Rare	Unlikely	Possible	Likely
Precinct 5	Rare	Unlikely	Likely	Almost Certain	Almost Certain
Cossack Road	Rare1				

11.1.3 Coastal Inundation Likelihood Scale

Assessment of the likelihood of coastal inundation is slightly different to that for coastal erosion. This is due to the fact that the potential for coastal inundation will change in the future as the sea level rises. This means that an area that would only be inundated during a very severe event in the present day could potentially be inundated by a much less severe event in the future. Assessment of the probability of an area being inundated within a given planning horizon therefore needs to consider the changing probability of event occurrence throughout that planning timeframe.

As an example, based on the estimated inundation levels, an area with an elevation of around 6.0m AHD would just be inundated by the 500 year ARI event in the present day. However, it would be inundated by the 300 year event in approximately 2066 and in the order of the 90 year event in 2116. Combining all of these probabilities of occurrence on an annual basis would mean that the actual chance of an area with an elevation of 6.0m AHD being inundated over a planning horizon to 2116 would be around 34%. A similar process has been used to determine the probabilities of inundation for the most vulnerable areas within each precinct. These probabilities are reflected in the likelihood ratings presented in Table 5.

Table 5 – Assessment of Likelihood of Coastal Inundation Impact

Asset / Asset Group	Present Day	2041	2066	2091	2116
Precinct 1	Rare	Possible	Likely	Almost Certain	Almost Certain
Precinct 2	Rare	Possible	Likely	Almost Certain	Almost Certain
Precinct 3	Unlikely	Likely	Almost Certain	Almost Certain	Almost Certain
Precinct 4	Rare	Rare	Unlikely	Unlikely	Unlikely
Precinct 5	Rare	Unlikely	Possible	Likely	Almost Certain
Cossack Road	Unlikely	Likely	Almost Certain	Almost Certain	Almost Certain

11.1.4 Consequence

The second part of the risk assessment is determining the consequence of the coastal hazards on Cossack. A scale of consequence has been developed which provides a range of impacts and is generally consistent with the Australian Standard Risk Management Principles and Guidelines (ISO 31000:2009). Refer to Table 6.

Table 6 – Consequence Scale

Rank	Rating	Physical/Economic	Environmental	Social
1	Catastrophic	Permanent loss or damage > \$5 million	Permanent loss of flora and fauna – will not recover	Long-term or permanent loss of function > 75% of community affected
2	Major	Permanent loss or damage \$2 - \$5 million	Long-term loss of flora and fauna limited chance of recovery	Medium term or permanent loss of function < 50% of community affected
3	Moderate	Permanent loss or damage \$200k - \$2 million	Medium term loss of flora and fauna – recovery likely	Minor long term or major short term loss of function < 25% of community affected
4	Minor	Permanent loss or damage \$20k - \$200k	Short term loss of flora and fauna - strong recovery	Small to medium disruption to function < 10% of community affected
5	Insignificant	Permanent loss or damage < \$20k	Negligible to no loss of flora and fauna	Minimal short term inconvenience < 5% of community affected

Similar to the assessment of likelihood, the consequence rating has been completed separately for coastal erosion and coastal inundation. Typically for infrastructure and assets, the consequences associated with coastal erosion are more significant than those associated with coastal inundation. This arises due to the fact that coastal erosion is generally more permanent and more difficult to overcome than coastal inundation. For instance if the foundations of a house were undermined by erosion it is likely that the house would fall. However if a house was inundated, while there may be some damage, structural failure would be less likely.

The consequence ratings for coastal erosion and coastal inundation are outlined in the following sections.

11.1.5 Coastal Erosion Consequence Scale

The assessed consequences of coastal erosion for each of the planning timeframes are outlined in Table 10.5. As shown in the table, the consequences of erosion vary for some key assets over different timeframes due to the potential effects of increased erosion. For instance, a small amount of erosion could expose the foundation of a house but not cause any significant damage, and would therefore be insignificant, however a larger amount of erosion could undermine this foundation, with the effect being far more severe. Refer to Table 7.

Table 7 – Assessment of Consequence of Coastal Erosion Impact

Asset / Asset Group	Present Day	2041	2066	2091	2116
Precinct 1	Moderate	Major	Major	Major	Major
Precinct 2	Insignificant	Insignificant	Minor	Moderate	Moderate
Precinct 3	Moderate	Moderate	Moderate	Moderate	Moderate
Precinct 4	Insignificant	Insignificant	Insignificant	Minor	Minor
Precinct 5	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Cossack Road	Moderate	Moderate	Moderate	Moderate	Moderate

11.1.6 Coastal Inundation Consequence Scale

The assessed consequence of coastal inundation for each of the key assets and each of the planning timeframes is presented in Table 10.6. Importantly, this assessment of the consequence of coastal inundation has been completed on the basis that the public safety risk is managed for inundation events. Given that the major inundation events are likely to be associated with the passage of cyclone events, management of public safety is something that already occurs through the emergency management procedures of the Department of Fire and Emergency Services. Refer to Table 8.

Table 8 – Assessment of Consequence of Coastal Inundation Impact

Asset / Asset Group	Present Day	2041	2066	2091	2116
Precinct 1	Minor	Minor	Moderate	Moderate	Moderate
Precinct 2	Minor	Minor	Minor	Moderate	Moderate
Precinct 3	Moderate	Moderate	Moderate	Moderate	Moderate
Precinct 4	Minor	Minor	Minor	Moderate	Moderate
Precinct 5	Minor	Minor	Minor	Moderate	Moderate
Cossack Road	Moderate	Moderate	Moderate	Moderate	Moderate

11.2 Risk Evaluation

11.2.1 Risk Scale

The following risk scale has been adopted in relation to the Cossack CHRMAP as set out in Table 9.

Table 9 - Risk Matrix

Likelihood	Consequence	Insignificant	Minor	Moderate	Major	Catastrophic
		1	2	3	4	5
Almost Certain	5	5	10	15	20	25
Likely	4	4	8	12	16	20
Possible	3	3	6	9	12	15
Unlikely	2	2	4	6	8	10
Rare	1	1	2	3	4	5

Table 10 establishes the tolerances to risk and corresponds to the Risk Matrix.

Table 10 - Risk Acceptance Criteria

Level of Risk	Descriptor	Description	Criteria for Risk Acceptance	Responsibility
0	Insignificant	Acceptance	Insignificant risk	N/ A
1-4	Minor	Acceptance	Risk acceptable with adequate controls, managed by routine procedures and subject to annual monitoring	Operational Manager
5-9	Moderate	Monitor	Risk acceptable with adequate controls, managed by specific procedures and subject to semi-annual monitoring	Operational Manager
10-16	Major	Urgent Attention Required	Risk acceptable with excellent controls, managed by senior management/executive and subject to monthly monitoring	CEO / Council
17-25	Catastrophic	Unacceptable	Risk only acceptable with excellent controls and all treatment plans to be explored and implemented where possible, managed by highest level of authority and subject to continuous monitoring	CEO / Council

11.3 Risk Evaluation by Precinct

11.3.1 Erosion Risk by Precinct

The erosion risk per precinct is set out in Table 11.

Table 11 – Erosion Risk per Precinct

Precinct	Present Day	2041	2066	2091	2116
Precinct 1	Minor	Moderate	Major	Catastrophic	Catastrophic
Precinct 2	Minor	Minor	Moderate	Major	Major
Precinct 3	Minor	Major	Major	Major	Major
Precinct 4	Minor	Minor	Minor	Moderate	Moderate
Precinct 5	Minor	Minor	Minor	Moderate	Moderate
Cossack Road	Minor	Minor	Minor	Minor	Minor

11.3.2 Inundation Risk by Precinct

The inundation risk per precinct is set out in Table 12.

Table 12 – Inundation Risk per Precinct

Precinct	Present Day	2041	2066	2091	2116
Precinct 1	Minor	Moderate	Major	Major	Major
Precinct 2	Minor	Moderate	Moderate	Major	Major
Precinct 3	Moderate	Major	Major	Major	Major
Precinct 4	Minor	Minor	Minor	Moderate	Moderate
Precinct 5	Minor	Minor	Moderate	Major	Major
Cossack Road	Moderate	Major	Major	Major	Major

12. Adaptation Options

12.1 Risk Management and Adaptation

12.1.1 Risk Management and the Adaptation Hierarchy

Where a risk associated with a coastal hazard has been identified, there is a requirement for that risk to be managed. SPP2.6 provides a hierarchy of adaptation responses to coastal hazards. This hierarchy is outlined as follows, in order of general preference:

- Avoid locating development within areas vulnerable to the coastal hazard.
- Planned or Managed Retreat of assets located within areas that may be vulnerable to coastal hazards over their planning timeframe.
- Accommodate the risks associated with the potential coastal hazards through measures such as design and/or management strategies that reduce the risk posed by coastal hazards to acceptable levels.
- Protect where the risk from coastal hazards cannot be accommodated, coastal protection works may be completed.

The risk management and adaptation hierarchy is illustrated in Figure 14.

Figure 15. Coastal Adaptation Hierarchy



12.1.2 Adaptation Options Assessment by Precinct

A high level review of the range of potential adaptation options was initially completed to help inform the assessment of the preferred adaptation strategies. Details of these adaptation strategies are outlined within Table 13.

It is noted that these adaptation strategies are focused primarily on the safety of infrastructure, with the expectation that public safety will be managed in accordance with current management practices in the area, if required. The intention for proposed development in Cossack will be to avoid or accommodate risks associated with coastal inundation as far as is practicable.

DFES manage public safety and evacuations associated with severe coastal weather events along the entire coastline of Western Australia. To manage risks associated with cyclone inundation, DFES communicate with the Bureau of Meteorology to receive updates on the potential cyclone tracks and associated storm surge and areas of inundation. Evacuations are then completed as required in order to manage public safety prior to event impact. For Cossack, any evacuation would need to occur early, given the low elevation of Cossack Road. Alternatively, suitable evacuation spaces would need to be found within Cossack.

Table 13 – Adaptation Options Assessment

Precinct	Option Type	Option Explanation	Benefits	Issues
Precinct 1	Avoid	Do not build any new assets in the precinct in areas that will be vulnerable to coastal hazards. Abandonment of existing infrastructure.	Financial resources will not be required to be spent on management and adaptation.	Tourist development/accommodation will not be built or will be limited to areas not vulnerable to coastal hazards. No development on freehold lots, loss of value of those lots. Loss of heritage value of buildings in townsite.
	Planned or Managed Retreat	Existing assets are demolished/relocated in areas that are not vulnerable to coastal hazards as risk becomes unacceptable. Buildings with shorter service life may still be able to be constructed in areas vulnerable to coastal hazards, and then moved as the risk becomes unacceptable. This option would need to be strongly informed by a foreshore monitoring plan.	Financial resources will not be required to be spent on protection. The amenity of the heritage buildings remains until risk becomes unacceptable. Demolition/relocation of some assets may coincide with the end of service life allowing construction of tourist development/accommodation with shorter service life.	Costs associated with design, management and implementation of monitoring plan. Loss of heritage value of buildings in townsite as risk becomes unacceptable. Development may be limited to assets with short service life, or temporary assets which can be relocated easily. May restrict development on freehold lots, loss of value of those lots. No reduction to existing coastal hazard risk until retreat is undertaken. Costs associated with demolition and reconstruction.
	Accommodate	Design/retrofit assets to withstand impacts. Raised floor levels, raised electrical sockets. (Consistent with the City's existing CHRMAP and DP19 Policy). Emergency evacuation plans.	Reduce risk exposure of existing and new assets vulnerable to inundation hazards. May allow construction of assets in areas which are more exposed to inundation and less exposed to erosion.	Only addresses risks associated with inundation hazards, erosion is also a significant hazard in this location. Development may be limited to areas where erosion is not the dominant coastal hazard. May restrict development on freehold lots, loss of value of those lots. Retrofitting of heritage buildings likely to result in loss of heritage value.
	Protect	Construction of a seawall to retain shoreline.	Heritage value of existing townsite retained and coastal hazard risk is reduced. Development is less likely to be limited to assets with shorter service life. May allow construction of more permanent tourist accommodation. Some development may be possible on freehold lots.	Costs associated with design, construction, monitoring and maintenance of sea wall. Potentially reduced aesthetic may reduce social value of natural/serene landscape.
Precinct 2 - 5	Avoid	Do not build any new assets in the precinct in areas that will be vulnerable to coastal hazards. Abandonment of existing infrastructure.	Financial resources will not be required to be spent on management and adaptation.	Tourist development/accommodation will not be built or will be limited to areas not vulnerable to coastal hazards. No development on freehold lots, loss of value of those lots.
	Planned or Managed Retreat	Existing assets are demolished/relocated in areas that are not vulnerable to coastal hazards as risk becomes unacceptable. Buildings with shorter service life may still be able to be constructed in areas vulnerable to coastal hazards, and then moved as the risk becomes unacceptable. This option would need to be strongly informed by a detailed foreshore monitoring plan.	Financial resources will not be required to be spent on protection. The amenity of the heritage buildings remains until risk becomes unacceptable. Demolition/relocation of some assets may coincide with the end of service life allowing construction of tourist development/accommodation with shorter service life.	Costs associated with design, management and implementation of monitoring plan. Development may be limited to assets with short service life, or temporary assets which can be relocated easily. May restrict development on freehold lots, loss of value of those lots. No reduction to existing coastal hazard risk until retreat is undertaken. Costs associated with demolition and reconstruction.
	Accommodate	Design assets to withstand impacts. Raised floor levels, raised electrical sockets. (Consistent with the City's existing CHRMAP and DP19 Policy). Emergency evacuation plans.	Reduce risk exposure of existing and new assets vulnerable to inundation hazards. May allow construction of assets in areas which are more exposed to inundation and less exposed to erosion.	Only addresses risks associated with inundation hazards, erosion is also a significant hazard in this location. Development may be limited to areas where erosion is not the dominant coastal hazard. May restrict development on freehold lots, loss of value of those lots.
	Protect	Construction of a seawall to retain shoreline.	Development is less likely to be limited to assets with shorter service life. May allow construction of more permanent tourist accommodation. Some development may be possible on freehold lots.	Costs associated with design, construction, monitoring and maintenance of sea wall. Potentially reduced aesthetic may reduce social value of natural/serene landscape.
Cossack Road	Avoid	Abandonment of existing infrastructure.	Financial resources will not be required to be spent on management and adaptation.	Loss of access to Cossack via road.
	Planned or Managed Retreat	Existing assets are demolished/relocated in areas that are not vulnerable to coastal hazards as risk becomes unacceptable.	Reduce exposure of Cossack road to coastal hazards.	No alignment of road will allow access to Cossack whilst remaining outside of areas vulnerable to coastal hazards. Significant works would be required to reconstruct the road at a higher elevation. Costs associated with design, demolition and reconstruction.
	Accommodate	Implement measures such as road closures, weather warnings and signage to manage risk.	Reduces risk to human life.	Costs associated with management measures. Does not reduce vulnerability of Cossack road to coastal hazards.
	Protect	Construct protection (seawall or similar) running alongside Cossack road.	Reduces vulnerability of Cossack road to erosion.	Costs associated with design, construction and maintenance of protection. Does not reduce vulnerability of Cossack road to inundation.

12.1.3 Adaptation Approach

12.1.3.1 Preferred Adaptation Approach per Precinct

The preferred adaptation approach is set out in Table 14.

Table 14 – Preferred Adaptation Approach

Asset / Asset Group	Risk Circumstance	Adaptation Approach	Mechanisms and Trigger Points
Precinct 1	Erosion	Protect (where funding is available) Planned and Managed Retreat	<ul style="list-style-type: none"> Existing historic buildings and archaeological sites to remain as is. The impacts of coastal erosion and storm surge processes on existing assets to be monitored on a regular basis. Funding avenues to be explored on an as needs basis to identify opportunities to protect heritage sites from coastal processes. Buildings with shorter service life may still be able to be constructed in areas vulnerable to coastal hazards, and then moved as the risk becomes unacceptable.
	Inundation	Planned and Managed Retreat Accommodate (temporary new development)	<ul style="list-style-type: none"> Existing heritage buildings to remain as is. Minor maintenance to heritage buildings may continue. Any temporary development be designed to accommodate storm surge flood levels.
Precincts 2 to 4	Erosion	Planned and Managed Retreat	<ul style="list-style-type: none"> Locate temporary development (structures with a lifespan of <30 years) on least hazardous portion of the lot/s. Permit onsite services and temporary structures to support temporary accommodation. Consider coastal hazard in design but accept that assets are vulnerable and landowners to accept the risk of loss as a result of a major event. Require Section 70a notifications on certificate of title.
	Inundation	Avoid (where possible) Accommodate	<ul style="list-style-type: none"> Where possible, locate development on portions of lots not at risk of storm surge inundation. Otherwise: Design assets to withstand impacts. Raised floor levels, raised electrical sockets. (Consistent with the City's existing CHRMAP and DP19 Policy). Preparation of Emergency Evacuation Plans. Require Section 70a notifications on certificate of title (where applicable).
Precinct 5	Erosion	Avoid (where applicable)	<ul style="list-style-type: none"> Avoid placing any new development or infrastructure on areas at risk of coastal erosion. Allow low scale tourism development on rocky outcrop not at risk of coastal erosion processes.
	Inundation	Avoid (where applicable)	<ul style="list-style-type: none"> Avoid placing any new development or infrastructure on areas at risk of storm surge inundation.
Cossack Road	Erosion	Planned and Managed Retreat	<ul style="list-style-type: none"> The section of Cossack Road at risk of coastal erosion over the planning timeframe is where it enters the Cossack settlement. The remainder (Cossack Causeway) is situated inland on not at risk of coastal erosion. Plan for a managed retreat scenario over time by requiring properties fronting Cossack Road to obtain primary access to any new development from Perseverance Street. In the event that Cossack Road is subject to coastal erosion, freehold properties in Precincts 1 and 3 will maintain frontage access to Perseverance Street.
	Inundation	Accommodate	<ul style="list-style-type: none"> Preparation of an Emergency Evacuation Plan to evacuate Cossack residents and visitors ahead of a cyclonic event. Redesign / reconstruct sections of Cossack Road as required with location and design of road to factor risk of storm surge inundation.

12.1.3.2 Mitigation Options for Coastal Erosion Risk

Mitigation Options for Precinct 1

Table 15 – Mitigation Options for Precinct 1

Mitigation Option	Description
Do nothing	<p>It is not proposed to protect the historic precinct of Cossack due to the expense of constructing and maintaining a seawall or other artificial structure to mitigate the heritage buildings from the risk of coastal erosion.</p> <p>Therefore if coastal erosion does eventuate on this section of the shoreline, a do nothing approach has been adopted, and it is proposed that the historic precinct be permitted to erode over time.</p> <p>If this situation does eventuate, then the impacts of erosion will form part of the overall 'story' and historic tale of the Cossack townsite.</p> <p>Notwithstanding, if the State government forms the view that the historic precinct should be protected from coastal processes, then funding will need to be sourced to fund construction of the necessary infrastructure at a point in time that erosion becomes a threat to the assets.</p>

Mitigation Options for Precincts 2 to 5

A combination of the following mitigation measures are proposed for Precincts 2 to 5 to mitigate against the risk of the impacts of coastal erosion on any tourism or residential accommodation development.

Table 16 – Mitigation Options for Precincts 2 to 5

Mitigation Option	Description
Temporary Structures	<p>Require consideration of design life of proposed structures as part of future applications for development. Typically structures should not exceed a design life of 30 years on land seaward of the coastal erosion hazard line.</p> <p>Development on land seaward of the coastal erosion hazard line is to be relocatable, temporary and/or sacrificial by design. Structures should be built to be easily decommissioned or relocated as the hazard eventuates.</p>
Require development to be located as far landward in hazard zone as practical	<p>Ensure new development is situated as far landward as practical in the hazard zone on each lot to provide the greatest potential to extend the life of the development.</p> <p>Development approval are to be conditioned based on the distance to the shoreline. Development approval is valid until the eroding shoreline comes within a specific distance to the development, after which the development approval ceases to be valid.</p>
Notification on Title	<p>Require Section 70A notifications on title alerting prospective purchasers to the potential risk of coastal erosion on the property and / or development.</p>
Indemnification	<p>City to consider imposing a condition on future planning approvals which requires the landowner to indemnify the City against future actions, claims, demands or costs relating to damage to property as a result of coastal erosion.</p>
Emergency Management	<p>Require preparation of monitoring and warning systems including the provision for a whole of townsite evacuation procedure in the event of a cyclone or major storm.</p>

Mitigation Options for Cossack Road

Table 17 - Mitigation Options for Cossack Road

Mitigation Option	Description
Abandon section of Cossack Road in front of townsite properties	<p>Section of Cossack Road abutting Precincts 1 to 3 is proposed to be abandoned as and when the threat of coastal erosion becomes imminent. Instead it is proposed that lots currently fronting this road obtain their primary access from Perseverance Street acknowledging that this section of Cossack Road is potentially at imminent risk of eroding as a result of coastal processes.</p>
Relocate Cossack Road	<p>The inland section of Cossack Road is not identified as being at risk of coastal erosion, however notwithstanding, this section of Cossack Road could be relocated if coastal erosion becomes a threat.</p>

12.1.3.3 Mitigation Options for Coastal Inundation Risk

Elevated Finished Floor Level (Coastal Inundation)

In order to help Accommodate the risk associated with potential inundation, and to reduce the requirements for repairs after an inundation event, it is recommended that new development seek to locate the finished floor level above the peak steady water level associated with a 500 year ARI storm surge event. This may require the finished floor levels to be elevated above the natural ground level. The acceptable design responses associated with this approach are outlined in the following table.

Table 18 – Elevated Finished Floor Levels Design Response

Height of Storm Surge above Natural Ground Level of Subject Property	'As of Right' Design Response
0 – 500mm	<ul style="list-style-type: none"> Raise height of the finished floor level for all habitable rooms (dwellings) or finished floor level of the net lettable area for a commercial oriented tourism use (i.e. a cafe) above the identified storm surge level through either: <ul style="list-style-type: none"> Filling of the land; or Structural / building design response (i.e. Elevated 'Queenslander' style housing); or A combination of fill/retaining and stilt construction.
500mm – 1 metre	<ul style="list-style-type: none"> Raise height of the finished floor level for all habitable rooms (dwellings) or finished floor level of the net lettable area for a commercial/community building to the height of the identified storm surge level through either: <ul style="list-style-type: none"> Filling of the land*; or Structural / building design response (i.e. Elevated 'Queenslander' style housing); or A combination of fill/retaining (to a maximum of 0.5m) and stilt construction. <p>* Filling of the site between 500mm and 1 metre above natural ground level may be considered on a case by case basis however the onus will be on the applicant to demonstrate that this approach will not have a detrimental impact on the amenity of adjoining properties and that the application complies with other relevant policy considerations.</p>
1m – 2m +	<ul style="list-style-type: none"> Raise height of the finished floor level for all habitable rooms (dwellings) or finished floor level of the net lettable area for a commercial oriented tourism use (i.e. a cafe) above the identified storm surge level through a structural / building design response (i.e. Elevated 'Queenslander' style housing); or A combination of fill/retaining (to a maximum of 0.5m) and stilt construction.

Where a structural / building design response (i.e. 'Queenslander' style housing) is adopted, the design should draw upon the requirements outlined within the Queensland Reconstruction Authority guidelines. The general recommendations for development are to:

- Not enclose the understory in order to minimise the potential loads on the structure associated with water flow or wave impact. If enclosure is required consideration should be given to providing retractable enclosures that can be closed in day to day use, but can be easily opened during a storm surge alert.
- Ensure foundations and footings are adequate to withstand potential erosive action during coastal inundation.
- Where considered necessary, ensure that all important services, including electricity, permanent fixtures and plumbing are elevated and / or protected from the impact of waves.

Cossack Road

The following mitigation measures are proposed to minimise the risk of storm surge inundation on Cossack Road.

Table 19 – Mitigation Options for Cossack Road

Mitigation Option	Description
Redesign / relocation of Cossack Road over time	Sections of Cossack Road and Cossack Road Causeway may be subject to storm surge inundation. The City shall assess any damage to Cossack Road and factor in potential redesign (i.e. seawall reinforcement, elevated levels) and or relocation of the road to mitigate the risk of the road from future storm surge events.
Emergency Management	The City to prepare an emergency evacuation and management plan to evacuate the Cossack townsite ahead of a cyclonic or storm event to mitigate the risk of occupants being stranded in Cossack for a period of time.

13. Implementation Plan

It is proposed that the following modifications to the City of Karratha's Town Planning Scheme No. 8 be undertaken in order to establish the adaptation responses identified for each development precinct within Cossack.

Table 20 – Proposed Modifications to Town Planning Scheme No. 8

Existing TPS8 Clause	Proposed Modification
7.6 Cossack Historic Town 7.6.3 All development within the Cossack Historic Town shall be connected to three-phase-power, scheme water and reticulated effluent disposal.	Delete Clause 7.6.3
Appendix 7 – Development Areas DA23 1. Development to be for residential and community purposes. 2. Development subject to the provision of adequate essential services and coastal vulnerability studies.	Delete DA23 and replace with a new Special Control Area outlined below.

Not applicable	<p>Inserting a new Special Control Area for the Cossack townsite in accordance with the following:</p> <p>Special Control Area – Cossack</p> <p><u>Purpose</u></p> <p>The purpose of the Cossack SCA is to provide guidance as to the appropriate scope of land use and development permitted in the context of the Cossack Heritage Precinct and coastal erosion and inundation hazard risk.</p> <p><u>Objectives</u></p> <ul style="list-style-type: none"> a) To reinstate the character of the past in the town centre while also supporting compatible tourism development. b) To ensure public safety and reduce risk associated with coastal erosion and inundation. c) To ensure decisions are made with regard to the cultural heritage significance of the place. d) To facilitate tourism and other associated land use and development in appropriate locations that does not compromise the heritage character and visual amenity of the area. e) To minimise the risk to land use and development from coastal erosion and coastal inundation. f) To ensure that development has regard to and addresses the relevant requirements of the Cossack Conservation Management Plan, the Cossack Coastal Hazard Risk Management and Adaptation Plan and the Cossack Development Guidelines. <p><u>Additional Provisions</u></p> <ul style="list-style-type: none"> a) A Bushfire Management Plan shall be prepared for the SCA area to minimise the risk to existing and future development from the threat of bush fires. b) All proposed land use and development within the SCA requires planning approval. c) In considering applications for planning approval within the SCA, the Council shall have regard to the Conservation Management Plan and any adopted policy, guideline or plan that relates to the area. d) Any application for land use or development proposed on land identified as being within a coastal erosion and/or storm surge inundation hazard risk area shown in the adopted CHRMAP for Cossack shall be accompanied by a report prepared by a suitably qualified consultant which assesses the risk of coastal processes to the subject property and which identifies appropriate mitigation response/s for the proposed development. e) Any land use or development proposed on land identified as being within a coastal erosion hazard risk area shown in the adopted CHRMAP for Cossack shall be granted on an appropriate temporary or time limited basis. f) On-site and self-sufficient essential services to support development shall be considered on a case by case basis. g) As a condition of planning approval, the Council may impose a condition requiring the landowner to place a notification pursuant to Section 70A of the Transfer of Land Act 1893 on the certificate of title of the lot(s) to notify prospective purchasers that the lot(s) is located in an area that may be subject to coastal erosion and/or inundation over the next 100 years. <p><u>Referral of Applications</u></p> <ul style="list-style-type: none"> a) All applications for planning approval relating to land located within the boundaries of the Cossack Heritage Precinct registered under Part 5 of the Heritage Act of Western Australia 1990, shall be referred to the Heritage Council of Western Australia. b) All applications for planning approval relating to land identified as being within a coastal erosion and/or coastal inundation hazard risk area shown in the adopted CHRMAP for Cossack may at the discretion of the local government, be referred to the Department of Planning, Lands and Heritage and any other relevant authority for advice and comment on the coastal risk.
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Modification to Scheme Maps

In addition to the above text modifications, it is proposed to modify the Scheme Map as it relates to Cossack as follows:

1. Deleting the DA23 Development Area and replacing it with a new Special Control Area boundary; and
2. Rezoning those lots currently zoned 'Urban Development' to 'Tourist' zone.

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14. Monitoring and Review

Coastal monitoring and review is essential in order to track changes to the shoreline over time. Whilst the results of the Coastal Hazard Assessment provide an indication of the potential changes to the shoreline (and incorporate a justifiable level of conservatism), the system is inherently complex and the actual shoreline response could be different to that presented. Monitoring should therefore be completed to track changes over time and indicate whether the timing for risk mitigation should be adjusted.

There are a number of different monitoring strategies that are available. These strategies are generally complementary, so the more information that is collected, the more thorough the review would be. Details of the recommended monitoring processes are provided below.

14.1 Aerial Photography

Aerial photography is generally used to map the location of the coastal vegetation lines or other shoreline indicators. However, aerial photographs can also be used to quantitatively assess changes to the shoreline or coastal features.

The State Government (now through Landgate) has historically undertaken aerial photography of the coastline at approximately 5 year intervals. Since approximately 2000, aerial photography frequency has been increased, even in regional areas such as Cossack.

Review of rectified aerial imagery enables tracking of shoreline changes over time. This can be used to provide an early warning system that the shoreline is changing and will therefore allow adaptation strategies to be enacted if the risk levels become intolerable. Review of aerial photography is a relatively simple and cost effective method of tracking coastal change and is therefore considered to be appropriate for the initial monitoring of shoreline movement around Cossack. Initially, it is recommended that an analysis of the aerial imagery is completed approximately every 5 years. The

analysis would be reasonably brief unless significant changes were detected. When/if the behaviour of the shoreline changes and chronic erosion trends become obvious, more detailed assessment and review may be warranted for shorelines adjacent to significant infrastructure.

14.2 Beach Profile Data

Shoreline movement data extracted from aerial imagery provides information on the plan-form movement of coastal features. By supplementing this with beach profile data, overall changes to the shoreline can be assessed and volumes of change estimated. This is generally a more cost effective approach to monitoring volumes of change, compared to detailed hydrographic surveys of the entire coastline.

There is probably little requirement to complete beach profile monitoring in the early years given the relatively small variations in shoreline position that have been observed around Cossack historically. However, if it is found that the shoreline is receding, then it would be prudent to commence completing beach profile monitoring to better understand the nature of any changes.

If beach profile monitoring is to commence, then it is recommended that beach profiles are taken every 2 years. The timing of these surveys should be consistent throughout the year in order to reduce the potential for seasonal changes.

The beach survey profiles should be completed for sections of shoreline fronting the potentially at risk infrastructure. Profiles should also cover the shoreline surrounding the at risk areas by a distance of at least 200 m. Covering a wider area of beach in this way would enable review of the extent of beach change over the general area, rather than just in front of the at risk infrastructure.

14.3 Beach Photography

Land based photographs from fixed locations and consistent frames of reference can provide a useful tool for monitoring general changes to shorelines. DoT released a guideline on How to Photo Monitor Beaches (2012) to normalise photo monitoring as part of coastal monitoring programs. This methodology suggests photography be completed at fixed locations with fixed field of views. This is a relatively low cost monitoring strategy, that can provide very useful results, particularly if completed at regular intervals.

14.4 Geotechnical Assessment

Further detailed geotechnical survey and investigations may be undertaken to better understand the extent of rock within this section of the coastline. Depending on the results of any further geotechnical investigations, it may require the coastal erosion hazard line to be revised. It is expected that any further geotechnical investigation would be funded and undertaken by individual landowners within Cossack.

14.5 Emergency Response Planning

Emergency response planning will be necessary to support any further development and intensification within the Cossack townsite for tourism and residential purposes. A specific focus will be on the functionality of Cossack Road and the ability to safely evacuate residents, visitor and tourists during a cyclone event.

14.6 Requirements for Review

The analysis of the monitoring information that is collected should be completed or reviewed by an experienced coastal engineer to determine any trends in shoreline movement or significant change to coastal processes. The analysis would be reasonably brief unless significant changes were detected. If the behaviour of the shoreline changes to the extent that beach profile monitoring is required it would be prudent to complete the review every 2 years. This reduction in time between analysis and reporting is due to the increased risk that could be associated with a reduced buffer.

The analysis and reporting would summarise movements on beach profiles (if applicable), assessment of shoreline movement and any relevant information on metocean conditions. Should the shoreline movement indicate large changes in key areas (particularly erosion) this would be highlighted. Additional investigations to determine the cause of the change would be recommended. As a result, the following triggers are recommended.

- Retreat of the shoreline (defined in this instance as the coastal vegetation line) to within 20 m of the proposed infrastructure as a result of chronic erosion will prompt review by a specialist coastal engineer to commence planning for managed retreat or abandonment of assets (with removal);
- Retreat of the shoreline to within 10 m of the proposed infrastructure caused by chronic erosion will prompt managed retreat or abandonment of assets (with removal);
- Retreat of the shoreline to within 20 m of the proposed infrastructure caused by acute erosion will prompt review by a specialist coastal engineer to ascertain the potential for recovery of the shoreline before any relocation is completed.

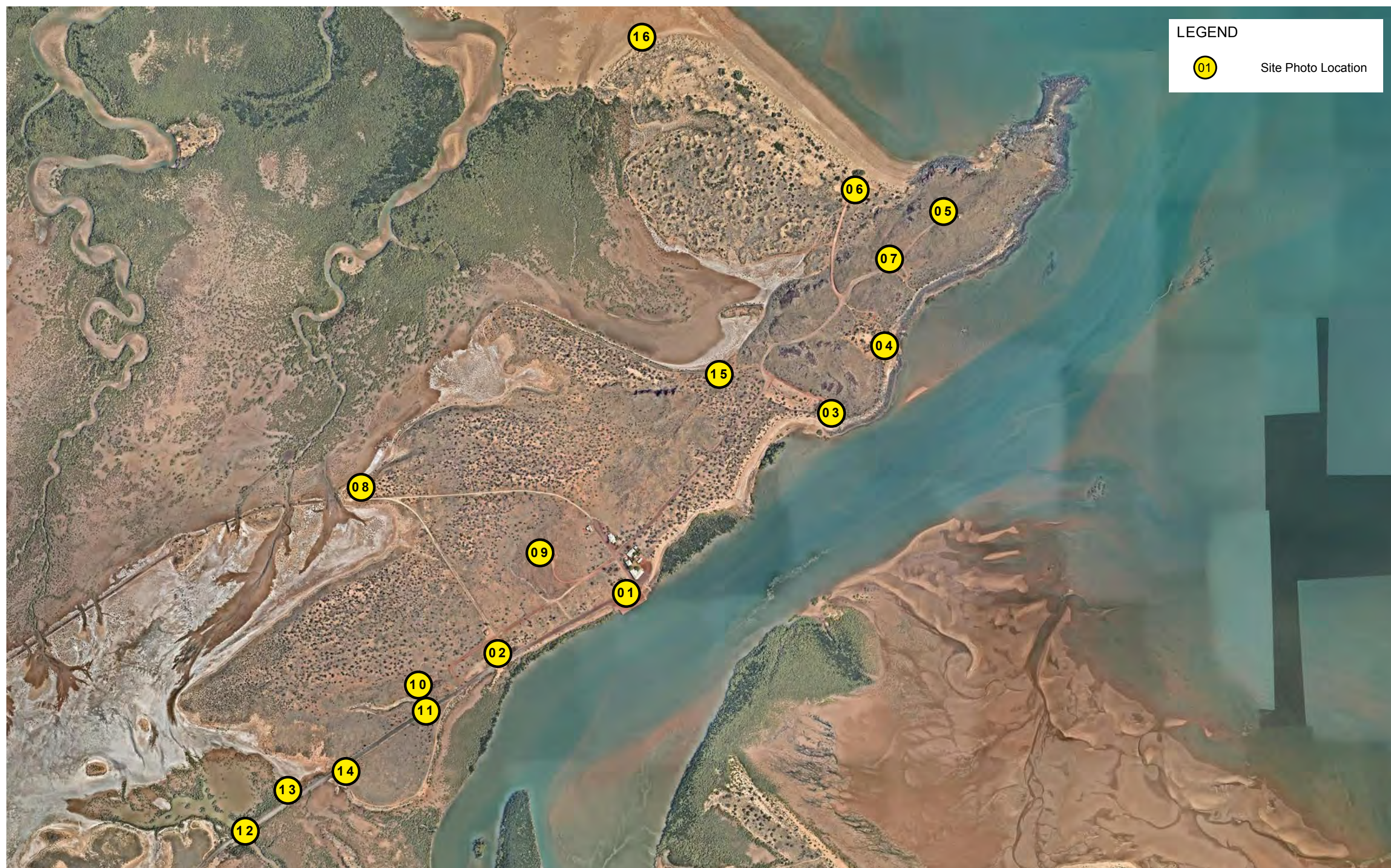
If the rate of change in shoreline position observed during the monitoring is materially different from that allowed for within the erosion hazard assessment, this CHRMAP should be updated to quantify any changes to the risks posed by coastal hazards.

Likewise, should the State Government guidance on the required allowances for erosion of this bank change as a result of new information becoming available, the CHRMAP should also be updated.

Appendix A

Site Photography

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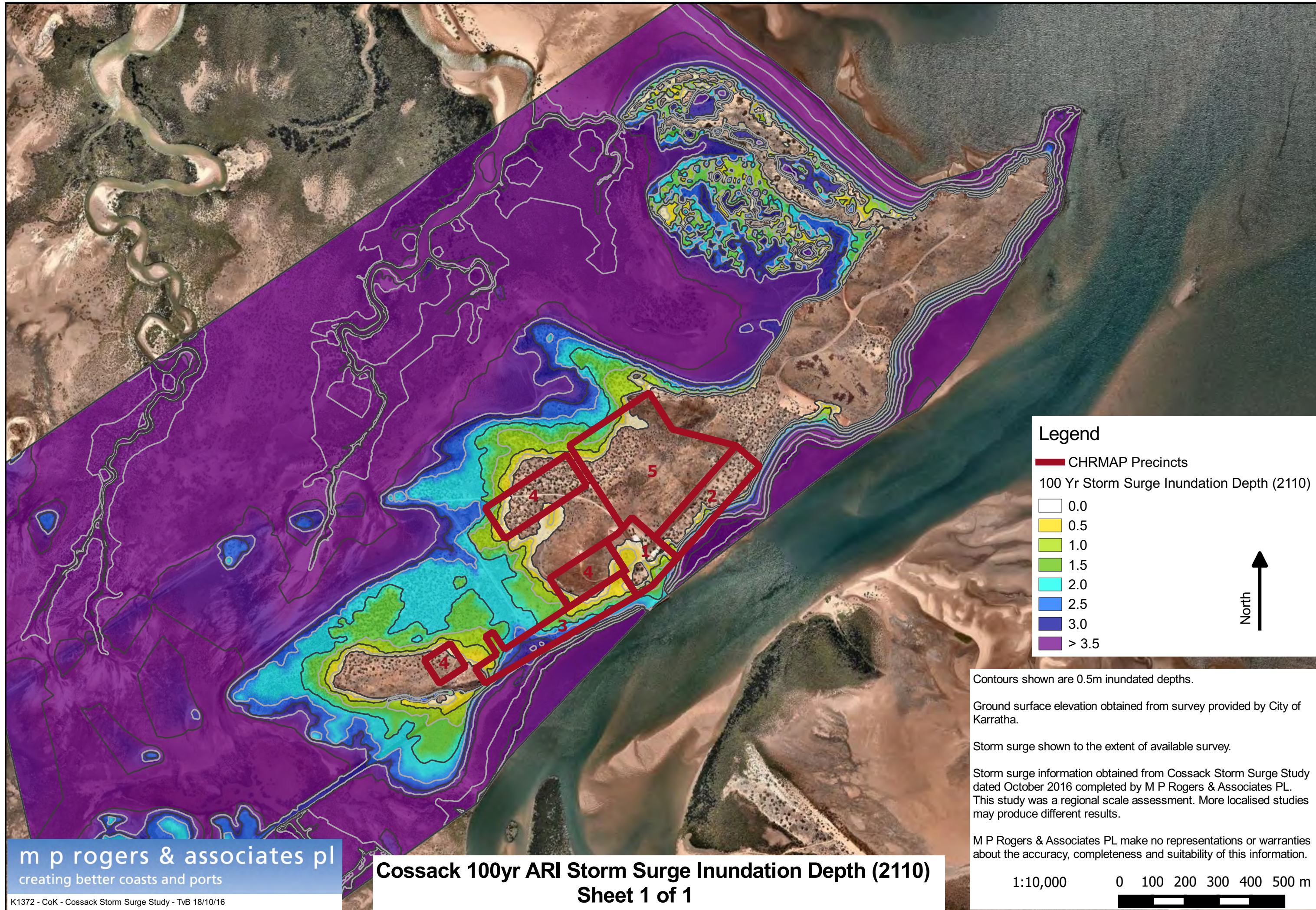


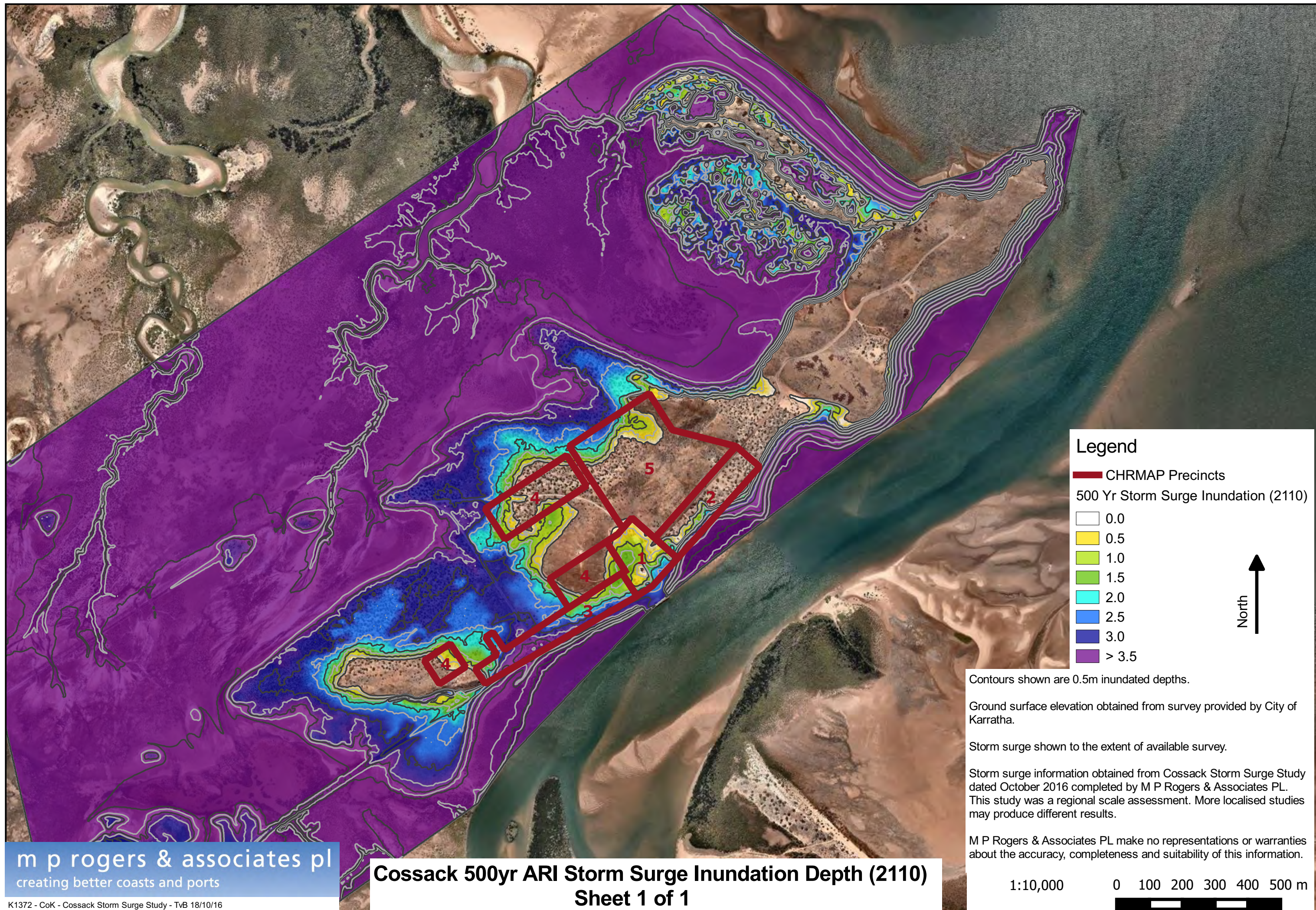


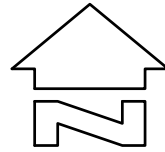
Appendix B

Coastal Hazard Mapping

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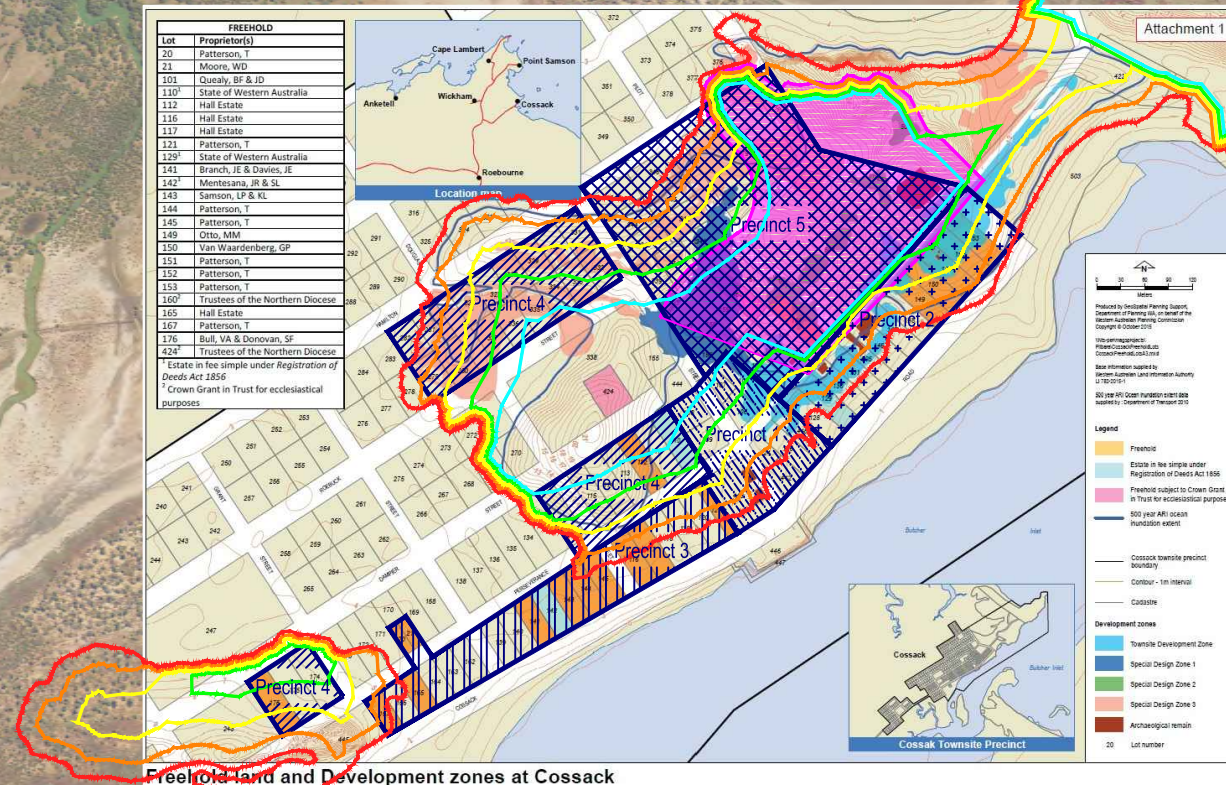






Legend

- Present (2016) Erosion Hazard Line
- 25 year (2041) Erosion Hazard Line
- 50 year (2066) Erosion Hazard Line
- 75 year (2091) Erosion Hazard Line
- 100 year (2116) Erosion Hazard Line
- Area of rock shoreline (Erosion Hazard Lines do not apply)



Freehold land and Development zones at Cossack

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Appendix C

GHD Geotechnical

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