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Coastal Zone Management Study

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Kempsey Coastal Zone Management Study

Prepared for:	Kempsey Shire Council
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Synopsis: **This is a CZMS prepared in accordance with the NSW Guidelines for preparing Coastal Zone Management Plans. It includes a discussion of values and issues, outcomes from community and stakeholder consultation, a risk based assessment of threats to coastal values and a cost benefit analysis of available management options.**

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Executive Summary

This document sets out a Coastal Zone Management Study for the Kempsey Coastline. It is underpinned by a technical assessment of coastal processes and related hazards for the Kempsey Coast (BMT WBM 2013).

Audience

The primary audience for this Coastal Zone Management Study is the community, Kempsey Shire Council (Council) and the NSW Office of Environment and Heritage (OEH). Other stakeholders, including relevant government agencies and organisations, community groups and the general public, may also refer to this document in respect to their role in management of the coast.

Context

This Coastal Zone Management Study has been developed for Kempsey Shire Council with financial support from the NSW Government's Estuary Management Program in accordance with the specifications of Part 4a of the *Coastal Protection Act 1979*. It complies with the requirements of the NSW Coastal Policy 1997, and the NSW Government's Guidelines for Preparation of Coastal Zone Management Plans.

The coastal zone of the Kempsey Local Government Area (LGA) extends from just north of Point Plomer in the south (including Big Hill) to just north of Middle Head in the north (including Middle Head Beach). The study area includes offshore marine areas as well as land features such as beaches, dunes, headlands and bluffs. The study area extends inside estuaries and coastal entrances as far as applicable to determining coastal processes and hazards extents. Within this area, 60% of the coastline is managed by National Parks and Wildlife Service.

A Coastal Zone Management Plan (CZMP) will be prepared based on the information presented within this Coastal Zone Management Study. The CZMP will complement a wide range of planning instruments and environmental management strategies and initiatives currently being adopted by Council and other stakeholders. This includes new LEPs and DCPs as well as Catchment-based Plans of Action.

Risk Analysis

This Coastal Zone Management Study report outlines and prioritises the risks to natural and built assets along the Kempsey Coastline from coastal hazards for an immediate, 2050 and 2100 timeframe.

The hazards considered are:

- Erosion and accretion, and
- Coastal inundation.

These hazards were described and quantified in a previous report, *Kempsey Coastal Processes and Hazards Definition Study* (CPHDS) (BMT WBM 2013). The findings of the CPHDS are summarised in Chapter 2 of this report.

The method used to assess and prioritise risks and threats within the Kempsey Coastal Zone are based on a risk management approach (as outlined in the Australian and International standard, ISO 31000), tailored for coastal management (see Rollason & Haines, 2011; Rollason et al., 2010). The risk assessment is described in detail in Chapter Appendix A of the present report.

The outcome of the risk assessment shows that there is a range of built and natural assets at unacceptable risk from coastal hazards both now, and increasingly into the future. Fortunately, however, the Kempsey LGA has comparatively less built infrastructure at risk when compared to many other Councils along the NSW coast. All assets and their final risk rating are mapped and documented within an appendix of this report.

Significant community consultation was carried out to assist with the risk assessment process. This included an assessment of the present day land use, planning and community amenity values of the coastline.

Risk Treatment and Recommended actions for the CZMP

Options for addressing the unacceptable risks are presented and discussed in Chapter 5. The most suitable options have been recommended for inclusion in the Kempsey Coastal Zone Management Plan (CZMP).

As well as consideration of threats from coastal hazards (including climate change impacts), the recommendations include options to manage threats to overall community use and amenity of the coastline that are derived from a range of natural and human induced pressures.

Key recommended actions for addressing coastal hazards across the LGA are:

- Set aside land for future protection works (on freehold land)
- Require redevelopment / renovations to be located as far landward within the hazard zone as practical
- Ensure an appropriate allowance for sea level rise and other coastal hazards is incorporated into design and planning standards in the Kempsey DCP(e.g. floor heights are set at year 2100 1% AEP +0.5m)
- Undertake periodic monitoring of beach profiles in high risk areas using ground surveys and LiDAR
- Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in Council's Asset Management Plan. Account for such coastal risks when prioritising asset maintenance and replacement
- Assess existing adequacy and remaining functional life of existing protection works
- Conduct education activities to inform the community about coastal risks and intended future actions – to build community acceptance and resilience for managing future impacts
- Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds
- Prepare and implement a wetland management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential Endangered Ecological Communities (EEC) mapping, and investigate options for impact mitigation and resilience building
- Introduce planning controls on undeveloped land in future hazard zones

- Seek to have the CZMP certified by the Minister. Keep abreast of the roll out of stage 2 Coastal Reforms
- Utilise a flow and transport model for the Macleay Sands Aquifer and available new data sets to assess impacts of sea level rise (and climate change) to 2100
- Review and update the Lower Macleay Flood Risk Management Plan for all villages downstream of Frederickton including the role of ocean outlets at Crescent Head and Hat Head
- Check that arrangements are in place to ensure flood mitigation structures and their management are formerly identified and acknowledged within Plans of Management of National Parks
- Determine the impact of coastal inundation and erosion upon existing flood mitigation structures and reassess their effectiveness over time with a view to deploying alternative flood mitigation measures.

Other recommendations for addressing threats to short term community use and access include:

- Design and construct formal protection works at South West Rocks surf club to build upon (and be in keeping with) the existing natural alignment of the beach (e.g. use existing boulders but replace with a gentler slope)
- Investigate, design and construct improved access to Grassy Head Beach from the public car park
- Extend the access provided by the bridge over Saltwater Creek through the dunes and onto the beach to provide disabled access as well as access for surf club boats etc.
- Prepare and adopt a Memorandum of Understanding (MoU) between Council and National Parks covering the coordination of management for the intertidal zone and dunes (with both Council and NP officers to have authority to undertake compliance actions)
- Support the recognition of Point Plomer as an Aboriginal Place
- Work with the Aboriginal Community to develop a plan for responding to uncovering of important items during coastal storms
- Promote the NSW Ocean Hauling Fishery Commercial Fishers Code of Practice
- Update and distribute an information pack for use of recreational vehicles on beaches (e.g. 4WDs)
- Provide formalised beach access points at sensitive locations to restrict impacts to saltmarsh (e.g. on the north and south sides of the Macleay River)
- Evaluate the suitability of 4WD access at all beaches and restrict access in sensitive locations (e.g. shorebird breeding areas, where saltmarsh is present, in the vicinity of important Aboriginal places).

All management actions to be outlined in the CZMP will be potentially eligible for funding through a range of funding sources including the States Coastal Program.

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1 Introduction

The Kempsey coastline is subject to a variety of natural coastal processes that generate hazards on the shoreline, including periodic erosion during storms and inundation during high ocean water levels which may inundate back beach areas via the Macleay River and other smaller creeks and lagoons (refer to Section 2.1.12 for details). With future sea level rise, the shoreline is expected to recede landward, and coastal inundation will become more extensive relative to current conditions. Fortunately, much of Kempsey's shores are undeveloped, with the exception of low key recreational facilities, while the majority of the coastal zone is retained in public ownership within National Parks and Crown Reserves. This controlled land tenure largely affords the ability to maintain unique natural values and provides greater resilience to coastal processes and the potential impacts of future sea level rise.

This report, the Kempsey Coastal Zone Management study (CZMS), is the second report prepared for Kempsey Shire Council (Council) with funding and assistance from the NSW Office of Environment and Heritage (OEH) under the states Coastal Program covering the Kempsey coastline. It follows the Kempsey Coastal Processes and Hazard Definition Study (CPHDS) (BMT WBM, 2013), which is discussed in Section 2, and has been prepared in accordance with the NSW Government's Guidelines for Preparing Coastal Zone Management Plans (OEH, 2013). This CZMS includes a discussion of values and issues, outlines outcomes from community and stakeholder consultation, details a risk based assessment of threats to coastal values and provides a cost benefit analysis of available management options.

The subsequent and final document will be a Coastal Zone Management Plan (CZMP) for the Kempsey coastline. The CZMP will present implementation details for a series of actions designed to address the issues associated with coastal hazards and other threats such as development pressure.

In accordance with the Guidelines for Preparing Coastal Zone Management Plans, a risk based approach has been applied throughout the process of developing this CZMS.

Coastal Zone management planning is an ongoing process and the CZMP will be reviewed in light of new scientific information, changes in community aspirations and changes to planning and policy in the future.

1.1 Objectives

The current CZMS has been prepared to provide the necessary background information and technical rigour to support the subsequent CZMP to be prepared by Council in the near future.

The overarching aims for the CZMP are to provide practical and affordable actions to improve community use and facilities of the coastal zone, and to plan and initiate actions that protect values and build resilience to existing and future coastal hazards. While it is expected that the CZMP will be reviewed and updated periodically (every 10 years or so), the longer-term directions established by the current coastal zone management process will be maintained and supported in the future.

The present CZMS has been developed using community and stakeholder consultation and with consideration of the NSW Government's Guidelines for Preparing Coastal Zone Management

Plans (OEH, 2013). Specific objectives for the subsequent CZMP that have been established through the process of preparing this CZMS include:

- Preserving the natural and rugged character of the Kempsey Coastline,
- Recognising and accommodating natural coastal processes and hazards, including sea level rise in the management of the coastal zone,
- Protecting the natural attributes of beaches, dunes and undeveloped headlands, permitting only minor development for essential public purposes,
- Managing and reducing the risks to existing development and values,
- Preparing to manage future risks to existing development and values, and
- Providing safe access within the coastal zone to the community and visitors.

1.2 Coastal Management Process in NSW

The CZMP is being prepared in accordance with the *Coastal Protection Act 1979* (CPA Act), the NSW Coastal Policy 1997, and the Guidelines for Preparing Coastal Zone Management Plans (OEH, 2013; herein referred to as the 'CZMP Guidelines'), as well as other legislation and guidelines applicable to managing the coastal zone of NSW.

The process followed to prepare the CZMP (as per the CPA Act and CZMP Guidelines), is as follows:

(1) Identify coastal processes and quantify coastal hazards affecting the coastal zone through a Coastal Hazards Definition Study;

(2) Adopt a Risk Management Approach to assess the level of risk from coastal hazards (now and at 2050 and 2100);

(3) Identify and evaluate management options to treat the priority coastal risks, considering the technical and financial viability and the social, economic, aesthetic, recreational and ecological costs and benefits of the options, and prepare a Coastal Risk Management Study documenting the recommended management options;

(4) Prepare a draft Coastal Zone Management Plan consisting of the best combination of options for reducing the risks from coastal hazards and achieving the plan objectives, including an implementation schedule for the preferred actions;

(5) Review the draft Plan through public exhibition and consultation;

(6) Council to formally adopt the Plan and commence implementation of the plan (noting that certification of CZMPs by the State Government is currently on hold, awaiting reforms to the coastal management process); and

(7) Review the Coastal Zone Management Plan on a regular basis (5-10 years), to enable periodic update and review of coastal risks and management measures.

1.2.1 Guidelines for Preparing Coastal Zone Management Plans

The CZMP Guidelines specify the requirements for preparing a CZMP in accordance with the Coastal Protection Act 1979, including requirements additional to those specified in the Act.

Under Section 733 of the *Local Government Act 1993*, Councils are taken to have acted in 'good faith' and thus receive an exemption from liability for land affected by coastal hazards where their actions substantially accord with the principles contained in the specified manual, in this case being the CZMP Guidelines. As a quick reference guide, Table 1-1 outlines each of the relevant principles and how they have been addressed by the Kempsey CZMs. Further details on the technical process undertaken in developing this CZMP can be found in the preceding Coastal Processes and Hazard Definition Study (BMT WBM, 2013).

Table 1-1 Addressing the Coastal Management Principles

	Coastal Management Principles	Addressed by this document
Principle 1	Consider the objects of the *Coastal Protection Act 1979* and the goals, objectives and principles of the NSW Coastal Policy 1997	These have been considered throughout the document and in particular applied to the options assessment.
Principle 2	Optimise links between plans relating to the management of the coastal zone	By using a risk-based approach, existing controls within existing plans are reviewed and incorporated into the analysis of risk, and also used as starting point for developing risk treatments (i.e. management options).
Principle 3	Involve the community in decision-making and make coastal information publicly available.	Comprehensive community consultation has been undertaken throughout the development of this plan.
Principle 4	Base decisions on the best available information and reasonable practise; acknowledge the interrelationship between catchment, estuarine and coastal processes; adopt a continuous improvement management approach.	The Coastal Processes and Hazard Definition Study describes coastal processes and interactions along the Kempsey Coastline. It identifies and maps the potential extent of coastal hazards for the current year, 2050 and 2100 timeframes. The properties and infrastructure within each hazard area are mapped. Refer to BMT WBM 2013 for further information.
Principle 5	The priority for public expenditure is public benefit; public expenditure should cost effectively achieve the best practical long-term outcomes	Cost benefit analysis for management options has recognised the public benefit as priority for management options
Principle 6	Adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risk where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions to manage high risks while long-term options are implemented	This plan has been prepared using the ISO 31000:2009 International Standard Risk Management Principles and Guidelines. The risk based approach is an internationally recognised framework for management because it incorporates the best available information and its uncertainty. The adopted Risk Management Framework intrinsically requires ongoing monitoring of risks and review and tailoring of risk treatments (management options).
Principle	Adopt an adaptive risk management	The Risk Management approach is an

	Coastal Management Principles	Addressed by this document
7	approach if risks are expected to increase over time, or to accommodate uncertainty in risk predictions	internationally accepted standard that intrinsically incorporates both the known and possible frequency and consequence of a threat, thereby incorporating the uncertainty in the occurrence of risks / threats.
Principle 8	Maintain the condition of high value coastal ecosystems; rehabilitate priority degraded coastal ecosystems	Ability of a management option to provide environmental protection or benefit has formed part of cost benefit analysis of options.
Principle 9	Maintain and improve safe public access to beaches and headlands consistent with the goals of the NSW Coastal Policy	This is addressed directly in Section 4.2
Principle 10	Support recreational activities consistent with the goals of the NSW Coastal Policy	This is addressed directly in Section 4.2

The CZMP Guidelines specify the use of a risk based approach for preparing a CZMP and actions for managing coastal hazards. A risk based approach has therefore been applied to the preparation of this study.

1.2.2 Adopted Sea Level Rise Projections

Previously, the NSW Sea Level Rise Policy Statement (DECCW, 2009) (the Policy Statement) set benchmarks of a 0.4 metre rise in sea level by 2050 and 0.9 metre rise by 2100 above 1990 sea mean sea level as the standard to be used in all forms of coastal assessment and planning, including coastal hazards definition studies. These values represent the best estimates for the NSW Coast at the present time, as they are based upon reports by the IPCC (2007) and CSIRO (2007).

The NSW Government repealed the NSW Sea Level Rise Policy Statement 2009 in September 2012, meaning that the state-wide sea level rise benchmarks no longer apply to coastal assessments (such as the Kempsey Coastal Processes and Hazards Definition Study, BMT WBM 2013). The NSW Government indicated that local councils “have the flexibility to determine their own sea level rise projections to suit their local conditions” (NSW Environment and Heritage, 2012), although it is unclear if or how local councils may be equipped to do this.

In lieu of sea level rise benchmarks, the Office of Environment and Heritage (OEH) has suggested that Councils should adopt sea level rise values that are widely accepted by competent scientific opinion, or indeed, investigate a range of sea level rises (pers. comm., Mike Sharpin, OEH, 25th October, 2012).

Under Section 733(2) of the *Local Government Act 1993*, Council has a duty of care to inform its local constituents of known risks in order to receive an exemption from liability for acting in good faith with respect to coastal hazards. Under Section 733(4) of that Act, Council is considered to have acted in good faith where decisions are based substantially in accordance with the relevant manual, in this case, the Guidelines for Preparing Coastal Zone Management Plans (OEH, 2013).

Thus, Council has a legal imperative to consider sea level rise, as it is a known and measured coastal process that will affect the likelihood of land being affected by coastal hazards. The

assessment of sea level rise is a requirement of the Guidelines for Preparing Coastal Zone Management Plans (OEH, 2013), upon which the *Local Government Act 1993* exemption from liability is based.

For the purposes of managing the coastal zone of the Kempsey LGA, and as agreed with Council and OEH, the sea level rise values that were used in the former NSW Government's sea level rise policy have been adopted for this CZMS and the preceding CPHDS (BMT WBM, 2013).

1.3 Emergency Action Plan

An Emergency Action Plan (EAP) has been formulated to guide the immediate actions undertaken in the event of severe storm damage to the coastal zone. The EAP will inform the provision and coordination of emergency services in the event of a severe and damaging coastal storm.

Actions included in the EAP are consistent with the objectives for the CZMP (please refer to Section 1.1). The EAP is intended to be integrated into Councils Disaster Plan (DISPLAN). The EAP is included as Appendix C

1.4 Study Area

The coastal zone of the Kempsey Local Government Area (LGA) extends from just north of Point Plomer in the south (including Big Hill) to just north of Middle Head in the north (including Middle Head Beach). The study area is illustrated in Figure 1-1 to Figure 1-4.

The study area includes offshore marine areas as well as land features such as beaches, dunes, headlands and bluffs. The study area extends inside estuaries and coastal entrances as far as applicable to determining coastal processes and hazards extents.

Focus locations for the Kempsey CZMP include the beaches associated with the coastal villages, namely:

- Crescent Head
- Hat Head
- South West Rocks
- Grassy Head
- Stuarts Point, and
- Delicate Nobby and the beach towards Point Plomer.

Title:

Kempsy Coastline Study Area:
Middle Head Beach to Smokey Cape

Figure: 1-1

Rev: B

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Approx. Scale

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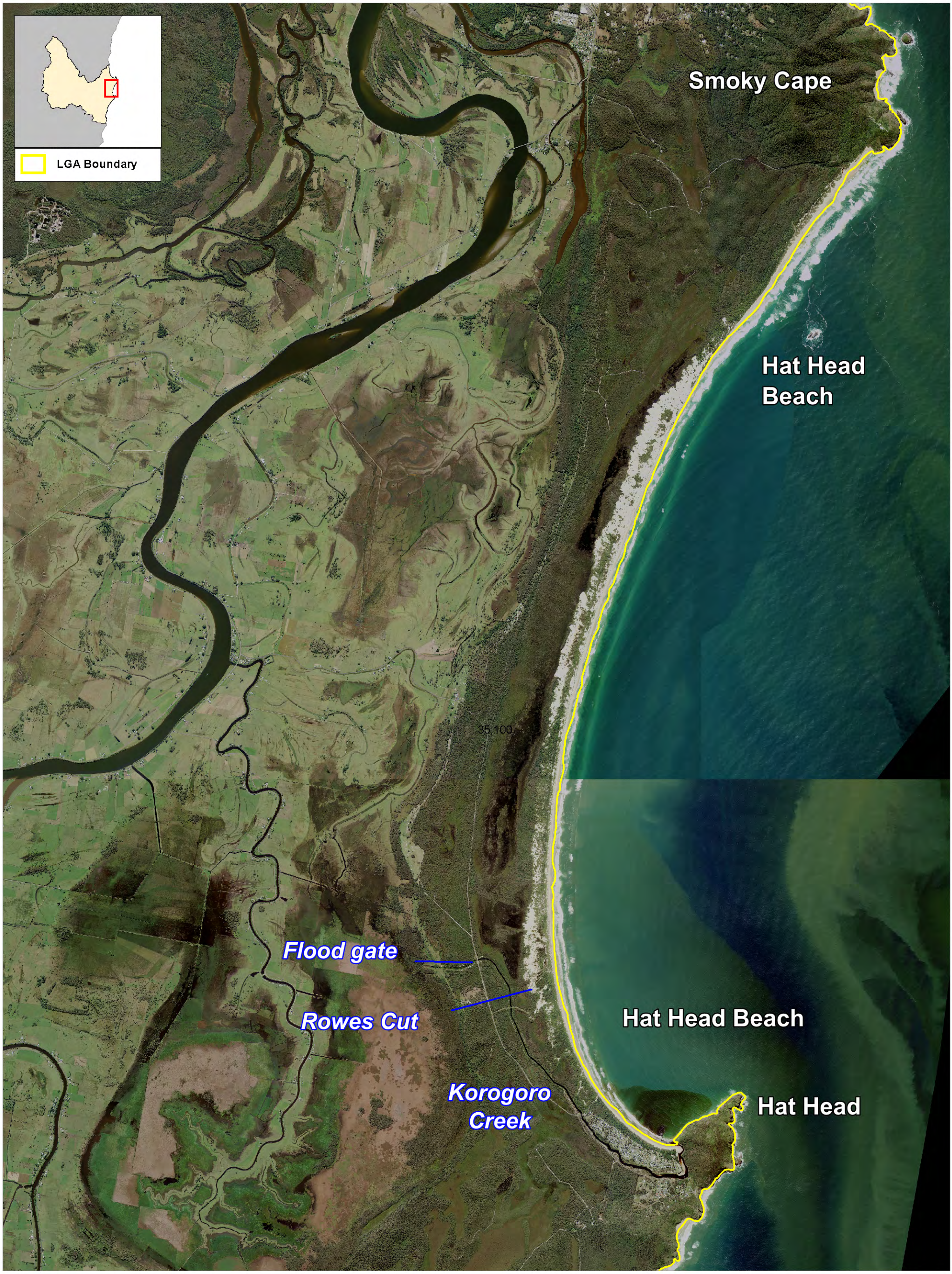

Title:

Kempsy Coastline Study Area:
Smokey Cape to Hat Head

Figure: 1-2

Rev: B

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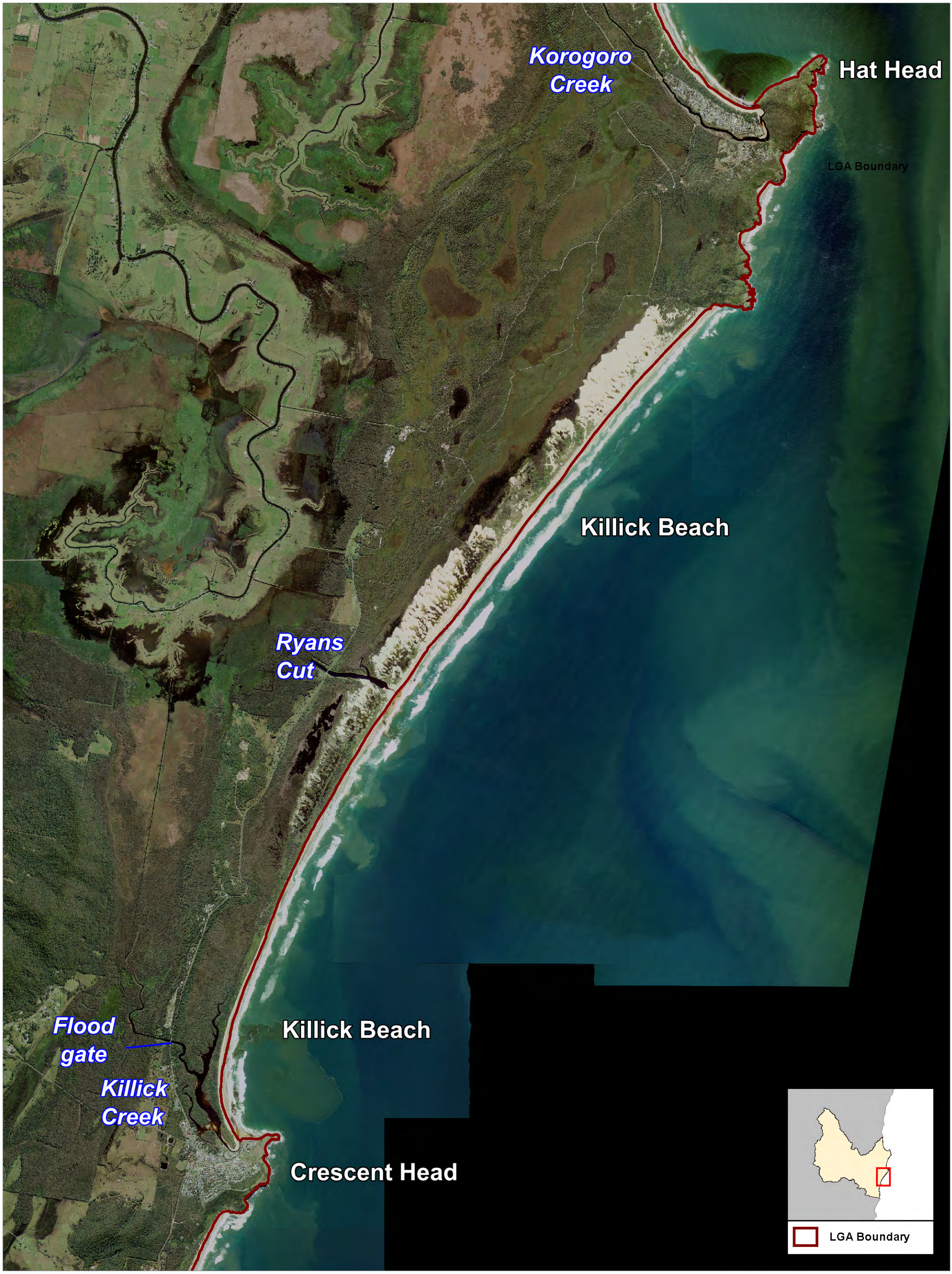

Title:

Kempsy Coastline Study Area: Hat Head to Crescent Head

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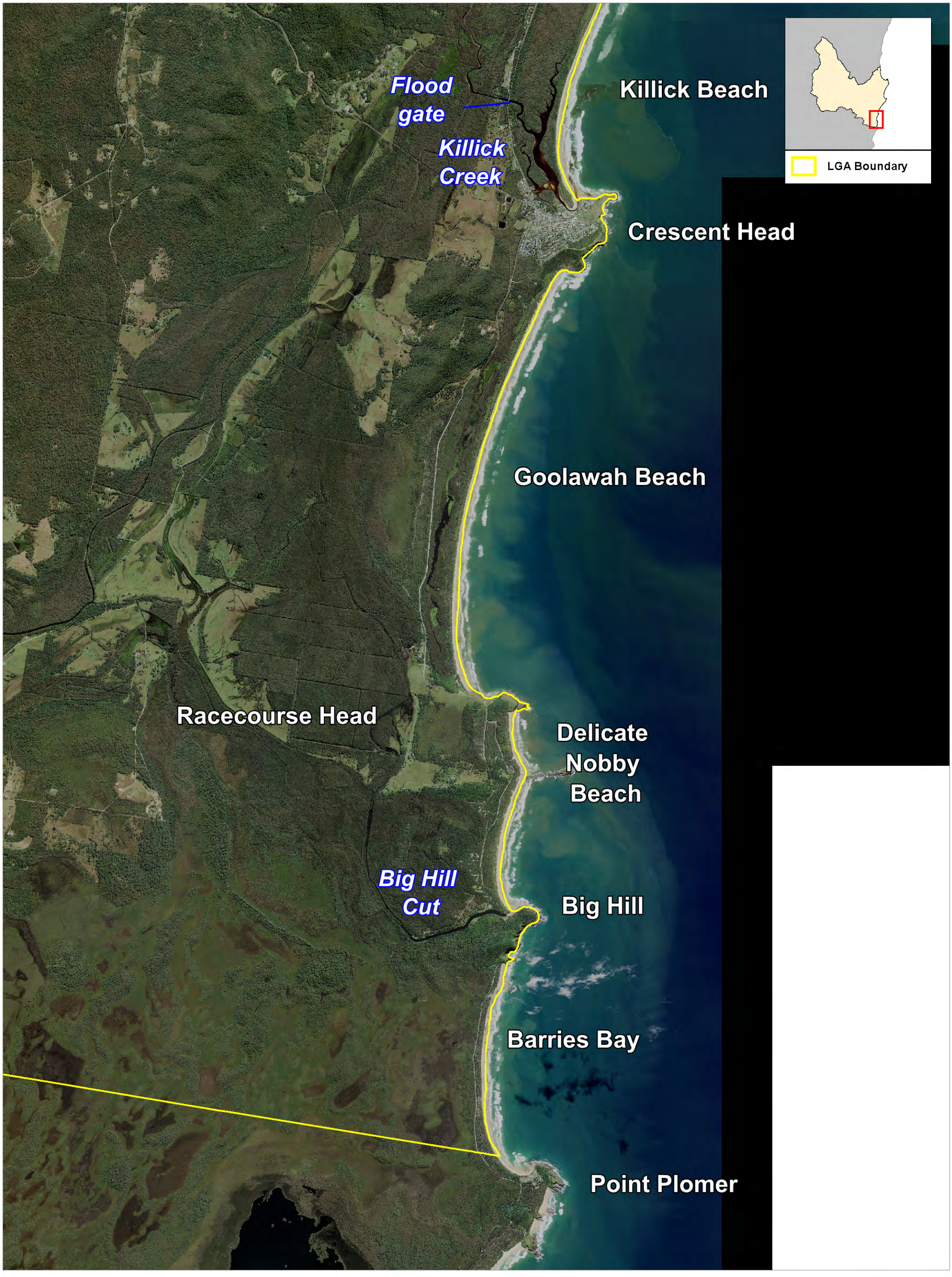

Title:

Kempsy Coastline Study Area: Killick Beach to Point Plomer

Figure: 1-4

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2 Review of Coastal Processes and Hazard Definition Study

This chapter provides an overview of information presented in the Kempsey Coastal Processes and Hazards Definition Study (BMT WBM 2013). The discussion of coastal processes provided herein is aimed at a wider audience. Details and technical information relating to the coastal processes are provided in BMT WBM (2013).

2.1 Coastal Processes

The prevailing coastal processes together with the underlying geology shape the Kempsey coastline. The regional geology determines the orientation of the coastline, the width and slope of the continental shelf, the type and location of headlands, reefs and other structures and the sediment size and type. Coastal processes are considered a hazard where they impact upon human developments or values.

2.1.1 Geology, Geomorphology and sediments

The bedrock along the Kempsey coastline that forms the headlands, reefs and other outcrops includes a range of mostly Permian age rock types (250-300 million years ago).

In some areas along the New South Wales coast (including Kempsey), separate sand barriers can be recognised, corresponding to cycles of sea level variation. The Pleistocene barrier was formed around 120,000 years ago when sea levels were around 5 m higher than they are today. The second more seaward barrier formed during the Holocene period, around 6500 years ago.

During the Pleistocene, large quantities of marine sand accumulated in the Trial Bay embayment to form wide beach ridge barriers. Holocene barriers form the present shoreline and are described as narrow (typically less than 500 m in width, although wider areas are evident particularly at the northern ends of Hat Head, Killick and Stuarts Point Beaches). The barriers exhibit beach and foredune deposits, but not extensive beach ridges that would suggest a period of progradation during the Holocene (PWD, 1980).

The width and slope of the continental shelf affects the dissipation and shoaling of waves as they move from deep water into the near shore zone. The slope of the continental shelf in the vicinity of Kempsey is found to be 1:140 on average. The width of the continental shelf is around 15km. Smoky Cape is a relatively prominent outcrop, extending significantly eastward, and the width of the continental shelf is particularly narrow at this point.

Sand in the study area is mostly marine in origin. Nearshore sediment at Trial Bay is composed of very fine to medium grained marine sand. Sediment sampling from the Macleay River Entrance showed sand that was predominantly marine in origin with a small quantity of fluvial sands. The river entrance will hold marine sediments during non-flood periods. During floods, fluvial sand and mud is expelled into the coastal zone via rivers and creeks. The entrance marine sand and possibly an additional minor supply of fluvial sand are delivered back into the coastal system during floods from the Macleay.

The finer grained fluvial sediments (i.e. muds and silts) delivered by floods tend to remain in suspension and become diffused seaward across the inner shelf and are deposited in the mid shelf region.

Shelf sand bodies are believed to occur off Smoky Cape and Hat Head (Roy, 2001 quoting Ferland, 1990). The shelf sand body at Hat Head has been measured at up to 38 m thick occurring in water depths of 25-60m, while the shelf sand body off Smoky Cape has not been measured.

Sand mining occurred in the area around the 1950's to 1970's. The impacts of sand mining are an important consideration when trying to understand past erosion / recession processes and predicting future impacts of coastal processes and sea level rise as it can distort the interpretation of sand volume change. This aspect is given much consideration within the CPHDS (BMT WBM 2013).

2.1.1.1 Headlands, Reefs and Coastal Structures

The orientation of the shoreline and protruding headlands, reefs and man-made structures dictate how wave energy arriving at the shoreline moves sand around within and between embayments. Along the Kempsey Coastline, headlands have a strong control on sediment transport between embayments (beaches). Smoky Cape and the associated breakwater extension is the most significant outcrop and it is believed to influence wave patterns into beaches beyond Scotts Head (north of the Kempsey Local Government Area). Other notable headlands include Hat Head, Crescent Head, Big Hill and Point Plomer.

Most of the beach embayments face east with the exception of the extreme eastern end of Trial Bay that is almost westerly facing. The shoreline north of Laggers Point tends to be oriented north east to east and south of Smoky Cape, the beach is oriented to the east south east.

Between headlands, the beaches are mostly sandy with the exception of rock reefs such as the outcrop known as Delicate Nobby Island and the offshore rock outcrop around 1km off Smoky Cape.

2.1.2 Waves

Sources of waves arriving to the Kempsey Coastline are:

- Tropical Cyclones (generating easterly waves from November to May),
- East Coast Cyclones (generating south easterly to easterly waves, typically in May, June and July), and
- Mid latitude cyclones generating predominantly south easterly swell, anytime of the year, but particularly March to September).

The largest waves (based on average significant wave heights measured offshore) arrive in autumn, then winter, then summer and the smallest in spring. Most waves (i.e. approximately 60%) arriving to the Kempsey coastline are sourced from the south to south east.

There are subtle shifts in the wave climate (wave height, wave direction) between years and even decades that relate to the intensity and frequency of storms. Variability in wave height and direction that persists for years to decades will result in alternating cycles of erosion and accretion

and rotation of the shoreline. A series of storms over months to years will have a cumulative effect upon the shoreline, which may result in greater erosion than a single severe storm alone. There is some correlation between the south eastern Australian wave climate and the El Nino Southern Oscillation (ENSO). Climate variability over a ten to 30 year time scale is also apparent. A period of dramatic erosion and shoreline retreat over the 1950s to 1970s is well documented. From this time until about 1997, calmer conditions were experienced, which was characterised predominantly by beach recovery.

2.1.2.1 Storm History

The storm history over the available records is documented in the CPHDS (BMT WBM, 2013). The most significant coastal storms within this period (in terms of damage to the Kempsey Coastline) include:

- Storms coinciding with the occurrence of spring high tides in February 1954, June 1967 and February 1974,
- Storm in May 1974 that coincided with the highest water level reordered off the NSW coast of 2.37 m (above ISLW), and
- Storm in May 1997, which coincided with an elevated ocean water level 0.7 m higher than the predicted tide.

2.1.3 Tides

Tides along the Kempsey coastline are semi-diurnal with significant diurnal inequalities. This means there are two high tides and two low tides a day and that they are generally at different levels (i.e. the two high tide levels are different in any one day).

2.1.4 Elevated water levels

Elevated water levels during a storm may be caused by the following elements:

- **Barometric pressure setup** due to the low atmospheric pressure of the storm,
- **Wind Setup** due to strong winds during the storm “piling up” water onto the coastline,
- **Astronomical tide**, particularly king tide conditions,
- **Wave Set Up**, which is the super elevation of the water surface due to the release of energy by breaking waves. It is directly related to wave height, so will be greater during storm conditions, and
- **Wave run up**, which is the vertical distance of the uprush of water from a breaking wave on the shore.

During extreme storm conditions these components may add together to give an ocean water level of to 2.9mAHD (excluding wave run-up). By 2050, under the most extreme scenarios assessed, this may be as high as 3.5m AHD and by 2100 up to 4.3m AHD (due to the influence of projected sea level rise). This is considered a rare scenario.

2.1.5 Wave run-up

A small component of the inundation hazard refers to overtopping of dune barriers by wave run-up. Wave breaking processes on the shoreline will cause wave run-up onto the beach face and over dune crests during elevated water levels. For a 1 in 100 year ARI 6 hour duration wave height of 8m with a wave period of 12 seconds, run-up of 6.4 m may be assumed for the immediate timeframe. The run-up would increase with sea level rise by an amount equivalent to the sea level rise (i.e. equating to 6.8 metres by 2050 and 7.3m by 2100 with projected sea level rise of 0.4m by 2050 and 0.9m by 2100 above the 1990 sea level.

2.1.6 Wind

Wind is directly responsible for the sea state and may generate noticeable currents. Winds also transport sand from the beach face into incipient foredunes allowing for the growth of dunes and storage of sediment.

Winds are generally offshore in the morning (due to the cooler land mass relative to the sea), and onshore from the east to north east direction in the afternoon, as the land mass is heated during the day and the overlying air is heated and rises causing cool air to flow in from the sea to replace it. During the cooler months, winds tend to originate from the west to south directions. Occasional afternoon sea breezes occur during cooler months, however, these are of lesser strength than those in summer months (MHL, 1983; Binnie and Partners, 1987). These patterns are broadly true along the entire NSW coast.

2.1.7 Longshore Sediment Transport

Waves approaching the shoreline from an oblique angle generate a current alongshore which is capable of transporting sand. This is referred to as longshore sediment transport. Depending on the prevailing wave direction, the longshore sediment transport may be directed either north or south. On NSW beaches, the net longshore sediment transport is to the north, due to the predominant south east wave climate relative to the general north to south orientation of the coastline.

Where more sand is transported out of a beach area than is being brought in over an extended period of time, the active beach system will move landward over time. The erosion will occur initially in the surfzone where sand transport is greatest, and manifest as beach retreat following onshore/offshore readjustment of the nearshore profile. Correspondingly, beach accretion may occur where longshore transport brings more sand than is taken away.

Longshore transport around headlands and artificial structures such as breakwaters generally occur as ‘slugs’ of relatively large quantities of sand moved around by high wave energy during storm events.

The entrance to the Macleay River is now constrained by training walls. A breakwater was also constructed from Laggers Point at the turn of last century. These features have affected the shoreline within the Stuarts Point to Trial Bay embayment.

2.1.7.1 Impact of the Macleay Breakwaters on Beaches

The Macleay River entrance remains fixed and permanently open due to the construction of twin breakwaters. Historically, the entrance location would have migrated between the south and north ends of Stuarts Point Beach, from South West Rocks to Grassy Head (with Back Creek connected to the Macleay system). Large flood events would have caused the river to breakout at locations further south (such as occurred in 1893). During calmer weather, the entrance would migrate slowly north under the influence of typically south-easterly waves and northerly directed longshore transport. The breakwaters have acted like a groyne to interrupt the northerly longshore sediment supply. The result has been accretion and formation of Back Beach and recession of the southern portion of Stuarts Point Beach (up to 180m landward retreat).

2.1.7.2 Effect of the Laggers Point Breakwaters on Beaches

The initial plan for the Laggers point breakwater, constructed by prison labour from the Trial Bay Prison, was for a breakwater up to 1,524 m in length off Laggers point to form a safe harbour in Trial Bay. The construction of the breakwater commenced in 1889. While construction was successful during the first year, coastal storms soon became an issue and large sections were washed away and the original plan for the breakwater was abandoned. Regardless, the remants of the early sections of the breakwater remain and have an influence on local coastal processes.

Before the breakwater was constructed, waves traveling past Smoky Cape and Laggers Point into Trial Bay prior to the breakwater construction would have bent (or refracted) into the bay. Sand would have been transported in a current along the shore bypassing the extreme end of the embayment. Under existing conditions, wave energy is lost as the waves pass the relict breakwater with sand forming shoals behind the structure. The lower energy waves slowly rework the deposited sand onto the beach where they rejoin the shoreline mid-way along Trial Bay.

2.1.7.3 Ferry Wrecks in Trial Bay

Three car ferries were wrecked in Trial Bay in January 1972. The ferries were being transported from Newcastle to Manila in the Philippines where they were to be used as scrap or barges. The three ferries were being moored in Trial Bay when a storm hit in January 1972. The ferries were not able to be salvaged and have now largely been destroyed by saltwater and covered in sand. The top masts are visible during low tides. The ships are unlikely to influence coastal processes on the shoreline.

2.1.8 Cross Shore Sediment Transport

During storms, increased wave heights and elevated water levels cause sand to be eroded from the upper beach/dune system (often termed ‘storm bite’) and transported offshore, typically forming one or more shore-parallel sand bars in the nearshore zone. As the sand bars build up, wave energy dissipation within the surfzone increases and wave attack at the beach face reduces. The severity of wave attack at the dune is dependent on wave height and elevated water level (the combination of tide, storm surge and wave setup) and preceding beach condition (i.e. if the beach is accreted or eroded prior to the storm). In addition, depending upon the orientation of the coastline relative to the direction of the incoming storm, the beach may either experience

unimpeded wave power and severe erosion, or may be shadowed and protected from incoming wave energy.

During calmer weather, sand slowly moves back onshore from the nearshore bars to the beach forming a wave-built berm and, subsequently, a wind-formed incipient foredune.

2.1.9 Rip Currents

Rip currents contribute to the extent of beach erosion during severe storms both in terms erosion of the upper beach face at the landward end of the current, as well as transporting offshore the sand mobilised by wave breaking. On the open beach, rips may form at any location along the beach. Their formation at any potential location needs to be considered when planning development set-backs along the coast.

The spacing of rips is dependent upon the wave energy conditions, such that during large waves, fewer rips will form at greater distance apart, however the currents are wider and stronger. Feeder currents and troughs into the rips will also increase in width and strength during high waves. This can be seen in Figure 2 7, where tannin water exiting Ryan's Cut at low volume is taken both north and south by feeder currents into rips and offshore, to the north and south.

Figure 2-1 Example of Feeder and Rip Currents

2.1.10 Wind Blown Sand

Wind blown sand is referred to as aeolian transport of sand. It has an important role in building dunes. For example, the accretion along the Trial Bay shoreline in incipient foredunes and active dune fields at Hat Head and Killick Beaches have formed largely from wind blown sediments from the upper beach face. Wind blown sand can be a hazard where back beach development is being inundated by dune sands.

2.1.11 Dune Rehabilitation Works

Dune stabilistaion works began in the 1970's, which was initiated largely in response to siltation of channels by sand drift.

Historical siltation and closure of the Macleay entrance at Grassy Head is believed to have allowed cattle to access the dunes at Stuarts Point Beach. Cattle grazing was believed to have been a key reason for the lack of vegetation on the dunes at Stuarts Point Beach by the 1970s. A program of dune revegetation commenced in 1972 and continued for approximately 13 years. By this time, dune vegetation extended across the 80 hectares of formerly active dune. At present, dune vegetation is still extensive at Stuarts Point, however, there is notable infestation by Bitou Bush. In any case, the dune vegetation works allowed for the capture and stabilisation of windborne sediments at Stuarts Point.

The first Dune Care group in NSW began at Hat Head. The group still works within the dunes particularly around the village to remove Bitou Bush. Likewise, a Dune Care group at Crescent Head works predominantly at the Killick Creek entrance, mostly removing Bitou Bush and increasing vegetation coverage at the entrance. The entrance to Saltwater Creek at South West Rocks was revegetated around 20 years ago (pers. comm., Rod McDonagh, NSW Maritime), and is currently well vegetated.

A range of Bitou Bush control works are currently being undertaken by Kempsey Shire council and Dune Care.

2.1.12 Coastal Creeks and Rivers

Coastal Creeks and Rivers on the Kempsey coastline (excluding flood mitigation works) from south to north are:

- Killick Creek, at the southern end of Crescent Head Beach;
- Korogoro Creek, at the southern end of Hat Head Beach;
- Saltwater Creek, at the southern (western) end of Trial Bay Beach;
- Back Creek, adjacent to South West Rocks; and
- the Macleay River on Stuarts Point Beach.

These are only considered insofar as they impact upon open coastal processes.

Marine sand is carried into the creeks and rivers to form entrance shoals as the incoming flood tide has more energy than the outgoing tide (due to the additional wave processes). During catchment floods, this sand can be scoured out by fast flowing flood waters. Like all coastal processes there

are trends across seasons, years and decades to terms of entrance dynamics and sand accumulation.

2.1.13 Flood Mitigation Works

In response to the floods in 1949 and 1950, a series of flood mitigation works were constructed by NSW Government, Federal Government and County Council to ease flooding downstream of Kempsey. A flood mitigation scheme was commenced in the 1950's and completed in the 1970's with the aim of:

- Protecting the Kempsey township in a 1 in 10 year flood,
- Protecting the lower Macleay agricultural areas from a 1 in 2.5 year flood,
- Allowing rapid drainage of flood waters from inundated farmland
- Providing erosion protection to stream and drain banks
- Improving flood mapping and data, and
- Providing a flood warning system for residents and landholders (Tony Castle, pers. Comm.)

The key aspect of interest in the present study is the ability for flood waters to continue to drain to the ocean as sea level rises. Significant flood mitigation works considered include:

- Big Hill Floodgates,
- Killick Creek Flood Gates,
- Ryans Cut,
- The Choke Floodgates on Korogoro Creek, and
- Rowes Cut.

2.1.14 Climate Change Considerations

The implications of projected climate change on the Kempsey coastal zone are considered within this study. A much more detailed account of this is given in BMT WBM (2013). The changes considered include sea level rise, shifts in the wave climate, increased storm surge, changes to rainfall and changes in wind directions and speed.

The most significant change is projected sea level rise. In this assessment, sea level rise has been considered as 0.4m by 2050 and 0.9 metres by 2100. These are recognised as the best available national and international projections for the NSW coast.

A shift in mean wave direction of 5^{o} by 2100 has been considered for 2100. The projected changes in wave height are included within the natural variability.

Storm surge increases include the abovementioned sea level rise and also changes to wave set up.

Projections for rainfall include increased magnitude in extreme rainfall events with less rainfall overall. This will impact on coastal creek and river entrance conditions.

Projected changes to mean wind speed and direction are minor, but have been considered with regard to wind blown sand transport.

2.2 Coastal Hazards

For coastal planning purposes, it is more important to understand the potential envelope of gross beach movement in response to periods of extended storminess rather than impacts of individual storm events.

The coastline hazard assessment (as detailed in BMT WBM, 2013) uses an accepted methodology to estimate the likely landward extent of coastal hazard impacts for the present day, 2050 or 2100 should a severe storm or series of severe storms be experienced. The methodology includes:

- Photogrammetric data – historical air photos of beaches are used to calculate changes to beach sand volume and the position of dunes over time,
- Estimations of historical long term recession (permanent landward movement of the shoreline) (although this is not being experienced in Kempsey),
- A computer based numerical “shoreline evolution” model that predicts shoreline changes in response to projected sea level rise, and
- Likley extents of coastal inundation of low lying areas near and behind coastal barriers and coastal entrances during high ocean water levels.

The key output of the hazard assessment is a series of maps. Due to the inherent uncertainty of predicting future storm events, coastal processes and also the magnitude of climate change (including sea level rise), a risk based approach is used. Rather than trying to provide a single answer with absolute and potentially unfounded accuracy, the risk assessment approach allows consideration of a range of events, their likelihood, consequence and thus overall level of risk.

The hazard mapping therefore gives the likelihood for coastal hazards occurring. For each of the Kempsey beaches, maps have been produced that show:

- The erosion and recession hazards for the immediate time frame, 2050 and 2100, and
- The periodic coastal inundation hazard for the immediate time frame, 2050 and 2100.

Each of the lines have likelihood descriptors. For each hazard and time period, there the following three lines are presented:

- Almost Certain – hazards of this extent have been measured previously on a relatively frequent basis
- Best estimate – this hazard is expected to occur, albeit infrequently, and
- Rare – this provides a worse case scenario of hazard (similar to the probable maximum flood estimate provided for flood hazard mapping), which would not normally be expected to occur, but may occur in a very extreme case.

2.3 Artificial Entrance Management

The entrances to Killick Creek, Saltwater Creek and Korogoro Creek are managed in accordance with the Estuary Management Plans for these systems.

Since 2010, Coastal Zone Management Plans are also prepared for Estuaries. The plans outlay a range of actions to improve the ecological sustainable use of estuaries, and have an overarching objective of improving the ecological health into the future. Plans of this nature were formerly known as Estuary Management Plans. The Kempsey Coastline has four plans of this nature:

- Killick Creek Estuary Management Plan
- Saltwater Creek Estuary Management Plan
- Korogoro Creek Estuary Management Plan, and
- Macleay River Estuary Coastal Zone Management Plan.

The triggers for opening are outlined in the respective documents. When the Estuary Management Plans are reviewed, the opening policies will also be reassessed.

3 Community and Stakeholder Consultation

Community consultation is an essential component of this project. In particular community and stakeholder consultation was essential for understanding the consequences of coastal hazards and other threats upon the built and natural assets of the Kempsey coastline. Community and stakeholder consultation was also an important method for understanding the status and adequacy of beach access and public amenity arrangements.

The consultation to date has involved:

- Publication of a Project Web Site
- Media Release
- Community Survey
- Two Community Meetings
- Direct correspondence

3.1 Project Web Site

The project website was established to summarise the process, project outcomes and importantly to encourage the wider community to become involved in the project. The survey was also available to be completed from the project web site.

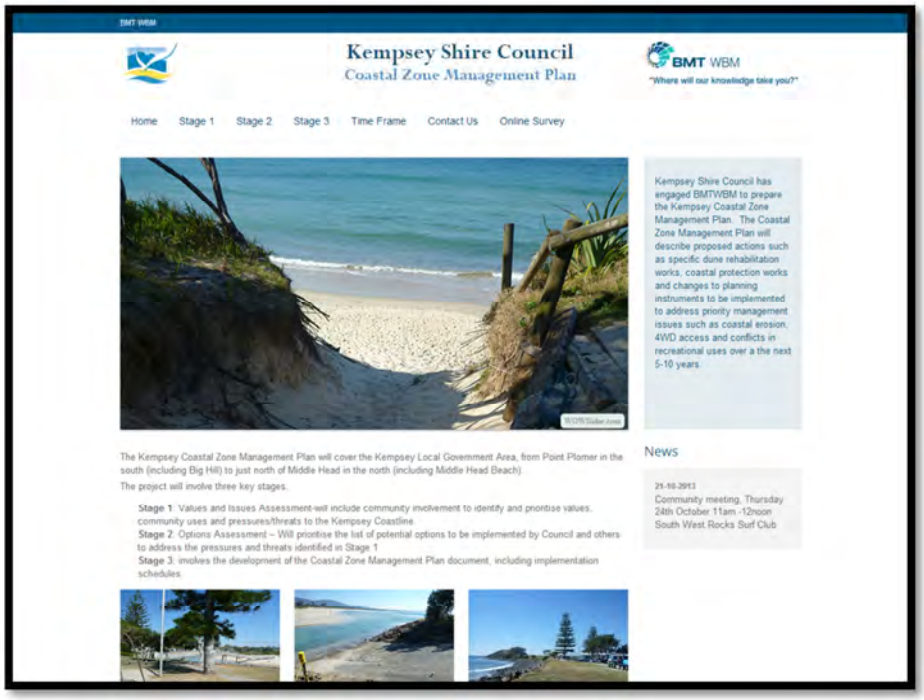


Figure 3-1 Screen shot of the project web site

3.2 Community Survey

A community survey was developed to gather relevant information from the community. The survey was available on the website, distributed at community meetings and 40 copies of it were posted to the Rate Payers Association with replied paid envelopes.

In total, 21 replies were received and results analysed. While the response was insufficient to support rigorous statistical analysis, it still provided significant qualitative information that was pertinent to the study.

Recurring themes through the survey responses were:

- A desire to keep the low key nature of the Kempsey coastal zone,
- Maintenance of the existing level of access and amenities,
- Concerns over the Master Plan for Horseshoe Bay (refer to Section 4.2.4).

3.3 Community Meetings

Two community drop in meetings were held in South West Rocks and Crescent Head in October 2013. The sessions allowed community members to speak directly with the study team as well as representatives of OEH and Council.

Specific work sheets were created to elicit information from a community perspective regarding:

- aspects of the coastal zone that are valued,
- Issues of concern, and
- How the coastal zone is used and the adequacy of existing facilities.

The first activity focussed on establishing what attendees valued about the Kempsey coastal zone. The second activity involved focussing on the most highly rated values and identifying the processes that are threatening, or potentially threatening, the values, based on individual participants experience and knowledge of the area.

3.4 Risk Assessment Workshop

Coastal hazard consequence was determined from the outcomes of a formal Risk Assessment Workshop conducted with key stakeholders and government representatives as part of this study. Consequences were assessed in terms of:

- the type of impact (e.g. short term or permanent);
- the type of assets and land affected; and
- the social, economic and/or environmental values associated with the affected land and assets.

Consideration was also given to the coastal values and issues identified in the community surveys, with regards to assigning coastal hazard consequences. The workshop was attended by key Council staff and representatives of a number of state government agencies.

The risk assessment workshop was discussed in Section A.1.3.1.

3.5 Ongoing engagement with the community

The process of managing coastal hazard risks will be an iterative one and will involve more information and also more difficult decisions moving into the future. While this generation needs to make decisions about immediate risks, it is also important that we limit the expansion of the risk profile into the future for the next generation to manage. In this regard, planning restrictions on land identified as being at risk of coastal hazard into the future are important as is a program of community engagement to ensure that when difficult decisions need to be made (for example, whether to protect or relocate development), the community are in the best position to be a part of that decision. It is therefore recommended that Council begin to conduct education activities to inform the community about coastal risks and intended future actions – to build community acceptance, resilience and preparedness for managing future impacts. This is considered useful to for avoiding reactive management decisions.

For many of the highly valued beach areas, the best long term option is to allow for natural retreat, which will require planned loss of land behind the beaches. New opportunities may also become available in the future through changes to legislation and practices regarding offshore sand sources and beach nourishment. These potential changes to regulatory management regimes is one of the reasons for periodic review and updating of the CZMP (every 5 – 10 years say).

4 Land Uses and Community Amenity

4.1 Land Zoning

The *Environmental Planning and Assessment Act 1979* (EPA Act) is the key NSW legislation for planning and land use. The NSW Government is currently revising the planning system in NSW, as detailed in A New Planning System for NSW White Paper (NSW Government, 2013). Repeal of the EPA Act and adoption of the new planning legislation is expected to take effect in 2014. Until that time, however, the EPA Act remains in force.

The EPA Act provides a system of environmental planning and assessment for NSW, and involves developing plans to regulate competing land uses, through 'environmental planning instruments'. The EPA Act establishes three types of environment planning instruments (EPI):

- Local Environmental Plans;
- Regional Environmental Plans (now deemed SEPPs); and
- State Environmental Planning Policies.

Land use zoning for the Kempsey coastal zone is governed by the Kempsey Local Environmental Plan 2013. Land use zones for the immediate coastal zone are shown in Figure 4-6 to Figure 4-13.

4.2 Beach Access and Amenity Infrastructure

Access to Kempsey's beaches ranges from minimal, such as within the Hat Head National Park, to more extensive, such as at Crescent Head, based upon the visitation to these locations. Road access to the beaches also ranges from four-wheel drive only (such as the northern parts of Hat Head and Killick Beaches), to sections of dirt/gravel road, to fully signposted. Again this is commensurate with the level of use of the beaches. Patrolling of beaches for surf life safety is available at Grassy Head, South West Rocks, Hat Head and Crescent Head with the remainder of the beaches unpatrolled. Discussion of facilities at individual beaches is given below.

The current level of access and amenity is considered in keeping with the largely natural state of Kempsey's beaches. Large areas of the Kempsey coastline are located within a national park, and the more low key access to these areas is in keeping with their protected status. Indeed, these sections of the coastline are unpatrolled and have highly dangerous surf conditions, so restricted access is considered favourable from a public safety perspective. Control of four wheel drive use within the undisturbed and natural beach sections is important to preserve dunal vegetation.

4.2.1 Grassy Head and Middle Head Beaches

The main beach access for users of Grassy Head and Middle Head Beaches is via the dilapidated walkway and viewing platform that extends from Grassy Head Beach. Information regarding the erosion issues that have resulted in the destruction of the beach access from the car park are given in Section 5.3.3.

The parkland behind the southern end of Grassy Head contains beach showers, picnic tables and other amenities. Informal tracks also pass to the south of Grassy Head Beach, through the caravan park and also across the headland (where the remnants of a walking track can be seen).

Four wheel drive access is permitted to professional fishers only on from the southern end of Grassy Head Beach to Middle Head. Beyond this, vehicular access is totally prohibited.

The Beach is Crown Land.

Figure 4-1 Dilapidated signage along the remnants of a walkway to the lookout platform on Grassy Head

4.2.2 Stuarts Point Beach

The main access to Stuarts Point Beach is via a footbridge across the Macleay Arm then a sandy track across the dunes onto Stuarts Point Beach. As noted above, there is an informal track across Grassy Head which provides access to the northern end of Stuarts Point Beach, however this is not used frequently.

In general, visitors to Stuarts Point make use of the Macleay Arm for swimming or fishing (including off the bridge). At the Stuarts Point side of the bridge, there are beach showers, fish cleaning and boat launching facilities, parkland, car parking and amenities. However, the open coast beach itself is less frequented, as it typically has dangerous surf conditions (for swimming or surfing) and no life guard patrols. Once again, the level of access infrastructure is suitable to the level of usage, although the track from the bridge to beach should be reviewed for impacts upon dune vegetation, and stabilised as necessary.

The southern half of Stuarts Point Beach to the Macleay Entrance is far less accessible. This is likely suitable given the lack of beach patrolling and generally dangerous swimming conditions, particularly in close proximity to the entrance itself, which has fast flowing tidal currents and is well utilised by boat traffic, both unsafe for swimming.

The beach and in fact all the land back to the Macleay River is Crown Land. Four wheel drive access is permitted to Beach Driving Permit Holders only, except the northern most 250 metres

where vehicular access is prohibited. Through the community and stakeholder consultation, concerns were raised regarding impacts on saltmarsh in the vicinity of the Macleay River by 4WDs.

4.2.3 Back Beach

Access to Back Beach is via a pedestrian bridge crossing Back Creek around 500 m upstream of the creek entrance. The bridge carries a pipeline to the sewage disposal site located in sand dunes behind Back Beach. A sandy track follows the creek edge to the trained entrance and onto Back Beach.

Car parking is available at the southern side of the bridge. There are no other beach facilities for Back Beach at the creek entrance or beach itself. The beach is not patrolled, and is likely to experience dangerous swimming conditions at times in proximity to both Back Creek entrance and the Macleay River entrance. The beach is popular for day visitors, including from boats.

The southern breakwater of the Macleay River Entrance forms the northern boundary of the beach. A tarred walkway is provided along the top of the breakwater and frequently used by visitors for walking and fishing. Access from the breakwater to the beach is relatively difficult, discouraging visitors from swimming in proximity to the breakwater and channel entrance as consistent with the dangerous swimming conditions at the river entrance.

Four wheel drive access is available along Back Beach to permit holders. There are some issues with impacts from 4WD on saltmarsh in accessing the beach (discussed later in Section 5.7.3).

Figure 4-2 Back Beach Pedestrian Walkway and Pipeline

4.2.4 Horseshoe Bay South West Rocks

Horseshoe Bay is a very popular beach located at South West Rocks, providing safe swimming for visitors and particularly children. Access is via either the Horseshoe Bay Beach Caravan Park immediately behind the beach, or the car park adjacent to South West Rocks Surf Life Savings Club (SLSC). Facilities are provided within the caravan park or adjacent to the SLSC. South West Rocks SLSC provides surf life savings patrols for the beach.

A Master Plan for Horseshoe Bay was released in August 2013, which has caused some concern amongst the community. The Master Plan includes changes to car parking arrangements, a new shelter structure and other landscaping works. It also includes cabins where caravans now occupy. Horseshoe Bay Beach is closed to all vehicles.

Figure 4-3 Horseshoe Bay at South West Rocks

4.2.5 Trial Bay

Access to the southern end of Trial Bay is provided adjacent to the southern side of South West Rocks SLSC. When the creek entrance is open, beach goers must cross Saltwater Creek to access the beach.

South West Rocks SLSC is founded on bedrock, which provides suitable foundation capacity for the building. However, storms during May 2009 resulted in wave run up into the base of the building. Currently, the SLSC buggy is stored in the lower garage. There is currently erosion occurring along northern bank of Saltwater Creek that forms a thin strip of land in front of the SLSC (see Section 5.5.3). Attempts to stabilise the bank with rocks and fill by the SLSC members have

failed to stem the erosion. The erosion is a result of creek outflow and wave processes along the northern bank of the creek during storm conditions.

The northern end of Trial Bay is accessible from within Arakoon State Conservation Area and from Trial Bay Gaol itself. Suitable beach access, car parking and camping facilities are also available at the base of Trial Bay Gaol. Trial Bay Boat Ramp is a concrete structure located immediately behind (westward) the Laggers Point breakwater. There are competing use issues between boat users, nearby campers, and recreational users at the boat ramp at times, which are discussed further in Section 5.5.3. The Arakoon State Conservation Area and Trial Bay Gaol are managed by the National Parks & Wildlife Service (NPWS).

Four wheel drives are prohibited for the length of Trial Bay, except when launching boats at Arakoon.

4.2.6 Hat Head

The southern end of Hat Head Beach is accessed via the Hat Head Caravan Park. This includes a number of fenced tracks across the dunes, and car parking and other facilities behind the beach and boat ramp. The bitumen boat ramp into Korogoro Creek has fish cleaning facilities, and the beach can be also accessed along the southern creek bank. Issues regarding the Korogoro Creek boat ramp are discussed and assessed in Section 5.6.3.

The majority of Hat Head Beach lies within Hat Head National Park. Access to the northern part of Hat Head Beach is via four wheel drive only, either along Hat Head Beach or from the base of Smoky Cape. There are various four wheel drive beach access points at the southern end of the beach.

The beach extending 1.4 km north of Korogoro Creek entrance is closed to all vehicles, except those launching boats. The remaining 14.5 km of the beach, up to Smokey Cape, is open to permit holders except for the northern-most 500 metres, which is closed to all vehicles.

There is a sewage dune disposal area to the north east of the township of Hat Head.

4.2.7 Crescent Head

Crescent Head and Killick Beach are some of the most heavily used locations along the Kempsey coastline. As such, Crescent Head has extensive facilities, including amenities and cafes within the caravan park, car parking, a boat ramp accessing Killick Creek, access to Crescent Head adjacent to the golf course, a skate ramp and picnic and barbeque facilities.

Council has recently undertaken some minor works at Crescent Head including formalising a walking / cycling path and adding rock to existing revetments along the Killick Creek bank.

Figure 4-4 Works underway for pedestrian footpath upgrade during 2013 and early 2014.

Crescent Head SLSC provides surf life saving patrols. The building is likely to require upgrade in the near future. KSC advises that the SLSC has received funding to upgrade the exiting clubhouse and facilities. The upgrade design should give consideration to the findings of the coastal hazard study.

Most of the land adjoining Killick Beach is National Park and all 4WD access is prohibited.

4.2.8 Goolawah, Delicate Nobby and Big Hill Beaches

From Crescent Head, the roadway access to Goolawah, Delicate Nobby and Big Hill is unsealed in part, although still accessible by two wheel drive vehicle. The northern end of Goolawah Beach is accessed via an unsealed track across the dunes with an informal car park in the sand dunes. The track provides four wheel drive vehicle access to Goolawah Beach.

The remainder of access ways for the beaches tend to be tracks (typically unfenced and unboarded) across the dunes, signalled to passing traffic only by relatively informal “car parks” with little to no signage. There are no other facilities for these beaches (e.g., beach showers, amenities, picnic tables etc), and this is in keeping with the current character of these beaches. The area is largely natural and managed within Goolawah State Park and Limeburners Creek Nature Reserve by NPWS. Private lands adjacent to the beach, focusing on many of the entranceways, is utilised for cabin or eco style accommodation. Many of the access pathways service these private enterprises almost exclusively, although the onus on maintenance falls on National Parks.

At Big Hill adjacent to Big Hill Floodgates there are more formal parking facilities above the rock wall adjacent to the flood gate and southern end of the beach.

Given the lower usage of these areas, the current level of facilities is suitable, although fencing or boarding of the existing informal tracks may ensure beach access is controlled and vegetation protected across the dunes.

Figure 4-5 Typical Informal Track Access to Delicate Nobby Beach

4.3 Values

Kempsey's relatively untouched coastline has intrinsic, environmental, social and economic value, for residents and visitors. This is best summarised in the following quote taken from one of the community response to the on-line survey:

"Locals and tourists alike are drawn to the quiet coastal hamlet feel of Crescent Head and surrounds. In surfing circles it is Australian folklore. Once it is changed, there is no going back"

4.3.1 Surf Reserve

The International and National significance of Crescent Head as an iconic surf location is formally acknowledged through its inclusion as a Surf Reserve. The National Surfing Reserve initiative aims to recognise and ensure that areas declared a Surf Reserve remain protected for generations to come. The National Surfing Reserves Organisation Website explains that Crescent Head was first surfed in the 1950's.

4.3.2 Low Key Nature

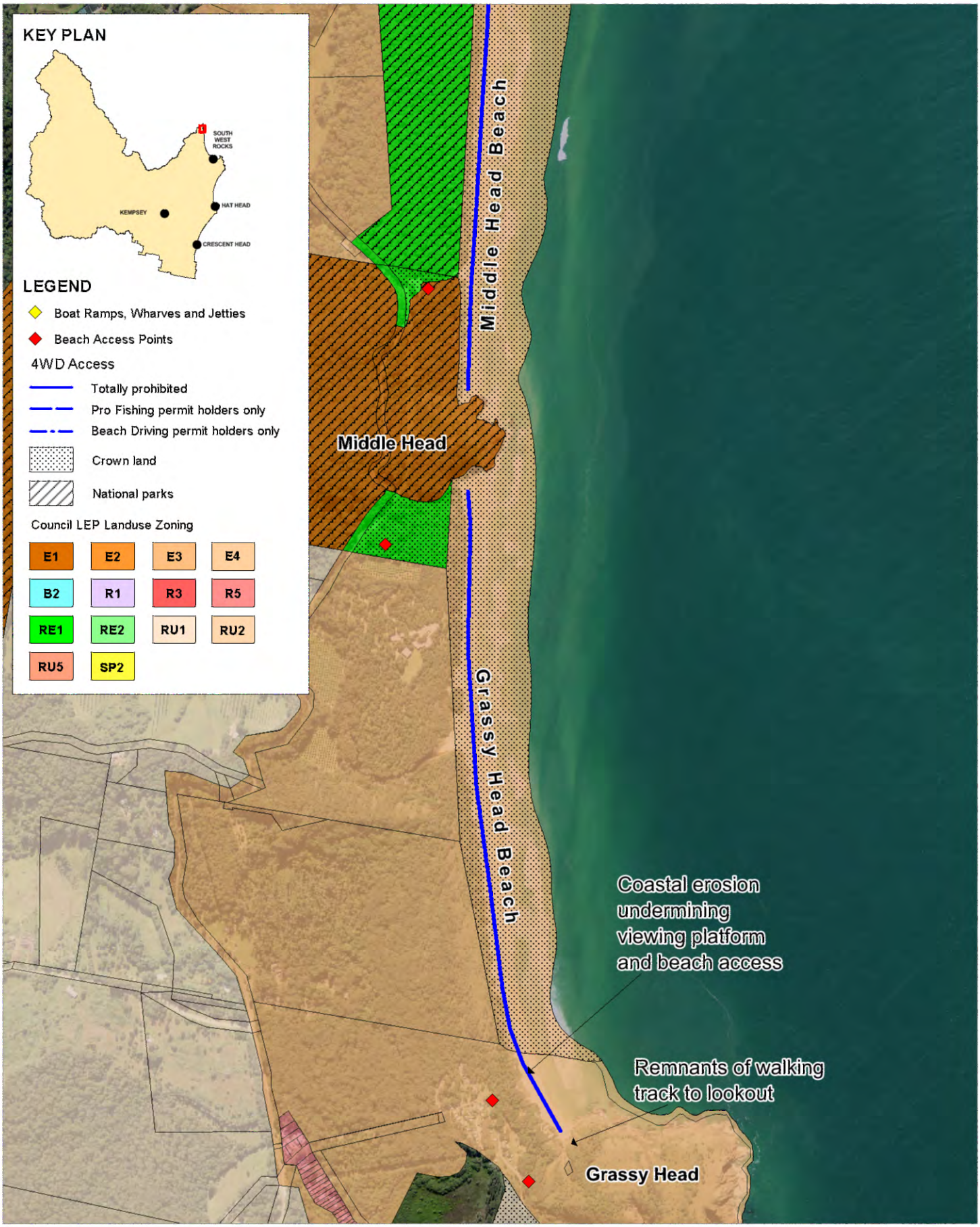
The low key nature of the Kempsey coastline is a value echoed throughout the consultation. This includes basic levels of access, dirt roads remaining in current locations, limited further development and uninterrupted natural scenic vistas.

4.3.3 Primitive Bush Camps

Bush camping to the south of Hat Head within National Parks is highly valued as it is one of the few coastal locations where campers can have rustic camp fires, take dogs and undertake cultural camping.

4.3.4 Economic Value of the Coast

The high level of visitation from outside of Kempsey to places such as Crescent Head, South West Rocks and Hat Head, particularly during summer, places a strain on local services. In order to continue to maintain the natural values of Kempsey's coastline, contributions from the visiting populations to assist funding should be considered.



Title:

Land Zoning and Coastal Amenities Mapping Grassy Head Beach

Figure: 4-6

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Approx. Scale

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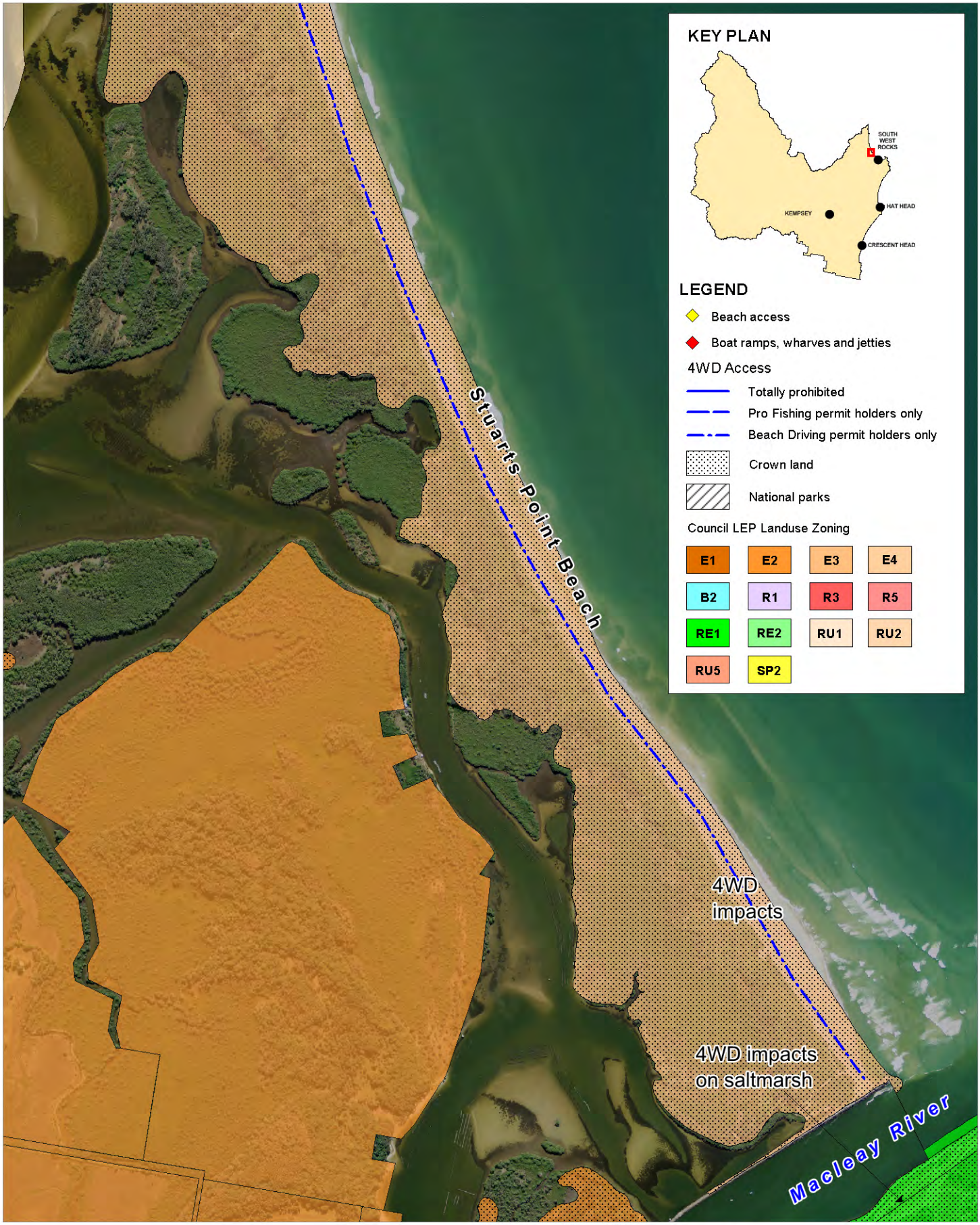

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Land Zoning and Coastal Amenities Mapping Stuarts Point Beach

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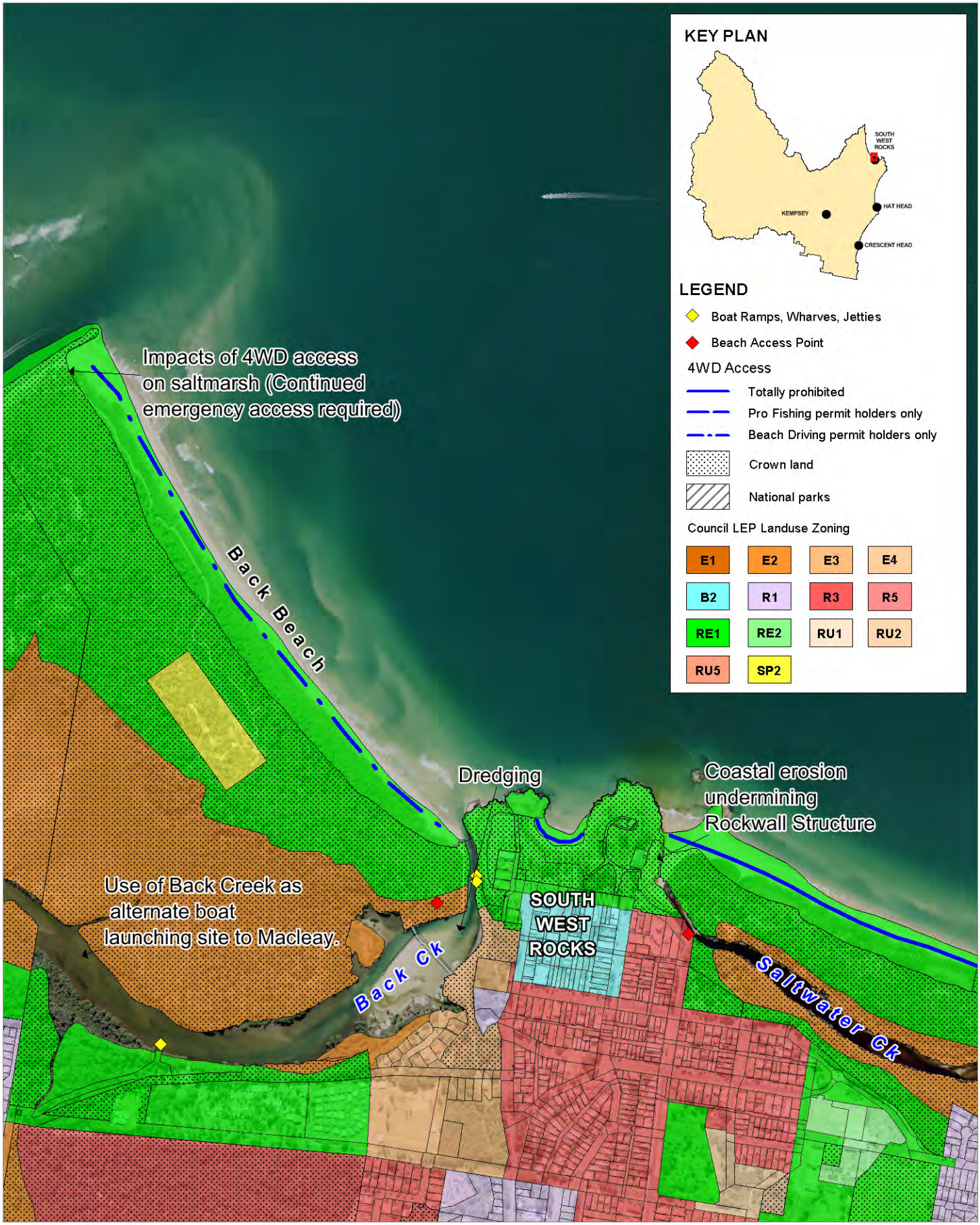

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Land Zoning and Coastal Amenities Mapping South West Rocks

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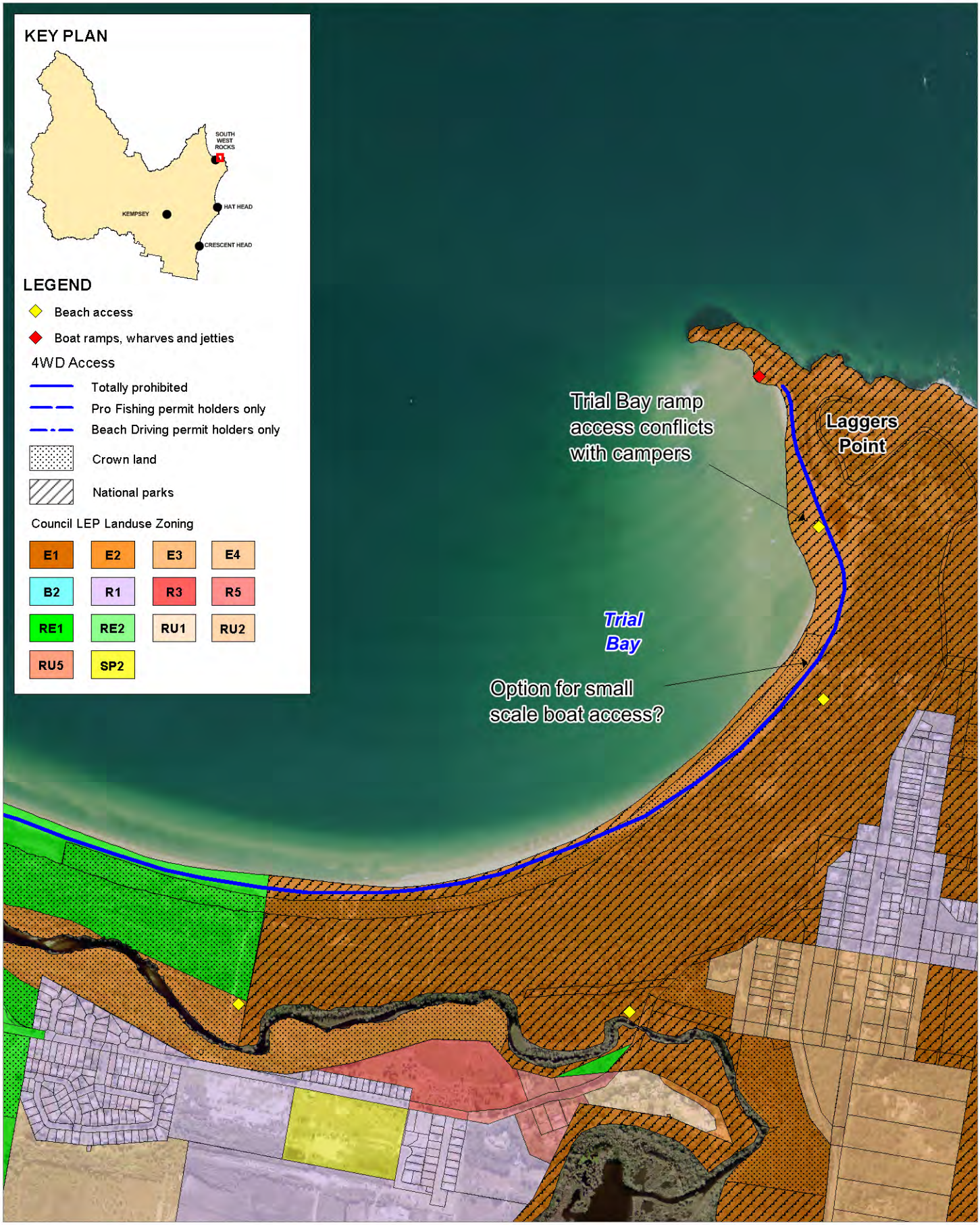

Title:

Land Zoning and Amenities Mapping Trial Bay

Figure: 4-9

Rev: B

N

0 250 500m

Approx. Scale

BMT WBM

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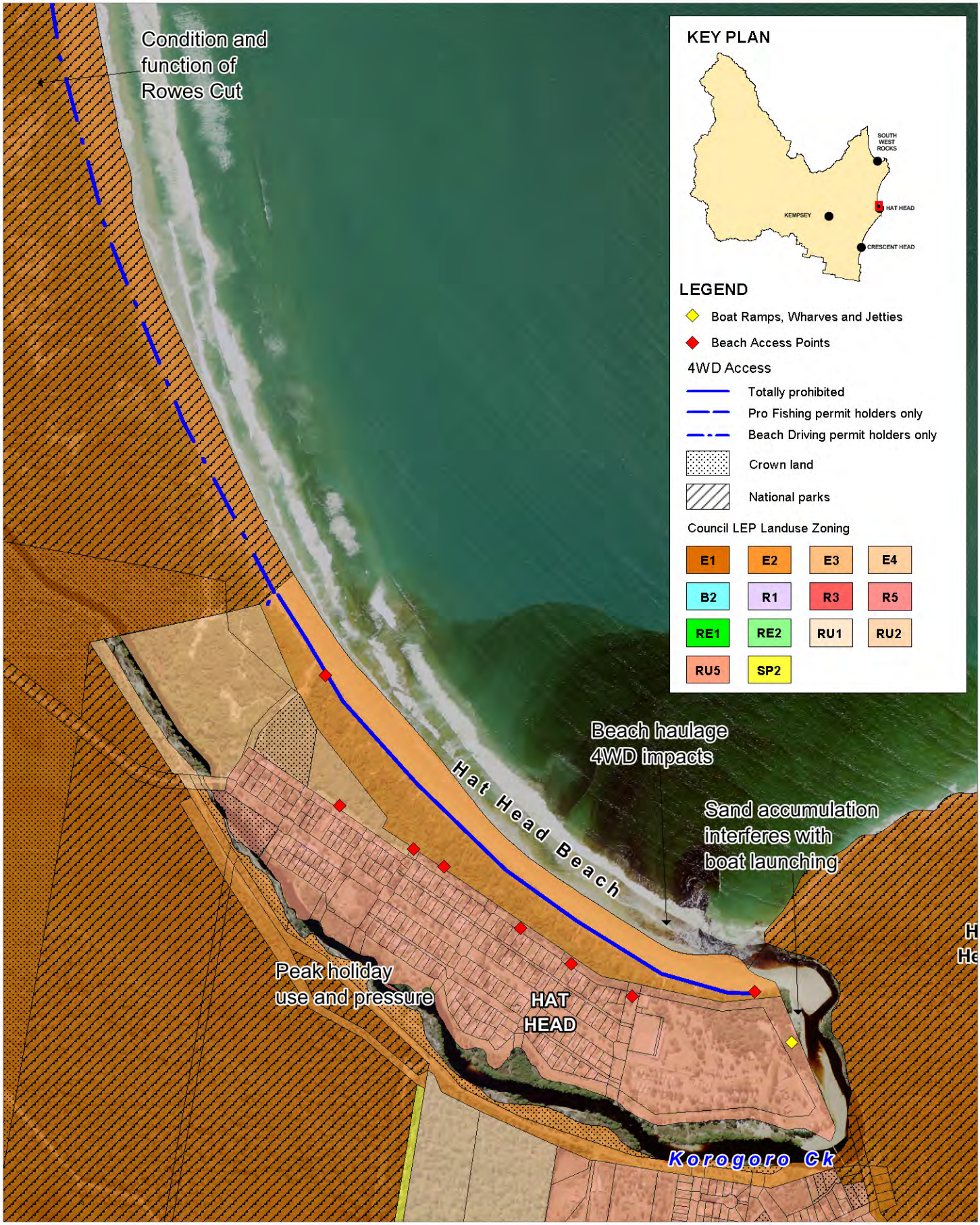

Title:

Land Zoning and Coastal Amenities Mapping Hat Head

Figure: 4-10

Rev: B

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0 250 500m

Approx. Scale

BMT WBM

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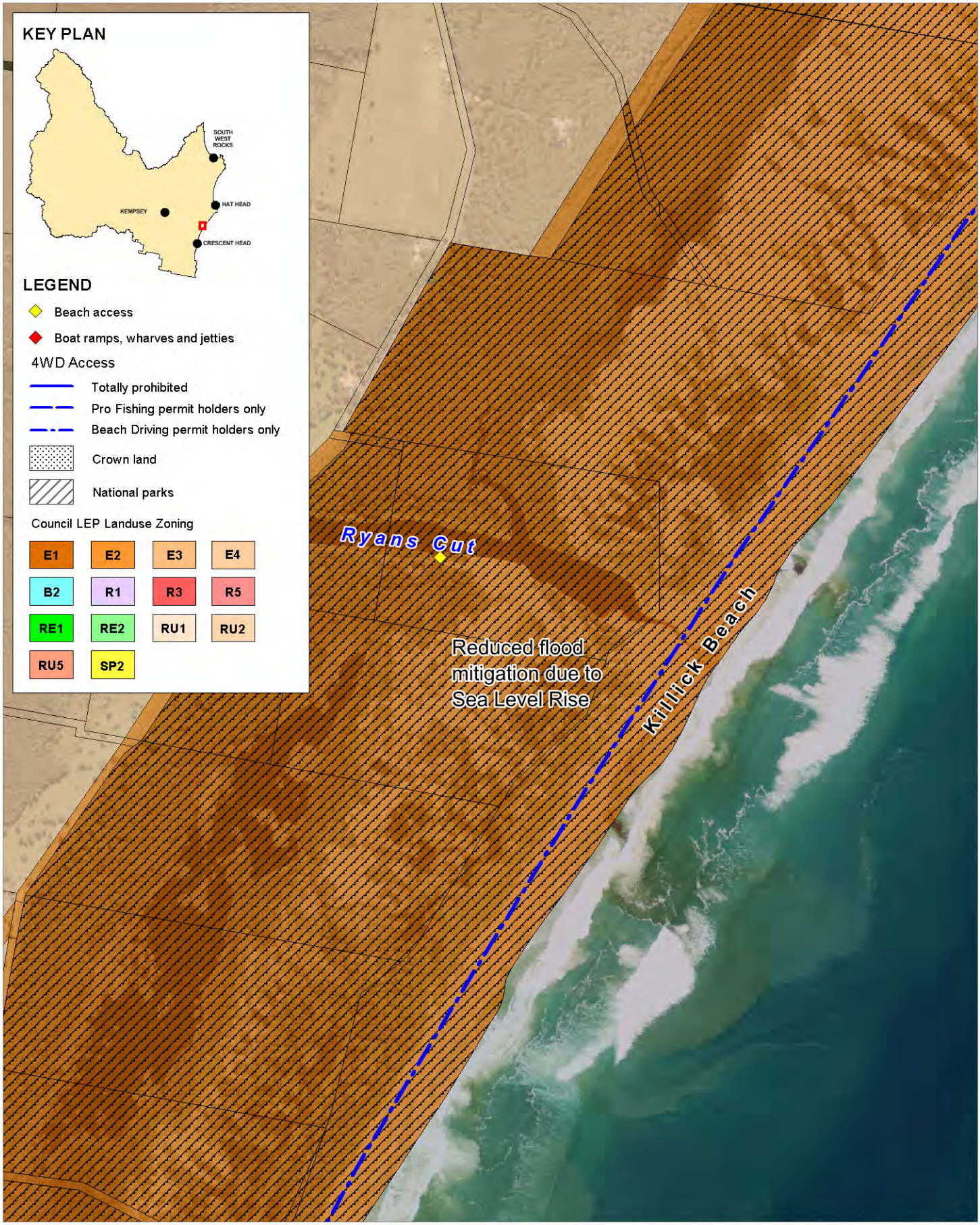

Title:

Land Zoning and Coastal Amenities Mapping Ryans Cut

Figure: 4-11

Rev: A

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0 250 500m

Approx. Scale

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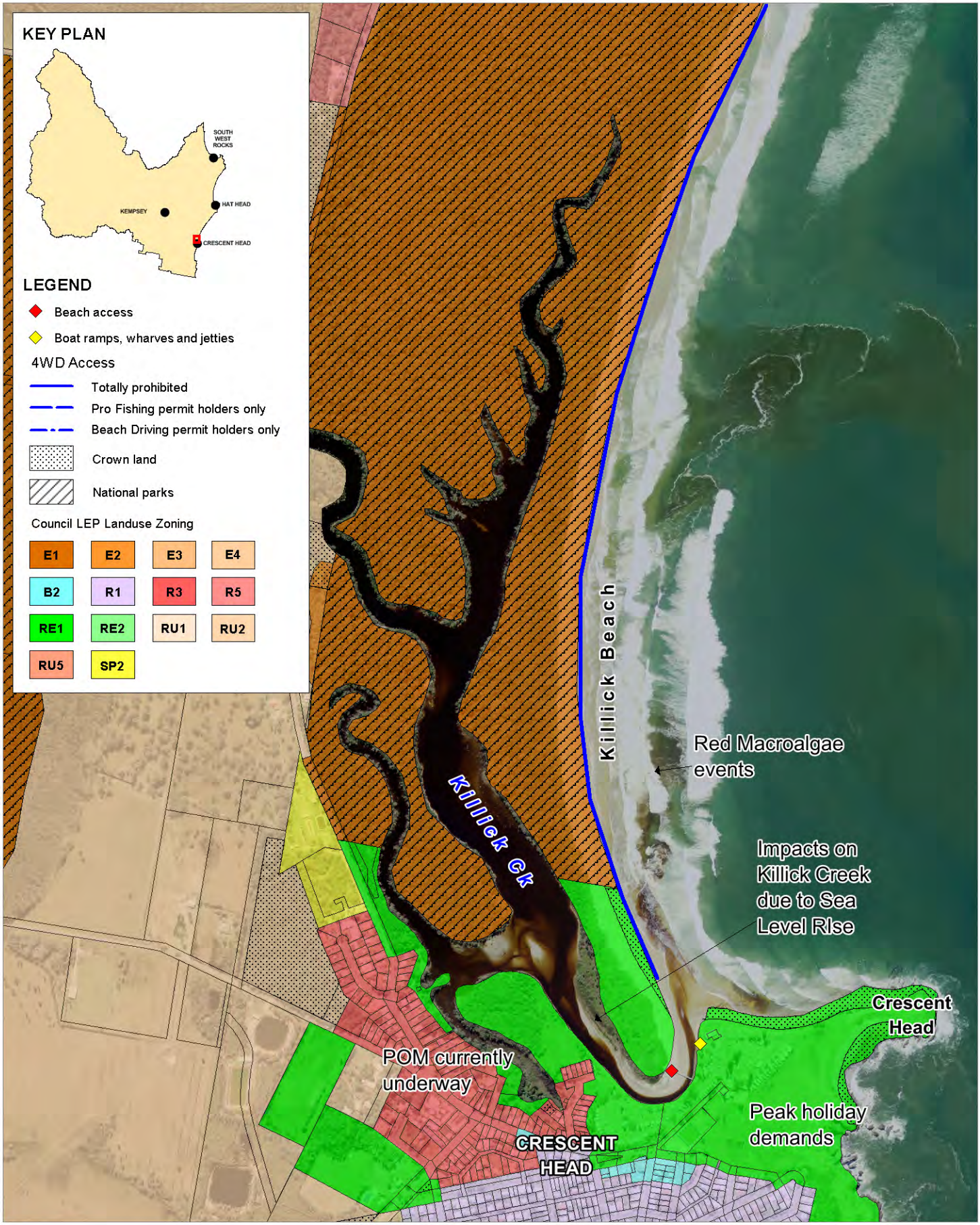

Title:

Land Zoning and Coastal Amenities Mapping Crescent Head

Figure: 4-12

Rev: B

N

0 250 500m

Approx. Scale

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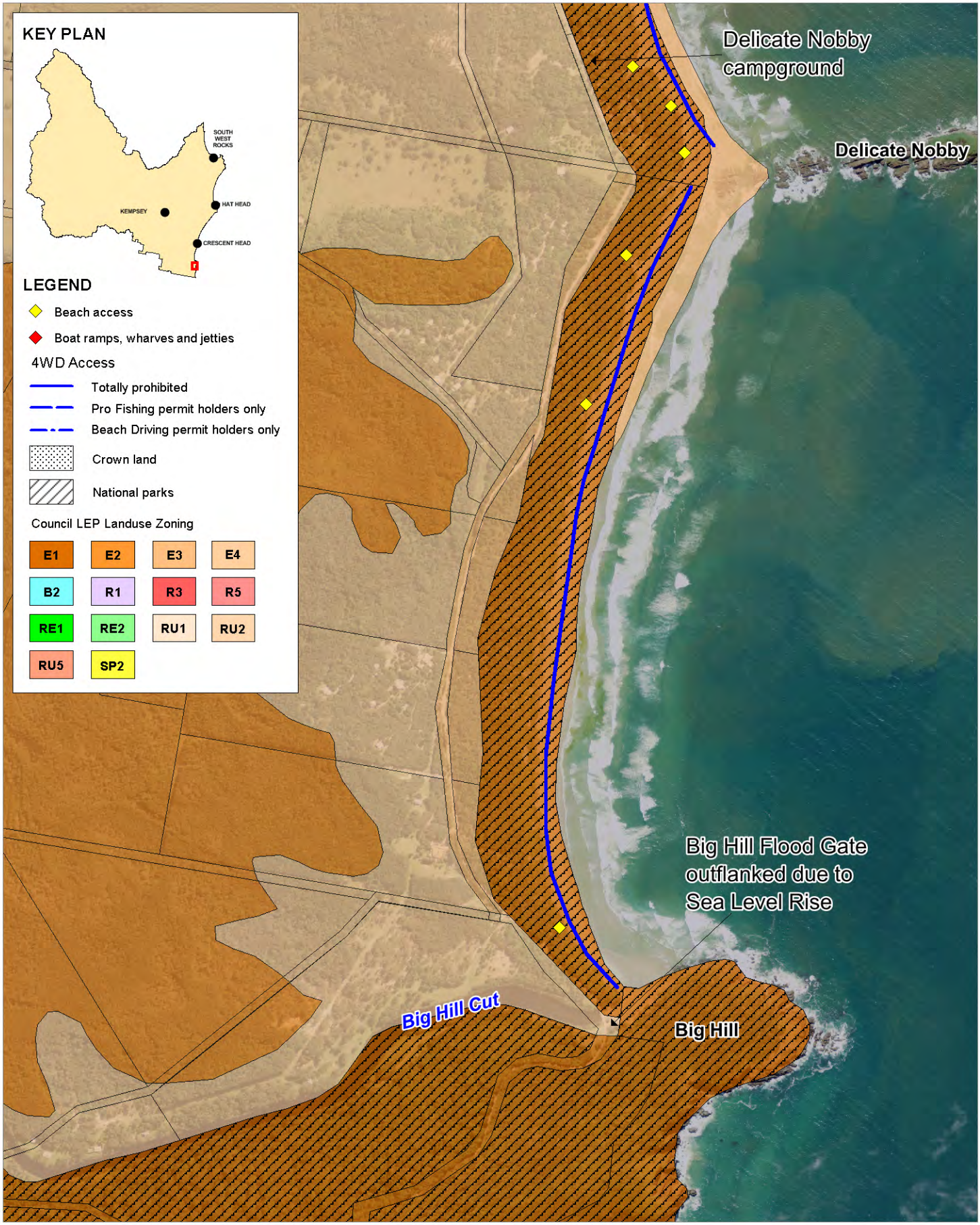

Title:

Land Zoning and Coastal Amenities Mapping
Big Hill Cut

Figure: 4-13

Rev: A

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0 250 500m

Approx. Scale

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5 Description of Coastal Hazard Risks and Management Options by Geographic Location

A methodology based on the Australian Standard for risk management has been adapted to coastal hazard assessment to assess the risks to built and natural assets from coastal hazards for the Kempsey Local Government area. The assessment essentially considers the likelihood of an event occurring and the severity of the consequences should that risk occur. The methodology is discussed in detail in Appendix A.

The first stage of the process (The Coastal Hazard Definition Study, BMT WBM 2012) essentially calculates the **likelihood** of coastal hazard events occurring based on the assessment of past events and future projections. The result of this is a series of hazard definition maps that are included as an appendix to that report. For the coastal erosion and recession hazard, these are presented as a series of lines on maps that indicate the potential landward extent of erosion and recession for the immediate, 2050 and 2100 timeframes. For the coastal inundation hazard these are presented as shading across areas potentially susceptible to short term inundation from oceanic waters for a defined storm event.

The second stage of the process determines the severity of the **consequence** of the hazard event occurring depends on the asset being considered. There is necessarily a subjective component to applying a consequence. The consequence ratings for this Kempsey Coastal Zone Management Study were developed using a consultative approach with stakeholders such as Council staff and state government agency representatives. A detailed description on this process is also included in Appendix A.

Once the likelihood and consequence are determined, these are combined to give a risk rating. The matrix used to combine likelihood and consequence to given in

Table 5-1 Risk Assessment Matrix

LIKELIHOOD	*Risk Assessment Matrix*	CONSEQUENCE				
		1	2	3	4	5
	Rare	Low	Low	Medium	Medium	Medium
	Unlikely	Low	Low	Medium	Medium	High
	Possible	Low	Medium	High	High	High
	Likely	Low	Medium	High	High	Extreme
	Almost Certain	Low	Medium	High	Extreme	Extreme

5.1 How to interpret the coastal risk mapping

For each geographic area there are risk maps for the coastal erosion and recession hazard and for the coastal inundation hazard. For a full understanding of the hazard assessment please refer to the CHDS (BMT WBM 2013). Further information on determining risk zones is included in Appendix A.

The CZMP will address intolerable risks identified through this process. This means risks rated as extreme or high. Medium and low rated risks are considered tolerable and will be accepted. This will need to be reassessed in the future (5-10 years time).

A qualitative discussion of risks and options for key locations is included below. A full breakdown of individual assets and their risk rating is also provided.

5.2 Options for addressing risks

There is a variety of measures and tools available to manage short and long term coastal erosion hazards and coastal inundation associated with coastal storms and sea level rise. A discussion on the range of options is included in Appendix B. A rapid cost benefit assessment of the options considered to address the identified risks and their relative cost benefit implications is given in Table 5-3

Table 5-2 Rapid Cost Benefit (Traffic Light) Assessment Criteria

	Capital Costs	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable Future	Effectiveness Over Time	Legal / Approval Risk	Technical Viability
STOP	Very expensive ($300K to Millions)	Very expensive ($300K to Millions)	Will impact negatively on environment, community or beach amenity	Unlikely to be acceptable to community and politically unpalatable; Extensive community education, endorsement by Minister(s) and Council required	Option is irreversible once implemented; Option limits alternatives options in the future	Option does not provide long term solution; Only effective over short term	Will require an EIS and/or Govt program to implement; There is a residual risk that approval will not be obtainable for the proposed works / strategy	Is unlikely to be technically viable without substantial engineering (or other) design investigation and capabilities for implementation
SLOW	Moderately expensive ($30,00 - $300,000)	Moderately expensive ($30,00 - $300,000)	No net impact	Would be palatable to some, not others (~50/50 response); Briefing to Councillors, GM and community education required	Option is reversible or adaptable, but at considerable cost / effort	Option is only a short term solution, but has other benefits; or Option requires further resources / changes to be effective over long term	Will require Govt approvals to be implemented, or assistance through existing Govt program; Generally approvals / assistance would be granted assuming requirements are met	Is likely to be technically viable at the site, but would require further investigations to clarify
GO	Little to no cost (< $30,000)	Little to no cost (< $30,000)	Will benefit environment, community or beach amenity (e.g. improve beach access, recreation, habitats etc)	Is very politically palatable, acceptable to community; Minimal education required	Option can be easily adapted for future circumstances or should impacts not occur, option would not negatively impact future generations	Option provides a long term solution	No or minimal government approvals required to implement	Is technically viable at the site / location

Table 5-3 Common Management Options to Address Coastal Hazards Assessed Using the Rapid Assessment Criteria

Option	Treats Erosion	Treats Recession	Treats Inundation	Capital Cost	Recurrent Costs	Environmental or Social Impact	Likely Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Ease of Implementation	Score (Go = 1, Sl = 0, St = -1)	Overall Analysis
Beach Scraping	✓			GO	GO	GO	GO	GO	STOP	GO	GO	6	GO
Dune Management	✓	✓		GO	GO	GO	GO	GO	STOP	GO	GO	6	GO
Habitat Management	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	GO
Heritage Management	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	GO
Seawalls	✓	✓		STOP	SLOW	STOP	SLOW	SLOW	SLOW	SLOW	SLOW	-2	SLOW
Beach Nourishment	✓	✓		STOP	STOP	GO	GO	GO	SLOW	SLOW	SLOW	0	SLOW
Artificial Breakwaters	✓			STOP	SLOW	STOP	STOP	STOP	SLOW	STOP	STOP	-6	STOP
Groynes	✓			STOP	SLOW	STOP	STOP	STOP	STOP	STOP	STOP	-7	STOP
Sacrifice Land or Assets	✓	✓	✓	GO	GO	GO	SLOW	STOP	GO	GO	GO	5	GO
Relocate Assets	✓	✓	✓	STOP	GO	GO	SLOW	GO	GO	GO	SLOW	4	SLOW
Acquisition	✓	✓	✓	STOP	GO	GO	SLOW	SLOW	GO	SLOW	GO	3	SLOW
Buy Back / Lease Back	✓	✓	✓	STOP	SLOW	GO	SLOW	GO	GO	SLOW	GO	3	SLOW

Description of Coastal Hazard Risks and Management Options by Geographic Location

Redesign or Retrofit	✓	✓	✓	SLOW	SLOW	SLOW	GO	GO	SLOW	GO	SLOW	3	SLOW
LEP Clauses and Rezoning	✓	✓	✓	GO	GO	GO	SLOW	GO	GO	GO	GO	7	GO
Coastal Hazard Development Controls	✓	✓		GO	GO	GO	SLOW	GO	GO	GO	GO	7	GO
Manage through flood program			✓	GO	GO	GO	SLOW	GO	GO	GO	GO	7	GO
Integration of CZM Planning Within Council	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	GO
Asset Management Planning	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	GO
Audit of Existing Council Assets	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	GO
Infrastructure Design Elements	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	GO
Monitoring	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	GO
Community Education	✓	✓	✓	GO	GO	GO	GO	GO	SLOW	GO	GO	7	GO

5.3 Grassy Head

5.3.1 Assets at risk due to erosion and recession at Grassy Head

There is an isolated residence toward the northern end of Grassy Beach, on the south side of Middle Head. This residence is at an intolerable High risk by 2100. The beach itself and the fringing coastal vegetation that is potentially an endangered ecological community (EEC) are also considered at intolerable risk.

5.3.2 Assets at risk due to coastal inundation at Grassy Head

Coastal inundation potentially threatens a water supply line, small sections of road as well as some rural lands. There are also expansive areas of potential EEC's at risk.

5.3.3 Community use and access considerations

Coastal erosion and dune slumping at Grassy Head Beach has resulted in undermining and loss of the viewing platform and beach access. The wooden walkway and viewing platform were still intact during 2011, with some erosion affecting the fencing to the south of the walkway. By 2013, erosion and dune slumping had undermined both the walkway and platform, and the dune fencing had been lost (see Figure 5-1). In early 2014, the viewing platform had been completely undermined. This is the main access way to Grassy Head Beach.

Figure 5-1 Main Beach Access, Grassy Head, March, 2011

Figure 5-2 Damage to Beach Access and Platform, 1st March, 2013 (photos: KCC)

The viewing platform structure should be rebuilt and dune stabilisation works completed. Consideration should be given to providing access at a lower point.

5.3.4 Immediate management recommendations for Grassy Head

In the next five to ten years the following management actions are recommended to be included in the CZMP for intolerable risks at Grassy Head:

- Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in Council's Asset Management Plan. Account for such coastal risks when prioritising asset maintenance and replacement.
- Coastal Hazard Development Controls: Require redevelopment / renovations to be located as far landward in hazard zone as practical. Planning controls on undeveloped land in future hazard zones
- Inform the National Parks and Wildlife Service of this risk rating
- Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential Endangered Ecological Communities (EEC) mapping, and investigate options for impact mitigation and resilience building
- Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds
- Seek to have the CZMP certified by the Minister. Keep abreast of the rollout of stage 2 Coastal Reforms
- Investigate, design and construct improved access way to Grassy Head Beach from the public car park Provides an access point where there is none in close vicinity. This will have the added benefit of a reduction in impacts to dunes and dune vegetation when large groups visit and during peak holiday times. Community engagement will be essential as there may be some community objection regarding formalised access due to the high value placed upon the rugged undeveloped nature of the coastline.

5.3.5 Future management options for Grassy Head

The risk profile at Grassy Head does not increase significantly into the future as the area is mostly undeveloped. The key focus will be appropriate asset management and planning to ensure that this remains the case. The difficult decisions that will have to be made will include the remote residence located along Grassy Head Beach, which will be at an intolerable risk level to coastal erosion and recession by 2100. The base decision that will need to be made into the future is essentially to protect or retreat. Protection in the form of a seawall is not considered appropriate for this location. This is primarily due to the value placed upon the natural beach area, which would be lost if the shoreline was locked in place by a seawall. Outlay costs are also likely to be prohibitive at around $5000 to $10 000 per linear metre. Beach nourishment has the potential to provide protection while retaining the natural beach amenity. At this time, sand of an appropriate quality and quantity is not available, however, in the future, regulations regarding offshore sourcing of sand may make this a viable (if expensive), option.

5.3.6 Risk register and mapping for Grassy Head

The erosion and recession risk register for Grassy is presented in Table 5-4, and the risk register for Coastal inundation is presented in Table 5-5. The risk mapping is presented in maps Figure 5-3 to Figure 5-8.

Table 5-4 Coastal Erosion and Recession Risk Register for Grassy Head

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended (reconsider after 5 – 10 years)
Residential, town centre and business										
Residence	Business / office	N/a	Medium	High	Remote residence between grassy head and middle head	Coastal hazard development controls: require redevelopment / renovations to be located as far landward in hazard zone as practical. Planning controls on undeveloped land in future hazard zones		Seek to have the CZMP certified by the Minister. Keep abreast of the rollout of stage 2 Coastal Reforms		Sea wall Beach nourishment Sacrifice asset Acquisition Buy back lease back
						Positives: • Life of development may be extended. • The sandy beach is retained because it can recede. • No cost to broader public. Cost is borne by the landowner. • Sets aside land for future protection works on freehold land	Negatives: • Reduced area within property boundary for development potential.	Positives: • May lead to clear direction regarding the management of coastal lands, especially regarding future hazards	Negatives: • Does not reduce hazard risk in the short term and immediate timeframe.	
Other infrastructure / services										
Water line	Water infrastructure	N/a	Medium	Medium		Accept risk – risk level is considered tolerable				
Community infrastructure										
Amenities	Amenities / block / sheds	Low	Medium	Medium		Accept risk – risk level is considered tolerable				
Natural assets										
Beaches Grassy beach Middle Beach	Beach	Extreme	Extreme	Extreme	Sandy beach amenity	Coastal hazard development controls: restrict future development that will prevent beach profile from receding.				Beach nourishment
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.			
						Positives: • No cost to broader public Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.			
Environmental management	Environmental protection zone	High	High	High		Implement dunecare / revegetation programs at locations here vegetation is degraded, limited or overcome by weeds				

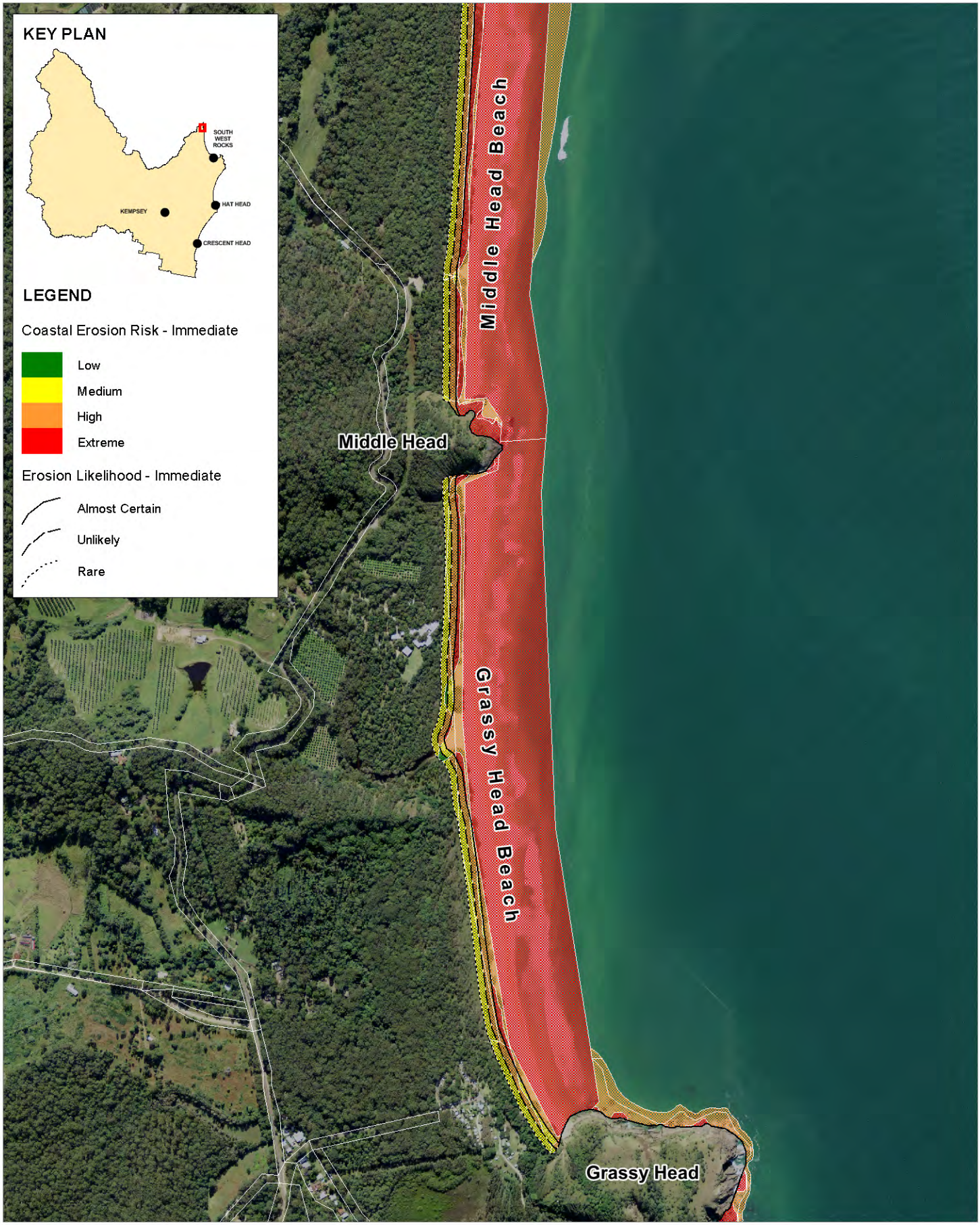
Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended (reconsider after 5 – 10 years)
Yarriabini national park	Parks, reserves and open space	High	High	High		Inform the national parks and wildlife service of this risk rating		
EECs: Littoral Rainforest Themeda grassland Sub-tropical coastal floodplain forest Freshwater wetland	Potential EEC (low tolerance)	Extreme	Extreme	Extreme		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised	Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds Positives • Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards Negatives • Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	

Table 5-5 Coastal Inundation Risk Register for Grassy Head

Asset name	*Asset type*	*2014*	*2050*	*2100*	*D'script.*	*Preferred option 1 (implement over next 5-10 years)*	*Preferred option 2 (implement over next 5-10 years)*	*Other options considered but not recommended * (reconsider after 5 – 10 years)*
Residential, town centre and business								
Rural zone	Rural landscape	N/a	Low	Medium		Accept risk – risk level is considered tolerable		
Primary production	Rural landscape	N/a	Low	Medium		Accept risk – risk level is considered tolerable		
Village	Rural landscape	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Other infrastructure / service								
Water line	Water infrastructure	Extreme	Extreme	Extreme	Water line servicing the caravan park	Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement. Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets		
Transport infrastructure								
Millington ave	City / village road	N/a	N/a	Medium		Accept risk – risk level is considered tolerable		
Reserve rd grassy head	City / village road	High	High	High	Road approaching the caravan park and used for public access	Manage through flood program - ensure sea level rise is considered explicitly for each waterway using a hydraulic flood model. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement. Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
Grassy head rd	Major road	N/a	Medium	High	In the vicinity of creeks (north arm of macleay river and small creek midway along grassy beach)	Manage through flood program - ensure sea level rise is considered in flood planning.		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		
						Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	
Community infrastructure										
Amenities Shed	Amenities / block / sheds	Low	Low	Low		Accept risk – risk level is considered tolerable				
Business / office	Residential, town center and business	High	High	High	Caravan park office	Manage through flood program - ensure sea level rise is considered in flood planning.		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		
						Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	
Public recreation	Public recreation	Low	Low	Low		Accept risk – risk level is considered tolerable				
Natural assets										
Beaches Grassy beach Middle beach	Beach	Low	Low	Low		Accept risk – risk level is considered tolerable				

Asset name	*Asset type*	*2014*	*2050*	*2100*	*D'script.*	*Preferred option 1 (implement over next 5-10 years)*	*Preferred option 2 (implement over next 5-10 years)*	*Other options considered but not recommended * (reconsider after 5 – 10 years)*
Environmental management	Environmental protection zone	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Grassy head rd bushland reserve Yarriabini national park	Parks, reserves and open space	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
EECs: • Littoral_rainforest • Themeda grassland • Sub-tropical coastal floodplain forest	Potential EEC (low tolerance)	Extreme	Extreme	Extreme		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised	within development controls, ensure that development application assessment includes consideration of a buffer that allows landward migration of wetland species in the vicinity of natural waterways in response to sea level rise Positives • Assists in the implementation of EEC's Negatives • May reduce development potential in the lga	
EECs: • Littoral rainforest	Potential EEC (low tolerance)	N/a	High	High		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised	within development controls, ensure that development application assessment includes consideration of a buffer that allows landward migration of wetland species in the vicinity of natural waterways in response to sea level rise Positives • Assists in the implementation of EEC's Negatives • May reduce development potential in the lga	
EECs • Coastal saltmarsh • Swamp oak floodplain forest	Potential EEC's(medium tolerance)	High	High	High		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised	within development controls, ensure that development application assessment includes consideration of a buffer that allows landward migration of wetland species in the vicinity of natural waterways in response to sea level rise Positives • Assists in the implementation of EEC's Negatives • May reduce development potential in the lga	
Waterways								
Macleay arm	Natural waterway	Low	Low	Low		Accept risk – risk level is considered tolerable		



Title:

Erosion and Recession Risk Map
Immediate Planning Horizon - Grassy Head Beach

Figure: 5-3

Rev: A

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Approx. Scale

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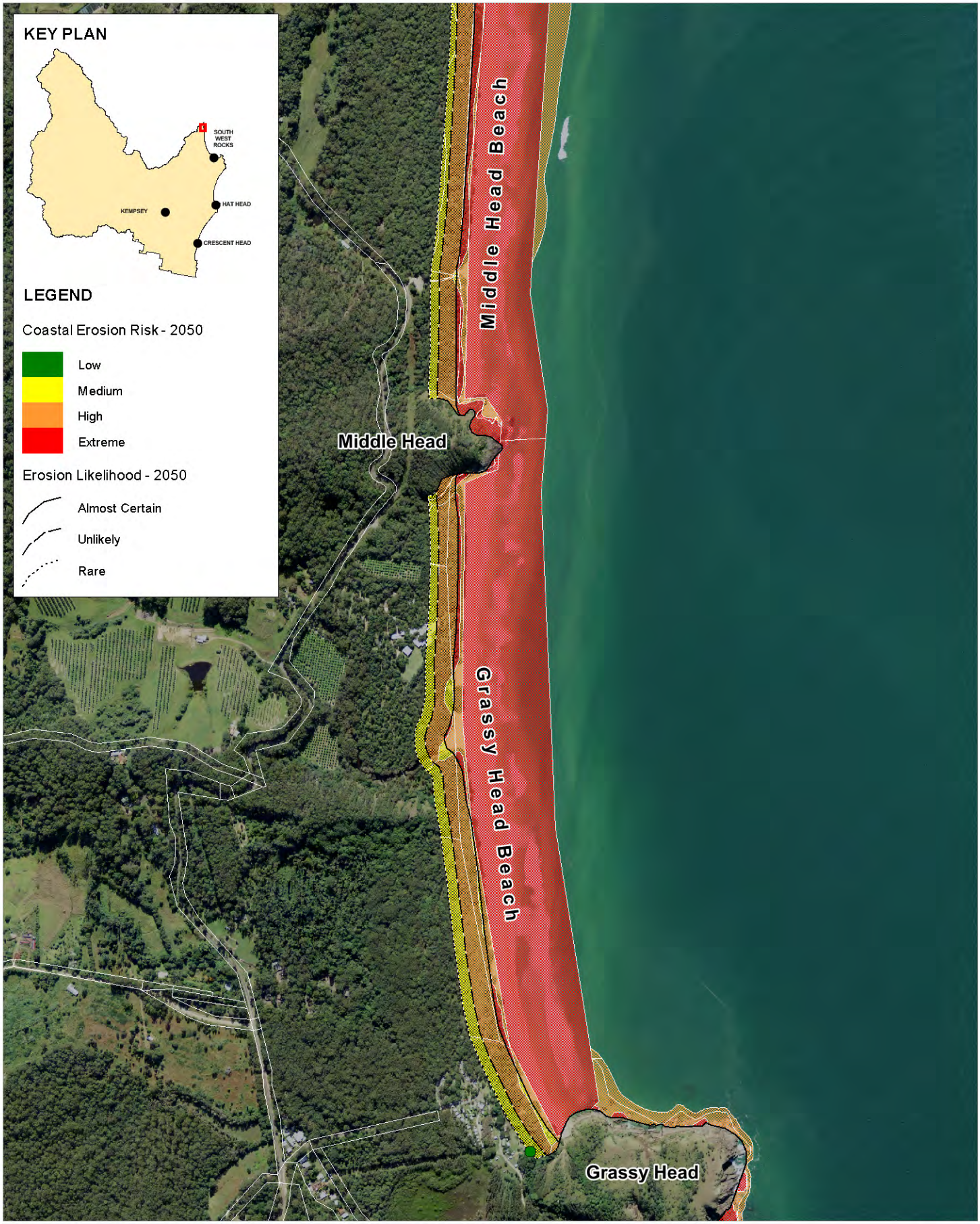

Title:

Erosion and Recession Risk Map
2050 Planning Horizon - Grassy Head Beach

Figure: 5-4

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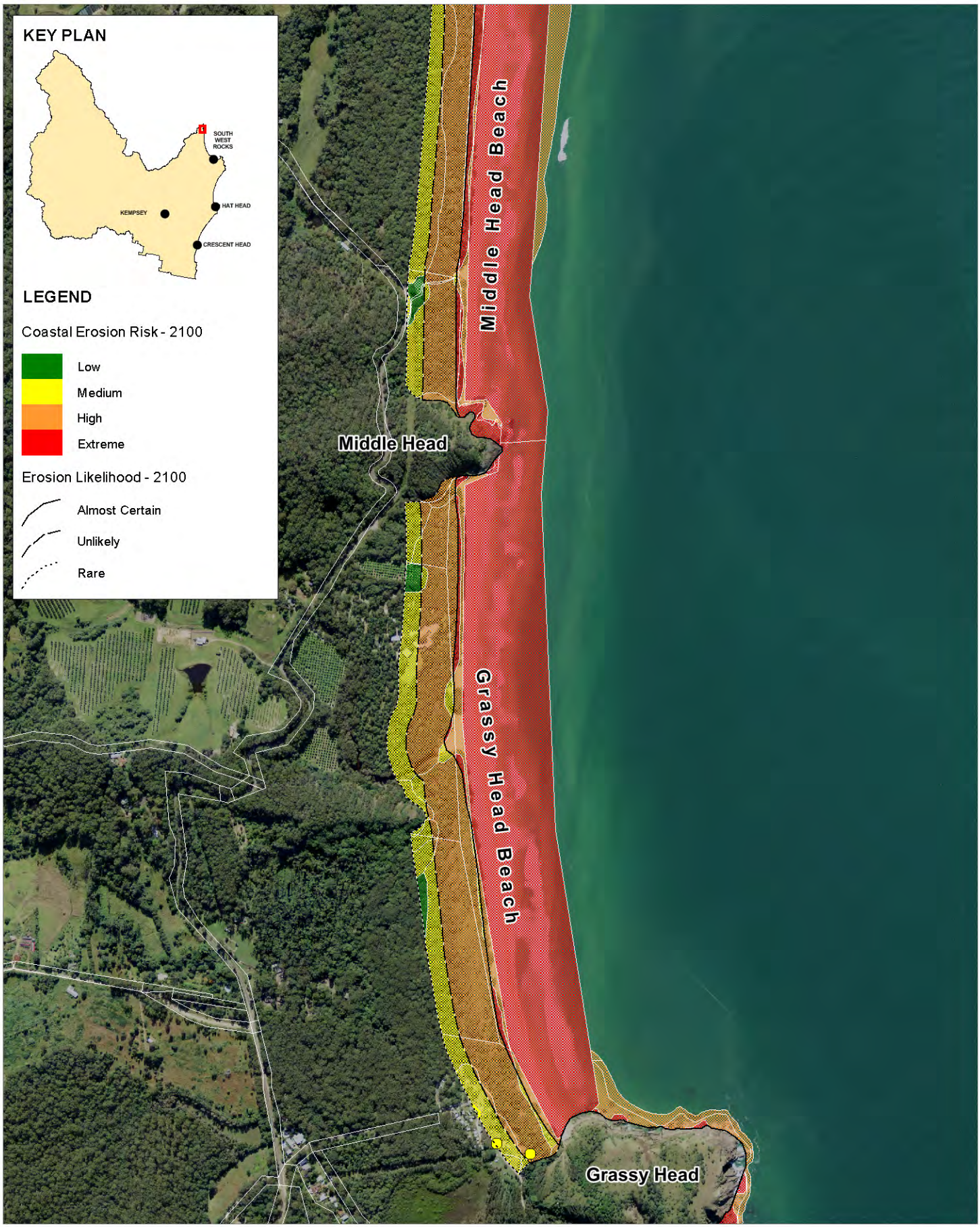

Title:

Erosion and Recession Risk Map
2100 Planning Horizon - Grassy Head Beach

Figure: 5-5

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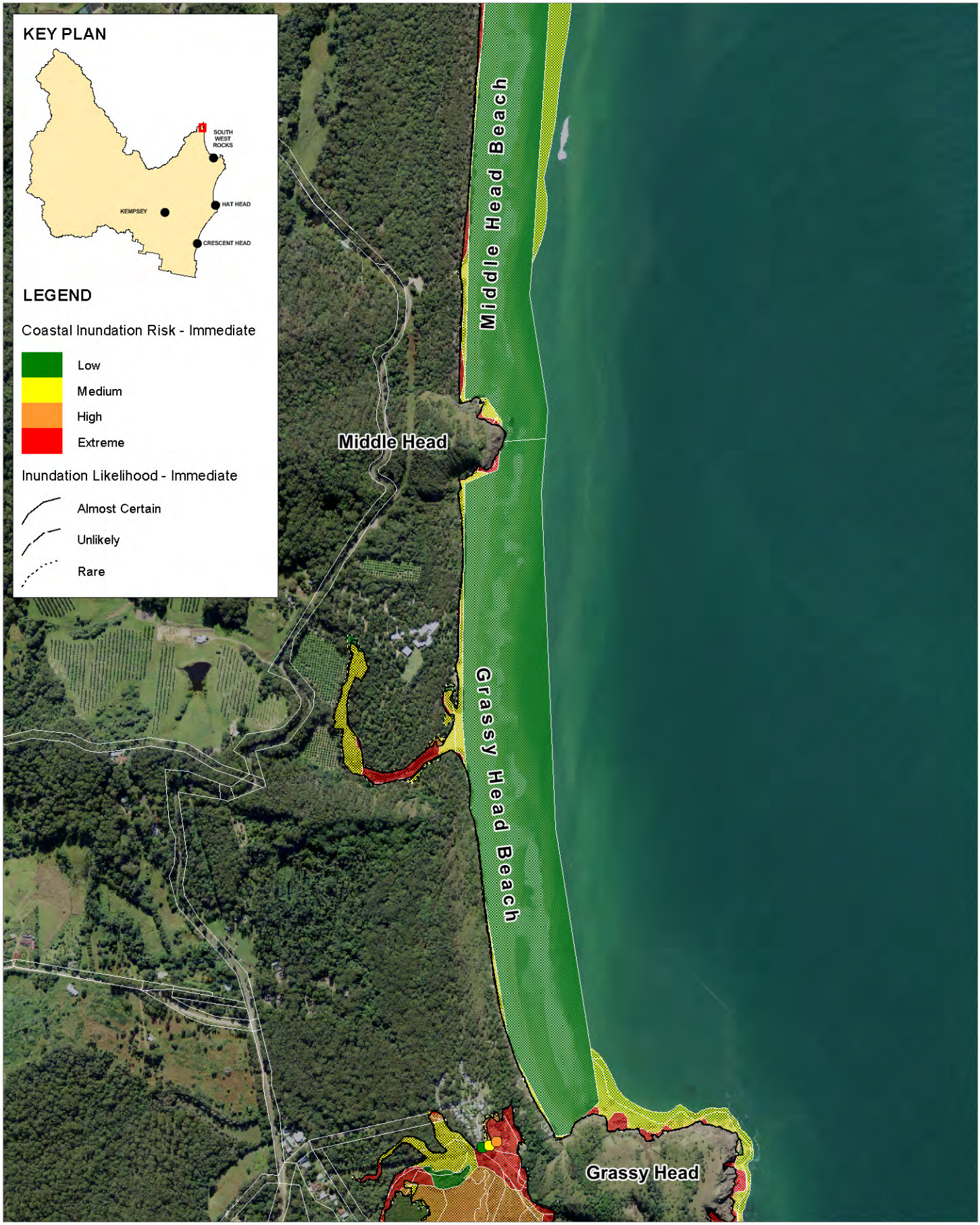

Title:

Coastal Inundation Risk Map
Immediate Planning Horizon - Grassy Head Beach

Figure: 5-6

Rev: A

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Approx. Scale

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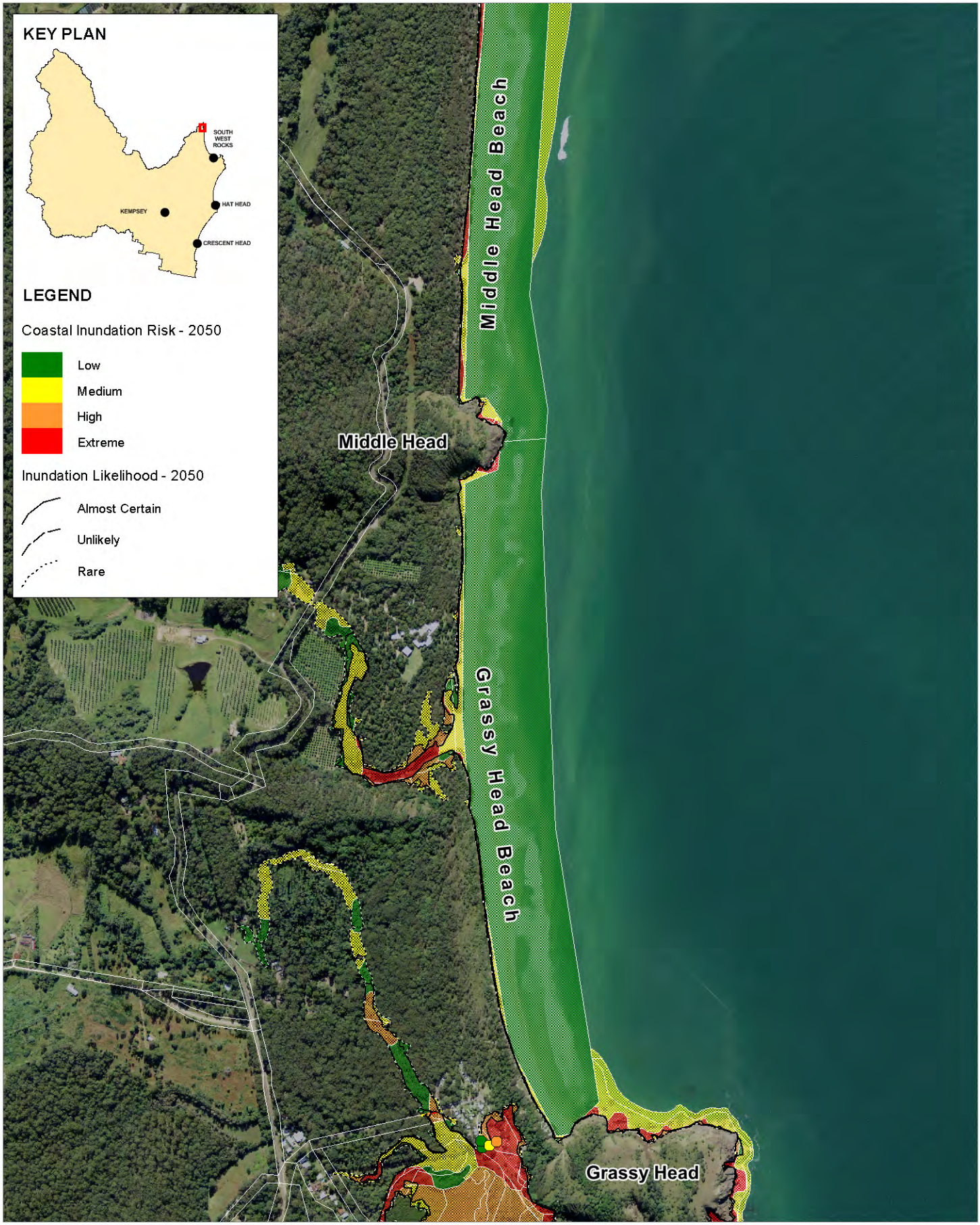

Title:

Coastal Inundation Risk Map
2050 Planning Horizon - Grassy Head Beach

Figure: 5-7

Rev: A

N

0 250 500m

Approx. Scale

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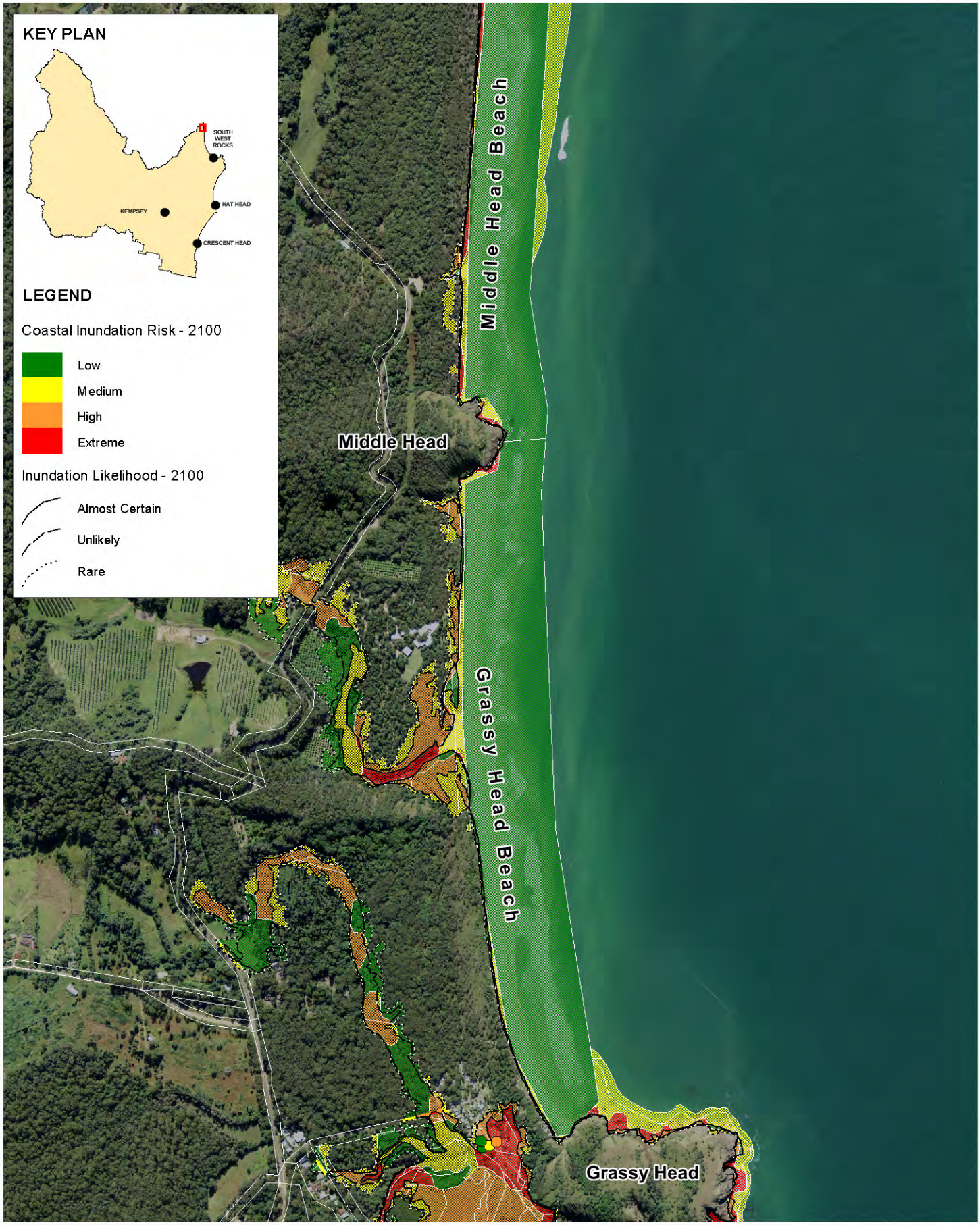

Title:

Coastal Inundation Risk Map
2100 Planning Horizon - Grassy Head Beach

Figure: 5-8

Rev: A

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0 250 500m

Approx. Scale

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5.4 Stuarts Point Beach

5.4.1 Assets at risk from coastal erosion and recession for Stuarts Point Beach

The assets at intolerable risk of erosion and recession for Stuarts Point Beach are non-built and include the beach itself, land zoned for environmental protection and the fringing coastal EEC vegetation.

5.4.2 Assets at risk from coastal inundation for Stuarts Point

Coastal inundation risks cover water infrastructure including stormwater, water supply and wastewater mains. There are also six cabins and a laundry building at Stuarts Point Holiday Park that are potentially affected by inundation. Sections of road, are also vulnerable.

5.4.3 Community use and access considerations

- Recreational 4WDing is impacting on vegetation to the north of the Macleay River Entrance. Ecological impacts of recreational 4WD on migratory shorebirds and marine mammals is possible, although the extent is unknown. Similarly, it is not known if recreational 4WD is impacting known or unknown aboriginal heritage.

5.4.4 Immediate management recommendations for Stuarts Point Beach

In the next five to ten years the following management actions are recommended to be included in the CZMP for intolerable risks at Stuarts Point Beach:

- Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in Council's Asset Management Plan. Account for such coastal risks when prioritising asset maintenance and replacement.
- Coastal Hazard Development Controls: Require redevelopment / renovations to be located as far landward in hazard zone as practical. Planning controls on undeveloped land in future hazard zones
- Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential Endangered Ecological Communities (EEC) mapping, and investigate options for impact mitigation and resilience building
- Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds
- Provide formalised beach access points at sensitive locations to restrict impacts to saltmarsh (for example on the north and south sides of the Macleay River).

5.4.5 Future management options for Stuarts Point Beach

The risk profile at Stuarts Point Beach does not increase significantly into the future as the area is mostly undeveloped. The key focus will be appropriate asset management and planning to ensure

that this remains the case. The difficult decisions that will have to be made will involve inundation risk, which needs to be considered through the flood management program.

5.4.6 Risk register and mapping for Stuarts Point Beach

The erosion and recession risk register for Stuarts Point Beach is presented in Table 5-6, and the risk register for Coastal inundation is presented in Table 5-7. The risk mapping is presented in maps

Table 5-6 Coastal Erosion and Recession Risk Register for Stuarts Point Beach

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
Natural assets										
Stuarts point beach	Beach	Extreme	Extreme	Extreme	Sandy beach amenity	Coastal hazard development controls: restrict future development that will prevent beach profile from receding.				Beach Nourishment
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.			
Environmental management	Environmental protection zone	High	High	High		Coastal hazard development controls: restrict future development that will prevent beach profile from receding.				
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.			
EECs: Sub-tropical Coastal Floodplain Forest Themeda Grassland on Headland	Potential EEC (low tolerance)	Extreme	Extreme	Extreme		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building		Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds		
						Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Positives • Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards	Negatives • Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	
Natural assets (fishermans reach)										
Environmental management	Environmental protection zone	High	High	High		Coastal hazard development controls: restrict future development that will prevent beach profile from receding.				
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.			
						Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Positives Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards		

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
Coastal saltmarsh Sub-tropical Coastal Floodplain Forest Themeda Grassland on Headland	Potential EEC (medium tolerance)	N/a	Medium	High		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building		Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds		
						Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Positives Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards	Negatives Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	
Waterways										
Macleay arm	Natural waterway	N/a	Low	Medium		Accept risk – risk level is considered tolerable				
Macleay rvr new entrance	Natural waterway	N/a	N/a	Low		Accept risk – risk level is considered tolerable				
Natural waterways	Natural waterway	N/a	N/a	Medium		Accept risk – risk level is considered tolerable				
Unnamed waterway	Recreational waterway	N/a	N/a	Low		Accept risk – risk level is considered tolerable				

Table 5-7 Coastal Inundation Risk Register for Stuarts Point Beach

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Rural, primary production, forestry and industry								
Primary production	Rural zone	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning. Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Rural landscape	Rural zone	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning. Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Village	Rural zone	High	High	High	including approx.. 20 houses at fisherman's reach	Manage through flood program - ensure sea level rise is considered in flood planning. Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	Implementation of flood related development controls	
Other infrastructure / services								
Stormwater line	Stormwater infrastructure	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement. Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	
Sewer line	Wastewater infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.	Manage through flood program - ensure sea level rise is considered in flood planning.	

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
						Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Water line	Water infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Transport infrastructure										
Roads: Marine pde Ocean ave	City / village road	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning.		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		
						Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	
						Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	
Grassy head rd	Major road	N/a	N/a	High		Manage through flood program - ensure sea level rise is considered in flood planning.		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		
						Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	
Unnamed row	Right of way (road)	N/a	Low	Medium		accept risk – risk level is considered tolerable				

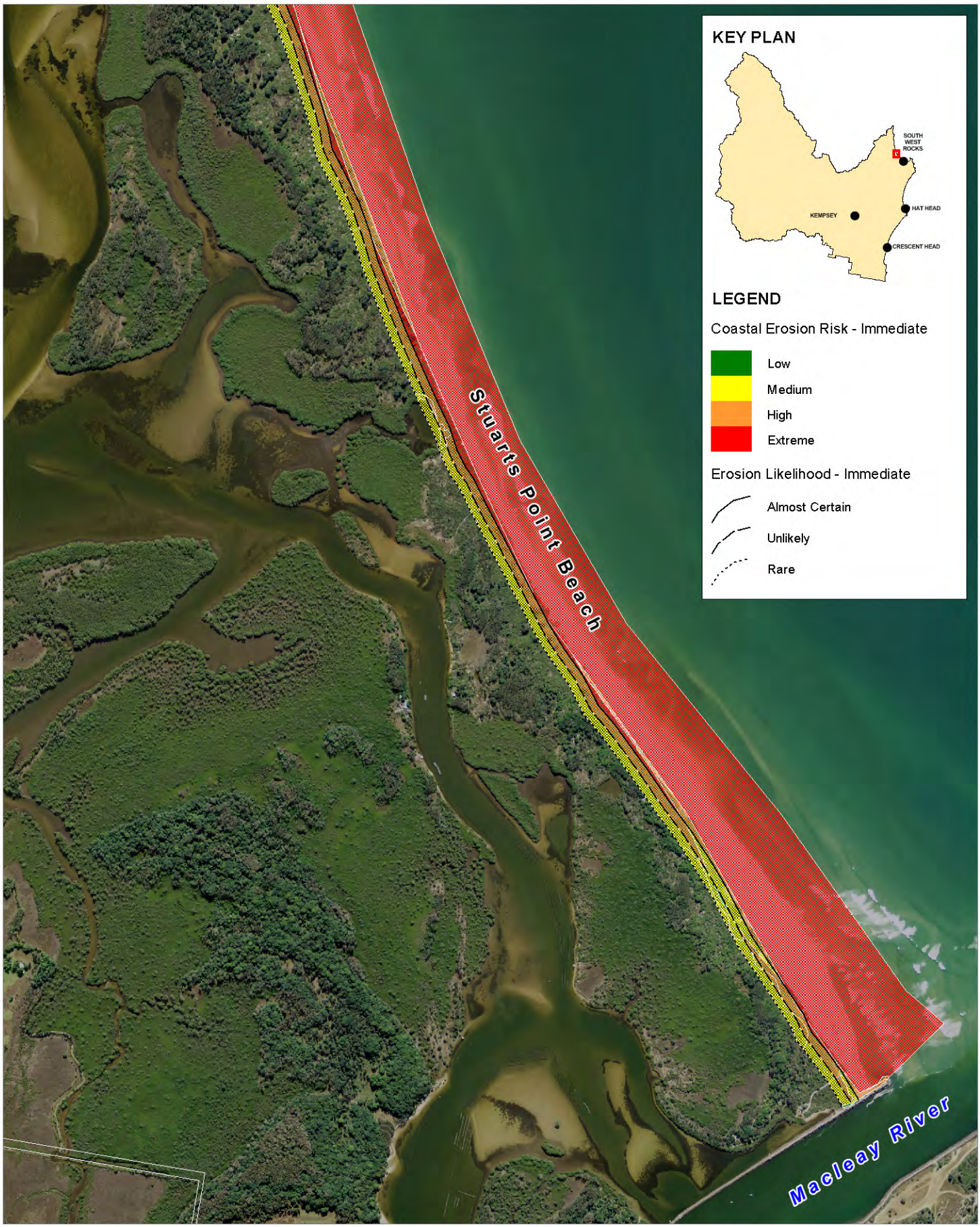
Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Community infrastructure								
Stuarts point holiday park	Caravan park	Medium	Medium	Medium		accept risk – risk level is considered tolerable		
Stuarts point community hall	Community buildings	Medium	Medium	Medium		accept risk – risk level is considered tolerable		
New amenities Old amenities	Amenities / block / sheds	Medium	Medium	Medium		accept risk – risk level is considered tolerable		
Cabins x 6 Laundry	Community buildings	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning. Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement. Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	
BBQ shelter	Public recreation	Medium	Medium	Medium		accept risk – risk level is considered tolerable		
Natural assets								
Stuarts point beach	Beach	Low	Low	Low		accept risk – risk level is considered tolerable		
Environmental conservation	Environmental protection zone	Medium	Medium	Medium		accept risk – risk level is considered tolerable		
Environmental management	Environmental protection zone	Medium	Medium	Medium		accept risk – risk level is considered tolerable		

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Fishermans bend national reserve Stuarts point reserve	Parks, reserves and open space	Medium	Medium	Medium		accept risk – risk level is considered tolerable		
EECs: subtrop_co Freshwater themeda Sub-tropical coastal floodplain forest	Potential EEC (low tolerance)	Extreme	Extreme	Extreme		Manage through flood program - ensure sea level rise is considered in flood planning. Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future Accurate mapping ensures that land is not unnecessarily sterilised Positives • Holistic approach to EEC conservation and management into the future Accurate mapping ensures that land is not unnecessarily sterilised	
Coastal saltmarsh Swamp oak floodplain forest	Potential EEC (medium tolerance)	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning. Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future Accurate mapping ensures that land is not unnecessarily sterilised Positives • Holistic approach to EEC conservation and management into the future Accurate mapping ensures that land is not unnecessarily sterilised	
Waterways								
Macleay arm	Natural waterway	Low	Low	Low		accept risk – risk level is considered tolerable		
Other infrastructure / services (fishermans reach)								
Water line	Water infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.	Manage through flood program - ensure sea level rise is considered in flood planning.	

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Transport infrastructure										
Roads: Fishermans reach rd New entrance rd	Rural road	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Roads: Fishermans reach rd Fishermans trail Serrata ln Shark island	Unsealed road	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Community infrastructure								
Public recreation	Public recreation	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Natural assets								
Environmental conservation	Environmental protection zone	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Clybucca historical site	Parks, reserves and open space	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Fishermans bend national reserve Yarrahapinni wetlands national park	Parks, reserves and open space	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
EECs: Subtrop co freshwater wetland Themeda grassland Littoral rainforest	Potential EEC (low tolerance)	Extreme	Extreme	Extreme		Manage through flood program - ensure sea level rise is considered in flood planning. Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future Accurate mapping ensures that land is not unnecessarily sterilised	
Coastal saltmarsh Swamp oak floodplain forest	Potential EEC (medium tolerance)	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning. Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future Accurate mapping ensures that land is not unnecessarily sterilised	
Waterways (fisherman's reach)								

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Waterways: Andersons inlet Macleay arm Macleay river Macleay rvr new entrance	Natural waterway	Low	Low	Low		Accept risk – risk level is considered tolerable		
Unnamed waterway	Recreational waterway	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		



Title:

Erosion and Recession Risk Map
Immediate Planning Horizon - Stuarts Point Beach

Figure: 5-9

Rev: A

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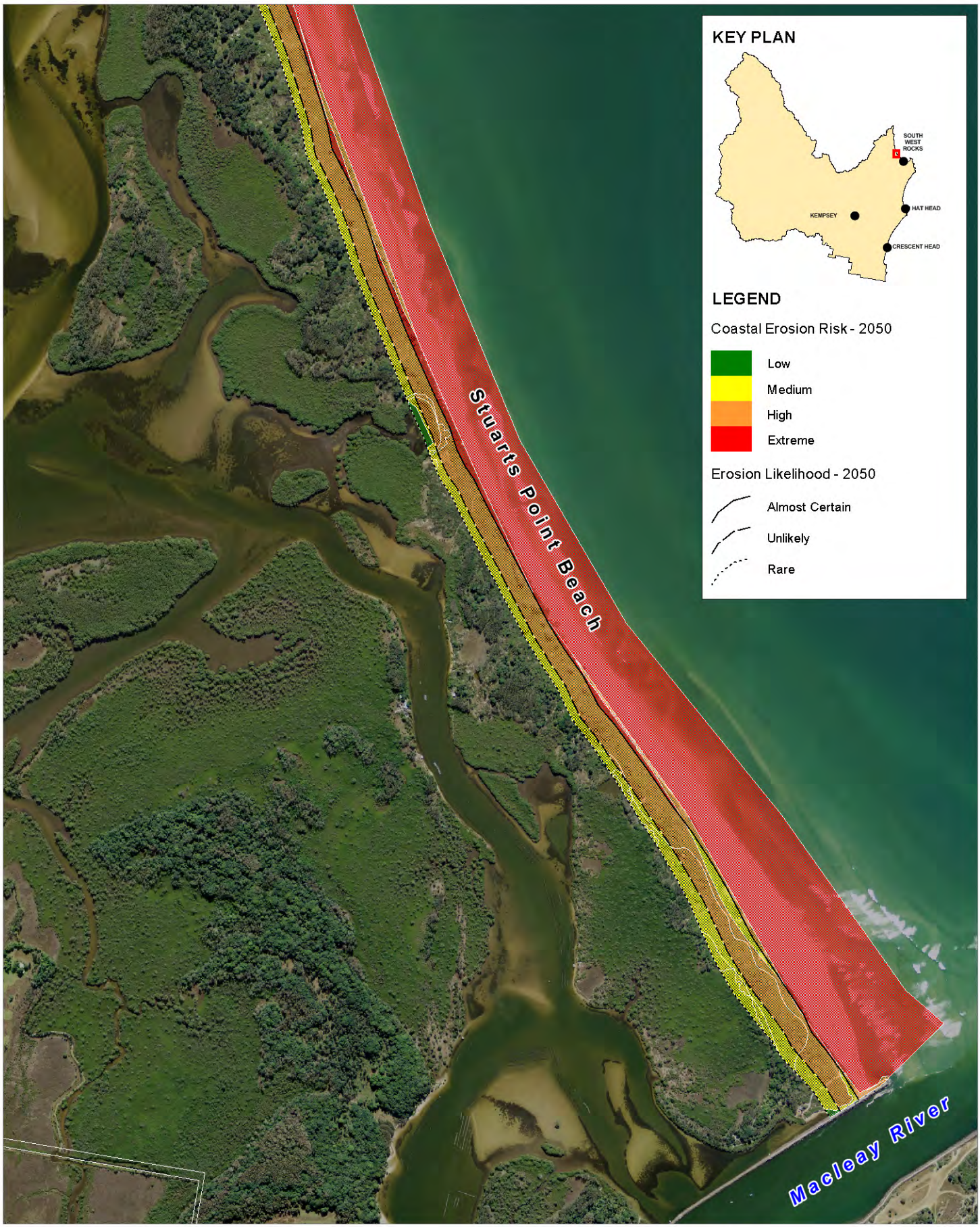

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Erosion and Recession Risk Map
2050 Planning Horizon - Stuarts Point Beach

Figure: 5-10

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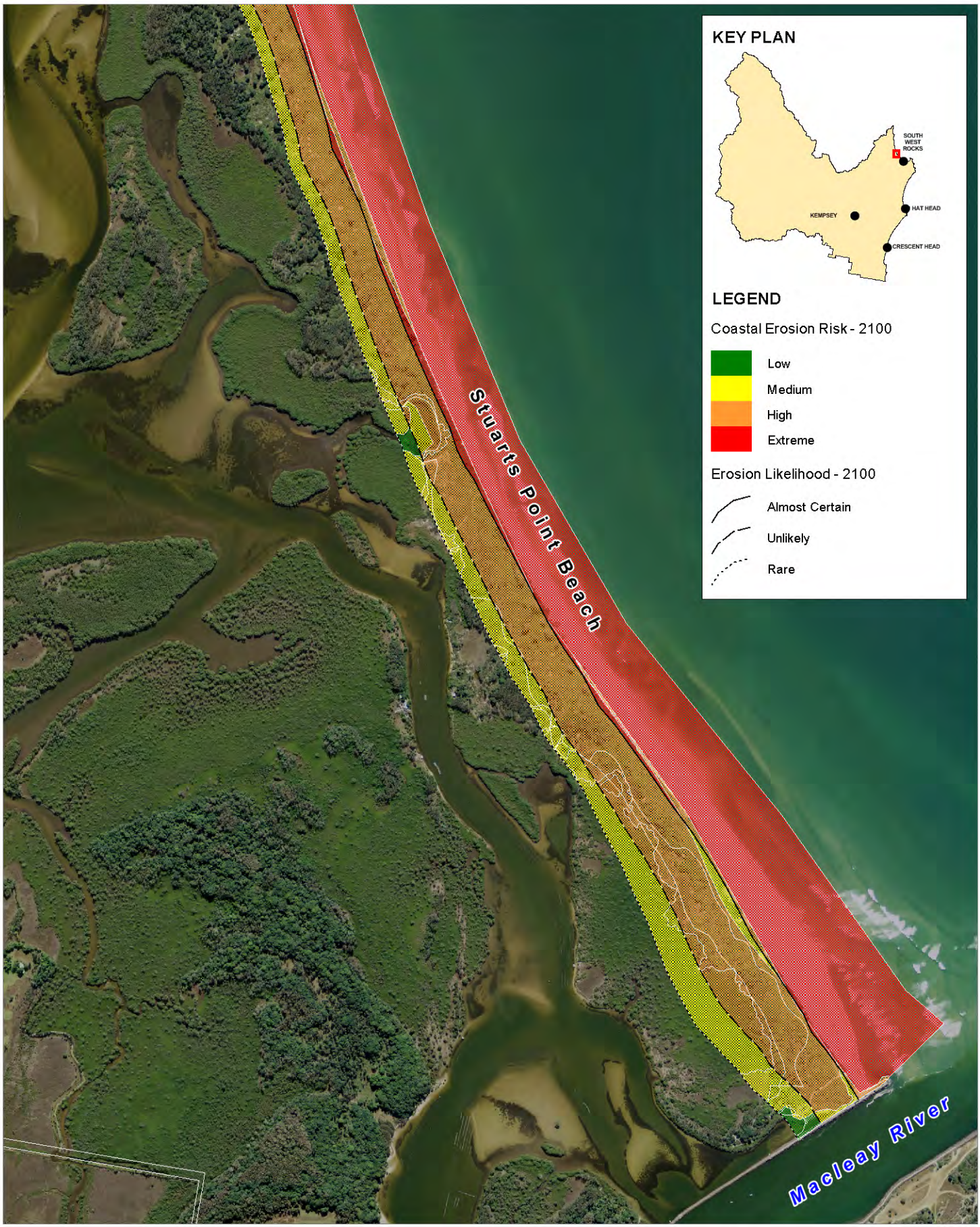

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Erosion and Recession Risk Map
2100 Planning Horizon - Stuarts Point Beach

Figure: 5-11

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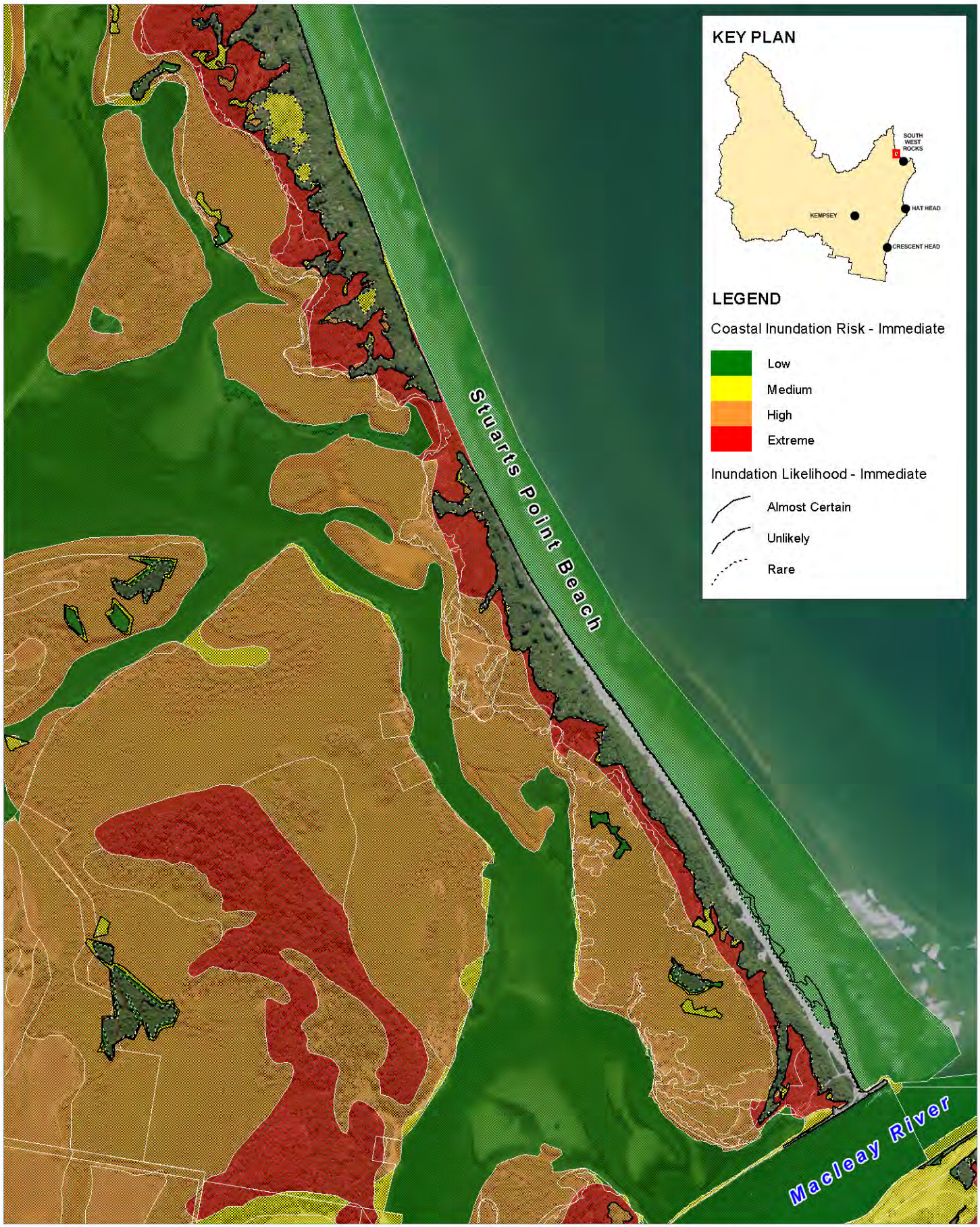

Title:

Coastal Inundation Risk Map
Immediate Planning Horizon - Stuarts Point Beach

Figure: 5-12

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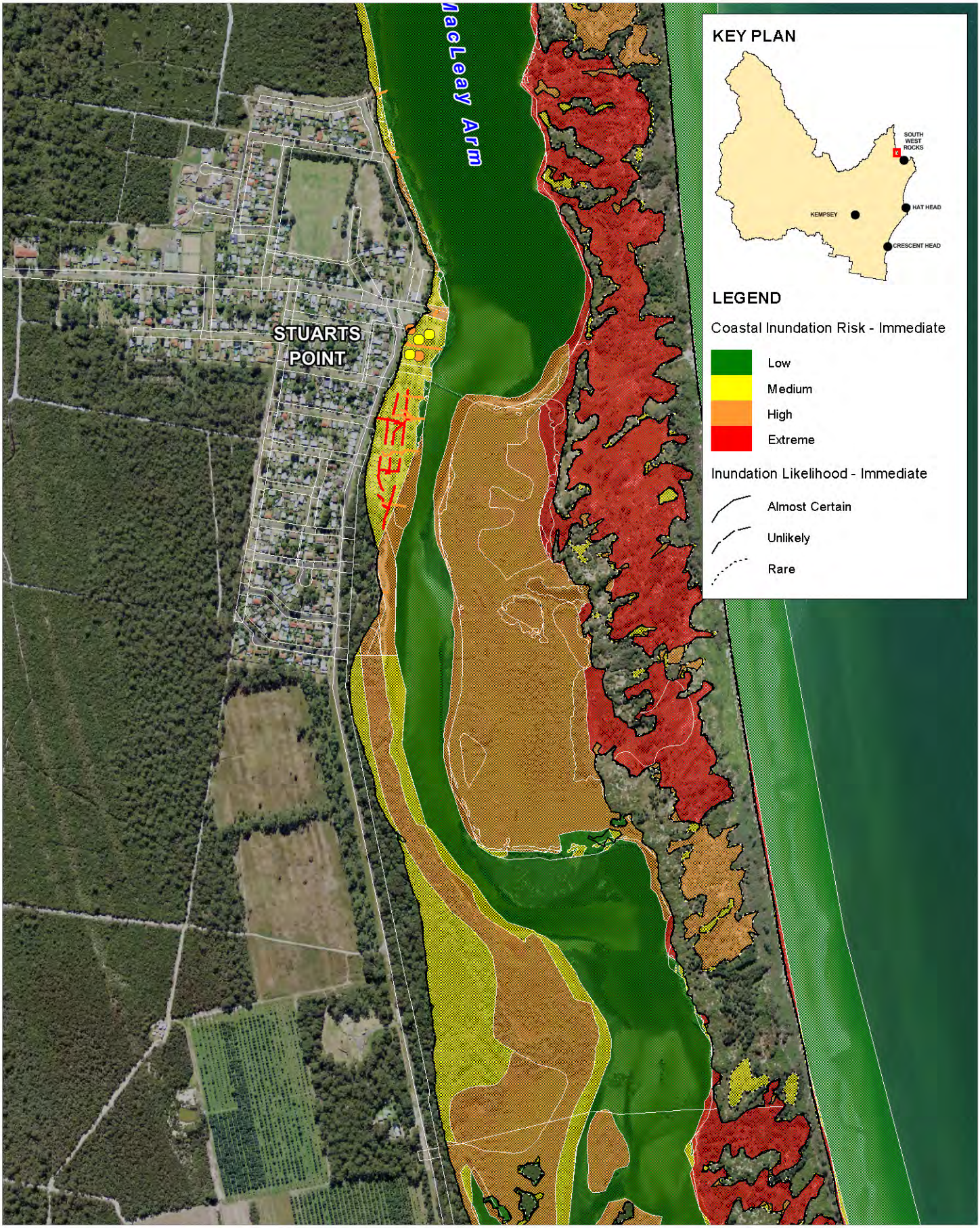

Title:

Coastal Inundation Risk Map
Immediate Planning Horizon - Stuarts Point Township

Figure: **5-12b**

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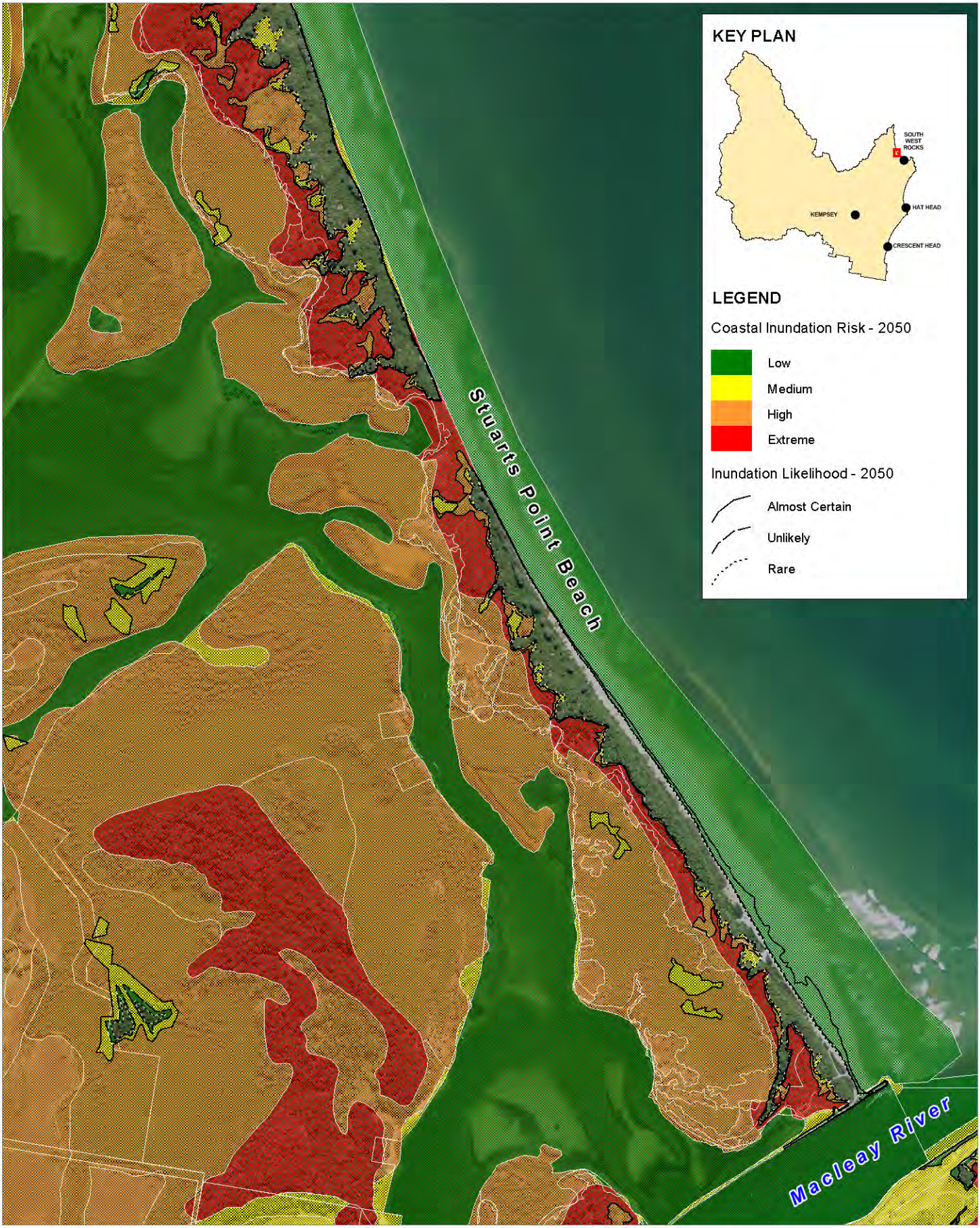

Title:

Coastal Inundation Risk Map
2050 Planning Horizon - Stuarts Point Beach

Figure: 5-13

Rev: A

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0 250 500m

Approx. Scale

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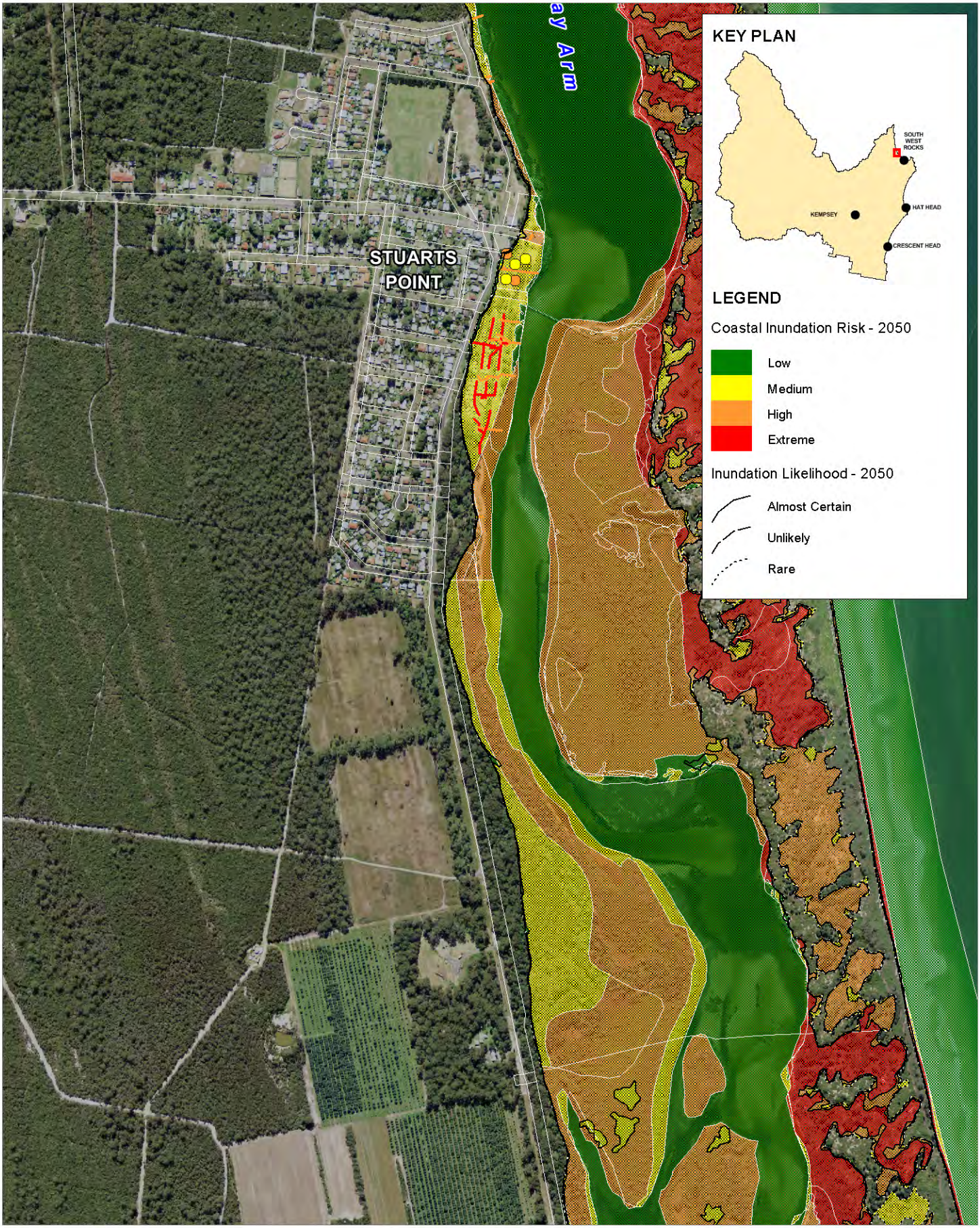

Title:

Coastal Inundation Risk Map
2050 Planning Horizon - Stuarts Point Township

Figure: 5-13b

Rev: A

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0 250 500m

Approx. Scale

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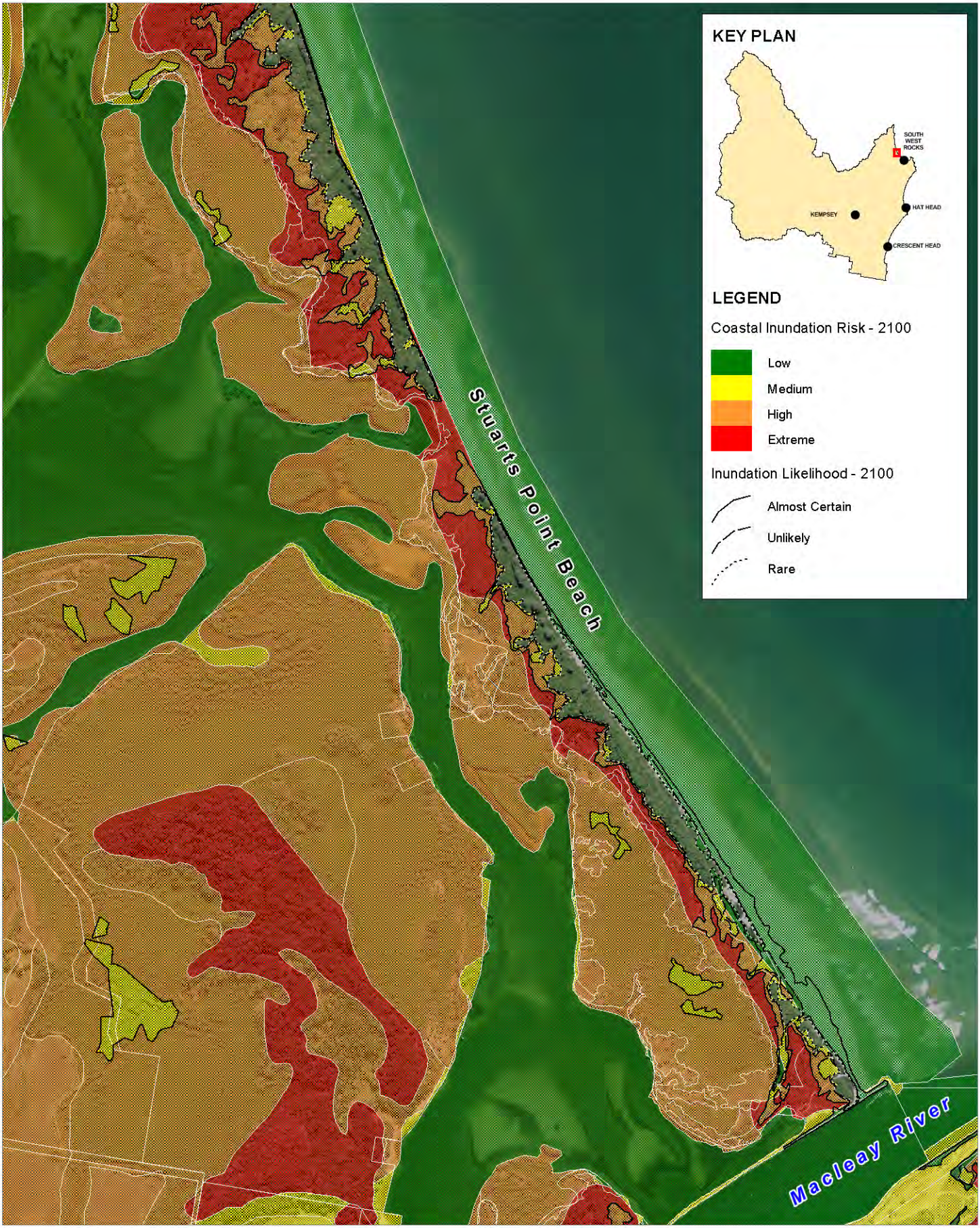

Title:

Coastal Inundation Risk Map
2100 Planning Horizon - Stuarts Point Beach

Figure: 5-14

Rev: A

N

0 250 500m

Approx. Scale

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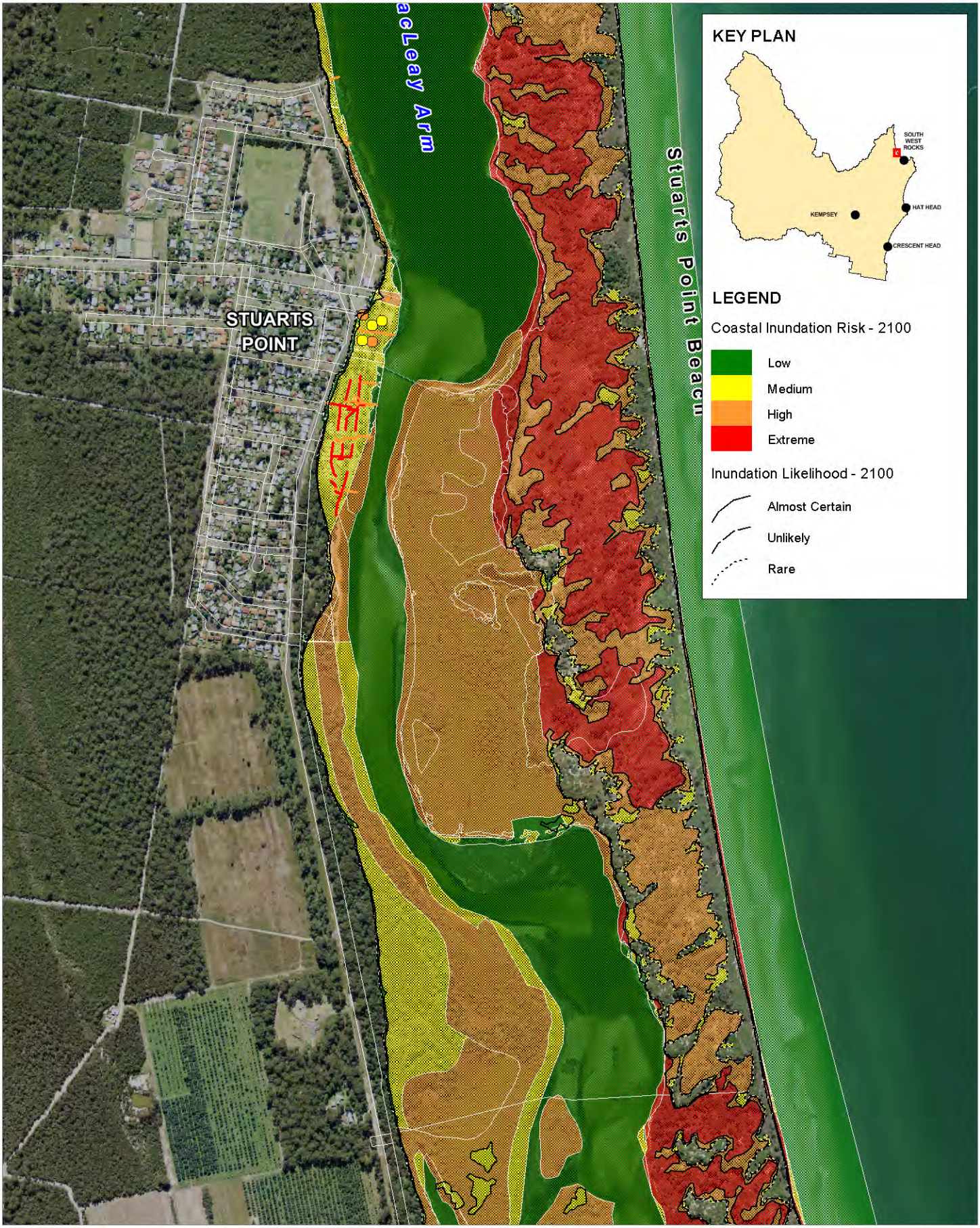
Filepath : K:\N20145_KempseyCZMP\MI\Workspaces\DRG_054_140728_RiskMap_A-2.WOR



Title:

Coastal Inundation Risk Map
2100 Planning Horizon - Stuarts Point Village

Figure: 5-14b

Rev: A

N

0 250 500m

Approx. Scale

BMT WBM
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5.5 South West Rocks and Trial Bay

5.5.1 Assets at risk from coastal erosion and recession

Erosion and recession threaten the highly valued beaches of Horseshoe Bay, Trial Bay and Back Beach. Other natural assets at risk include EEC vegetation and public land such as Horseshoe Bay Reserve. The built infrastructure at risk is part of the water supply network. The sewage dune disposal field (including the potential future expansion area) appear to be outside the hazard zone.

5.5.2 Assets at risk from coastal inundation at South West Rocks and Trial Bay

The inundation risks in and around South West Rocks are substantial. In particular the threat of coastal inundation of wastewater infrastructure is extreme, with sewerage lines and pump stations in the high and extreme risk category. Part of the treatment works site is included in the inundation hazard areas for all three time periods, however the majority of the site is sufficiently elevated to be above the inundation zone even at 2100 (presumably through flood mitigation in the original design). The dune disposal field is not within the mapped hazard area. It is important to note that changes to the effectiveness of the dune disposal could arise due to sea level rise and impacts upon groundwater levels. Part of the water supply network is also in the hazard area. As for catchment flooding, South West Rocks Road has the potential to be unusable during a coastal inundation event, effectively cutting off South West Rocks from Kempsey. The roads that are at highest risk in this area are South West Rocks Road, Gregory Street and Buchannan Drive. A number of minor roads are also at High risk. There are also parcels of rural, residential and light industrial land at risk for all three time periods, while there are potentially areas of lower tolerance EECs at risk in this area too.

5.5.2.1 Implications of the risk assessment for future development potential at South West Rocks

The hazard study includes a broad brushed coastal inundation assessment that in the absence of an explicit flood model for each waterway could be used as an interim flood level at the immediate, 2050 and 2100 timeframes. The coastal inundation mapping should serve as a flag for more detailed flood assessments using a hydraulic flood model that considers both catchment and coastal processes.

The analysis and mapping of coastal inundation of back beach areas, assumes that all components of the elevated water level (storm surge, sea level rise, tide, wave set up etc) are included using a 'bath tub' approach. It is recognised that elevated ocean levels will not always penetrate into the coastal lagoon to the same maximum height, given the attenuation through entrances and along channels. Elevated ocean levels occur during storm conditions, and so it is probable that there would be rainfall on the catchments associated with the storm.

For Saltwater Lagoon, council engaged WBM to prepare a site specific flood model that included sea level rise considerations to inform rezoning and the preparation of the LEP in 2006. This more detailed study would give a better indication of the coastal inundation and catchment flooding impacts than the broad brushed approach presented in the hazard study. Saltwater Lagoon is the only location for which this is the case in the Kempsey LGA.

In response to this assessment land was rezoned to residential use in 2009.

The new LEP specifically addresses the coastal hazard risk and in particular, environmental lands surrounding the lagoon through Clause 6.3, subclause 3, which states:

“The development control plan must provide for all of the following…..”:

…”f) amelioration of natural and environmental hazards, including bushfire, flooding and site contamination, and, in relation to natural hazards, the safe occupation of, and the evacuation from, any land so affected,”

…..”if in the Saltwater urban release area, as shown on the Urban Release Area Map:

(i) detailed arrangements on the management of the area of E2 land surrounding the Saltwater Lagoon and bisecting the urban release area, and

(ii) identification of hazards posed by the South West Rocks sewage treatment plant and measures required to reasonably accommodate and mitigate noise and odour impacts from that sewage treatment plant.”

The coastal inundation modelling presented in the hazard study does not supersede the flood modelling for Saltwater Lagoon undertaken in 2006, as that was a more detailed hydraulic model that included the impacts of catchment flooding. Due to the level of concern amongst the community and existence of more recent data, a management option to update this flood model will be recommended to be included in the CZMP.

5.5.3 Community use and access considerations

- Coastal erosion leading to undermining of the existing rock structure adjacent to the South West Rocks Surf Club reduces access and amenity and poses a public safety risk. Poor design and construction of the wall is resulting in loss of backfill material and unstable conditions. While the SLSC building is not under threat from erosion, the adjacent erosion poses an issue for safe public access to the beach as well as access for surf lifesaving equipment. More formal and properly designed protection works for the bank could be considered in conjunction with a formal provision for safe access to the beach. The effect of protection works upon flows and opening characteristics of Saltwater Creek should be considered as part of an assessment of the works.

- There are conflicts between the users of the National Park camping ground and the public boat ramp that provides relatively safe access to the ocean. NPWS is now closing the ramp during peak holiday periods so that campers are not disturbed by boat ramp users. The CZMP should recommend dialogue with National Parks and the users of this popular and important area. One option that may be considered for inclusion in the CZMP is the provision of small scale sail boat launching facilities further along Trial Bay Beach (please refer to Figure 4-9).

- The short-tailed shearwater birds migrate 10,000 kilometres from the Bering Sea, between Alaska and Japan, to Australian shores in late September to nest. When large numbers of dead ocean birds wash to shore, the events are called “wrecks” and the general cause is starvation. While it is considered normal for wrecks to occur every 10 years, and this usually indicated a particularly "poor year" for the birds with storms or no fish available on arrival, major wrecks

have occurred every second year since 2007, pointing to a wider problem (Lavers, in press, 2013). From the perspective of the CZMP, the issue raises impacts on beach use and amenity. The broader causes of more frequent wrecks are beyond the scope of this study.

- Many users favour the boat ramp in the upper reaches of Back Creek for accessing the ocean in preference to Macleay River facilities. This is due to a lower level of risk of capsizing whilst crossing the bar. Use of the Back Creek means there are impacts on the Back Creek channel and ecosystems as a result of the boat traffic. Consideration should be given for an additional ramp further downstream in the vicinity of the car park.
- Recreational 4WDing is impacting on saltmarsh on the lee side of the southern breakwater of the Macleay River. A level of emergency access needs to be provided in this area in the case of capsizing as boats cross the entrance bar.

5.5.4 Immediate management recommendations for South West Rocks

In the next five to ten years the following management actions are recommended to be included in the CZMP for intolerable risks at South West Rocks:

- Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in Council's Asset Management Plan. Account for such coastal risks when prioritising asset maintenance and replacement.
- Coastal Hazard Development Controls: Require redevelopment / renovations to be located as far landward in hazard zone as practical. Planning controls on undeveloped land in future hazard zones
- Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential Endangered Ecological Communities (EEC) mapping, and investigate options for impact mitigation and resilience building
- Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds
- Formal protection works designed to build upon (and be in keeping with) the existing natural alignment of the beach- use existing boulders but replace with a proper engineered design. This will have the advantage of ensuring that the shoreline will be held in current position with mostly existing materials. Care will need to be taken to minimise impacts on entrance of Saltwater Creek.
- Extension of the access provided by the bridge over Saltwater Creek through the dunes and onto the beach to provide disabled access and access to surf club boats etc. Improves disability access and surf club access
- Undertake an updated flood assessment for Saltwater Lagoon based on the latest available OEH guidance on the interaction of elevated ocean levels and catchment flooding through the State Floodplain Management Program.

5.5.5 Future management options for South West Rocks

The key focus will be appropriate asset management and planning to ensure the risk profile doesn't increase into the future. The difficult decisions that will have to be made will involve inundation risk, which needs to be considered through the flood management program.

5.5.6 Risk register and mapping for South West Rocks

The erosion and recession risk register for South West Rocks is presented in Table 5-8, and the risk register for Coastal inundation is presented in Table 5-9. The risk mapping is presented in maps Figure 5-15 to Figure 5-26

Table 5-8 Coastal erosion and recession risk register for South West Rocks

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
Water line	Water infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.				
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets			
Community infrastructure										
Public recreation	Open space - public recreation	High	High	High	Area to the north of flagstaff and behind back beach	Coastal hazard development controls: restrict future development that will prevent beach profile from receding.				
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.			
Heritage										
Flagstaff	Heritage item (local)	High	High	High						
Natural assets										
Beaches • Back beach • Front beach (trial bay) • Horseshoe cove	Beach	Extreme	Extreme	Extreme		Coastal hazard development controls: restrict future development that will prevent beach profile from receding.				assess suitability of sand extracted from back creek to nourish horseshoe bay beach
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.			
Environmental conservation	Environmental protection zone	High	High	High	Behind back beach	Coastal hazard development controls: restrict future development that will prevent beach profile from receding.				
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.			
Arakoon national park	Parks, reserves and open space	N/a	Medium	Medium		Accept risk – risk level is considered tolerable				

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
Horseshoe bay reserve	Parks, reserves and open space	High	High	High	Area in the southern corner	Coastal hazard development controls: restrict future development that will increase the risk profile.				Seawall Beach nourishment Beach scraping
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.			
Freshwater wetlands on coastal floodplains	Potential EEC (low tolerance)	Extreme	Extreme	Extreme		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building		Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds		
						Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Positives • Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards	Negatives Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	
Littoral rainforest	Potential EEC (low tolerance)	N/a	N/a	Medium		Accept risk – risk level is considered tolerable				
Themeda grassland on seacliffs/coastal headlands	Potential EEC (low tolerance)	High	High	High		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building		Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds		
						Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Positives • Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards	Negatives • Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	
Other infrastructure / services (arakoon)										
Stormwater line	Stormwater infrastructure	N/a	N/a	Low		Accept risk – risk level is considered tolerable				
Sewer line	Wastewater infrastructure	Extreme	Extreme	Extreme	In vicinity of laggers point	Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.				
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets			

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Water line	Water infrastructure	N/a	N/a	Medium		Accept risk – risk level is considered tolerable		
Community infrastructure (arakoon)								
Public recreation	Public recreation	High	High	High	Strip behind trial bay beach	Coastal hazard development controls: restrict future development that will increase the risk profile. Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential Negatives: • Reduced area within property boundaries for development potential.		
Smokey cape lighthouse group 1850129	Heritage item (state)	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Natural assets								
Beaches: • Front beach (trial bay) • Gap beach • Little bay beach • North smoky beach	Beach	Extreme	Extreme	Extreme		Coastal hazard development controls: restrict future development that will prevent beach profile from receding. Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential Negatives: • Reduced area within property boundaries for development potential.		
Arakoon national park Hat Head national park	Parks, reserves and open space	High	High	High		Inform the national parks and wildlife service of this risk rating		
Themeda grassland on seacliffs/coastal headlands Littoral rainforest	Potential EEC (low tolerance)	Extreme	Extreme	Extreme		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised	Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds Positives • Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards Negatives • Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	

Table 5-9 Coastal Inundation Risk Register for South West Rocks

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Residential, town centre and business								
General residential	Residential zone	High	High	High	For example the area zoned r1 (formerly 2a) near saltwater lagoon (presently not developed)	Undertake an updated flood assessment for Saltwater Lagoon based on the latest available OEH guidance on the interaction of elevated ocean levels and catchment flooding through the State Floodplain Management Program.- implement flood development controls and mitigation measures through the flood management plan		
Large lot residential	Residential zone	High	High	High		Undertake an updated flood assessment for Saltwater Lagoon based on the latest available OEH guidance on the interaction of elevated ocean levels and catchment flooding through the State Floodplain Management Program.- implement flood development controls and mitigation measures through the flood management plan		
Medium density residential	Residential zone	High	High	High	Undeveloped land to the north of philip drive (between philip drive and Saltwater Creek) and including residence at 149 philip drive	Undertake an updated flood assessment for Saltwater Lagoon based on the latest available OEH guidance on the interaction of elevated ocean levels and catchment flooding through the State Floodplain Management Program.		
Rural, primary production, forestry and industry								
Light industrial	Industrial zoned land	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Rural landscape	Rural zone	High	High	High				
Other infrastructure / services								
Stormwater line	Stormwater infrastructure	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.	Manage through flood program - ensure sea level rise is considered in flood planning.	

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Sewer line	Wastewater infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
S/works res,pump hse	Wastewater infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Ksc treatment lm - sewer north, treat works	Wastewater infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Sewer pump station	Wastewater infrastructure	N/a	N/a	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Water line	Water infrastructure	Extreme	Extreme	Extreme	In and around philip drive	Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Water tanks/shelter	Water infrastructure	Medium	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Infrastructure	Infrastructure zoned land	Medium	Medium	Medium		Accept risk – risk level is considered tolerable				
Transport infrastructure										
Austin st	City / village road	Low	Medium	Medium		Accept risk – risk level is considered tolerable				
Boat ramp access	City / village road	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		

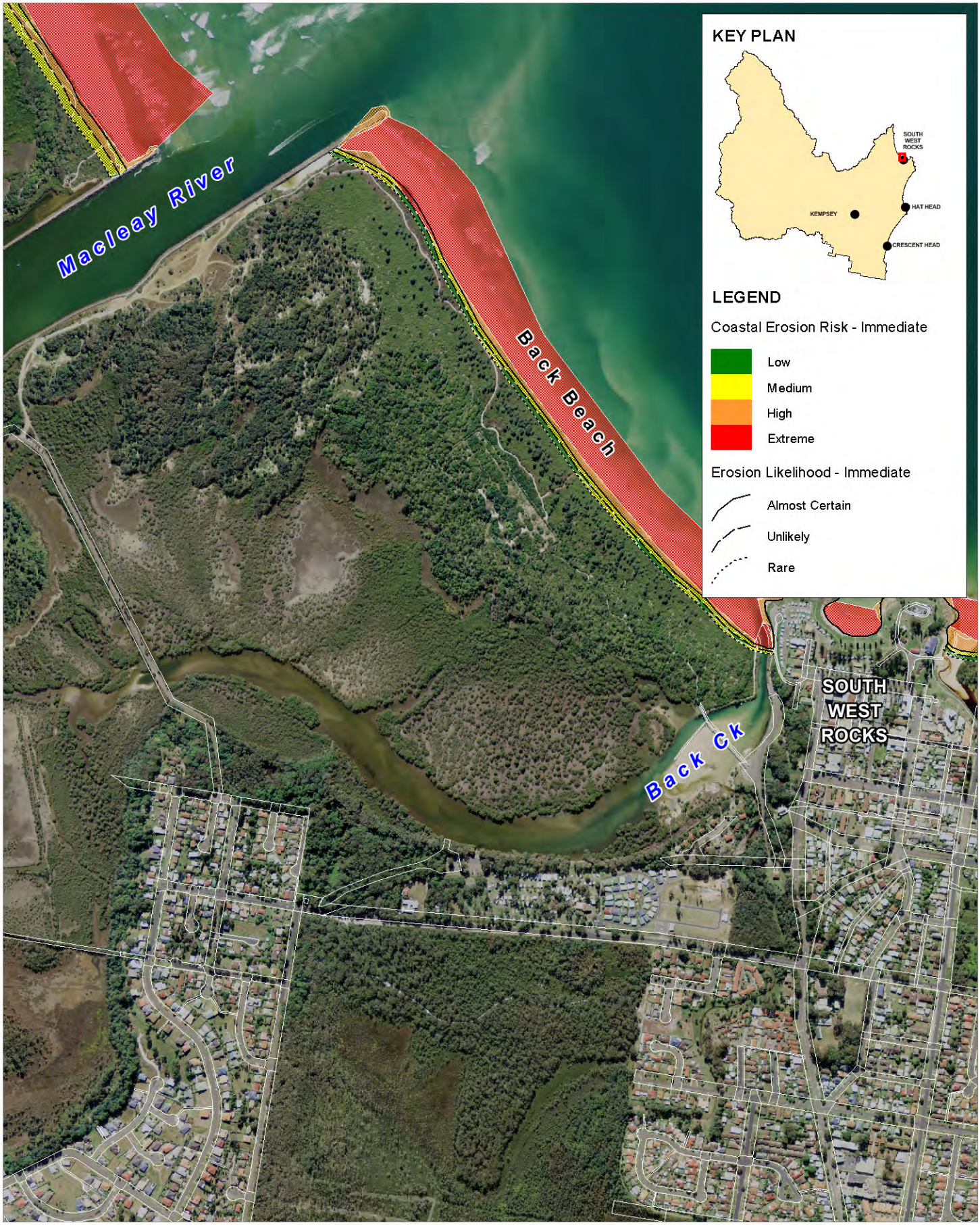
Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Cook dr	City / village road	N/a	N/a	Low		Accept risk – risk level is considered tolerable				
Roads: Cooper st Fig tree ln Buchanan dr Lindsay noonan dr Philip dr	City / village road	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Frederick kelly st	City / village road	N/a	N/a	Low		Accept risk – risk level is considered tolerable				
Roads: Gordon young dr Gregory st	City / village road	Low	Medium	Medium		Accept risk – risk level is considered tolerable				
Herbert appleby cct Hill st Landsborough st	City / village road	N/a	N/a	Low		Accept risk – risk level is considered tolerable				
Roads: Simpson st Waianbar ave	City / village road	N/a	N/a	Low		Accept risk – risk level is considered tolerable				
Walkway	City / village road	N/a	N/a	Low		Accept risk – risk level is considered tolerable				

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
Wilfred partridge st	City / village road	N/a	Low	Medium		Accept risk – risk level is considered tolerable				
Roads Gregory st South west rocks rd	Major road	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Arakoon rd	Rural road	Medium	Medium	Medium		Accept risk – risk level is considered tolerable				
Roads: Marlin dr New entrance rd	Rural road	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Mayta moran cl	Unclassified road	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Spencers creek rd	Unsealed road	Medium	Medium	Medium		Accept risk – risk level is considered tolerable				
Walkway	Unsealed road	N/a	N/a	Low		Accept risk – risk level is considered tolerable				
Community infrastructure										
South west rocks tourist park	Caravan park	N/a	Low	Low		Accept risk – risk level is considered tolerable				
South west rocks golf club	Private recreation	N/a	Low	Low		Accept risk – risk level is considered tolerable				
Public recreation	Public recreation	Medium	Medium	Medium		Accept risk – risk level is considered tolerable				
South west rocks slsc	Slsc	Low	Low	Low		Accept risk – risk level is considered tolerable				
Amenities Storage depot Toilets	Amenities / block / sheds	Medium	Medium	Medium		Accept risk – risk level is considered tolerable				
Heritage										
Flagstaff	Heritage item (local)	Medium	Medium	Medium		Accept risk – risk level is considered tolerable				
Natural assets										
Baches: Back beach Front beach (trial bay) Horseshoe cove	Beach	Low	Low	Low		Accept risk – risk level is considered tolerable				

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Environmental conservation	Environmental protection zone	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
National Parks: Arakoon national park Hat Head national park Horseshoe bay reserve	Parks, reserves and open space	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Arthur st/cook dr reserve	Parks, reserves and open space	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Mattys flat park	Parks, reserves and open space	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Mattys flat wetlands	Parks, reserves and open space	N/a	Low	Low		Accept risk – risk level is considered tolerable		
Phillp drive reserve	Parks, reserves and open space	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Swr forshore reserve	Parks, reserves and open space	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Wilfred partridge reserve	Parks, reserves and open space	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
EECs: • Subtrop_coastal floodplain forest • Themada graasland • Freshwater wetlands on coastal floodplains • Hunter red • Littoral rainforest	Potential EEC (low tolerance)	Extreme	Extreme	Extreme		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
EECs: • Coastal saltmars • Swamp oak floodplain forest	Potential EEC (medium tolerance)	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning.		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building		
						Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		Positives • Holistic approach to EEC conservation and management into the future Accurate mapping ensures that land is not unnecessarily sterilised		
Waterways										
Macleay river Macleay rvr new entrance Saltwater creek South west rocks creek Spencers creek	Natural waterway	Low	Low	Low		Accept risk – risk level is considered tolerable				
Unnamed waterway	Recreational waterway	Medium	Medium	Medium		Accept risk – risk level is considered tolerable				



Title:

Erosion and Recession Risk Map
Immediate Planning Horizon - South West Rocks

Figure: 5-15

Rev: A

N

0 250 500m

Approx. Scale

BMT WBM
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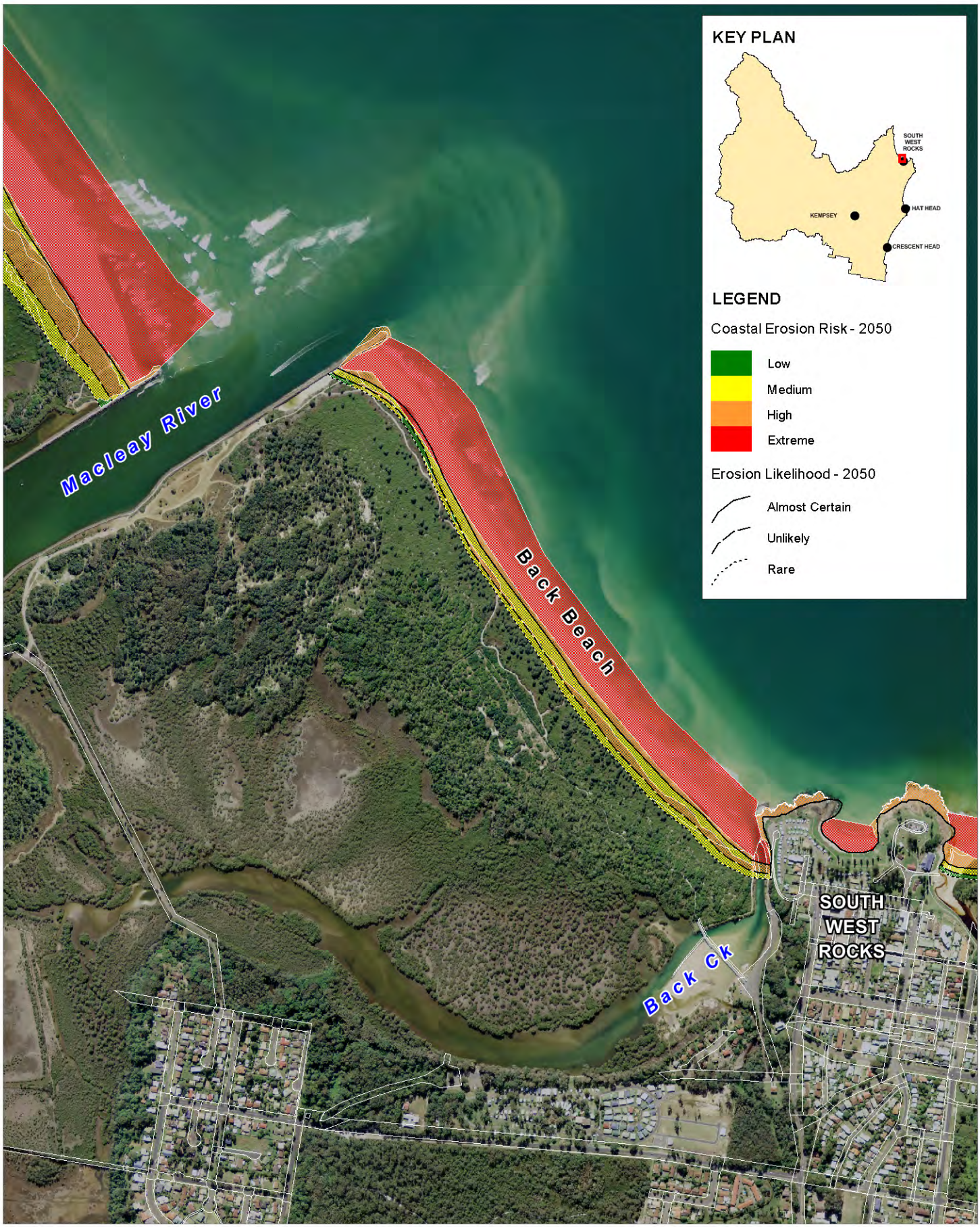

Title:

Erosion and Recession Risk Map
2050 Planning Horizon - South West Rocks

Figure: A-11

Rev: A

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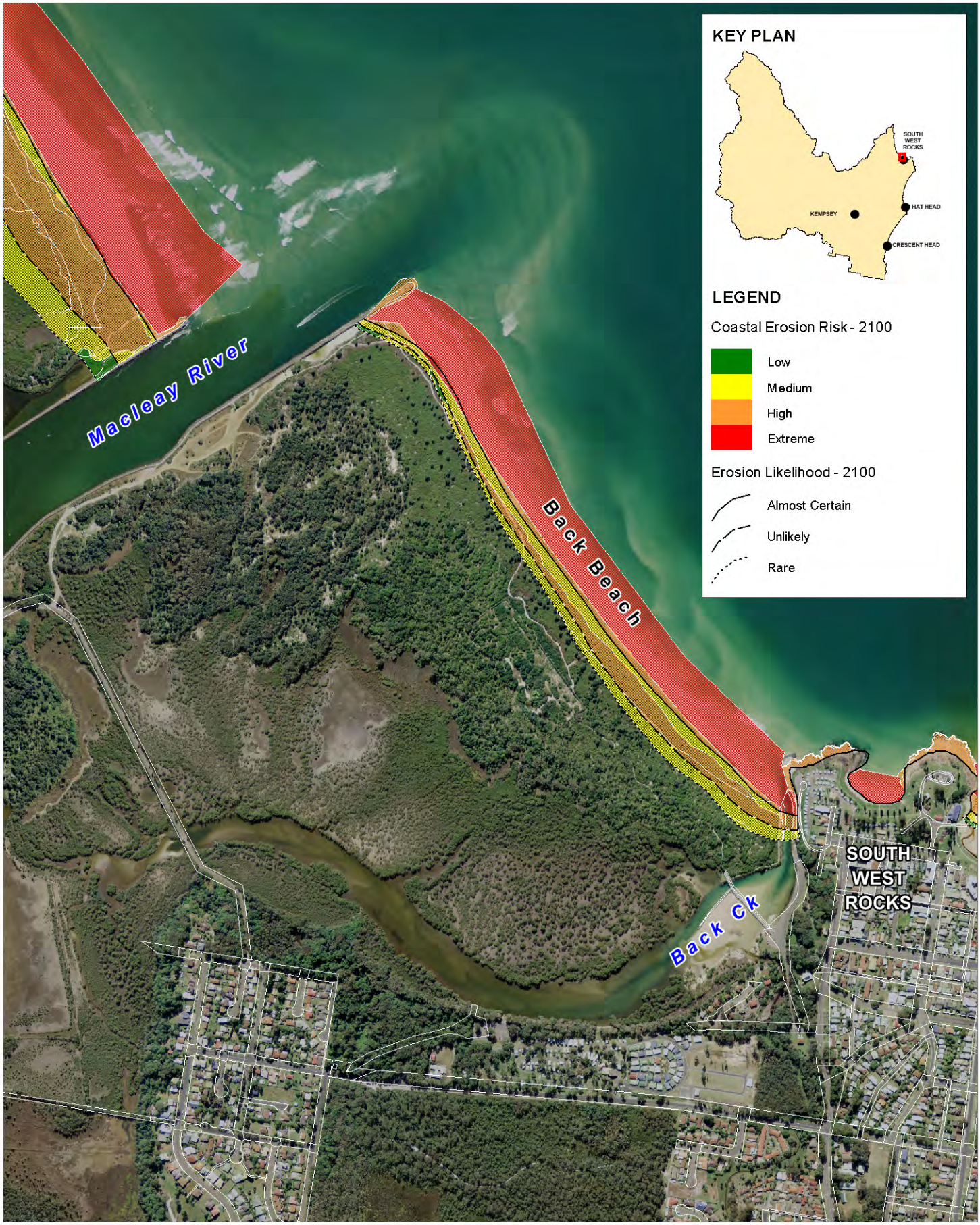

Title:

Erosion and Recession Risk Map
2100 Planning Horizon - South West Rocks

Figure: 5-17

Rev: B

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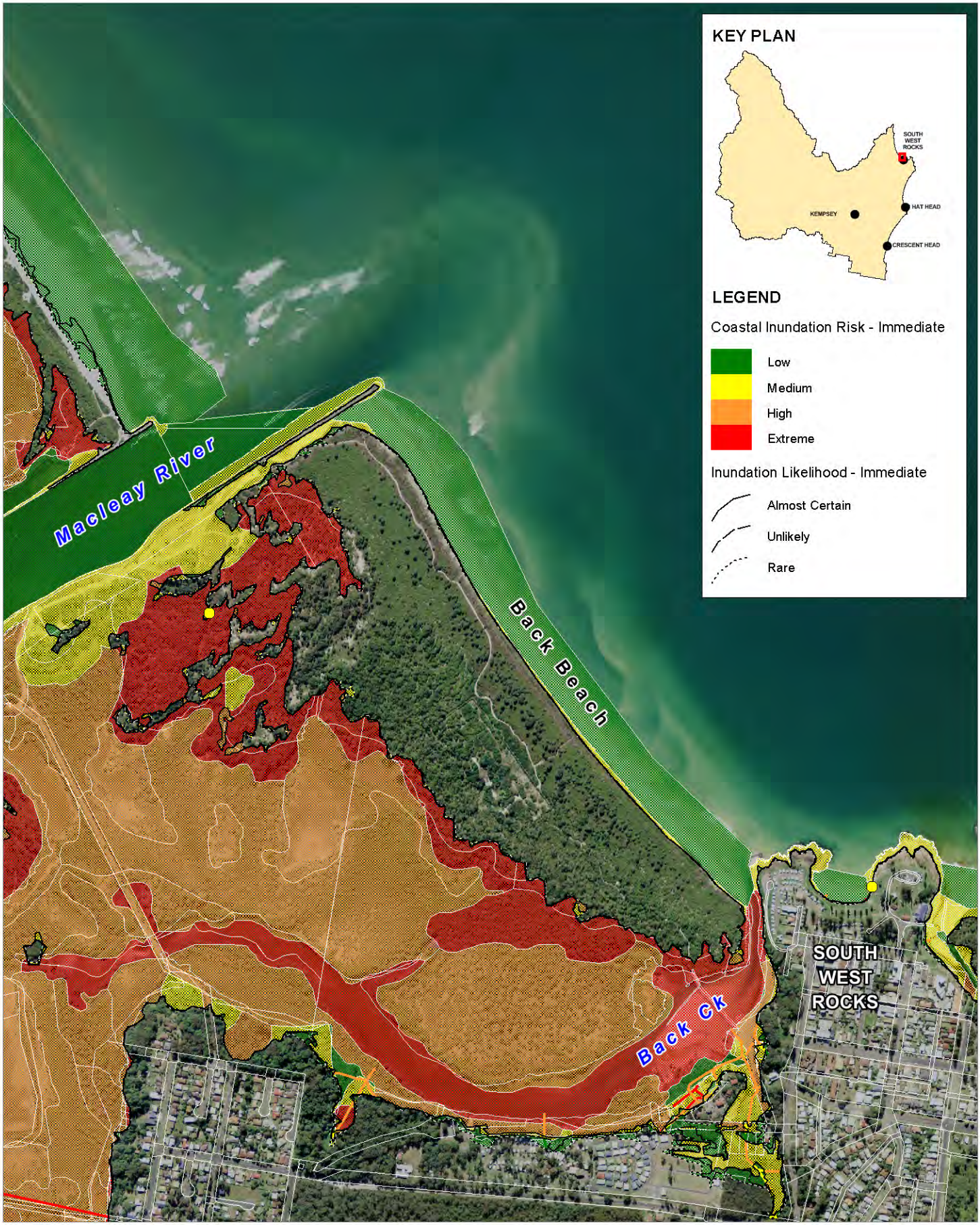

Title:

Coastal Inundation Risk Map
Immediate Planning Horizon - South West Rocks

Figure: 5-18

Rev: A

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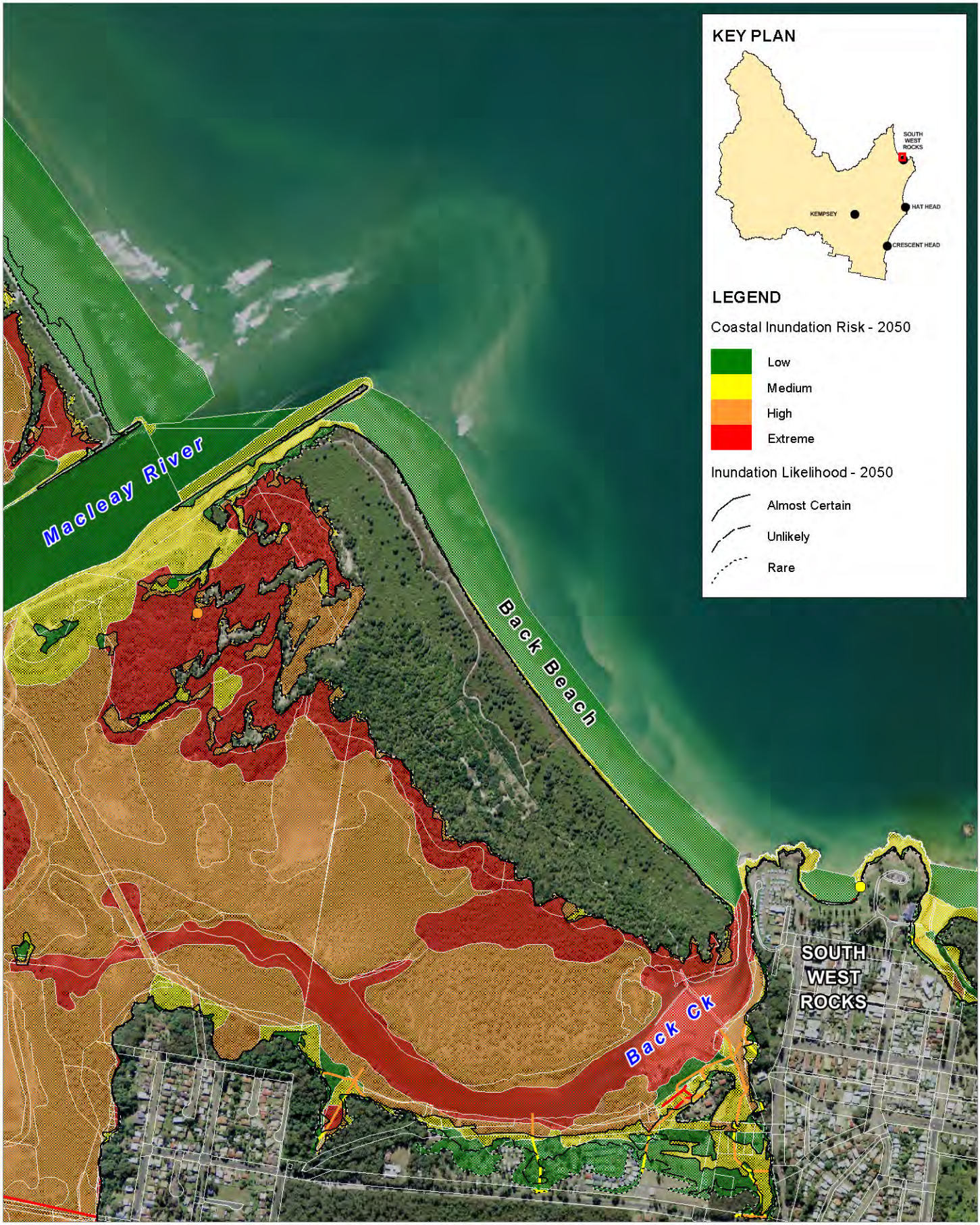

Title:

Coastal Inundation Risk Map
2050 Planning Horizon - South West Rocks

Figure: 5-19

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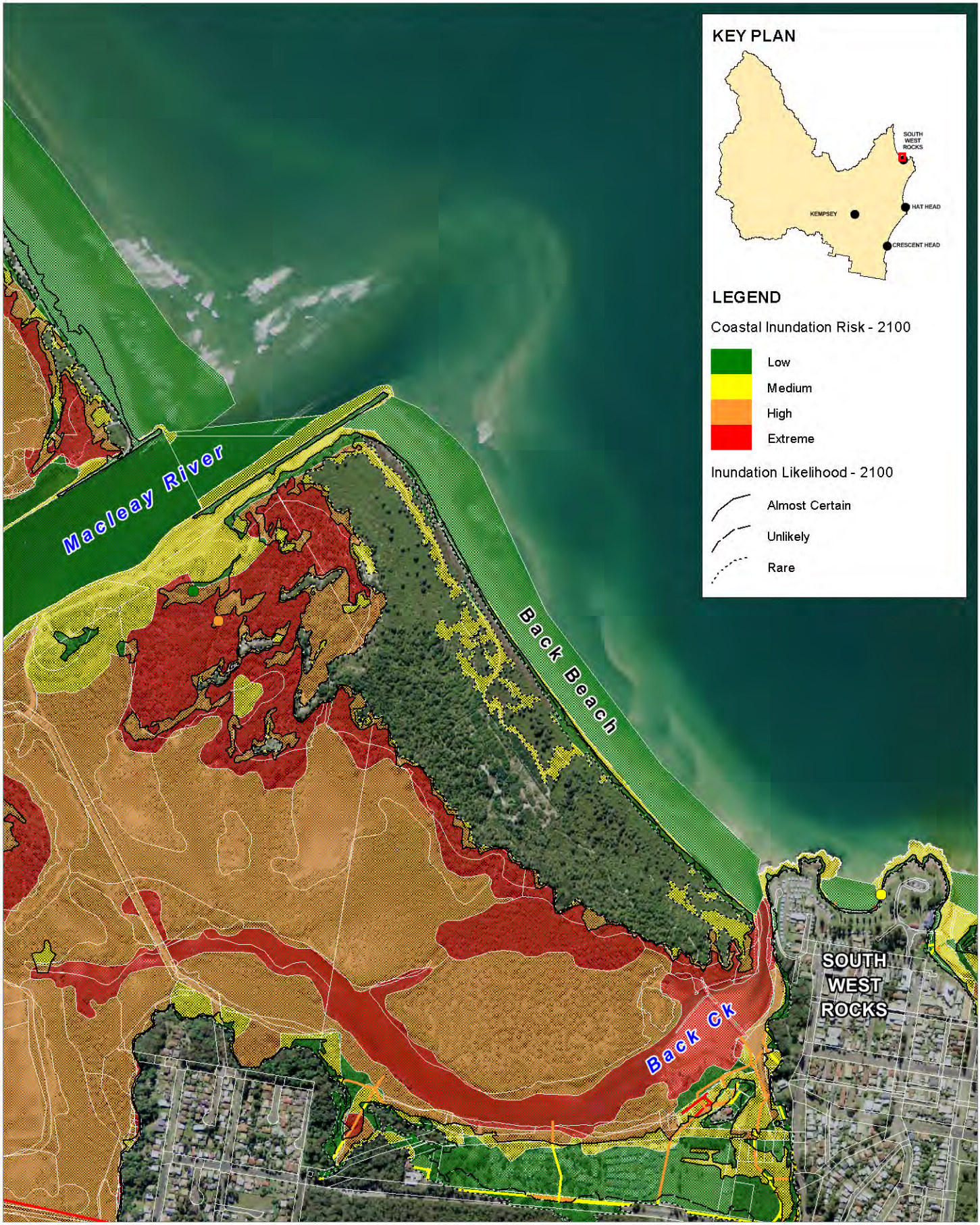

Title:

Coastal Inundation Risk Map
2100 Planning Horizon - South West Rocks

Figure: 5-20

Rev: A

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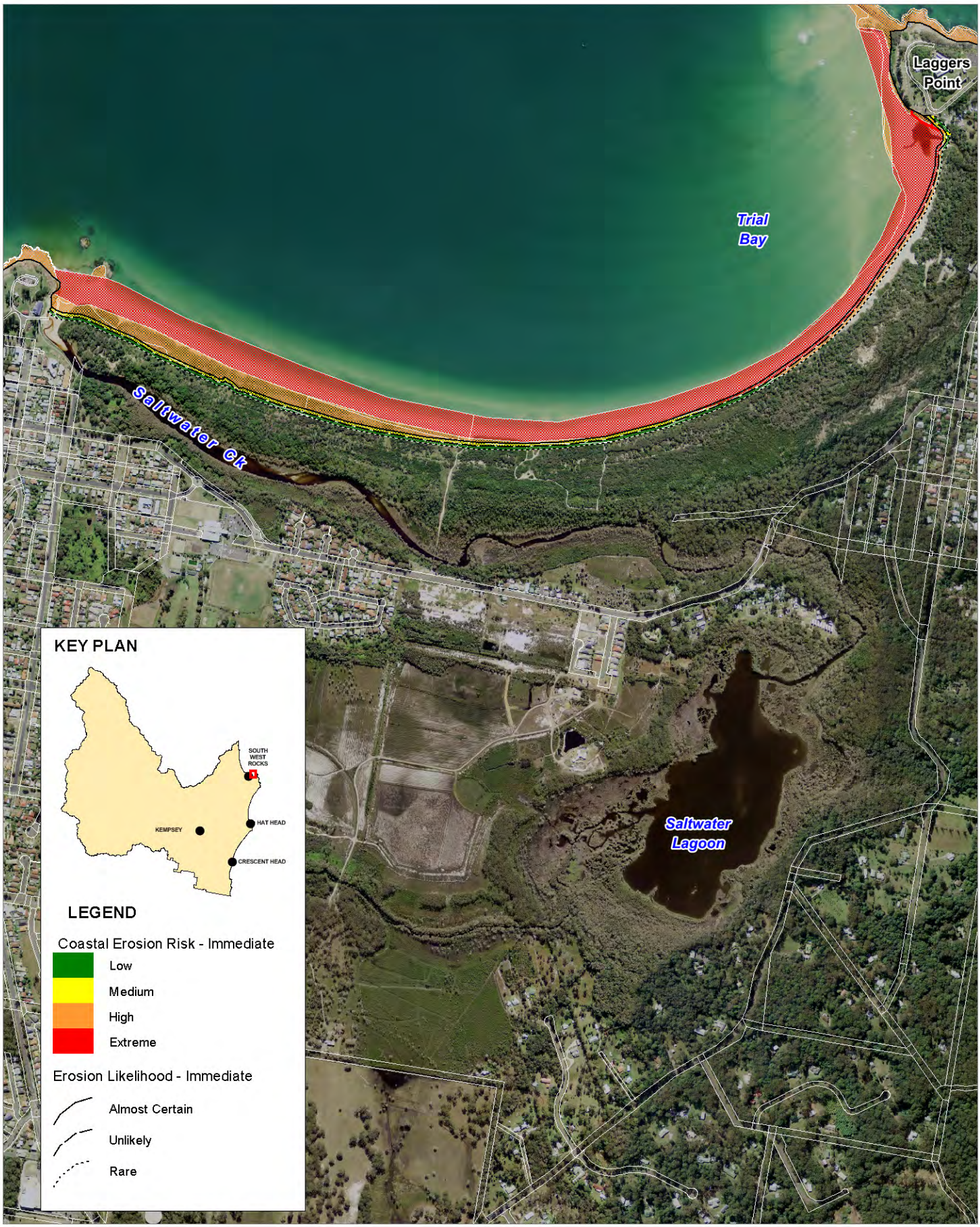

Title:

Erosion and Recession Risk Map
Immediate Planning Horizon - Trial Bay

Figure: 5-21

Rev: A

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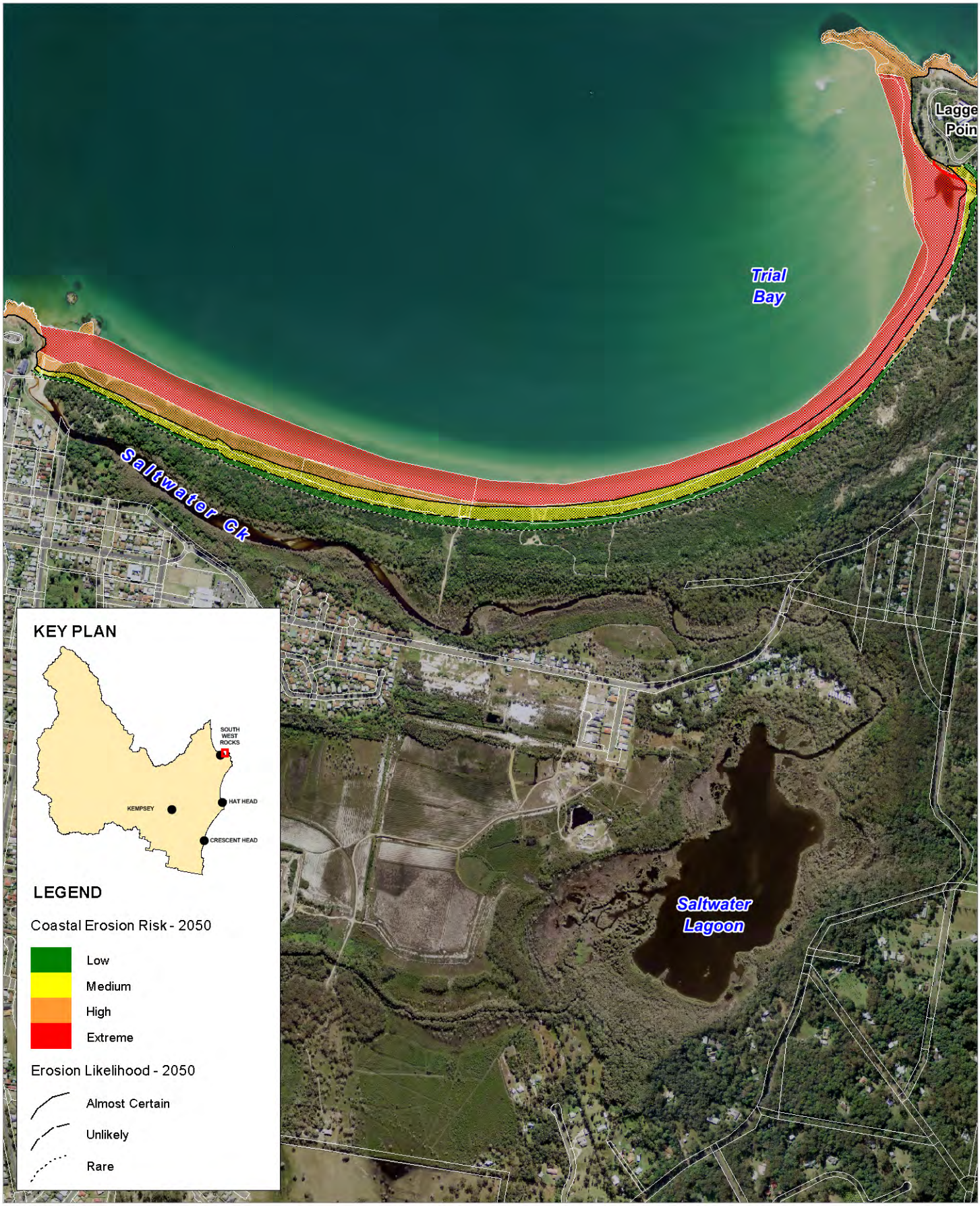

Title:

Erosion and Recession Risk Map
2050 Planning Horizon - Trial Bay

Figure: 5-22

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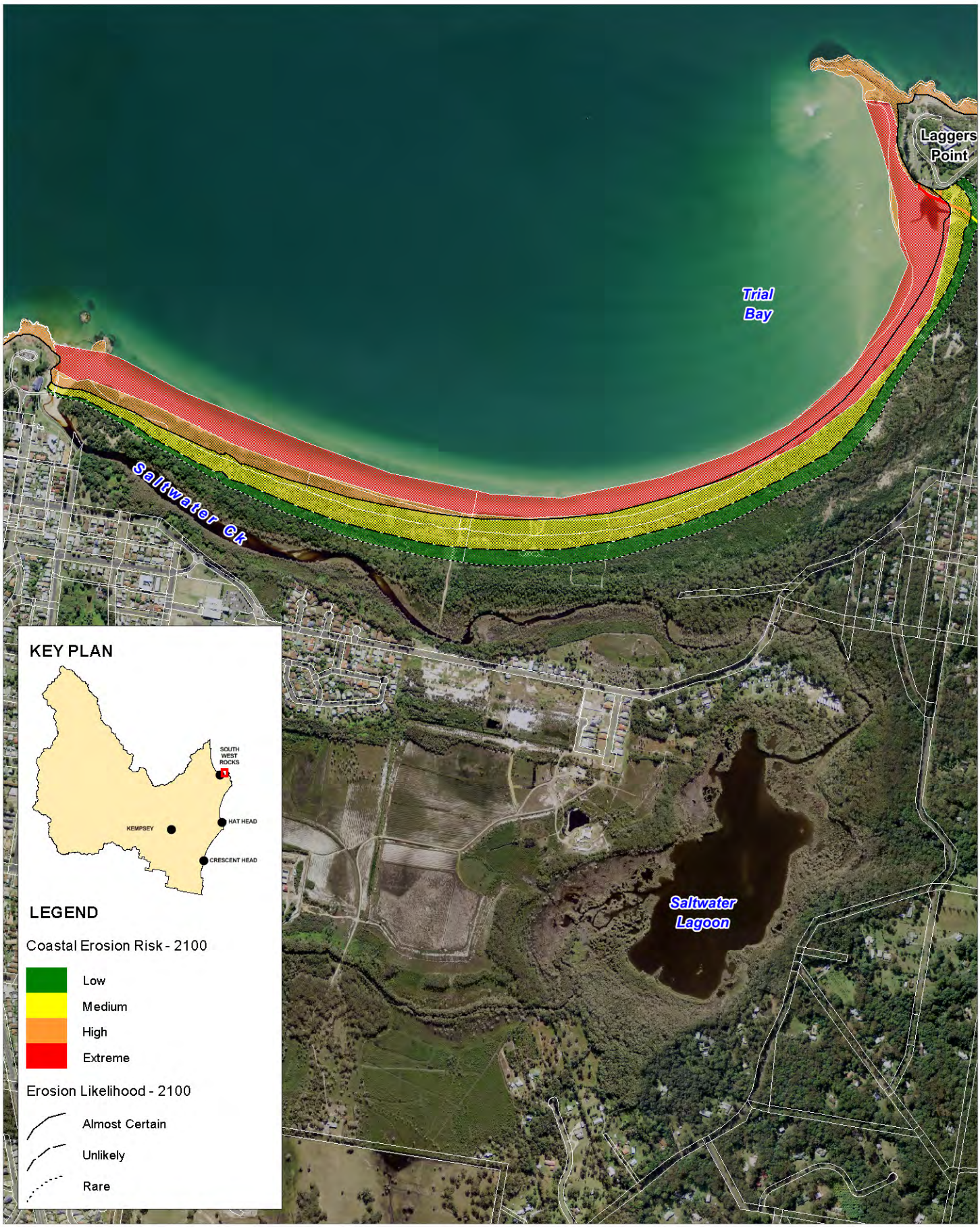

Title:

Erosion and Recession Risk Map
2100 Planning Horizon - Trial Bay

Figure: 5-23

Rev: A

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Approx. Scale

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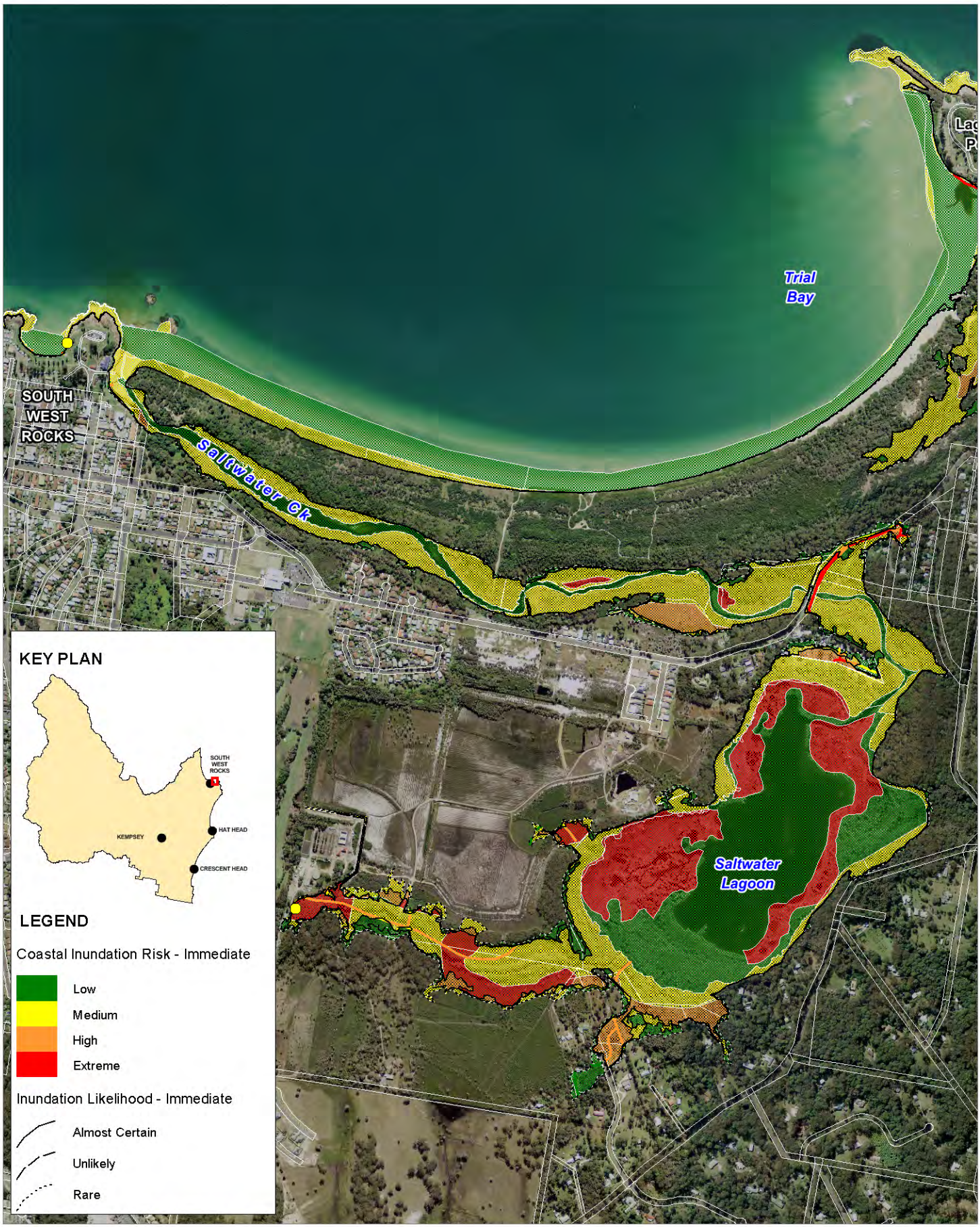

Title:

Coastal Inundation Risk Map
Immediate Planning Horizon - Trial Bay

Figure: 5-24

Rev: A

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Approx. Scale

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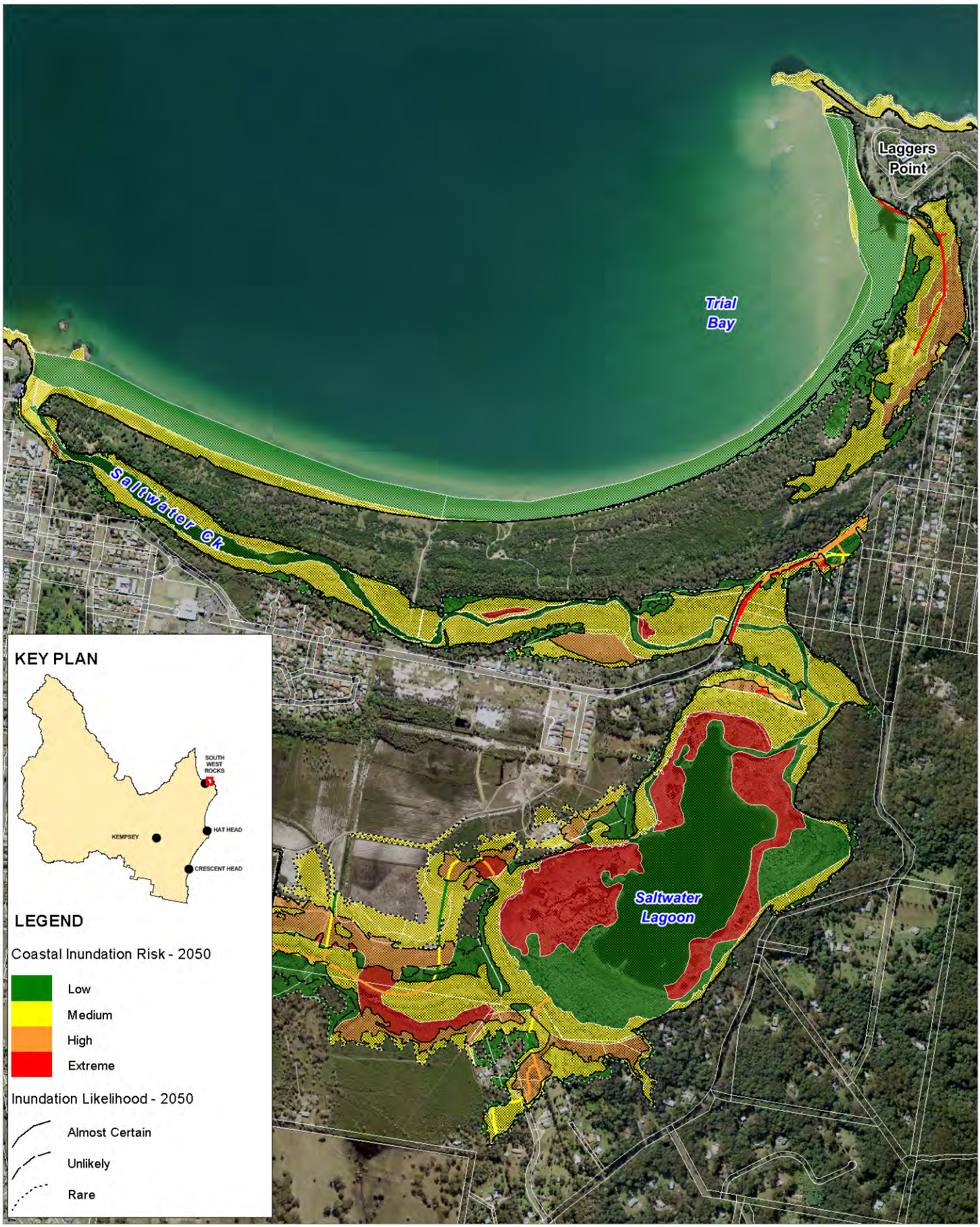

Title:

Coastal Inundation Risk Map
2050 Planning Horizon - Trial Bay

Figure: 5-25

Rev: A

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Approx. Scale

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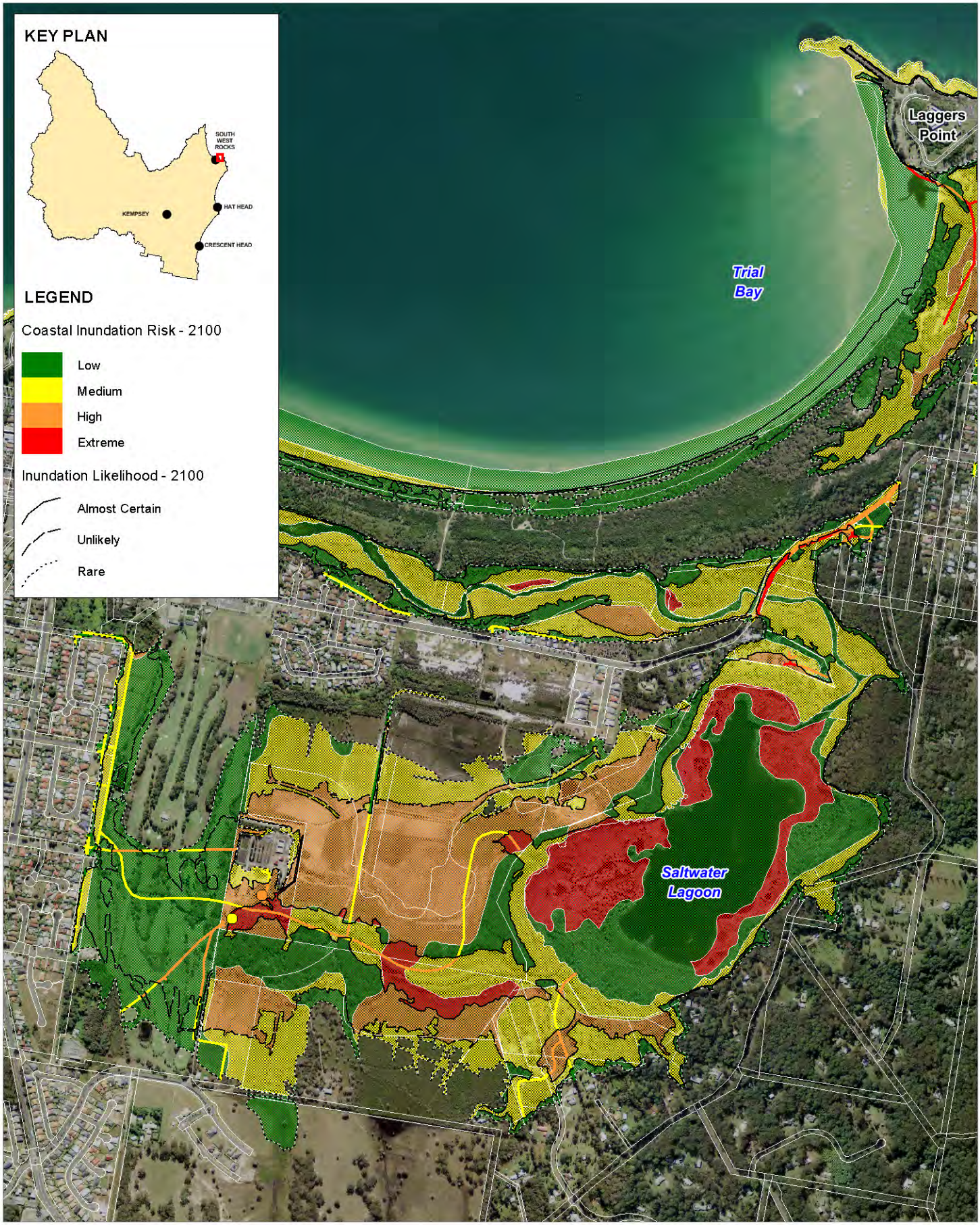

Title:

Coastal Inundation Risk Map
2100 Planning Horizon - Trial Bay

Figure: 5-26

Rev: A

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5.6 Hat Head

5.6.1 Assets at risk from coastal erosion and recession

For the immediate time frame, some water infrastructure is at intolerable risk from coastal erosion and recession threats. This includes components of the wastewater and water supply network. The consequence of erosion impacts for rising mains are considerable as the weight of overlying material on pressure pipes maintains their integrity. The consequences for pump stations are also significant as thrust restraints on pipes surrounding the pump station would be prone to failure due to erosion. Barbeque shelters and public toilets are also at risk. The remaining assets at extreme and high risk to the coastal erosion and recession threat in the immediate time frame are non-built. This includes the highly valued sandy beach areas, national park lands and some areas of Endangered Ecological Communities.

By 2050, coastal erosion and recession risk will affect built assets such as the Surf Club, caravan park and for the worst case scenario, up to 20 residential houses in the village zoning. The extent of impact to non-built assets is also increased.

At the 2100 timeframe, the Hat Head Bowling Club is also at an intolerable risk from coastal erosion and recession. The number of residential houses affected by 2100 hazards is much higher than 2050.

5.6.2 Assets at risk from coastal inundation

For the inundation hazard, the assets at intolerable risk include EEC's (with tolerance for salt and periodic inundation applied as per Table 7-8 in Appendix A, water infrastructure including the Hat Head Treatment Plant and sewage ex filtration dune disposal area and residential streets and houses.

5.6.3 Community use and access considerations

- Community and stakeholder consultation for this project revealed concerns regarding the condition of this boat ramp. In particular, it was reported that sand accumulation interferes with boat launching. Pot holes on the ramp itself were also reported. Any sand accumulation is most likely associated with the natural entrance processes of Korogoro Creek. During the incoming tide, marine waters would carry sand into the entrance and the slower velocity of the outgoing tide would result in sand dropping out of the water column and being deposited in the entrance. During large catchment rainfall events this sand would be scoured away by high velocity flood waters.
- Community consultation also raised concerns regarding beach haulage activities having impacts on beach dunes and foreshore systems at Hat Head (from the mouth of the creek to the breakout).
- More recently community sectors have indicated an interest in undertaking beach access point upgrade/rehabilitation.

5.6.4 Immediate management options for Hat Head

- Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in Council's Asset Management Plan. Account for such coastal risks when prioritising asset maintenance and replacement.
- Coastal Hazard Development Controls: Require redevelopment / renovations to be located as far landward in hazard zone as practical. Planning controls on undeveloped land in future hazard zones
- Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential Endangered Ecological Communities (EEC) mapping, and investigate options for impact mitigation and resilience building
- Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds
- Seek to have the CZMP certified by the Minister. Keep abreast of the rollout of stage 2 Coastal Reforms. This will help to establish clear direction from State Government regarding the management of coastal lands, especially regarding future hazards.
- Conduct education activities to inform the community about coastal risks
- Set aside land for future protection works
- Promote the NSW Ocean Hauling Fishery Commercial Fishers Code of Practice.
- Update information pack for recreational 4WD. Ensure all permit holders are getting the best information.
- Undertake an updated flood assessment for Hat Head/ Korogoro Creek based on the latest available OEH guidance on the interaction of elevated ocean levels and catchment flooding through the State Floodplain Management Program. This will include consideration of Rowes Cut, flood levees and choke functions.

5.6.5 Longer term considerations for Hat Head

The coastal inundation risks are most appropriately dealt with through a wider flood mitigation approach. Coastal erosion will present an intolerable risk that will need to be addressed through substantial and expensive measures. The decision will eventually come down to deciding between protection or relocation of assets. Protection may be in the form of hard structures (e.g. seawalls, groynes, offshore breakwaters / reefs, artificial headlands) or soft measures (e.g. beach nourishment). Some protection works can cause impacts to adjacent areas ('offsite impacts'), and therefore, the decision to implement a 'protect' option must consider all potential impacts. Rather than recommending an immediate management action, the focus for the CZMP will be designing a trigger level for future action. This approach effectively defers action until an area of land or an asset is approaching intolerable risk. An important component of this approach is community engagement so that when the time comes, the best decision can be made with enough lead in time to undertake appropriate assessments. Protection is a particularly costly option, both in terms of

the capital outlay (millions) and sacrifice of the sandy beach. Beach nourishment has the advantage of maintain the sandy beach, however the capital outlay is comparable to a sea wall, and at this time sand reserves are scarce. This may change in the future if offshore extraction is allowed. For a rapid assessment of some of the options available to manage coastal risk into the future at Hat Head, please refer to

5.6.6 Risk register and mapping for Hat Head

The erosion and recession risk register for Hat Head is presented in Table 5-10, and the risk register for Coastal inundation is presented in Table 5-11. The risk mapping is presented in maps Figure 5-27 to Figure 5-38

Table 5-10 Coastal Erosion and Recession Risk Register for Hat Head

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
Rural, primary production, forestry and industry										
Village	Rural zone	Medium	High	High	For 2050 it is residential land in the High risk zone, not actual houses. For 2100 24 houses fall in the High risk area to some extent.	Coastal hazard development controls: require redevelopment / renovations to be located as far landward in hazard zone as practical. Planning controls on undeveloped land in future hazard zones. This should include setting aside adequate land to allow future protection works		Undertake dune revegetation / stabilisation works to ensure vegetation on the dunes captures available sand		Protection Measures Beach nourishment Relocate Compulsory/ voluntary acquisition Rolling easement
						Positives: • Life of development may be extended. • The sandy beach is retained because it can recede. • No cost to broader public. Cost is borne by the landowner. Sets aside land for future protection works on freehold land	Negatives: • Reduced area within property boundary for development potential. • No financial or legal assurance that protection will be built in the future • If hard structures are used in the future there will be impacts on beach amenity	Positives: • In the short term this provides a store of sand to buffer from sand	Negatives: • Does not provide a solution to receding coastline over the longer term. The dunes will erode. This may form part of other longer term solutions such as beach nourishment.	
Other infrastructure / services										
Stormwater line	Stormwater infrastructure	N/a	N/a	Medium		Accept risk – risk level is considered tolerable				
Sewer line	Wastewater infrastructure	N/a	Medium	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.				Relocate Redesign
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets			
Water line	Water infrastructure	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Investigate opportunities to relocate		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets		Negatives: Relocation can be expensive and difficult given the role of gravity in water distribution	

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Transport infrastructure								
Bay st	City / village road	Low	Medium	Medium		Accept risk – risk level is considered tolerable		
Dodds st	City / village road	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Eversons ln	City / village road	N/a	N/a	Medium		Accept risk – risk level is considered tolerable		
Fern st	City / village road	N/a	N/a	Medium		Accept risk – risk level is considered tolerable		
Roads: Fern st Hat Head Hutcheson st Mason s	City / village road	N/a	Low	Medium		Accept risk – risk level is considered tolerable		
Myrtle st	City / village road	N/a	Medium	Medium		Accept risk – risk level is considered tolerable		
Roads: Perry st Straight st	City / village road	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Vine st	City / village road	N/a	Low	Medium		Accept risk – risk level is considered tolerable		
Beach vehicle access	Unsealed road	Low	Medium	Medium		Accept risk – risk level is considered tolerable		
Community infrastructure								
Hat Head holiday park	Caravan park	Medium	High	High		Coastal hazard development controls: do not allow more substantial development in the hazard zone Positives: • The sandy beach is retained because it can recede. • No cost to broader public. Cost is borne by the landowner. Negatives: • Reduced area within property boundary for development potential. •	Dune revegetation/stabilisation	Abandon / sacrifice Seawall Beach nourishment

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Cabinsx2	Community buildings	N/a	Medium	Medium		Accept risk – risk level is considered tolerable		
Amenities	Amenities / block / sheds	Low	Low	Low		Accept risk – risk level is considered tolerable		
BBQ shelter	Public recreation	N/a	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement. Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets		
Surf club	Public recreation	Medium	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement. Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent proliferating development at locations / assets that are not at risk Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Planning controls on undeveloped land in future hazard zones /require redevelopment to be located as far landward in hazard zone as practical	
Hat Head bowling and recreation club	Private recreation	N/a	Medium	High	Part of bowling green and existing building	Coastal hazard development controls: require redevelopment / renovations to be located as far landward in hazard zone as practical. This should include setting aside adequate land to allow future protection works Positives: • No cost to broader public. Cost is borne by the landowner. Negatives: • Reduced area within property boundary for development potential. • No financial or legal assurance that protection will be built in the future • If hard structures are used in the future there will be impacts on beach amenity		Relocate building landward Beach Nourishment

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
Natural assets										
Beaches • Hat Head beach • Killick beach • O'connors beach • Third beach	Beach	Extreme	Extreme	Extreme		Coastal hazard development controls: restrict future development that will prevent beach profile from receding.		Undertake dune revegetation / stabilisation works to ensure vegetation on the dunes captures available sand		Beach nourishment
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.	Positives: • In the short term this provides a store of sand to buffer from sand	Negatives: • Does not provide a solution to receding coastline over the longer term. The dunes will erode. This may form part of other longer term solutions such as beach nourishment.	
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.	Positives: • In the short term this provides a store of sand to buffer from sand	Negatives: • Does not provide a solution to receding coastline over the longer term. The dunes will erode. This may form part of other longer term solutions such as beach nourishment.	
Environmental conservation	Environmental protection zone	High	High	High		Coastal hazard development controls: restrict future development that will prevent beach profile from receding.		Undertake dune revegetation / stabilisation works to ensure vegetation on the dunes captures available sand		
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.	Positives: • In the short term this provides a store of sand to buffer from sand	Negatives: • Does not provide a solution to receding coastline over the longer term. The dunes will erode. This may form part of other longer term solutions such as beach nourishment.	
Environmental management	Environmental protection zone	Low	Medium	Medium		Accept risk – risk level is considered tolerable				
Hat Head national park	Parks, reserves and open space	High	High	High		Inform the national parks and wildlife service of this risk rating				
EECs: subtrop_co & freshwater & themeda	Potential EEC (low tolerance)	N/a	N/a	Medium		Accept risk – risk level is considered tolerable				
Freshwater wetlands on coastal floodplains	Potential EEC (low tolerance)	N/a	High	High		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building		Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds		

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
						Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Positives • Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards	Negatives • Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	
EECs: Littoral rainforest Themeda grassland on seacliffs/coastal	Potential EEC (low tolerance)	Extreme	Extreme	Extreme		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building		Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds		
						Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Positives • Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards	Negatives Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	
						Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Positives • Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards	Negatives Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	
Waterways										
Korogoro creek	Natural waterway	High	High	High						

Table 5-11 Coastal Inundation Risk Register for Hat Head

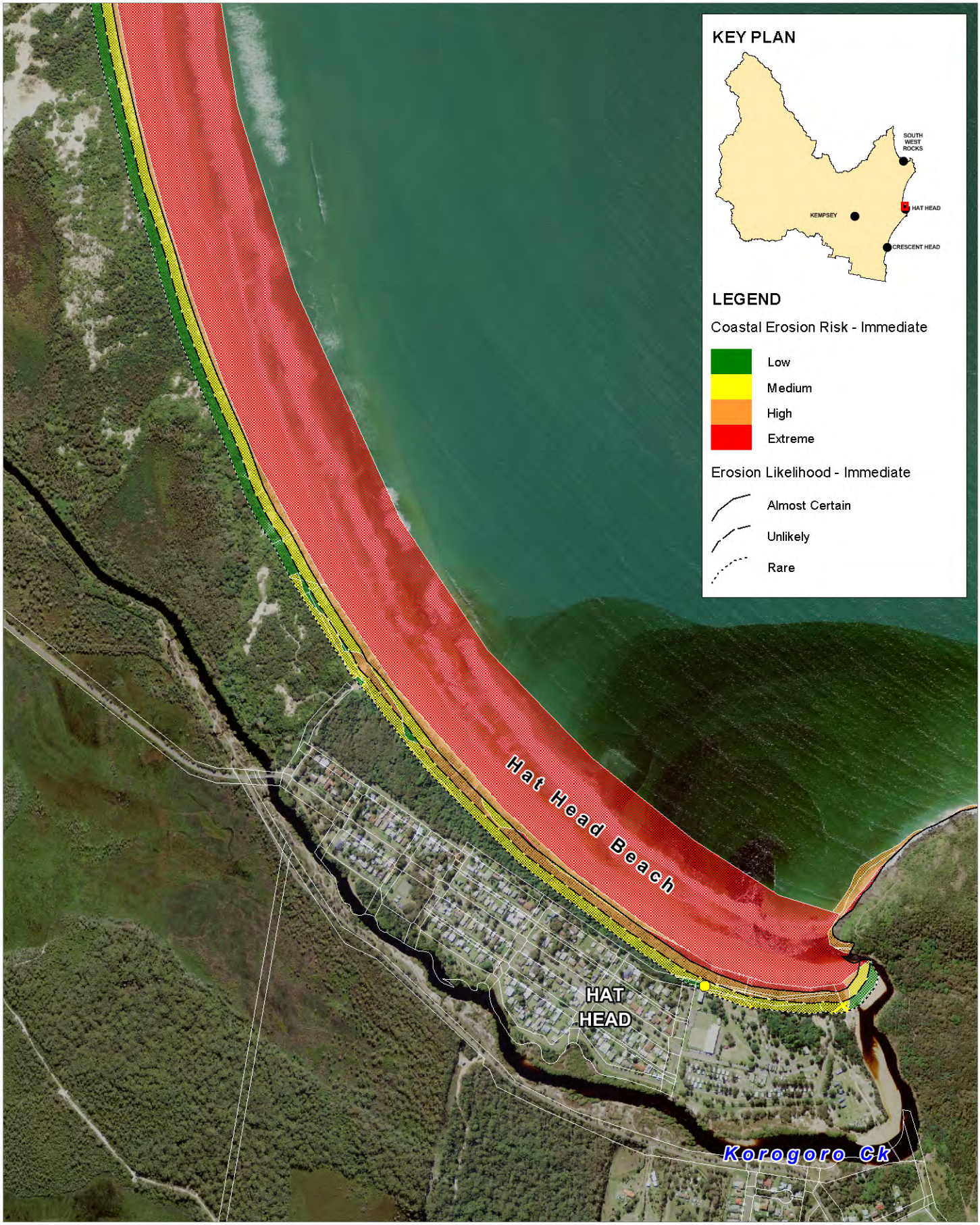
Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Rural, primary production, forestry and industry								
Primary production	Rural zone	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Rural landscape	Rural zone	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Village	Rural zone	High	High	High	While areas of land zoned village are at high risk, there are no existing dwellings at high risk over the time period.	Manage through flood program - ensure sea level rise is considered in flood planning. Undertake an updated flood assessment for Hat Head / Korogoro Creek based on the latest available OEH guidance on the interaction of elevated ocean levels and catchment flooding through the State Floodplain Management Program. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Other infrastructure / services								
Stormwater line	Stormwater infrastructure	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement. Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	
Sewer line	Wastewater infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.	Manage through flood program - ensure sea level rise is considered in flood planning.	

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Water line	Water infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
KSC Hat Head Town reservoir	Water infrastructure	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Infrastructure	Infrastructure zoned land	Low	Low	Low		Accept risk – risk level is considered tolerable				
Transport infrastructure										
Roads: Myrtle st Perry st Ward st Gap Rd Creek s Dodds stt	City / village road	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes Ensures funds are not ill spent at locations / assets that are not at risk	Negatives Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Roads: Gladstone st Hutcheson st Ledge st Les Dunford rd Marlin cct Mason st Bay st Boronia st Bream st Eversons ln Fern st Oak st Schnapper cl Straight st Vine st	City / village road	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Roads Home st Mowong cl	City / village road	Low	Medium	Medium		Accept risk – risk level is considered tolerable		
Hat Head rd	Major road	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement. Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	
Pathway	Unclassified road	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Beach vehicle access	Unsealed road	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Community infrastructure								
Hat Head holiday park	Caravan park	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Hat Head bowling and recreation club	Private recreation	Low	Low	Low		Accept risk – risk level is considered tolerable		

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Hat Head tennis club	Private recreation	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Hat Head SLSC	SLSC	Low	Low	Low		Accept risk – risk level is considered tolerable		
Natural assets								
Beaches: • Hat Head	Beach	Low	Low	Low		Accept risk – risk level is considered tolerable		
Environmental conservation	Environmental protection zone	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Hat Head national park	Parks, reserves and open space	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
EECs: Freshwater Wetland Themeda Grassland on Headland Sub-tropical Coastal Floodplain Forest Littoral rainforest	Potential EEC (low tolerance)	Extreme	Extreme	Extreme		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised	Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	
Coastal saltmarsh	Potential EEC (medium tolerance)	High	High	High		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised	Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	
Waterways								
Korogoro creek	Natural waterway	Low	Low	Low		Accept risk – risk level is considered tolerable		
Community infrastructure								

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Amenities	Amenities / block / sheds	Low	Low	Low		Accept risk – risk level is considered tolerable		
Toilets	Amenities / block / sheds	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Hat Head b.f.s.	Bfs	High	High	High				
Cabinsx2	Community buildings	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Kiosk	Community buildings	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
BBQ shelter	Public recreation	N/a	Low	Low		Accept risk – risk level is considered tolerable		
Tennis club	Public recreation	Low	Low	Low		Accept risk – risk level is considered tolerable		



Title:

Erosion and Recession Risk Map
Immediate Planning Horizon - Hat Head

Figure: 5-27

Rev: A

N

0 250 500m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

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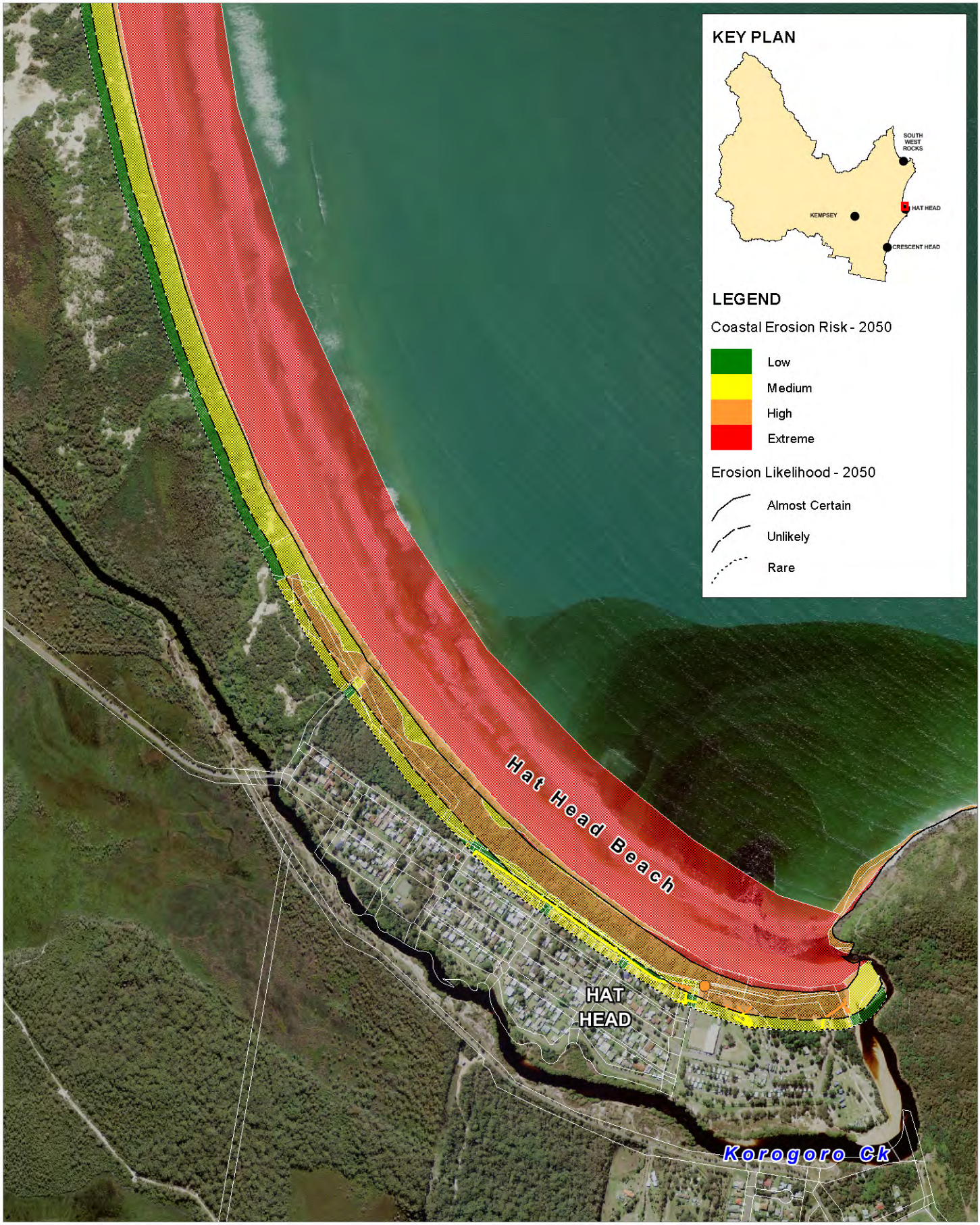

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Erosion and Recession Risk Map 2050 Planning Horizon - Hat Head

Figure: 5-28

Rev: A

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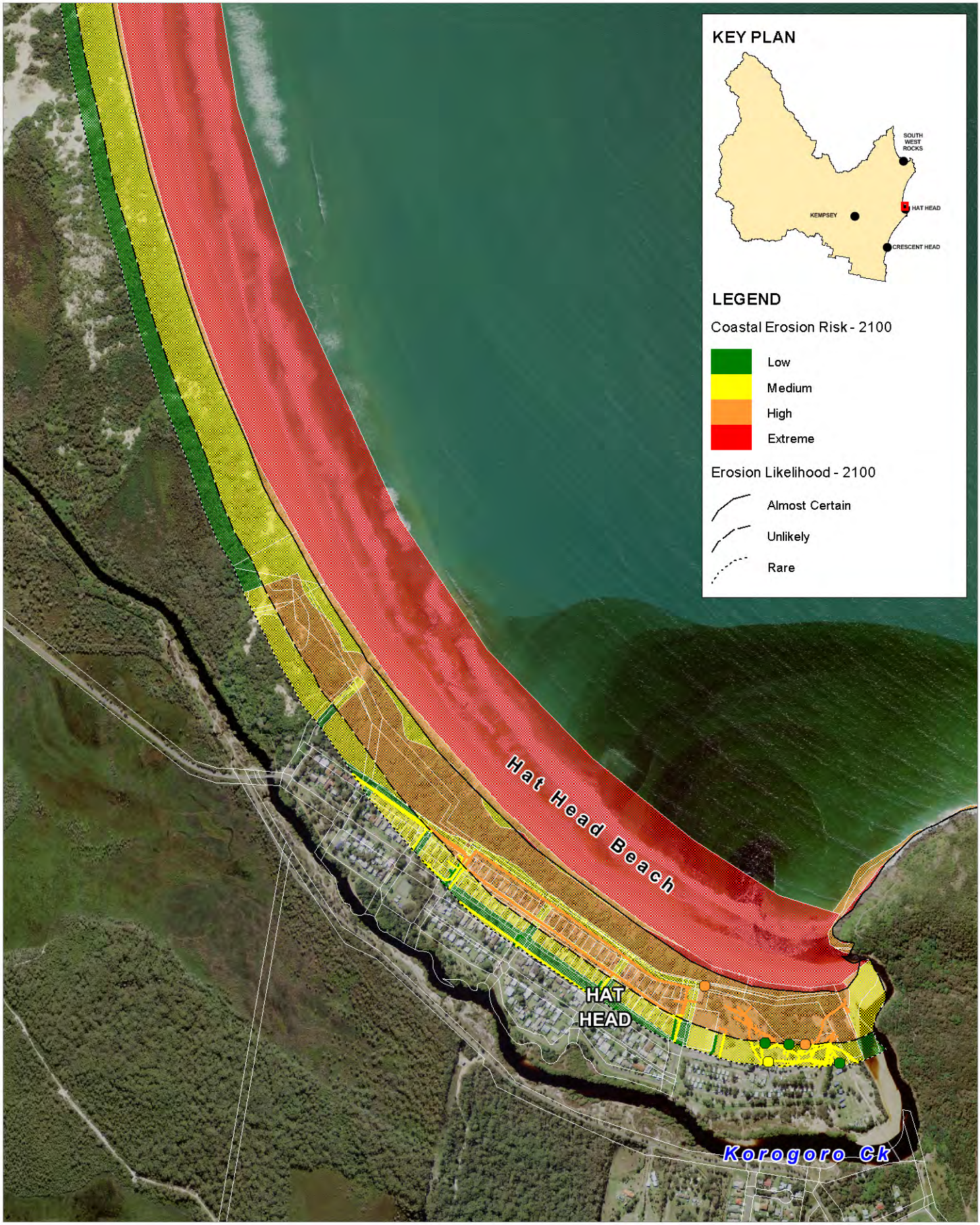

Title:

Erosion and Recession Risk Map 2100 Planning Horizon - Hat Head

Figure: 5-29

Rev: A

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Approx. Scale

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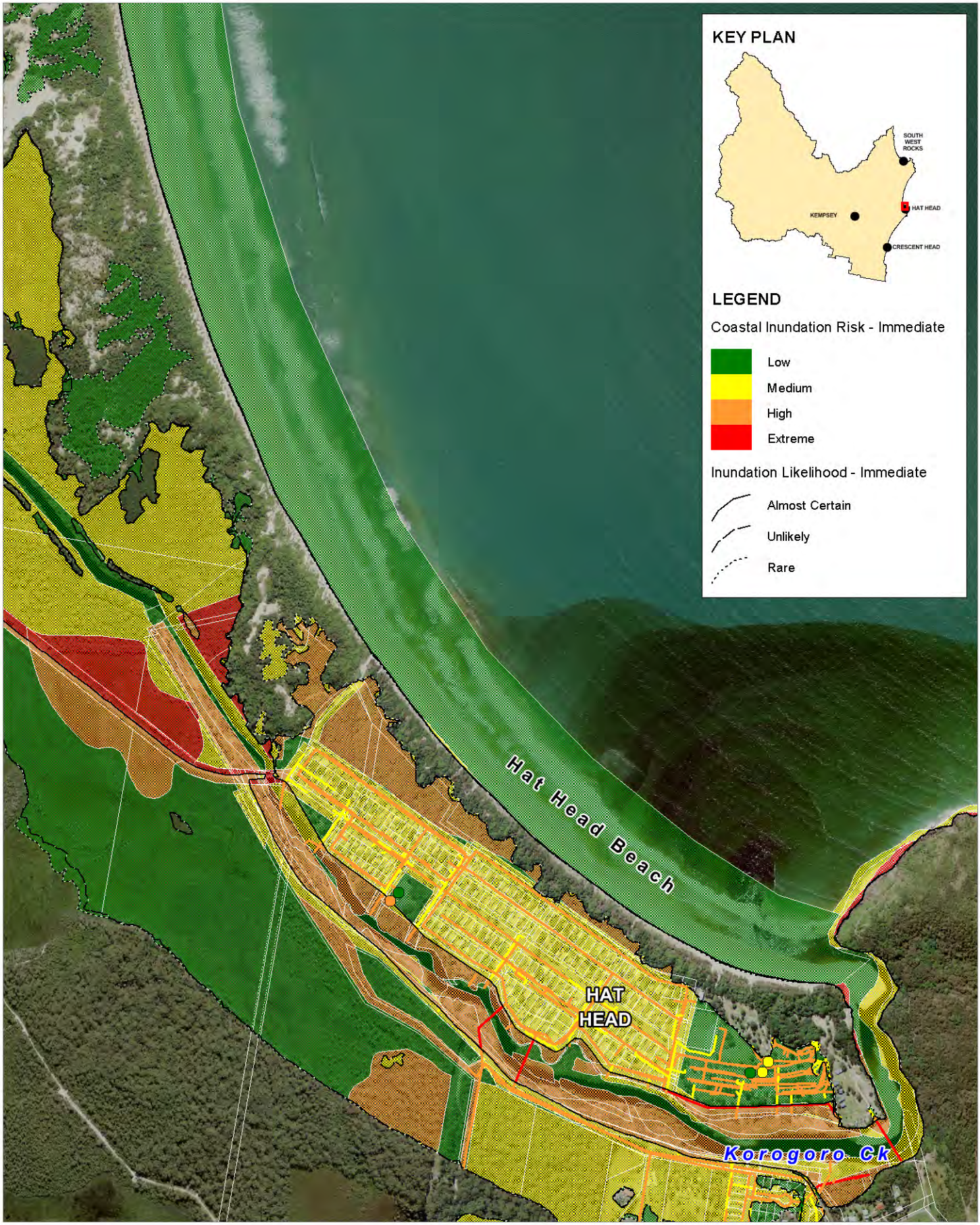

Title:

Coastal Inundation Risk Map
Immediate Planning Horizon - Hat Head

Figure: 5-30

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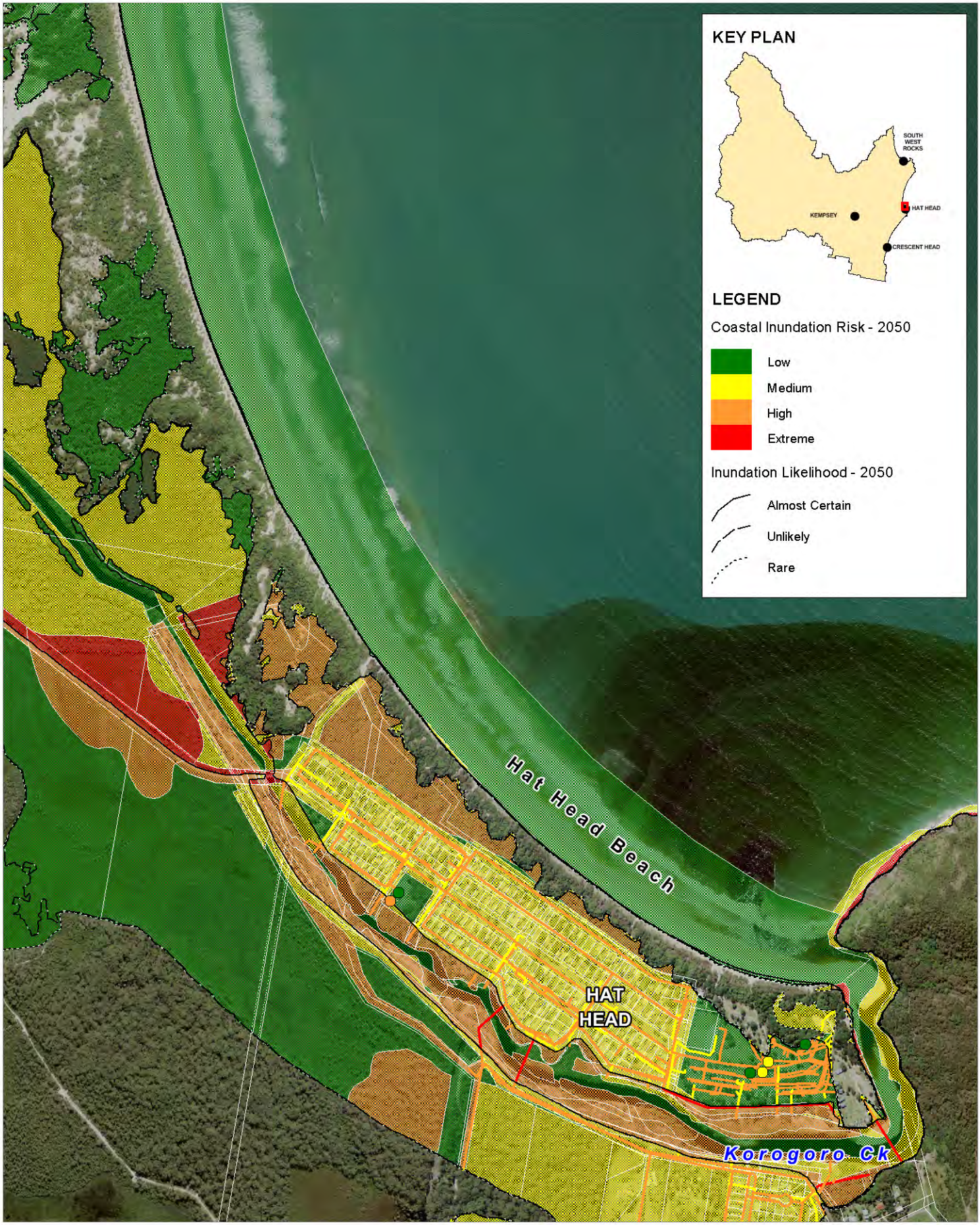

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Coastal Inundation Risk Map
2050 Planning Horizon - Hat Head

Figure: 5-31

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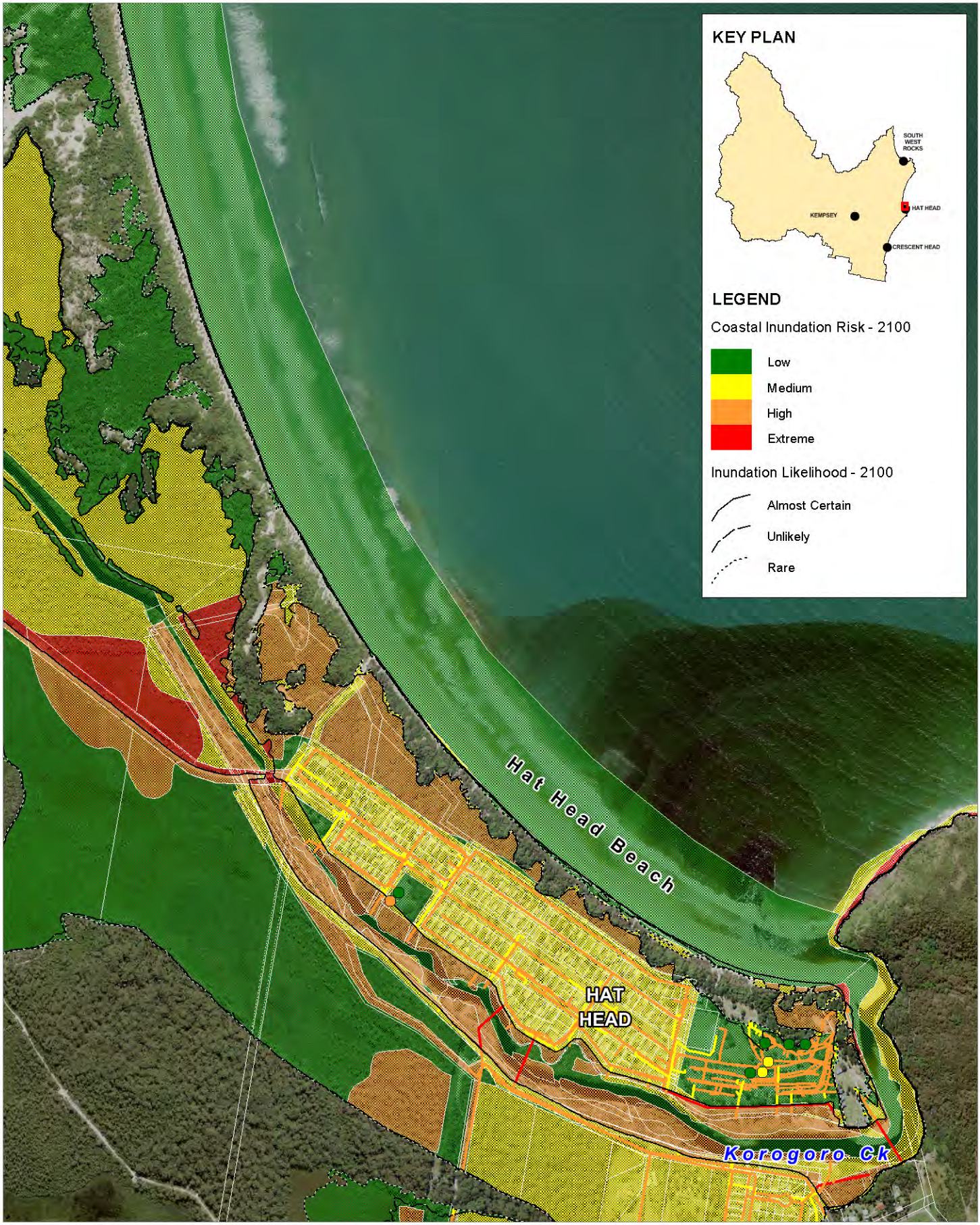

Title:

Coastal Inundation Risk Map
2100 Planning Horizon - Hat Head

Figure: 5-32

Rev: A

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Approx. Scale

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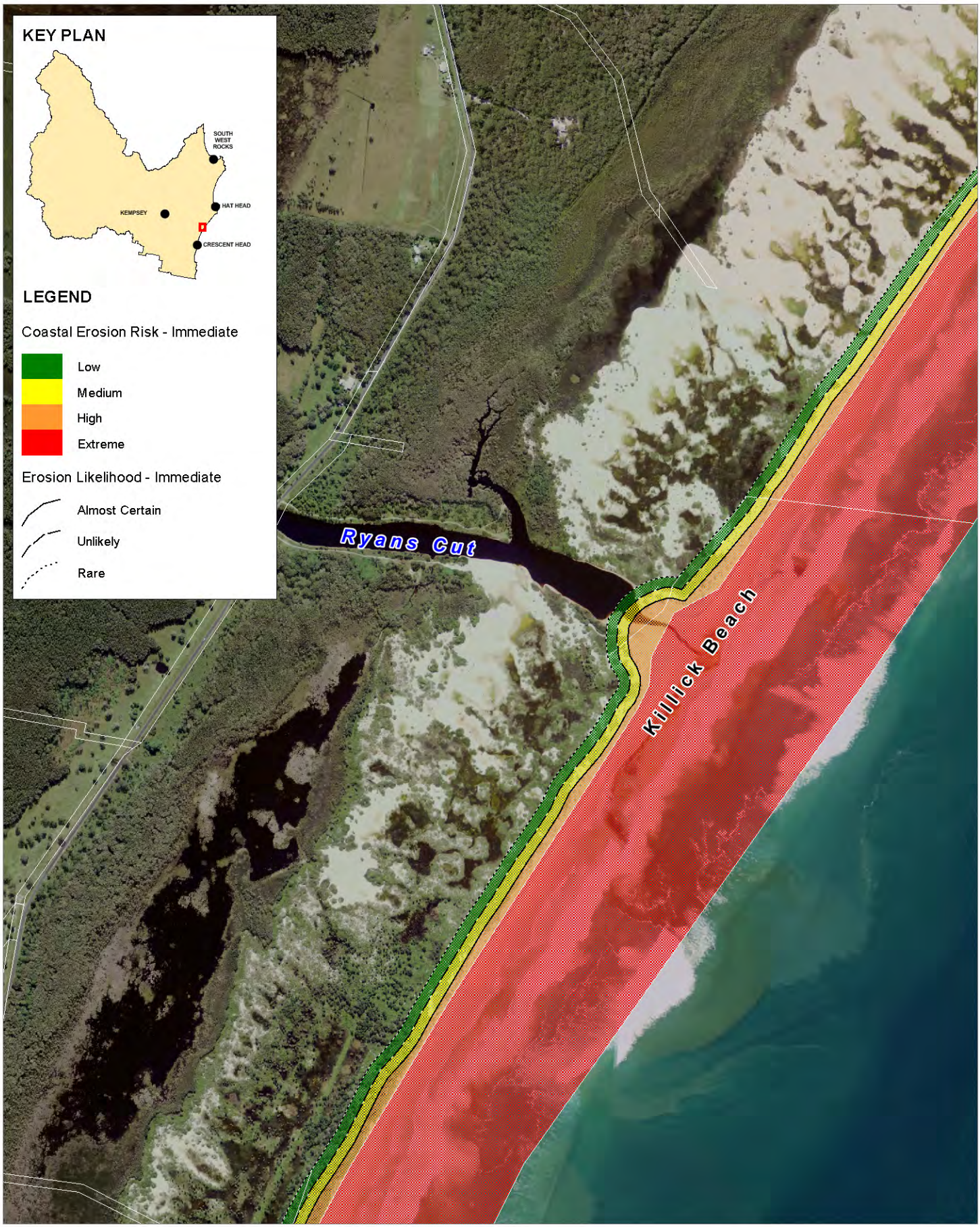

Title:

Erosion and Recession Risk Map
Immediate Planning Horizon - Ryans Cut

Figure: 5-33

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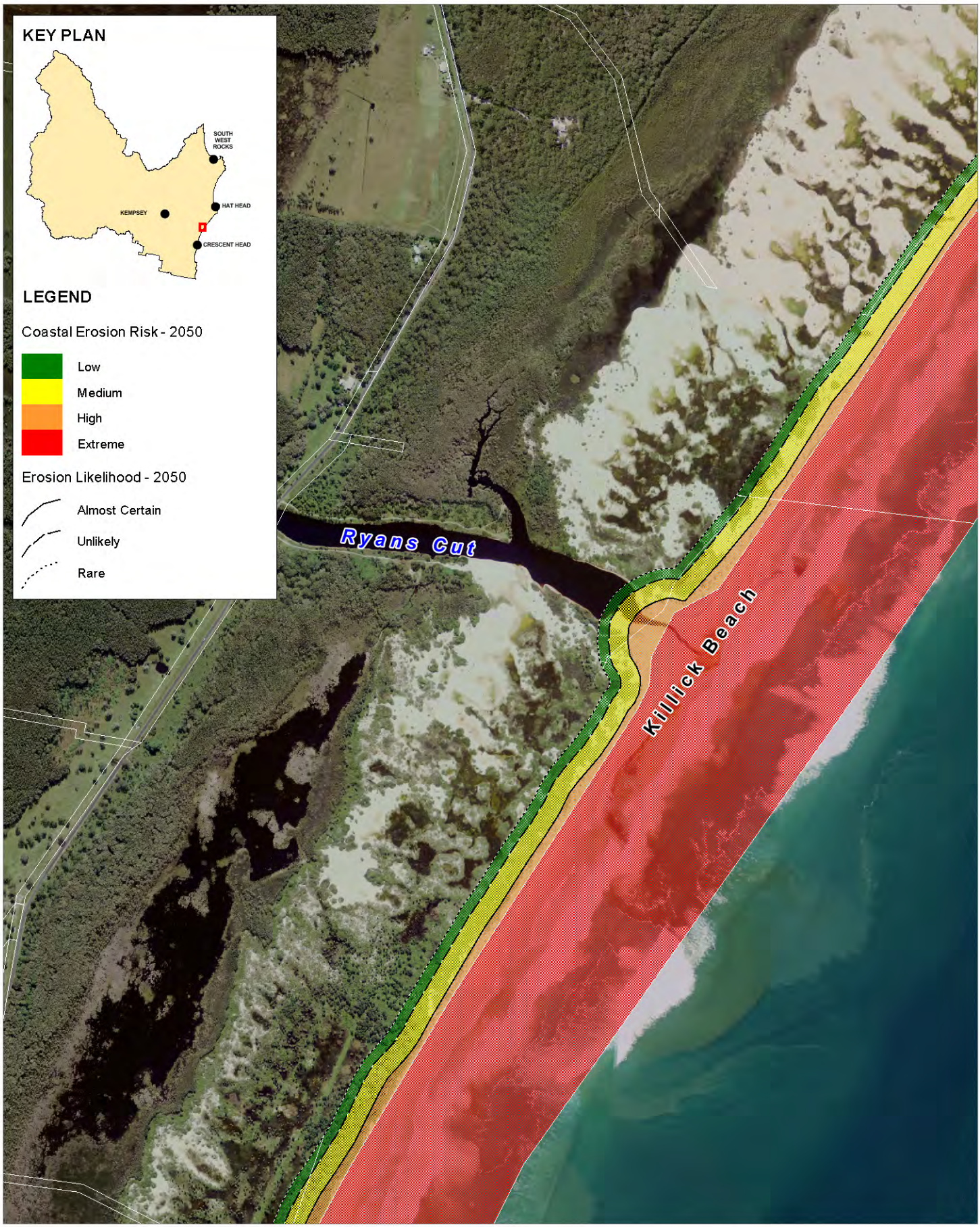

Title:

Erosion and Recession Risk Map
2050 Planning Horizon - Ryans Cut

Figure: 5-34

Rev: A

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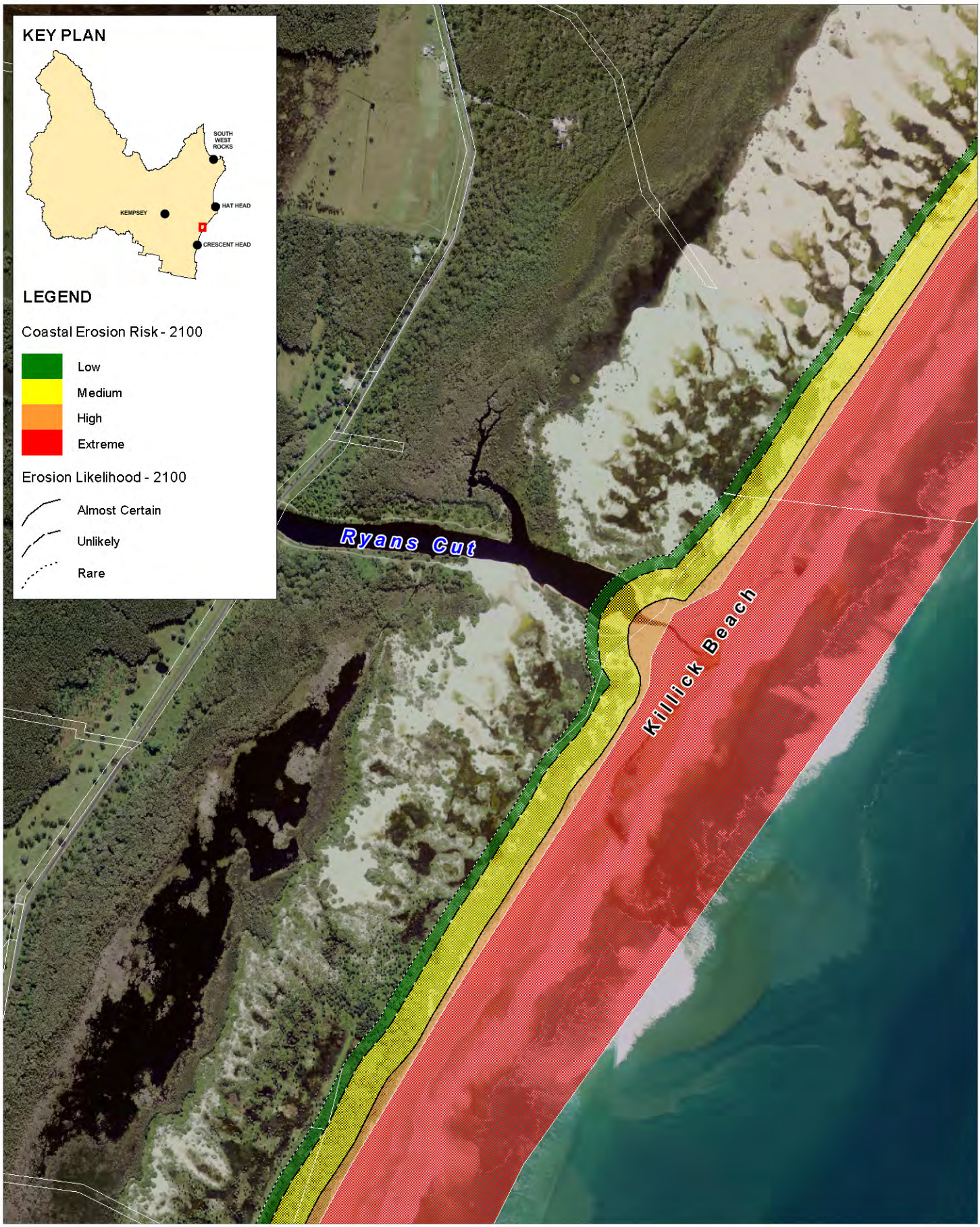

Title:

Erosion and Recession Risk Map
2100 Planning Horizon - Ryans Cut

Figure: 5-35

Rev: A

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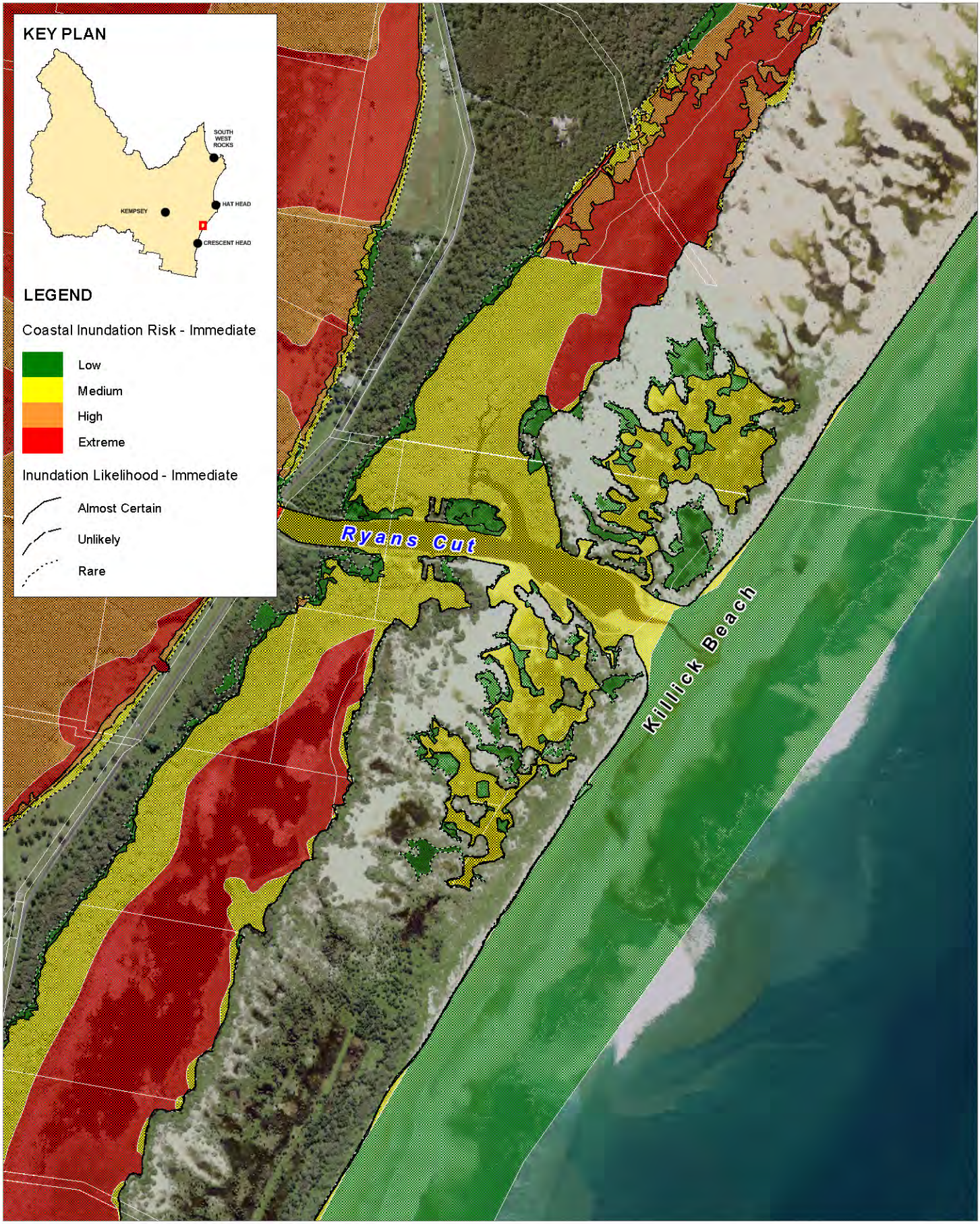

Title:

Coastal Inundation Risk Map
Immediate Planning Horizon - Ryans Cut

Figure: 5-36

Rev: A

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Approx. Scale

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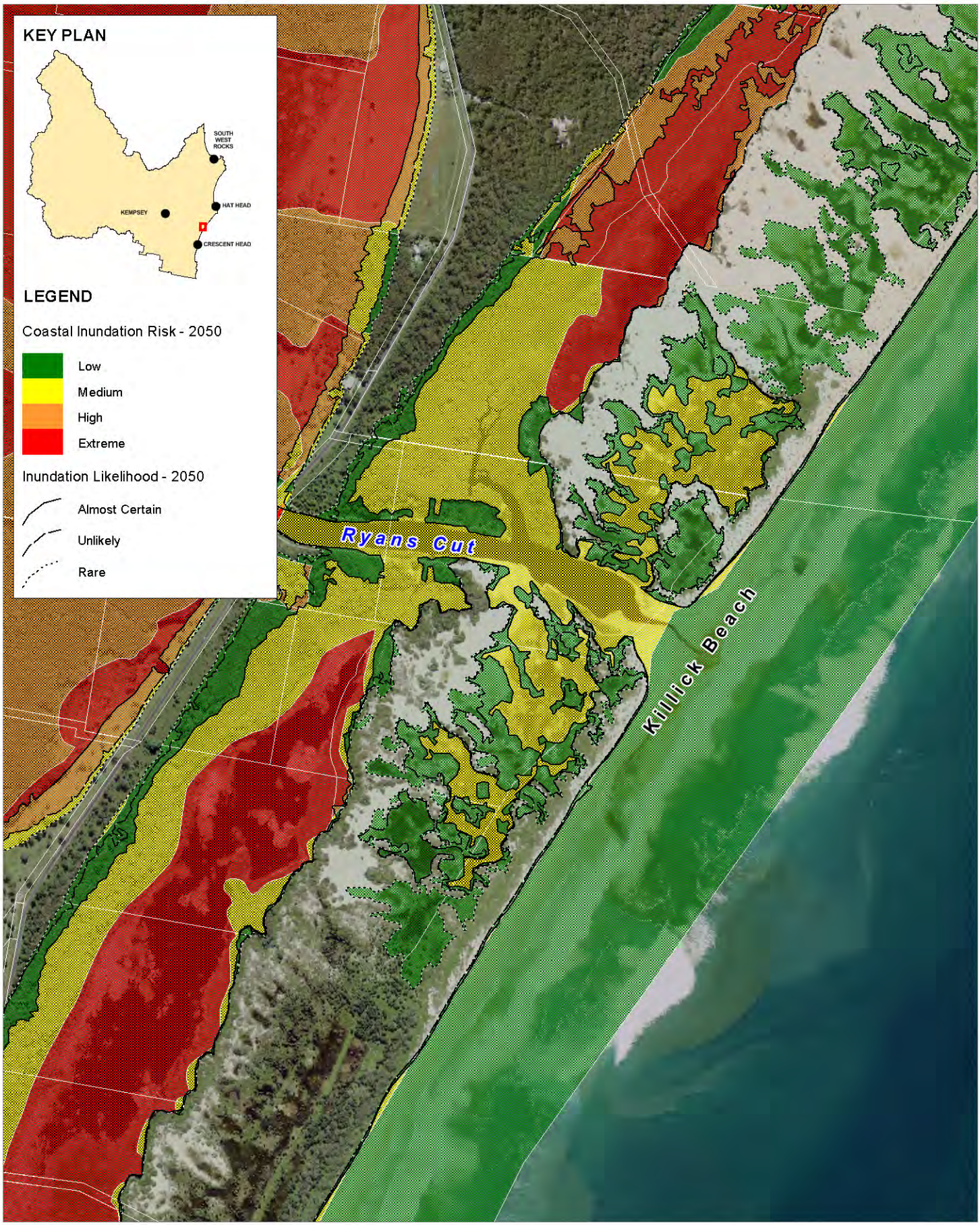

Title:

Coastal Inundation Risk Map
2050 Planning Horizon - Ryans Cut

Figure: 5-37

Rev: A

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Approx. Scale

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www.bmtwbm.com.au

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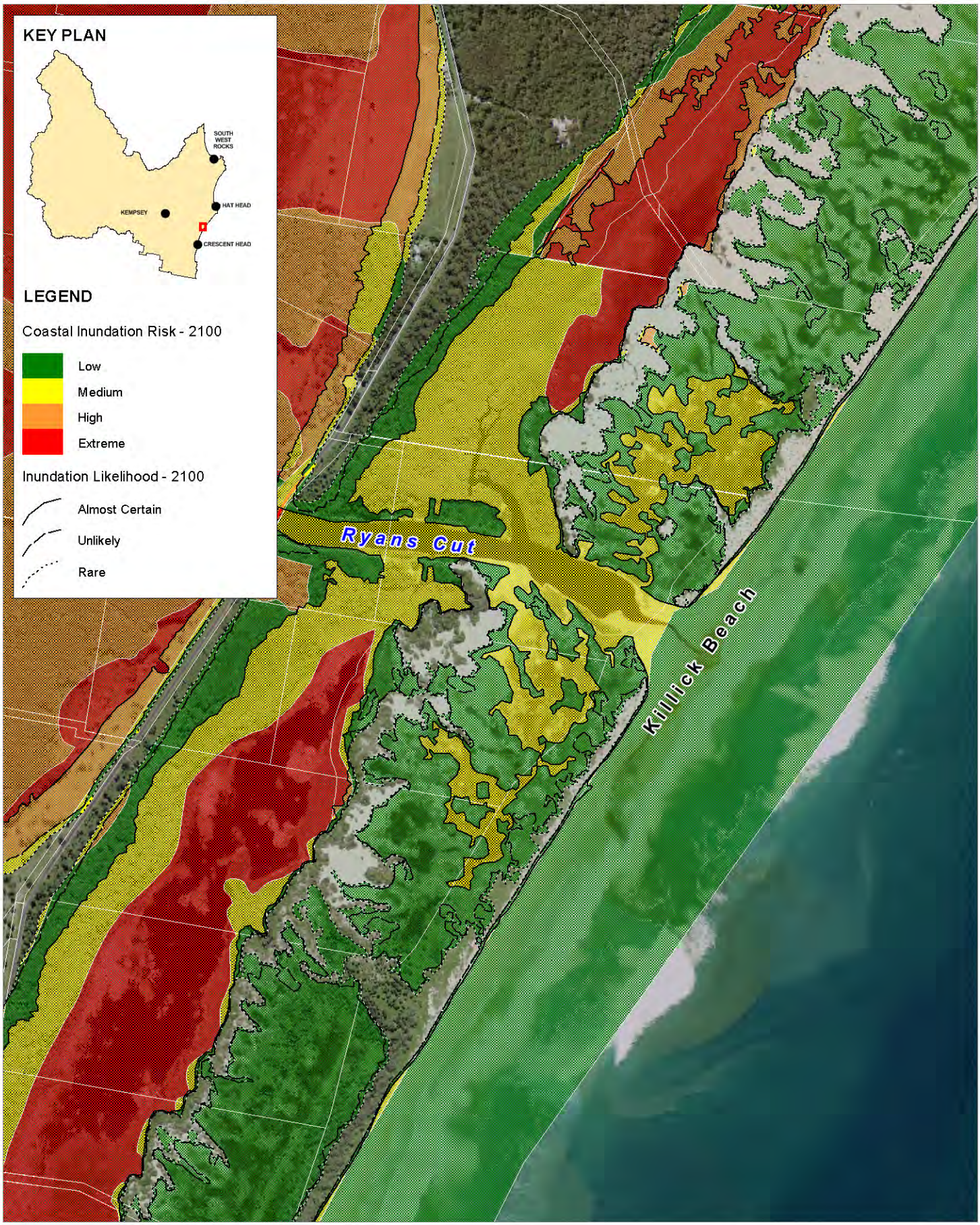

Title:

Coastal Inundation Risk Map
2100 Planning Horizon - Ryans Cut

Figure: 5-38

Rev: A

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Approx. Scale

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5.7 Crescent Head, Delicate Nobby and Big Hill Cut

5.7.1 Assets at risk from coastal erosion and recession

Crescent Head has considerable natural assets at intolerable risk from the coastal erosion threat. This includes the iconic beaches of Barrier Bay Beach, Delicate Nobby Beach, Goolawah Beach, Killick Beach, Point Plomer Beach and Racecourse Beach. There are also areas of parks, reserves and open space that include EEC vegetation along this coastline.

In terms of built assets, the Crescent Head Holiday Park is in the extreme category for all three time periods. The existing rock wall protection would in part form a control to this erosion risk. Behind the caravan park is the Crescent Head Country Golf Club and part of this parcel (although it is the bowling green not the club building) is rated as being in the extreme risk category.

5.7.2 Assets at risk from coastal inundation

There is a large area covered by the inundation hazard mapping in and around Crescent Head. In terms of the coastal inundation risk, there are a number of roads for which inundation poses an intolerable risk. These include Point Plomer Road, Crescent Head Road and Pacific Street. Birralee Hall in Crescent Head is also ranked as a high risk asset. There are large lot residential areas associated with Killick Creek and also privately owned rural landscape areas identified as high risk. Water infrastructure including the water supply line, sewerage and pump stations are at an intolerable risk level. There are areas mapped as potentially containing low tolerance EECs.

5.7.3 Community use and access considerations

- Natural wear-and-tear and changes in user needs and demands require upgrade to facilities at key locations such as Crescent Head. The relatively untouched nature of Kempsey's coastline is an important aspect to consider in the scale and design of structures and facilities on the coast.
- Access to Killick Beach is safest via a wooden walkway across Killick Creek, around 200 m upstream from the SLSC. A set of stairs adjacent to the SLSC provides access to the creek entrance. Storms in early 2013 caused erosion of the dune in the vicinity of the walkway and along the beach front.
- In certain north west wind and storm events, large quantities of 'red weed' can wash up on Crescent Head Beach. These events can result in impacts to community amenity and possibly fish kills. Research into this issue was undertaken by the Kempsey Coastal and Estuary Committee and a brochure prepared.
- Killick Beach has been rated as Poor in the Beach watch programs long-term assessment of suitability for swimming. This is the only Ocean beach monitoring site in the Kempsey Local Government Area that has received this rating. The estuarine site within Killick Creek was also rated poor.
- Management of the Kempsey coastal zone in the undeveloped southern area is shared between National Parks, Crown Land and Kempsey Shire Council. In some locations, the division of responsibilities can be complicated by National Park dunes fronting Council managed beaches adjoined by Crown Land headlands or shore side islands. Access and use of lands

can be different under the different management regimes, and signage along the coastal zone can be difficult to understand regarding permitted use and access.

5.7.4 Immediate management options for Crescent Head

- Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in Council's Asset Management Plan. Account for such coastal risks when prioritising asset maintenance and replacement.
- Coastal Hazard Development Controls: Require redevelopment / renovations to be located as far landward in hazard zone as practical. Planning controls on undeveloped land in future hazard zones
- Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential Endangered Ecological Communities (EEC) mapping, and investigate options for impact mitigation and resilience building
- Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds
- Coordination of management for the intertidal zone and dunes through an MoU (both Council and NP officers to have authority to undertake compliance actions)
- Support the recognition of Point Plomer as an Aboriginal Place.
- Work with the Aboriginal Community to develop a plan for responding to uncovering of important items during coastal storms. Low cost and having a plan in place will allow timely decisive action if exposure happens. Unable to provide preventative / pre-emptive asset management, as assets may not be found until impacts occur.
- Undertake an updated flood assessment for Killick Creek based on the latest available OEH guidance on the interaction of elevated ocean levels and catchment flooding through the State Floodplain Management Program. This will include consideration of Rowes Cut, flood levees and choke functions.

5.7.5 Longer term considerations for Crescent Head

An assessment of the existing wall structure near the Crescent Head Holiday Park and its adequacy and functional life will need to be undertaken to get a better understanding of risk.

5.7.6 Risk register and mapping for Crescent Head

The erosion and recession risk register for Crescent Head is presented in Table 5-12, and the risk register for Coastal inundation is presented in Table 5-13. The risk mapping is presented in maps Figure 5-39 to Figure 5-44.

Table 5-12 Coastal Erosion and Recession Risk Register for Crescent Head

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Rural, primary production, forestry and industry								
Rural landscape	Rural zone	High	High	High				
Other infrastructure / services								
Stormwater line	Stormwater infrastructure	Low	Low	Medium		Accept risk – risk level is considered tolerable		
Sewer line	Wastewater infrastructure	Medium	Medium	Medium		accept risk – risk level is considered tolerable		
Water line	Water infrastructure	Medium	Medium	Medium		accept risk – risk level is considered tolerable		
Transport infrastructure								
Reserve rd crescent hd	City / village road	N/a	Low	Low		Accept risk – risk level is considered tolerable		
Roads: Back beach rd Point Plomer rd	Unsealed road	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Crown	Unsealed road	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Community infrastructure								
Crescent Head slsc	SLSC	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Cabins x8	Community buildings	N/a	Medium	Medium		Accept risk – risk level is considered tolerable		
Amenities	Amenities / block / sheds	N/a	Low	Low		Accept risk – risk level is considered tolerable		
Toilet	Amenities / block / sheds	N/a	N/a	Medium		Accept risk – risk level is considered tolerable		

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Crescent Head country club	Public recreation	N/a	Medium	Medium		Accept risk – risk level is considered tolerable		
Crescent Head country golf club	Public recreation	High	High	High	Bowling green in hazard area	Coastal hazard development controls: require redevelopment / renovations to be located as far landward in hazard zone as practical. This should include setting aside adequate land to allow future protection works Positives: • No cost to broader public. Cost is borne by the landowner. Negatives: • Reduced area within property boundary for development potential. • No financial or legal assurance that protection will be built in the future • If hard structures are used in the future there will be impacts on beach amenity		
Crescent Head holiday park	Public recreation	High	High	High		Assess adequacy and remaining functional life of existing protection works to accurately assess risk		
Crescent Head tennis courts	Public recreation	N/a	Low	Low		Accept risk – risk level is considered tolerable		
Public recreation	Public recreation	High	High	High		Coastal hazard development controls: restrict future development that will prevent beach profile from receding. Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential Negatives: • Reduced area within property boundaries for development potential.		
B.b.q shelter	Public recreation	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Surf club	Public recreation	N/a	Medium	Medium		Accept risk – risk level is considered tolerable		
Crescent Head car park	Car park	Low	Low	Low		Accept risk – risk level is considered tolerable		
Natural assets								

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
Beaches • Barrier bay • Delicate nobby • Goolawah • Killick beach • Point plomer beach • Racecourse beach	Beach	Extreme	Extreme	Extreme		Coastal hazard development controls: restrict future development that will prevent beach profile from receding.		Undertake dune revegetation / stabilisation works to ensure vegetation on the dunes captures available sand		
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.	Positives: In the short term this provides a store of sand to buffer from sand	Negatives: Does not provide a solution to receding coastline over the longer term. The dunes will erode. This may form part of other longer term solutions such as sand nourishment.	
Environmental living	Environmental protection zone	N/a	N/a	Low		Accept risk – risk level is considered tolerable				
Environmental management	Environmental protection zone	High	High	High		Coastal hazard development controls: restrict future development that will prevent beach profile from receding.				
						Positives: • No cost to broader public • Prioritises maintenance of the rugged coastline and associated tourism potential	Negatives: • Reduced area within property boundaries for development potential.			
Goolawah national park Goolawah regional park Hat Head national park Limeburners creek national park	Parks, reserves and open space	High	High	High		Inform the national parks and wildlife service of this risk rating				
EEC's Littoral rainforest themeda grassland on seacliffs/coastal headlands Sub-tropical Coastal Floodplain Forest	Potential EEC (low tolerance)	Extreme	Extreme	Extreme		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building		Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds		
						Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Positives • Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards	Negatives Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
Coastal saltmarsh	Potential EEC (medium tolerance)	Medium	High	High		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds Positives • Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards	Negatives Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	
Waterways										
Killick creek	Natural waterway	High	High	High						

Table 5-13 Coastal Inundation Risk Register for Crescent Head

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Residential, town centre and business								
Local centre	Local centre	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
General residential	Residential zone	N/a	Low	Medium		Accept risk – risk level is considered tolerable		
Large lot residential	Residential zone	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Medium density residential	Residential zone	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Rural, primary production, forestry and industry								
Primary production	Rural zone	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Primary production small lots	Rural zone	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Rural landscape	Rural zone	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning.		

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
						Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk				
Other infrastructure / services										
Sewer line	Wastewater infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	
Ksc pump cres - sewer south, pump stn c1	Wastewater infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	
Ksc pump cres - sewer south, pump stn c2	Wastewater infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	
Ksc treatment ch - sewer south, cres hd treat wor*	Wastewater infrastructure	Medium	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
Pumphouse	Wastewater infrastructure	N/a	Medium	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Water line	Water infrastructure	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Chwtw	Water infrastructure	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Pumphouse	Water infrastructure	N/a	N/a	Medium		Accept risk – risk level is considered tolerable				
Stormwater line	Stormwater infrastructure	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		

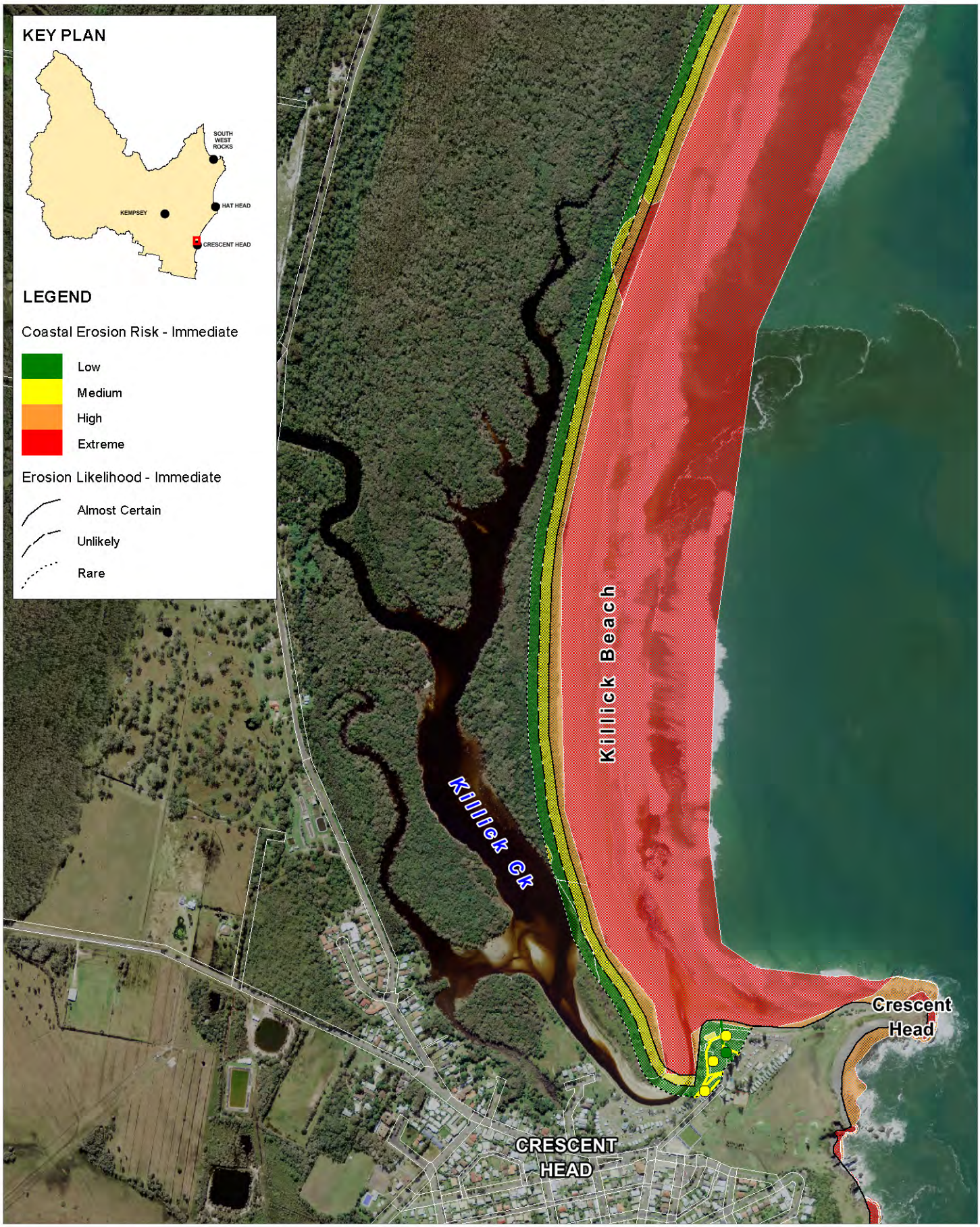
Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Ksc ryans cut - loftus rd	Flood infrastructure	Low	Low	Low		Accept risk – risk level is considered tolerable		
Infrastructure	Infrastructure zoned land	Low	Low	Low		Accept risk – risk level is considered tolerable		
Transport infrastructure								
Allman pl	City / village road	N/a	N/a	Medium		Accept risk – risk level is considered tolerable		
Baker dr	City / village road	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Roads: Belmore st crescent hd Lake st Lee st Point Plomer Rd Willow st	City / village road	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement. Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk	
Charles parry st	City / village road	N/a	Low	Medium		Accept risk – risk level is considered tolerable		
Roads: High st crescent hd Killuke cres Walker st	City / village road	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Reserve rd crescent hd	City / village road	N/a	Medium	Medium		Accept risk – risk level is considered tolerable		
Richard elrington st	City / village road	N/a	N/a	Medium		Accept risk – risk level is considered tolerable		
Roads: Crescent Head rd Pacific st crescent hd	Major road	Extreme	Extreme	Extreme		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.	Manage through flood program - ensure sea level rise is considered in flood planning.	

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Belmore st crescent hd	Rural road	Low	Medium	Medium		Accept risk – risk level is considered tolerable				
Roads: Loftus rd Maria river rd	Rural road	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Roads: Beranghi rd Maria river rd Nevertire rd Paperbark ln Point plomer rd Richardsons crossing Robinsons access Southern trail Unnamed	Unsealed road	High	High	High		Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in council's asset management plan. Account for such coastal risks when prioritising asset maintenance and replacement.		Manage through flood program - ensure sea level rise is considered in flood planning.		
						Positives: • Enables coastal hazard to be flagged in council's decision making processes • Ensures funds are not ill spent at locations / assets that are not at risk	Negatives • Cost and resources associated with assessment and documentation, as well as periodic follow-up to capture triggers for future decision making regarding the assets	Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Berrys ln	Unsealed road	Low	Medium	Medium		Accept risk – risk level is considered tolerable				

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Community infrastructure								
Crescent Head car park	Car park	Low	Low	Low		Accept risk – risk level is considered tolerable		
Crescent Head country club	Public recreation	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Crescent Head country golf club	Public recreation	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Crescent Head holiday park	Public recreation	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Public recreation	Public recreation	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Crescent Head SLSC	SLSC	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Amenities	Amenities / block / sheds	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Cabins x8	Community buildings	N/a	Low	Medium		Accept risk – risk level is considered tolerable		
Hall	Community buildings	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Pavillion	Community buildings	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
B.B.Q shelter	Public recreation	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Pool& amenities	Public recreation	N/a	N/a	Low		Accept risk – risk level is considered tolerable		
Heritage								

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)	Preferred option 2 (implement over next 5-10 years)	Other options considered but not recommended * (reconsider after 5 – 10 years)
Allman rowe grave in Crescent Head cemetery	Heritage item (local)	N/a	Low	Medium		Accept risk – risk level is considered tolerable		
Birralee hall 1850286	Heritage item (local)	High	High	High		Manage through flood program - ensure sea level rise is considered in flood planning. Positives • Impacts of elevated ocean levels on flooding extents associated with catchment runoff will give the most accurate indication of inundation risk		
Ruins of gordon's gaol	Heritage item (local)	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Natural assets								
Beaches: Barrier bay beach Delicate nobby beach Goolawah beach Killick beach Point plomer beach Racecourse beach	Beach	Low	Low	Low		Accept risk – risk level is considered tolerable		
Environmental conservation	Environmental protection zone	Medium	Medium	Medium		Accept risk – risk level is considered tolerable		
Reserve behind charles parry st	Parks, reserves and open space	N/a	Low	Low		Accept risk – risk level is considered tolerable		
EECs: subtrop coastal floodplain Freshwater	Potential EEC (low tolerance)	Extreme	Extreme	Extreme		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building	Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds	

Asset name	Asset type	2014	2050	2100	D'script.	Preferred option 1 (implement over next 5-10 years)		Preferred option 2 (implement over next 5-10 years)		Other options considered but not recommended * (reconsider after 5 – 10 years)
wetland Littoral rainforest Sub-tropical coastal floodplain Swamp sclerophyll forest Themada grassland on headland						Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Positives Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards	Negatives Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	
Coastal saltmarsh Swamp oak floodplain forest	Potential EEC (medium tolerance)	High	High	High		Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building		Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds		
						Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Positives Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards	Negatives Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	
						Positives • Holistic approach to EEC conservation and management into the future • Accurate mapping ensures that land is not unnecessarily sterilised		Positives Resilience building in vulnerable vegetation communities' may increase survival and migration in response to coastal hazards	Negatives Care needs to be taken to ensure resources are not prioritised in communities unlikely to survive sea level rise	
Waterways										
Creeks: Connection creek Killick creek	Natural waterway	Low	Low	Low		Accept risk – risk level is considered tolerable				



Title:

Erosion and Recession Risk Map
Immediate Planning Horizon - Crescent Head

Figure: 5-39

Rev: A

N

0 250 500m

Approx. Scale

BMT WBM
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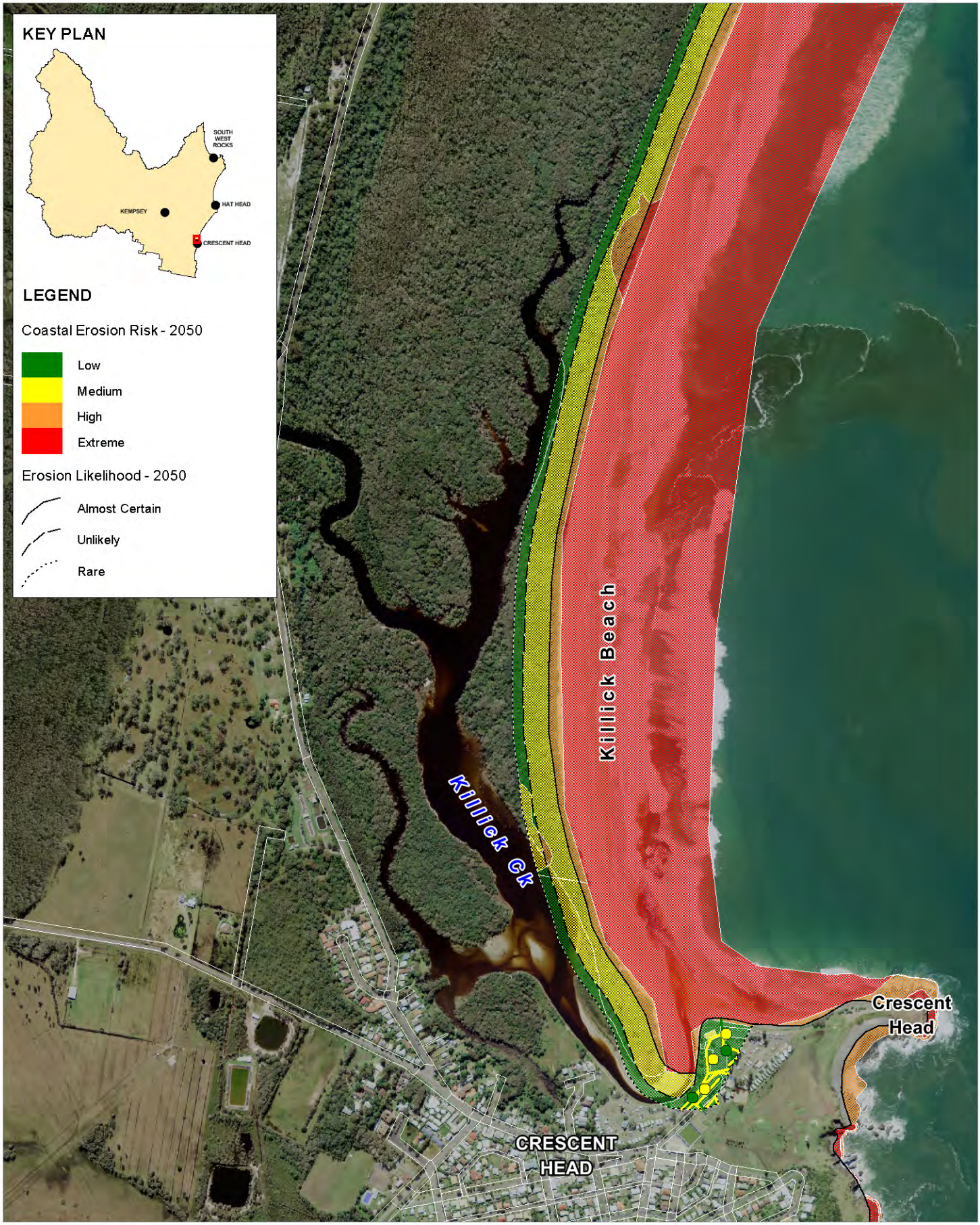

Title:

Erosion and Recession Risk Map
2050 Planning Horizon - Crescent Head

Figure: 5-40

Rev: A

N

0 250 500m

Approx. Scale

BMT WBM
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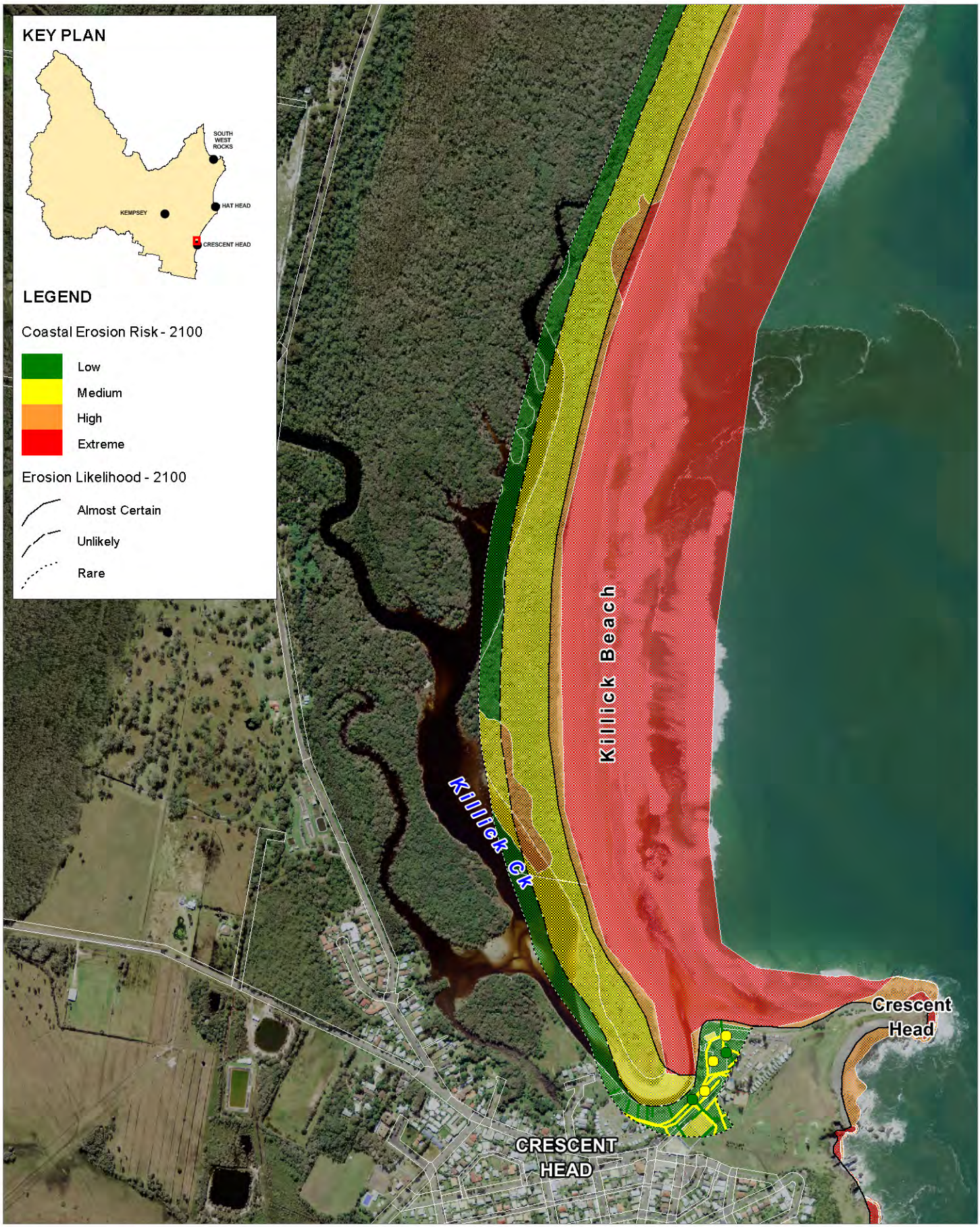

Title:

Erosion and Recession Risk Map
2100 Planning Horizon - Crescent Head

Figure: 5-41

Rev: A

N

0 250 500m

Approx. Scale

BMT WBM
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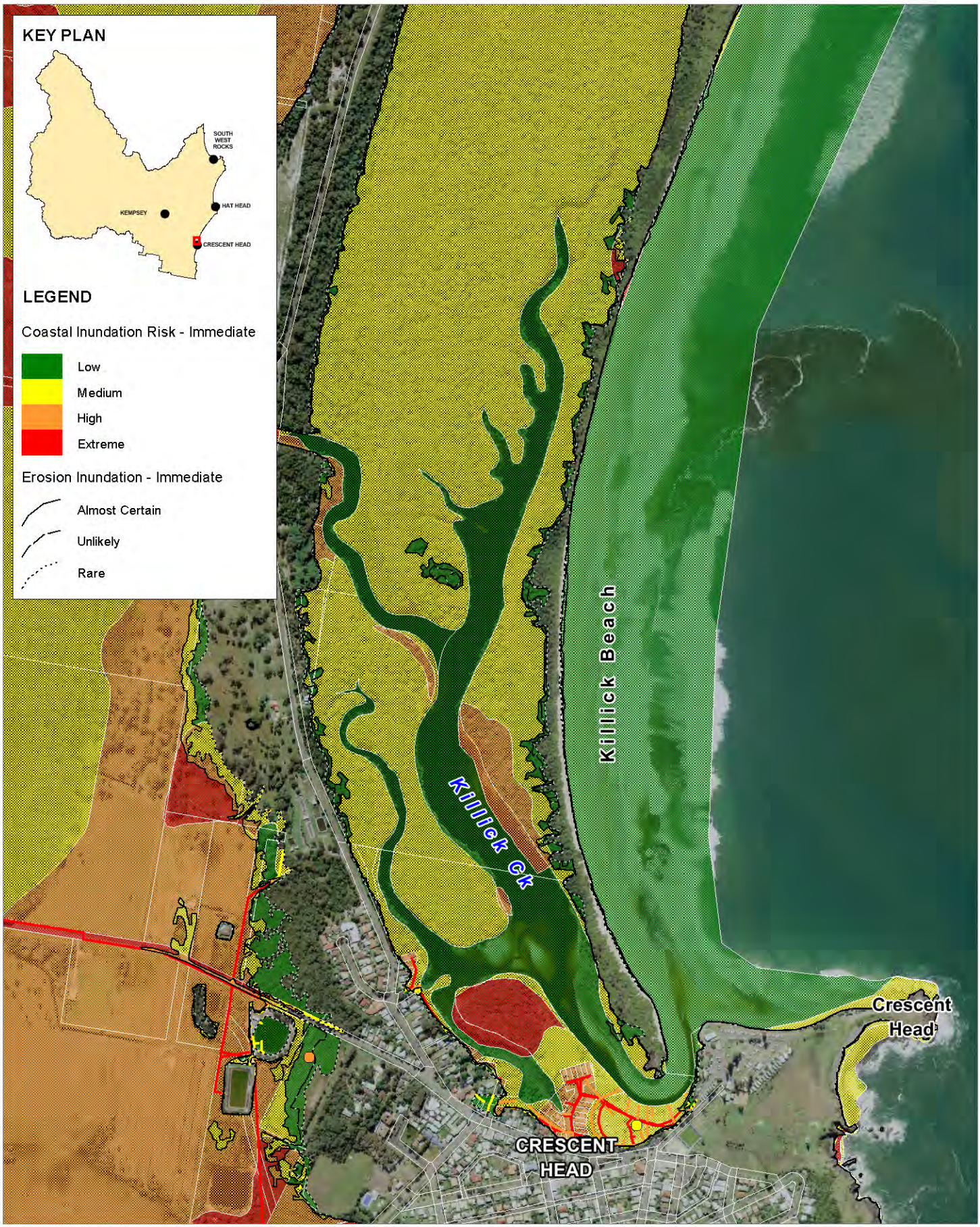


Title:

Coastal Inundation Risk Map
Immediate Planning Horizon - Crescent Head

Figure: 5-42

Rev: A

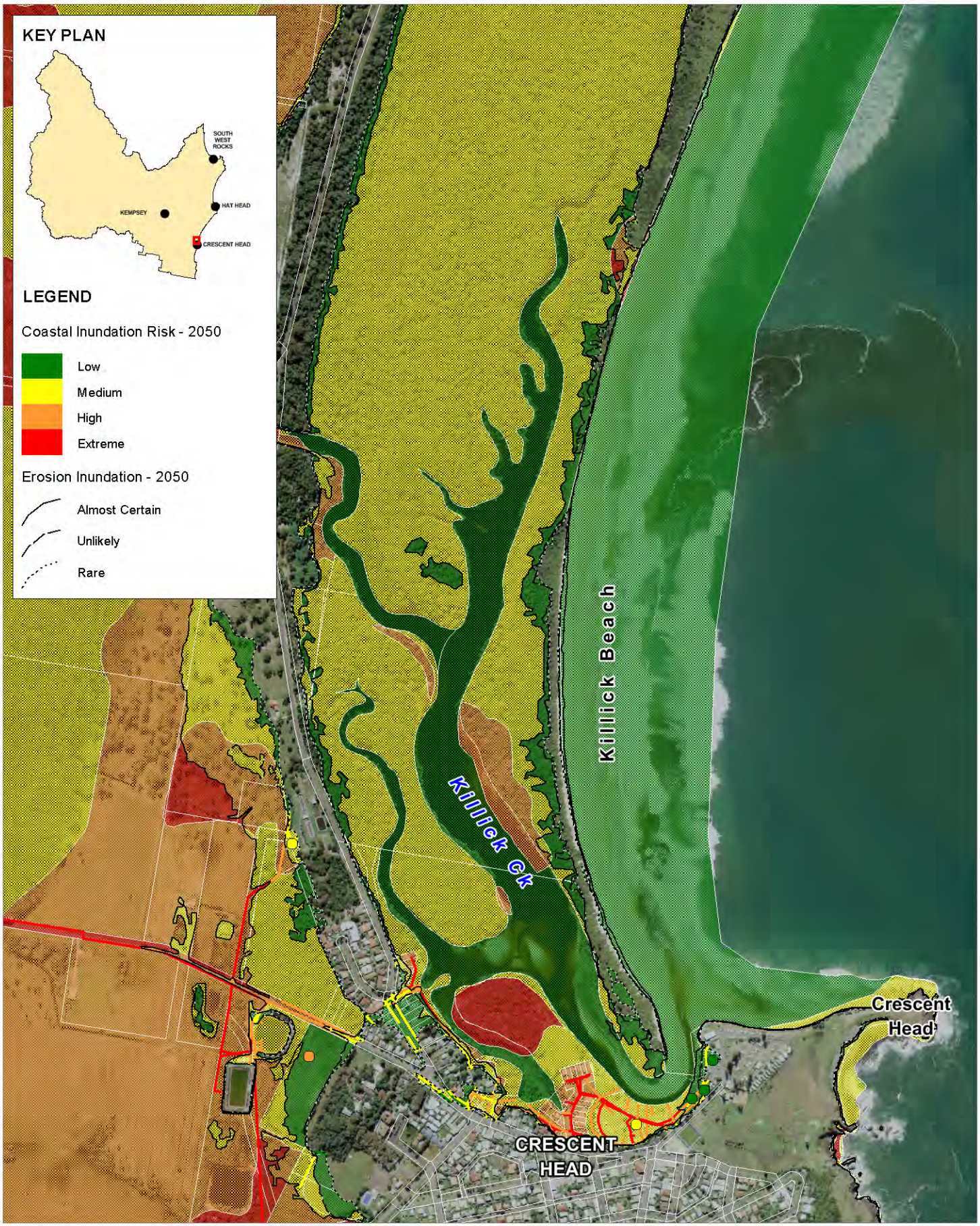
N

0 250 500m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

Filepath : K:\N20145_KempseyCZMP\MI\Workspaces\DRG_043_140728_RiskMap_A-7.WOR



Title:

Coastal Inundation Risk Map
2050 Planning Horizon - Crescent Head

Figure: 5-43

Rev: A

N

0 250 500m

Approx. Scale

BMT WBM
www.bmtwbm.com.au

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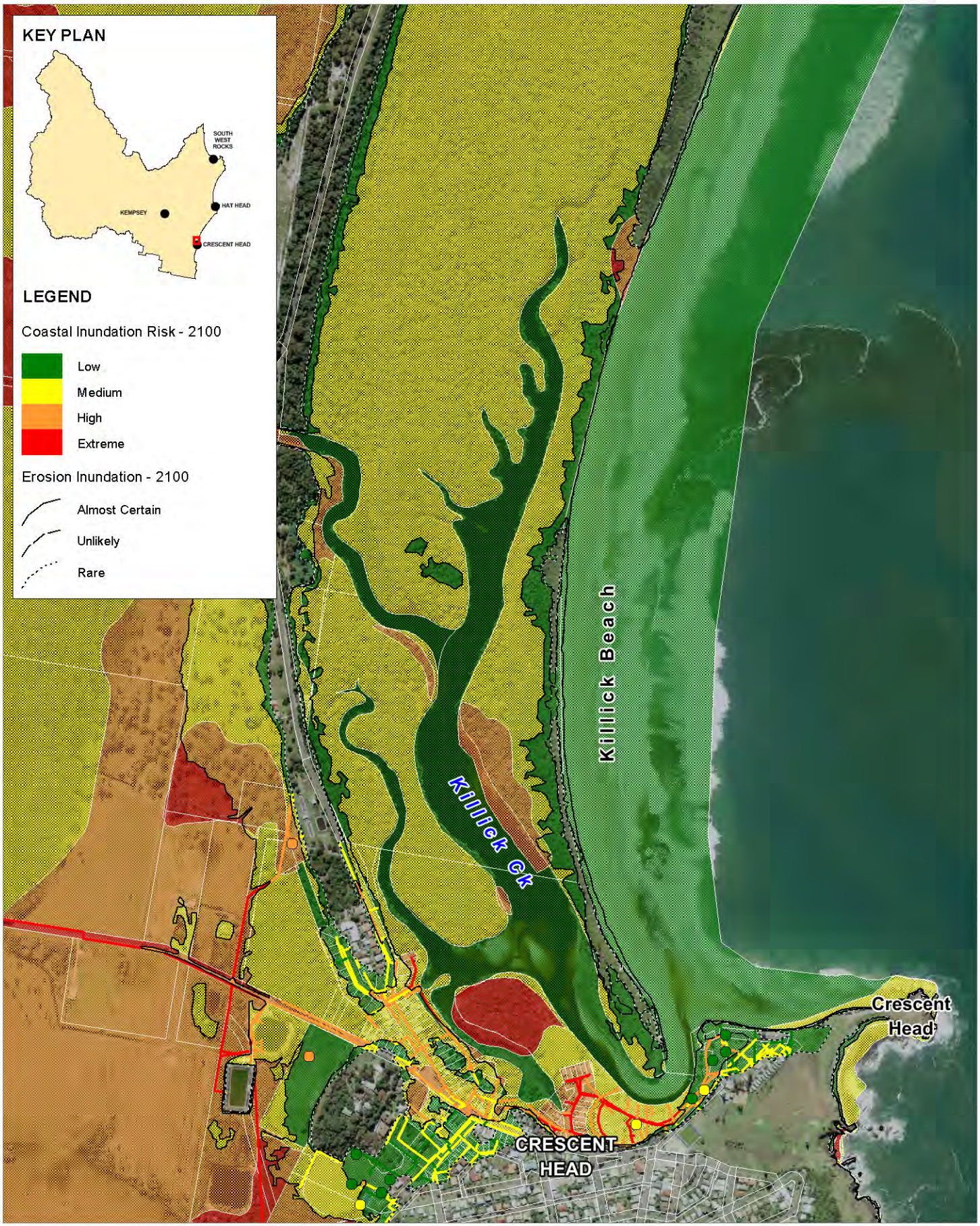

Title:

Coastal Inundation Risk Map
2100 Planning Horizon - Crescent Head

Figure: 5-44

Rev: A

N

0 250 500m

Approx. Scale

BMT WBM
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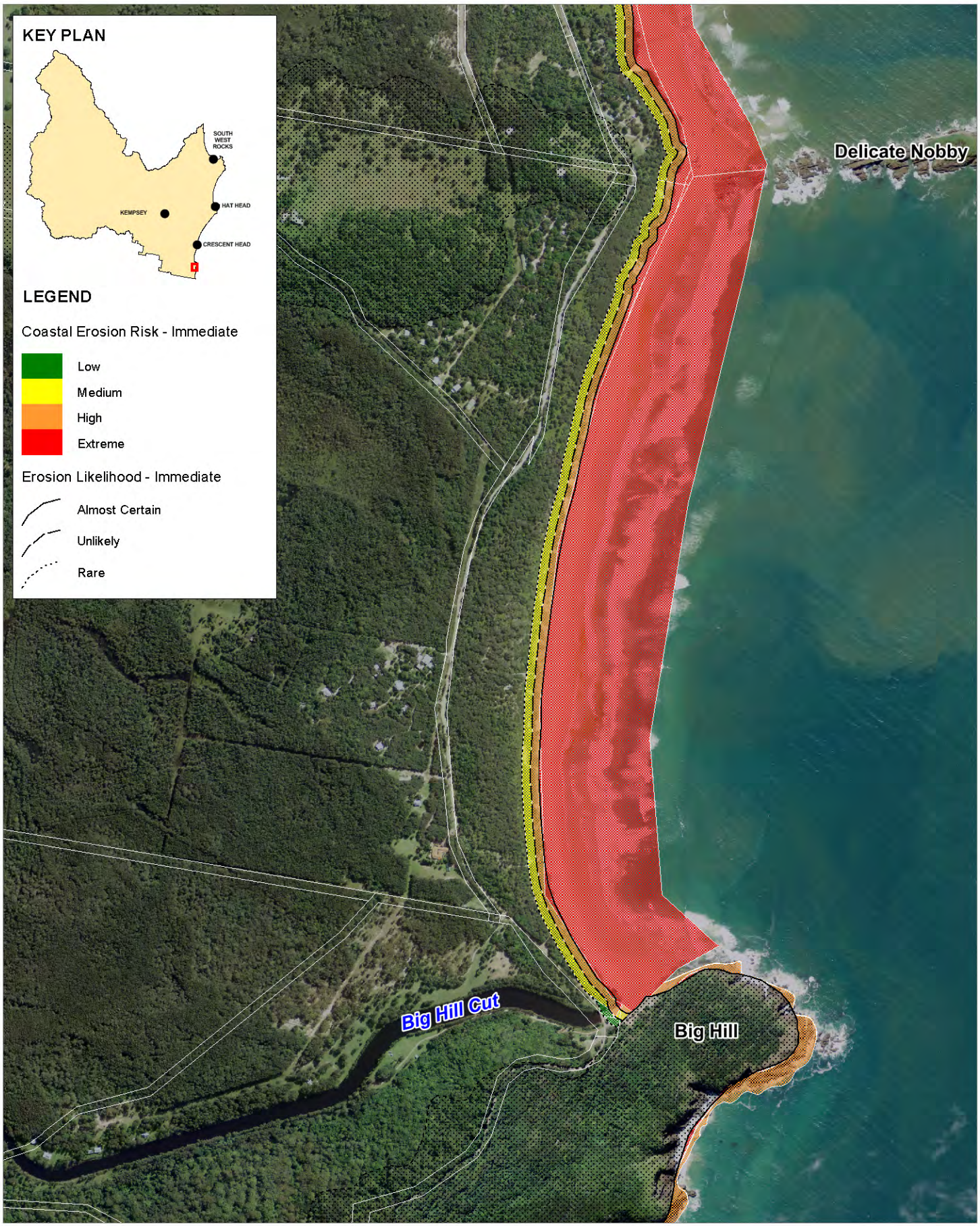

Title:

Erosion and Recession Risk Map
Immediate Planning Horizon - Big Hill Cut

Figure: 5-45

Rev: A

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Approx. Scale

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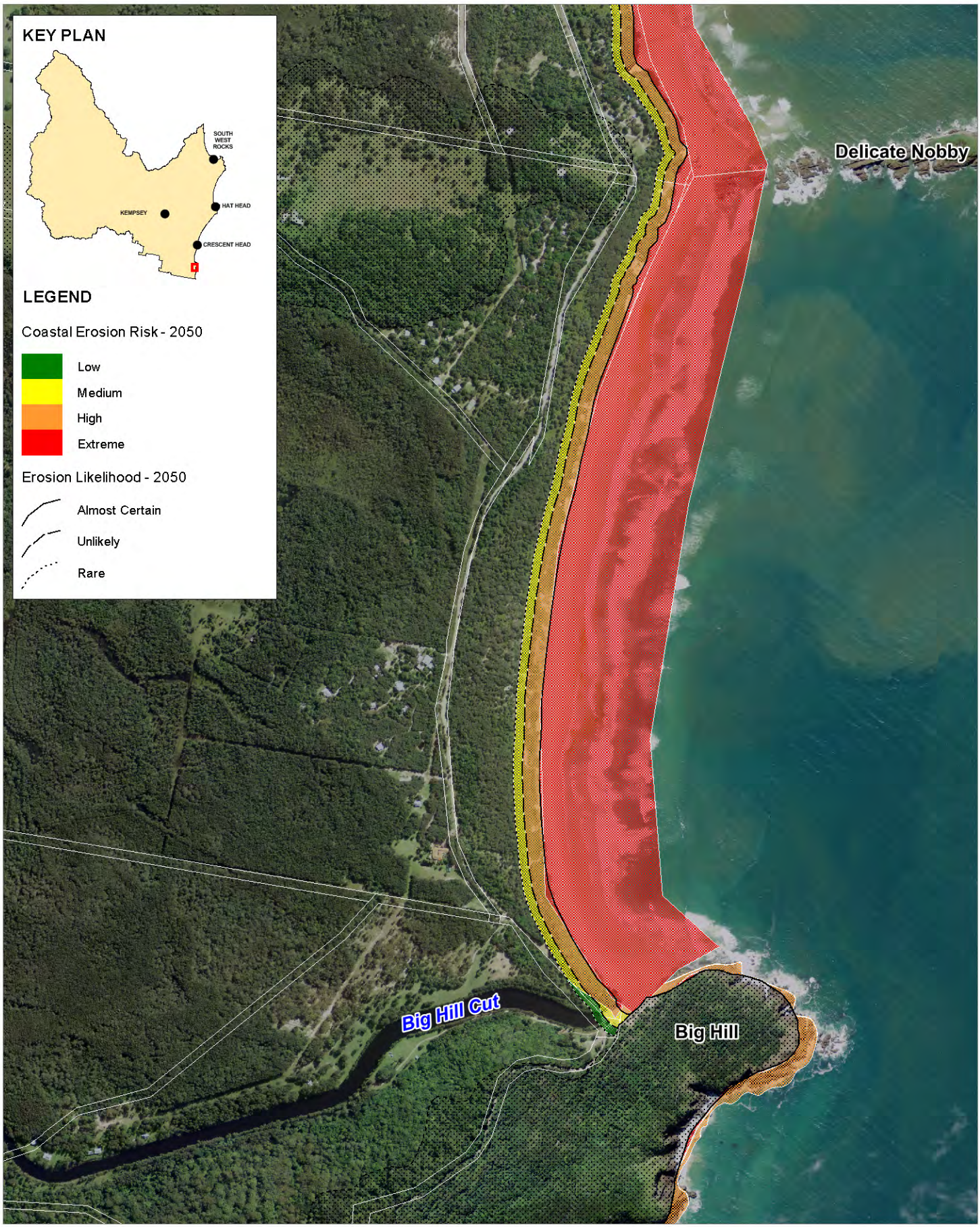

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Erosion and Recession Risk Map
2050 Planning Horizon - Big Hill Cut

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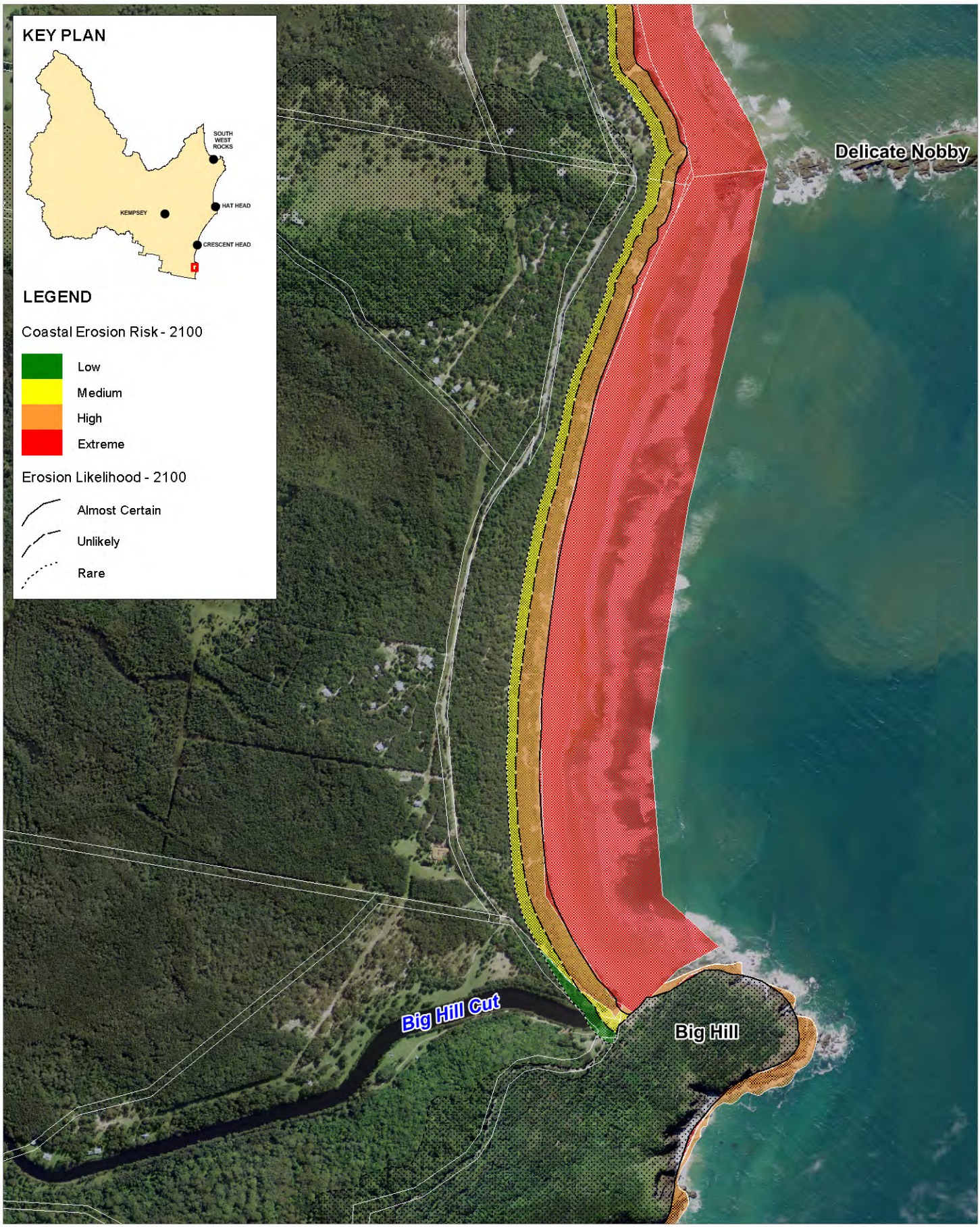

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Erosion and Recession Risk Map
2100 Planning Horizon - Big Hill Cut

Figure: 5-47

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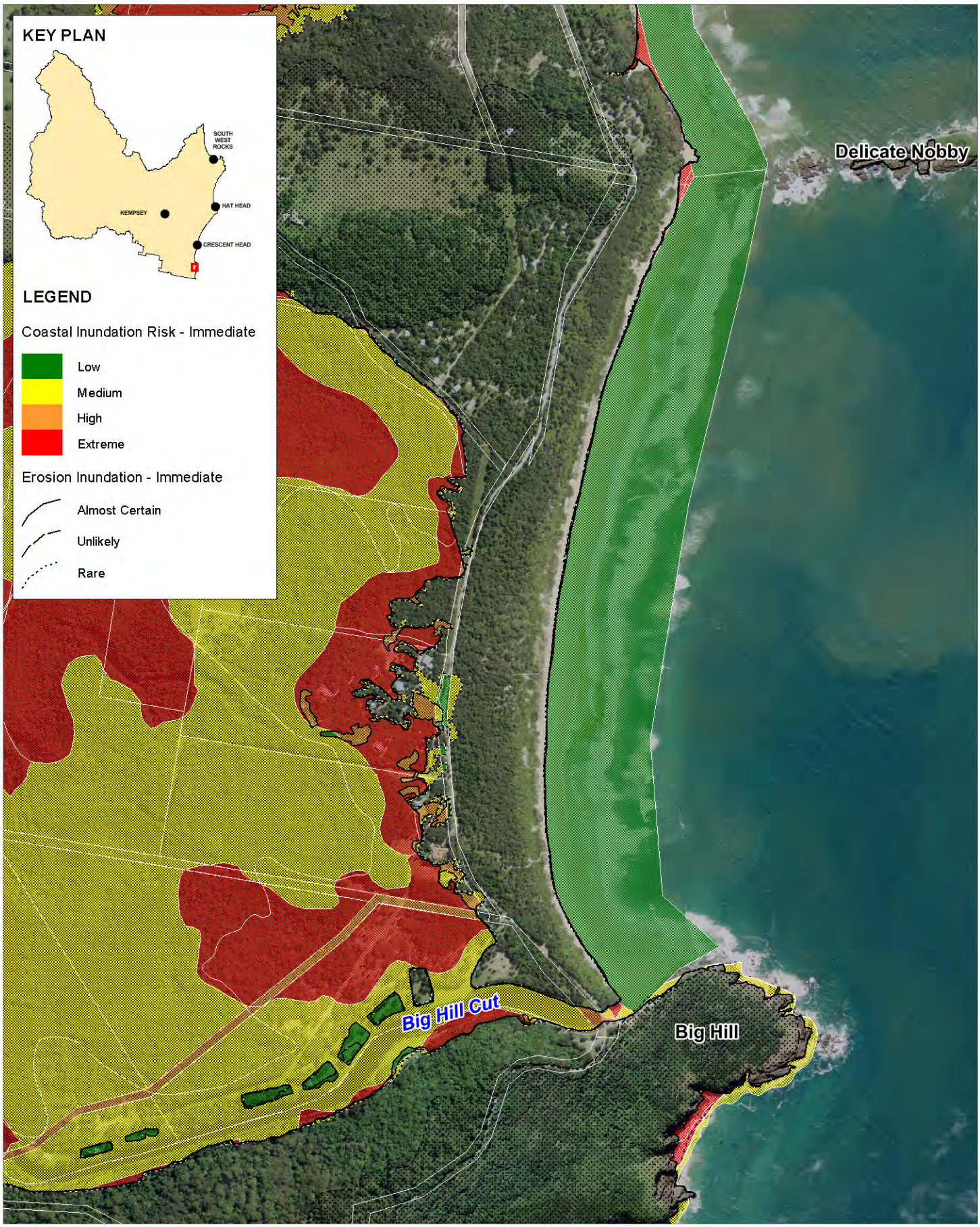

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Coastal Inundation Risk Map
Immediate Planning Horizon - Big Hill Cut

Figure: 5-48

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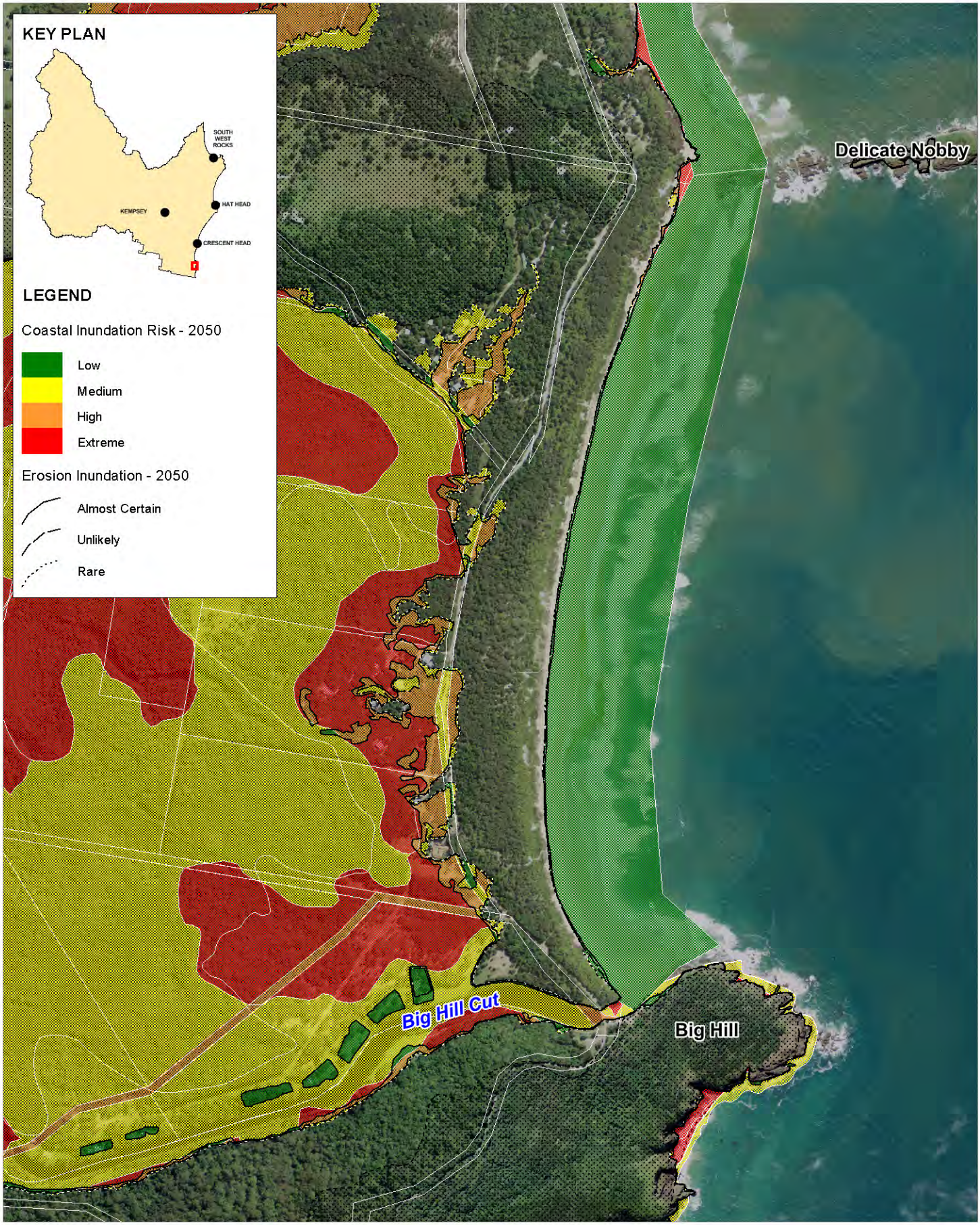

Title:

Coastal Inundation Risk Map
2050 Planning Horizon - Big Hill Cut

Figure: 5-49

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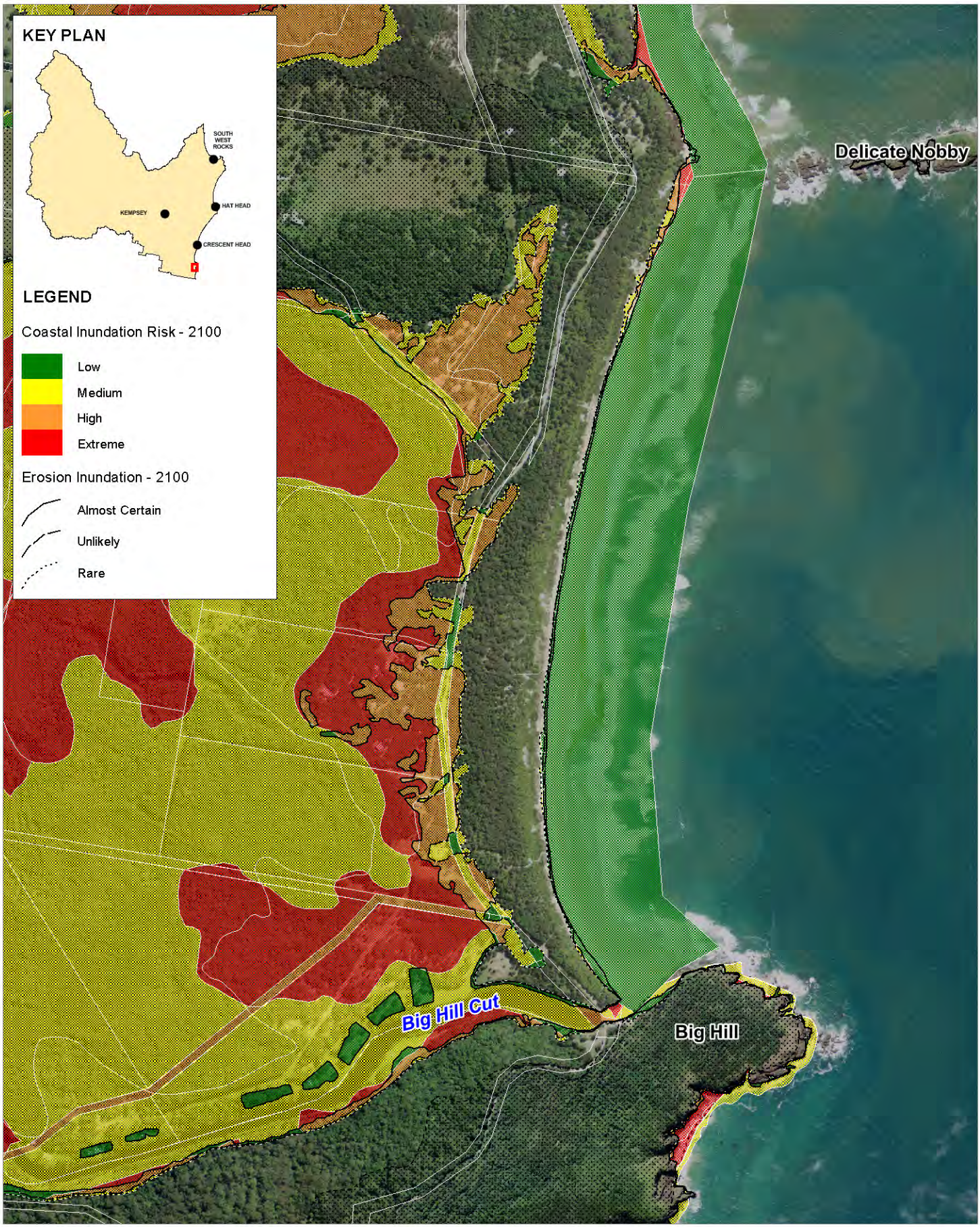

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Coastal Inundation Risk Map
2100 Planning Horizon - Big Hill Cut

Figure: 5-50

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5.8 Shire wide community use and access considerations

The following considerations are relevant across the Kempsey Coastal Zone

- Potential impacts on Aboriginal heritage and cultural places. The National Parks and Wildlife Service are in the process of developing a Heritage Management Plan for the Macleay Valley. Further direct consultation is required with representatives of the Local Aboriginal Community. It is understood that there are significant items of importance along the beaches including a Fish Trap at Point Plomer that has been damaged through recreational users (Tim Hill pers. comm., 2014). There are also a couple of very large middens and numerous smaller middens along the foredune along with some burial sites
- Marine mammals, turtles and shorebirds threatened by inappropriate beach use. A search of the NSW Wildlife Atlas shows a range of threatened species that potential visit the Kempsey LGA shoreline. Further locally-specific information is needed to ascertain the impacts of beach use on these species and any recommendations about changes to 4WD access or permitting domestic animals on beaches.
- General beach access, facilities and beach signage across the LGA.
- Much of the demand for provision of facilities arises from usage by visitors from outside of the Kempsey Shire during peak holiday periods.Holiday season introduces large pressures on services and facilities, including water and waste water supplies. The sewage treatment plants (STP's) at South West Rocks, Crescent Head and Hat Head are designed with capacities of approximately 6000, 2000 and 2000 equivalent persons (KSC, 2012). Holiday populations likely swell beyond these values. Provision of larger treatment facilities would be expensive for the relatively small rate payer base within these towns.
- Dogs on beaches. The extent to which dogs are impacting on the habitats and ecosystems of the coastline is unknown. Elsewhere along the coast, dogs have been shown to impact on the breeding and foraging efforts of important shorebird species. Within the community surveys and general conversations with community while on site, it was clear that some people value the freedom to take dogs to the beach. This is also recognised with the bush style camping at Point Plomer.

5.9 Recommended Short Term Actions

Based on the multi criteria assessment, the highest priority options that should be included within the CZMP are summarised in Table 5-14. These are considered to be the actions that can be implemented in the short-term, that is, they can be commenced within the next 5 – 10 years (i.e. the duration of the first iteration of the CZMP).

Table 5-14 High Priority Management Actions to be included in the CZMP

Asset Type	Short Term Actions
Residential	Set aside land for future protection works (on freehold land)
Residential	Require redevelopment / renovations to be located as far landward in hazard zone as practical

Asset Type	Short Term Actions
Residential	Ensure an appropriate allowance for sea level rise and other coastal hazards is incorporated into design and planning standards in the Kempsey DCP(e.g. floor heights are set at year 2100 1% AEP +0.5m)
All	Periodic monitoring of beach profiles using ground surveys and LiDAR
Water infrastructure	Identify and document the risk (low to high), type of hazard (erosion or inundation) and timeframes for impact (immediate, 2050, 2100) for all coastal assets in Council's Asset Management Plan. Account for such coastal risks when prioritising asset maintenance and replacement.
Crescent Head Holiday Park	Assess existing adequacy and remaining functional life of existing protection works
All	Conduct education activities to inform the community about coastal risks and intended future actions – to build community acceptance and resilience for managing future impacts.
Natural Values	Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds.
EEC's	Prepare and implement an EEC management plan that incorporates provision for responding to future sea level rise. This should include groundtruthing the potential endangered ecological communities (EEC) mapping, and investigate options for impact mitigation and resilience building
All	Planning controls on undeveloped land in future hazard zones
All	Updating and reviewing the Lower Macleay Flood Risk Management Strategy for all villages downstream of Frederickton including ocean outlets at Crescent Head and Hat Head (incorporating impacts of sea level rise and future erosion and recession)
National Parks and Nature Reserves	Inform the National Parks and Wildlife Service of this risk rating
All	Implement dune care / revegetation programs at locations where vegetation is degraded, limited or overcome by weeds
Built assets	Seek to have the CZMP certified by the Minister. Keep abreast of the rollout of stage 2 Coastal Reforms.
Community access	Provide formalised beach access points at sensitive locations to restrict impacts to saltmarsh (for example on the north and south sides of the Macleay River).
South West Rocks Surf Club and surrounds	Formal protection works designed to build upon (and be in keeping with) the existing natural alignment of the beach at South West Rocks- use existing boulders but replace with a proper engineered design. This will have the advantage

Asset Type	Short Term Actions
	of ensuring that the shoreline will be held in current position with mostly existing materials. Care will need to be taken to minimise impacts on entrance of Saltwater Creek.
Community access	Extension of the access provided by the bridge over Saltwater Creek through the dunes and onto the beach to provide disabled access and access to surf club boats etc.
All	Conduct education activities to inform the community about coastal risks
Ecological and social values	Update information pack for recreational 4WD. Ensure all permit holders are getting the best information.
Ecological and social values	Promote the NSW Ocean Hauling Fishery Commercial Fishers Code of Practice
Aboriginal Heritage	Work with the Aboriginal Community to develop a plan for responding to uncovering of important items during coastal storms. Low cost and having a plan in place will allow timely decisive action if exposure happens. Unable to provide preventative / pre-emptive asset management, as assets may not be found until impacts occur.

5.10 Recommended Future Options

The planning and asset management strategies described above will be crucial to ensure that the risk profile is not increased and that realistic expectations are set to manage the future coastal hazards and risks across the Kempsey coastline. This will ultimately require a decision to be made for some areas between protection or retreat. A trigger will need to be set as a measurable distance (in metres) between an erosion escarpment and built assets. The buffer distance will need to be sufficient to provide enough time for the desired management option to be implemented without the erosion hazard impacting on the existing asset. This will need to include enough time to secure the necessary funds to undertake any works. An indicative distance of 20 metres from buildings (such as house at Hat Head) to the erosion scarp could be adopted. Once this trigger distance is met, additional geotechnical investigations could be undertaken to determine the zone of reduced foundation capacity, informing decisions moving forward. More discussion on the use of triggers is included in Section 5.6.5

Options that may be appropriate for consideration in the future are summarised in Table 5-15.

Table 5-15 Options to be re-considered in the future

Option	Costs	Benefits
Seawall –A rock wall along the dunes of the beach	Loss of sandy beach in front of the wall – there is no beach – loss of amenity Expensive capital outlay ($ millions) plus needs ongoing maintenance and re-designed due to sea level rise In cases where private	Hold shoreline in current position (i.e. the land behind the beach is protected at the sacrifice of the beach)

Option	Costs	Benefits
	property is protected, some may consider it unfair to spend public money to protect private property Cannot be built in sections (individual properties) because beach erodes next to seawall. Wall must be built along lengths/major segments of beach	
Beach Nourishment - Putting sand on the beach from land-based or marine sources (estuary or offshore)	Very expensive option (e.g. $1- 2 million for first episode, $1 million for ongoing episodes) Needs to be continually repeated (ie every 5-10 yrs now, may be once a year by 2100) Sand sources of a suitable quality are not readily available, this may change in the future if offshore sourcing is allowed.	Retains a sandy beach in current position Largely retains beach amenity
Relocating roads, buildings etc landward beyond the hazard zone	A suitable alternative location must exist Private landholders must pay for the relocation of private buildings, which may not yet need replacement due to wear and tear	The sandy beach is retained because it can recede naturally. The relocation can mean a brand new building / road / facility in replacement of an old one
Compulsory /voluntary acquisition	The public (Council/State Govt) must fund full purchase price up-front. Coastal property can be very expensive, particularly where they have ocean views, are large blocks/houses, apartment blocks etc. Some may consider it unfair to spend public funds on private property. Many freehold coastal land owners will never accept the arrangement voluntarily – preference to protect freehold land	Private property owners are adequately compensated The public retains a sandy beach and gains public land
Development approval based on distance to	May be difficult to implement for redevelopments where owners have an expectation to	The sandy beach is retained because it can recede naturally. Property owners are aware of lifespan of

Option	Costs	Benefits
shoreline New developments/ redevelopments are legal until the eroding shoreline comes within a distance to the property	have the same rights for a new building as they had with the old building	development – no need for compensation = low cost to public.

5.11 Impacts of Sea Level Rise on Floodplain Drainage

By 2100, the present day mean sea level will potentially be the new low tide level. This would reduce the ability of existing flood gates to drain large parts of the Macleay River floodplain (particularly land that is less than 1 m AHD).

There are many flood mitigation structures across the Kempsey LGA that will be affected by future sea level rise. Flood gate structures on Killick Creek and Korogoro Creek, which essentially form the tidal limit of these creeks, are at present manually operated to release floodwaters from the Macleay River floodplain. Sea level rise will reduce the hydraulic gradient between the floodplain and the ocean, thereby reducing the efficiency of these secondary flood outlets. The consequence of this will be extended periods of inundation across the floodplain following catchment flood events. This extended inundation may be problematic for existing agricultural uses of the land, such as grazing and cropping.

5.11.1 Impacts of Coastal Erosion and Recession on Big Hill Cut Flood Gate

Big Hill Cut flood gate is anticipated to be affected by coastal erosion and recession in the future, and may become outflanked some time after 2050. Prior to being outflanked, the structure would be subject to significant wave attack and potential undermining of foundations due to beach erosion.

It is expected that the flood mitigation function of Big Hill Cut flood gate will diminish as future sea level rise reduces the hydraulic gradient between floodplain and ocean water levels. By 2100, it is anticipated that the existing flood gate would provide little to no value for drainage and flood relief to upstream areas.

5.11.2 Impacts of Sea level Rise on Ryans Cut

Ryans Cut consists of a sandy entrance berm on the coast with a flood gate approximately 1km landward. In response to future sea level rise, it is anticipated that the sand berm across the ocean entrance of Ryan's Cut will migrate landwards (consistent with the general alignment of Killick Beach) and will increase in height (approximately equivalent to the extent of sea level rise).

The higher entrance berm will require greater excavation efforts by Council in the future in order to release floodwaters from the Macleay floodplain through the Ryans Cut floodgates.

Although the flood gate structure on Ryan's Cut is not expected to be impacted directly by coastal erosion and recession, future sea level rise will reduce the hydraulic gradient between floodplain

and ocean water levels, which will reduce the efficiency of the floodgates to drain water from the floodplain, diminishing its value in the future.

5.11.3 Function of Rowes Cut

Rowes Cut forms part of the lower Macleay Flood Mitigation Scheme that was initiated following the 1949/50s floods. Located just north of Hat Head village, Rowes Cut had a 4m base width at 2.4m AHD with side slopes 2:1 and a sand plug at ocean end of channel that is designed to be excavated during a flood. The Cut is currently degraded, being full of sand and vegetation. Use of Rowes Cut for flood mitigation purposes is not included in the National Park Plan of Management.

It is expected that the efficiency of Rowes Cut to facilitate drainage of upstream floodplains would be significantly compromised by future sea level rise. It would also require a significant effort to re-establish the channel and remove the extensive sand build-up at the ocean end.

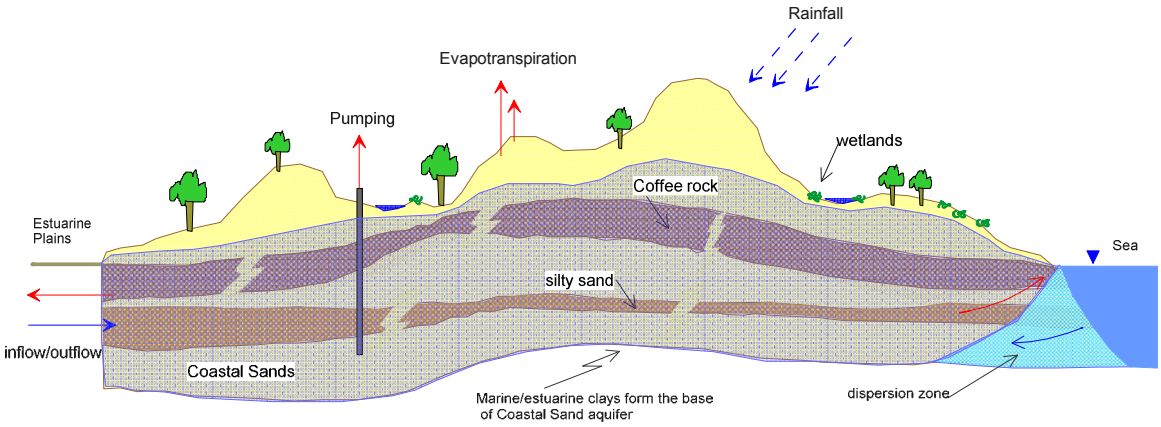
5.12 Impacts of Sea Level Rise on the Coastal Sand Aquifers (Kempsey's current raw water source)

The coastal dune aquifers in the Kempsey LGA provide potable water supply for all the towns and villages along the coast, and also support important groundwater dependent ecosystems.

A formal risk assessment for the coastal groundwater resources between Crescent Head and South West Rocks has been undertaken by the National Water Commission (Punthakey et al., 2012). The objective of the project was to develop management recommendations to prevent the groundwater resources becoming over allocated, depleted or degraded. A second objective was to combine groundwater and seawater intrusion modelling tools, an assessment of groundwater dependent ecosystems and applying a cost benefit analysis to support the long term management of the coastal sand aquifer.

The project involved development of a flow and transport model for the Macleay Sands Aquifer (refer Figure 5-51). The model was then used to predict impacts of different pumping and climate scenarios. In general, the investigation found that the current level of pumping is acceptable and does not have significant impact on groundwater dependent ecosystems. A number of specific recommendations, which include the relocation of bores to ensure they are pumping only from the deepest parts of the aquifer, are given in the project report. Of specific relevance to the Kempsey CZMP, are the following recommendations:

- Future modelling should consider expanding the eastern model boundary into the ocean by at least a few kilometres. The lack of knowledge of the aquifer offshore is a severe constraint, and
- Further work on adaptation to climate change (including both lower rainfall and higher sea levels) and impact analysis for coastal water supply areas needs to be undertaken. While the report advises that this can be done when additional data from the new monitoring regime becomes available to improve model calibration, Council staff have confirmed that this is now possible (Bourkes, pers. comm 2014).



Source: Punthakey et al 2012

Figure 5-51 Conceptual model for the Macleay Sands dune aquifer system at Hat Head (section through South West Rocks borefield)

5.13 Impacts of Coastal Hazards on Wastewater Dune Disposal

The South West Rocks STP has a capacity of 12000 EP (equivalent persons) and after treatment including chlorination, is discharged via dune disposal. The coastal erosion and recession hazards are not expected to impact upon the dune disposal infrastructure within the timeframes being examined within this study.

The Hat Head dune disposal system has a capacity of 11874 EP.

5.13.1 Recommended Management Options for Large Scale Infrastructure

Given the level of uncertainty regarding the flood mitigation scheme and the way it functions presently (and will function under sea level rise), a detailed flood assessment is recommended.

Options for further consideration in the CZMP include:

- Utilising a flow and transport model for the Macleay Sands Aquifer and available new data sets to assess impacts of sea level rise (and climate change) to 2100;
- Updating and reviewing the Lower Macleay Flood Risk Management Strategy for all villages downstream of Frederickton including ocean outlets at Crescent Head and Hat Head (incorporating impacts of sea level rise and future erosion and recession); and
- Checking that arrangements are in place to ensure flood mitigation structures and their management are formerly identified and acknowledged within Plans of Management of National Parks.

6 Where to From Here?

A program of consultation with community and stakeholder groups (including Council and State Government Staff) will be undertaken to encourage feedback on the shortlist of recommended management options. The final list of options selected to treat risks shall be decided in consultation with Council and based upon the outcomes of this next stage of community consultation.

The consultation program will involve a strategic workshop to confirm the options that should be carried forward as actions into the Kempsey CZMP.

The workshop will include a brief overview of the risk assessment outcomes, and discussion of the range of recommended options, including the details of costs and benefits of the options.

The next and final report in this series will be the Kempsey CZMP, and will be prepared following the workshop. It will include:

- Implementation Schedules for agreed options, detailing actions, responsibilities, estimated costs and triggers for implementation;
- Written approval from the State Government agencies and public authorities as required for actions relating to their activities, land and /or assets;
- Details of potential funding opportunities; and
- Monitoring and review requirements for the CZMP.

7 References

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Tony Castle, pers comm 2014 – comments on Draft CZMS

Appendix A Coastal Hazard Risk Assessment

A.1 Application of the risk approach to coastal hazard management

A.1.1 Introduction

A risk-based framework is a robust methodology for dealing with outcomes that are uncertain or have limited data, or for impacts with uncertain timeframes. This approach is therefore particularly applicable to the impacts of coastal hazards and projected sea level rise, where there is considerable uncertainty regarding when and if impacts will manifest. Uncertainties associated with future climate change presents huge challenges to local government and the wider community, who need to consider and manage future risks. Decisions made today are likely to have ramifications for up to 100 years or more (depending on the development), so consideration of an extended timeframe is essential, even though risks may not manifest for several decades.

The use of a risk-based approach for managing coastal hazards is a requirement of the new CZMP guidelines, and accords with current international best practice for natural resource management. The Risk Assessment process utilised for the Kempsey Coastal Zone Hazards and Management Studies is adapted from the Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000:2009), as described below.

- **Establish the Context –** the requirements of a coastal zone management plan set by NSW legislation and guideline documents provide the context for the risk assessment and intended outcomes. The purpose and context for the Kempsey CZMP, including the management objectives, are outlined in Section 1.1.
- **Identify the Risks –** the risks arise from the coastal hazards, as defined in the CZMP Guidelines and the Coastline Management Manual (1990), namely, beach erosion and recession, coastal inundation and wave overtopping, and to a lesser degree sand drift and erosion at stormwater outlets. Hazards were determined during the Kempsey Coastal Processes and Hazards Definition Study (BMT WBM, 2013), as summarised in Chapter 2. The risks shall impact upon coastal values, which include ecological, cultural, recreational and economic values, as identified during literature review and consultation with the local community, the Committee and key stakeholders.
- **Analyse the Risks –** this involves considering the **likelihood** and **consequence** of the identified risks, to determine the overall level of risk (extreme, high, medium or low).
- The *likelihood* of risks is largely related to the extent of coastal hazards, now and in the future. The likelihood of erosion and recession and coastal inundation at the immediate, 2050, 2100 timeframes was determined during the Kempsey CPHDS (BMT WBM, 2013) and is summarised in Section 2.2.
- The *consequence* of the risks will largely relate to the extent of existing or future development and the values (e.g. aesthetic, recreational, ecological) associated with land and assets within the coastal zone. The coastal assets mapping and incorporation of community consultation outcomes have been used to determine consequence of coastal risks, as presented in Section A.1.3.1.

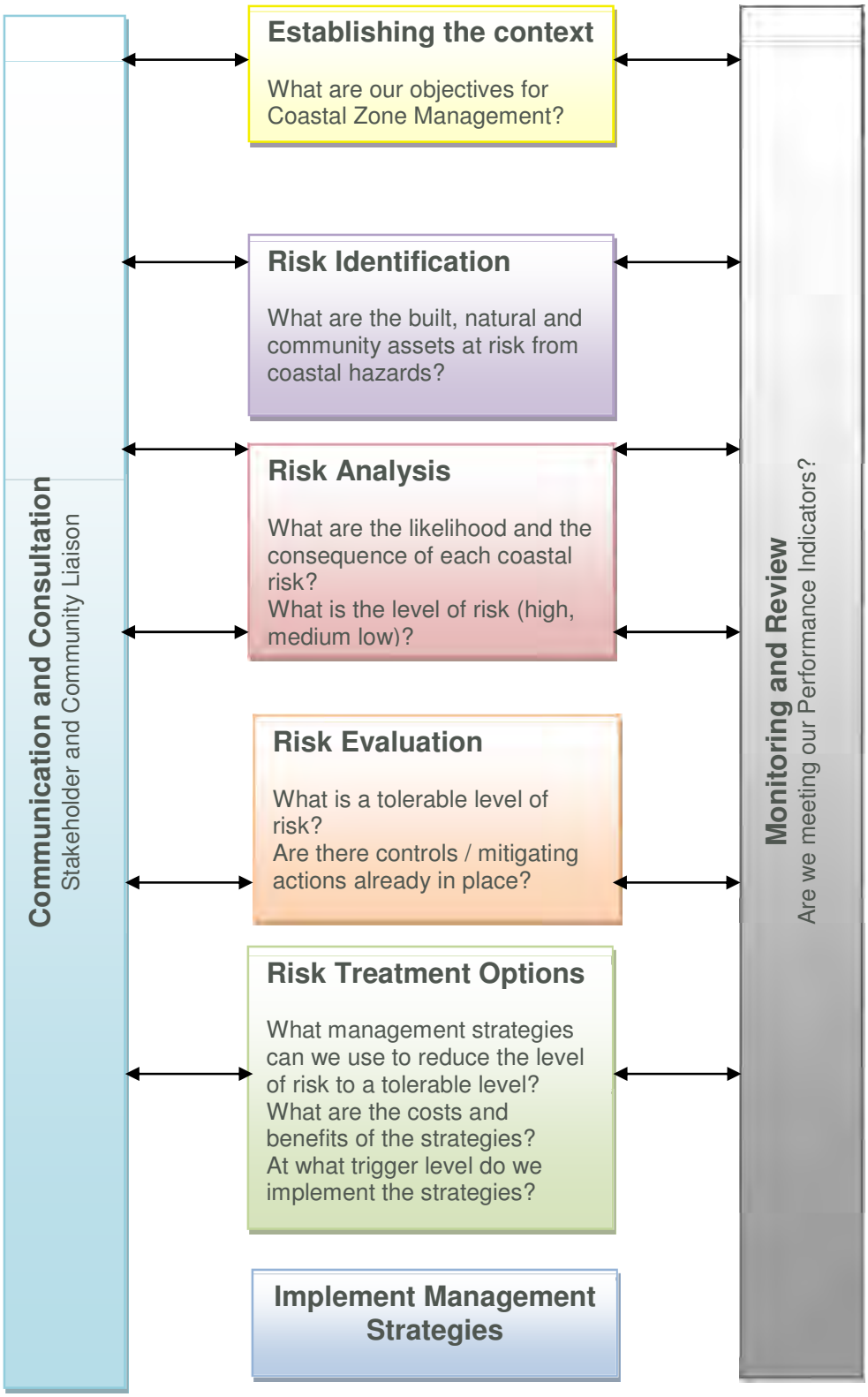

Figure A-1 Risk based approach applied to coastal management

- The consequence and likelihood have been combined (using GIS processing) to determine and map the *level of risk* for assets and land in the coastal zone. Existing controls that may reduce the level of risk are considered in Section A.3.
- **Evaluate the Risks –** in consultation with Council and relevant stakeholders, the level of risk that is deemed acceptable, tolerable and intolerable was determined. The evaluation criteria determines the intolerable risks that must be treated as a priority and to which management effort shall be directed.
- **Treat the Risks –** the process of developing coastal management options is directly related to reducing or eliminating intolerable risks. Acceptable and tolerable (low) risks can be flagged for monitoring, with no further actions necessary. Management options can be designed to reduce the likelihood of the risks (e.g. planning setbacks to reduce the likelihood of shoreline recession impacts), or reduce the consequence of the risk (e.g. emergency management to reduce the consequence of shoreline recession) or both.
- Management options were firstly considered based upon the technically viability of implementation in the study area. Analysis to consider the costs and benefits is then conducted to determine which of the risk treatments will provide the greatest benefit (relative to cost) in treating the highest priority risks. Management options are outlined and analysed in Chapter 5.
- *For existing development* given the uncertainty and timeframes over which hazards may manifest, a trigger for implementing the options has been flagged. Setting triggers ensures the management option and associated resources are not utilised until it is absolutely necessary to do so, which is particularly important for difficult and costly, but necessary, options.
- **Implement Management Strategies (Risk Treatments) –** The coastal zone management plan provides the forum to detail how the recommended management options (risk treatments) shall be implemented (costs, timeframes etc.) and funded. Ongoing monitoring and review of both the risks and management options is also detailed. The Coastal Zone Management Plan outlining the preferred actions for implementation shall be completed as the next part of this project.

A.1.2 Likelihood Scale

The hazards definition phase of the NSW coastal management process is suited to defining the 'likelihood' or probability of occurrence of coastal hazards, through the analysis of coastal processes and historical beach responses, and to account for uncertainty in both the occurrence of hazards and shoreline response to sea level rise.

As part of the Kempsey CPHDS (BMT WBM, 2013), a scale of 'likelihood' or probability of occurrence for a hazard impact based upon the Australian Standard for Risk Management (AS/NZS ISO 31000:2009) and its companion document (HB 436:2004) was derived. The timeframes over which coastal hazards probabilities were assessed is the immediate, 2050 and 2100 planning horizons, as consistent with the CZMP Guidelines for coastal planning.

The categories were rationalised and focus was given to Standard's 'Almost Certain', 'Unlikely' and 'Rare' probabilities (referred to herein as 'Almost Certain, 'Best Estimate' and 'Worst Case'). These categories are presumed to provide a sufficient level of detail for coastal planning purposes. As coastal processes data and assessment of the probability of hazard impacts improves into the future, it is expected that the approach to the definition of hazard will be incorporated into future revisions of the risk assessment and this CZMP.

Table 7-1 Risk Likelihood / Probability for Coastal Hazards (from BMT WBM, 2013)

Probability	Description	Hazard Descriptor
Almost Certain	There is a high possibility the event will occur as there is a history of frequent occurrence.	**Almost Certain**
Likely	It is likely the event will occur as there is a history of casual occurrence.	*Insufficient data to define*
Possible	There is an approximate 50/50 chance that the event will occur.	
Unlikely	There is a low possibility that the event will occur, however, there is a history of infrequent or isolated occurrence.	**Best Estimate**
Rare	It is highly unlikely that the event will occur, except in extreme / exceptional circumstances, which have not been recorded historically.	**Worst Case**

The translation of the erosion and recession hazard and inundation hazard to these likelihood descriptors is described fully in BMT WBM (2013).

The 'almost certain' line at 2050 and 2100 accounts for 'almost certain' (average) beach erosion without sea level rise. There is no evidence of long term recession on Kempsey's beaches and data analysis plus the shoreline evolution modelling indicated that the shoreline has already stabilised in response to the Macleay Breakwaters. Therefore, no additional shoreline setback for long term recession has been included in the 'almost certain' hazard at 2050 and 2100. While it is noted that Trial Bay has experienced accretion in the past and this may well continue in the future, it is considered prudent to assume the Trial Bay shoreline remains in its present position, and as for the other beaches, the 'almost certain' hazard maintained for 2050 and 2100 timeframes.

The *best estimate* (unlikely) hazard likelihood zone is the addition of future long term recession due to predicted sea level rise of 0.4 m and 0.9 m by 2050 and 2100 plus the *best estimate* (unlikely) beach erosion hazard extent.

For the *worst case* hazard likelihood zones, the maximum landward shift in shoreline position from extreme scenarios outlined (at 2050 and 2100) as described in **Error! Reference source not found.** was adopted. In nearly all cases, the higher than predicted sea level rise provided the greatest potential for recession and thus this was the main scenario adopted as defining the *worst case* hazard.

Table 7-2 Beach Erosion and Shoreline Recession Hazard Probability Zones

Probability	Immediate	2050	2100
Almost Certain	'average' beach erosion [1]	Immediate 'average' beach erosion	Immediate 'average' beach erosion
Likely	NM [2]	NM	NM
Possible	NM	NM	NM
Best Estimate (Unlikely)	'maximum' beach erosion at any position along the beach [1]	Immediate 'maximum' beach erosion + 0.4 m SLR	Immediate 'maximum' beach erosion + 0.9 m SLR
Worst Case (Rare)	'extreme' beach erosion [3]	**Worst Case of either**: Immediate 'maximum' beach erosion + 0.7 m SLR **OR** Immediate 'extreme' beach erosion + 0.4 m SLR **OR** Immediate 'maximum' beach erosion + 0.4 m SLR + 5 ° more easterly wave climate	**Worst Case of either**: Immediate 'maximum' beach erosion + 1.4 m SLR **OR** Immediate 'extreme' beach erosion + 0.9 m SLR **OR** Immediate 'maximum' beach erosion + 0.9 m SLR + 5 ° more easterly wave climate

[1] *as measured over the past 4 decades.*
[2] *NM = Not Mapped due to inadequate data to differentiate likelihoods between 'almost certain' and 'unlikely'.*
[3] *Assumed to be 'maximum' erosion plus the difference between 'maximum' and 'average' beach erosion.*

A.1.2.1 Application of the likelihood scale for the inundation hazard

The main impact of the coastal inundation hazard relates to the inundation of low-lying areas near and behind coastal barriers and coastal entrances during high ocean water levels. The elevated ocean levels cause inundation by either propagating into entrances or acting as a tailwater level precluding flood outflow from the creeks and so elevating the water levels within the rivers / creeks / lagoons.

For the purpose of defining the likelihood of coastal inundation within the immediate timeframe, it was considered '**almost certain**' would be equivalent to a 1 in 20 year return interval event, the **best estimate** (unlikely) would be equivalent to a 1 in 100 year event and **worst case** (rare) would be equivalent to a greater than 1 in 100 year event resulting from an extreme climatic condition.

For the 2050 planning period, extreme water levels will additionally include sea level rise, as well as minor projected changes to storm surge and wave height (as given by McInnes *et al*., 2007). The inundation levels are thus:

- an *almost certain* probability of a 1 in 20 year return interval event, without sea level rise (to provide the boundary of the coastal risk planning area);
- a *best estimate* (unlikely) probability of experiencing a 1 in 100 year event plus predicted sea level rise of 0.4m by 2050, and increased wave set up and increased storm surge due to climate change; and
- a *worst case* (rare) probability of a 1 in 100 year event plus greater than predicted sea level rise of 0.7 m by 2050, or an extreme climatic condition (e.g. a 1 in 1000 year still water level event,

excluding wave set up) plus predicted sea level rise of 0.4 m by 2050, whichever was the higher.

Similarly, the 2100 planning period coastal inundation extents will additionally include sea level rise and minor changes to wave set up and storm surge due to climate change. The almost certain, best estimate and worst case probability levels are thus the same as 2050, but with the additional sea level rise and wave height and storm surge change predicted by 2100.

Table 7-3 Coastal Inundation Likelihood Summary

Probability	Immediate	2050	2100
Almost Certain	1 in 20 yr storm surge and wave set up	As per immediate	As per immediate
Likely	NM[1]	NM	NM
Possible	NM	NM	NM
Best Estimate (Unlikely)	1 in 100 yr storm surge and wave set up	1 in 100 yr storm surge and wave set up + 0.4 m SLR and climate change impacts	1 in 100 yr storm surge and wave set up + 0.9 m SLR and climate change impacts
Worst Case (Rare)	1 in 100 yr storm surge and wave set up + extreme climatic conditions (e.g. tropical cyclone, 1 in 1000 year east coast low)	**Worst Case of either:** 1 in 100 yr storm surge and wave set up + extreme climatic conditions + 0.4 m SLR and climate change impacts **OR** 1 in 100 yr storm surge and wave set up + 0.7 m SLR and climate change impacts	**Worst Case of either:** 1 in 100 yr storm surge and wave set up + extreme climatic conditions + 0.9 m SLR and climate change impacts **OR** 1 in 100 yr storm surge and wave set up + 1.4 m SLR and climate change impacts

[1] *NM = Not Mapped*

Table 7-4 Adopted Inundation Levels

Adopted Inundation Levels	Immediate (m AHD)	2050 (m AHD)	2100 (m AHD)
Almost Certain	2.5	2.5	2.5
Best Estimate (Unlikely)	2.7	3.2	3.8
Worst Case (Rare)	2.9	3.5	4.3

A.1.3 Consequence Scale

The second component of risk is consequence. The consequence of impact from coastal hazards largely relates to the land affected by hazards, such as existing or future development and other assets and their values (i.e. aesthetic, recreational, ecological, cultural and economic). The type

and duration of impact needs also to be considered when assessing the consequence of the different coastal risks (e.g. short term periodic inundation compared with long term permanent loss of land with recession).

A consequence scale was developed specifically for coastal zone management that is relevant to both the type of impact to coastal land and assets and its effect across the entire community and the timeframe (up to 100 years) for coastal risk planning. The consequence scale follows a triple bottom line approach, to determine the consequence as shown in Table 7-5. Consequences were determined through a stakeholder workshop as described in Section 3.4.

Table 7-5 Triple bottom line consequence scale

Consequences	Social	Environmental	Economic
5	Extreme and widespread long term impacts on the amenity / heritage value – e.g. complete loss of access	Extreme and widespread devastating long term impacts to environment. Recovery unlikely.	Extensive financial loss (>$1m) or ongoing funding costs of $100,000 per year
4	Major impact on the amenity / heritage value, reversible only through intense management efforts.	Major habitat loss and/or triggering of nuisance species proliferation, over a wide area. Recovery may take many years	Major financial loss ($500,000 - $1m) or ongoing funding costs of $50,000-$100,000 per year
3	Moderate impact on the amenity / heritage value mainly reversible through management efforts. No similar access points available nearby for use in the short term.	Significant environmental changes isolated to a localized area. Recovery may take several years.	Significant financial loss ($50,000 - $500,000) or ongoing funding costs of $25,000-$100,000 per year
2	Minor impact to amenity/ heritage value, mainly reversible through management efforts. Access ways / beaches of a similar nature available nearby	Environmental damage of a magnitude consistent with seasonal variability	Minor financial loss ($10,000 - $50,000) or ongoing funding costs of $5000-$20,000 per year
1	Little to no change to amenity / heritage value	Little to no impact on terrestrial and or aquatic ecosystems	Little to no financial loss (<$10,000) or less than $5000 ongoing funding costs per year

A.1.3.1 Assigning consequence through the risk assessment workshop

The key process for determining consequence values was a Risk Assessment Workshop conducted with personnel from the various departments within Kempsey Council (e.g. planning, parks and recreation, engineering), the state agencies (e.g. OEH, LLS) and other stakeholders. Focus for the workshop was given to the erosion and recession hazard, as this hazard may have a greater impact generally and particularly in the township of Hat Head.

Attendees working in groups were required to assign a social, environmental and economic consequence to each asset.

Consequence were assessed separately for the erosion and recession hazard compared with the coastal inundation hazard because the types of impacts are different, even though the value of the land may be the same. The impacts from erosion and recession are permanent and irreversible. That is, once recession has undermined a building on a sandy dune, the loss of the building is permanent. Even though the beach may recover to some degree from erosion, the building (and its location) must be abandoned permanently. In contrast, coastal inundation resulting in flooding of property is a short term phenomenon, as the water recedes after the storm surge and tide ebbs. While this temporary inundation may cause damage (substantial damage in some instances), the total value of the land and associated assets is not completely lost as is the case for erosion.

The results from the workshop activity for erosion and recession were used to determine an overall or average consequence value, which was then assigned spatially (within GIS) to each of the assets mapped across the LGA. Experience of the study team and information from various reports pertaining to the local area were used to adjust consequence levels compared with workshop outcomes in some isolated cases. For coastal inundation consequence levels, information gathered during the workshop was combined with the experience of the study team to derive the overall consequence values. Thus, for each of the coastal assets and each hazard, either of the following were established:

- a generic consequence value, as given in Table 7-6; or
- a consequence value for specific assets where it was apparent from the risk assessment and other values information that a higher or lower consequence should be applied (i.e. because the specific asset or value was determined to be exceptional from other similar assets in the LGA)

The coastal inundation hazard is different from permanent inundation due to sea level rise. The coastal inundation hazard refers to elevated water levels during a coastal storm that may overtop dunes, or penetrate into estuaries, causing flooding of adjacent property. Coastal inundation will be exacerbated over time by sea level rise, causing an increase in the frequency and water depth during such events. However, where possible and relevant, the risk assessment has attempted to consider and incorporate permanent inundation due to sea level rise as part of the erosion and recession hazard. This is because the impacts are permanent, and so, may be expected to have a similar consequence to coastal assets and land.

Table 7-6 Consequence of Coastal Inundation Hazard

Asset Category / Asset Name	Coastal Inundation Consequence Level
Residential, Town Centre and Business	
Residential Property	**Moderate**
Local Centre	**Moderate**
Business Zoned Land	**Moderate**
Rural, Primary Production, Forestry and Industry	
Village	**Moderate**
Rural Landscape	**Moderate**
Primary Production	**Moderate**

Asset Category / Asset Name	Coastal Inundation Consequence Level
Forestry Land	Minor
Industrial Zoned Land	Minor
Other Infrastructure / Services	
Council Operation Land – Bushfire / Depot / Tip	Moderate
Council Operation Land – Quarry / FM Land	Minor
Infrastructure Zoned Land	Minor
Flood Infrastructure	Insignificant
Wastewater Infrastructure	Major
Water Infrastructure	Major
Stormwater Infrastructure	Moderate
Wastewater Dune disposal	Major
Coastal Sand Aquifers	Major
Transport Infrastructure	
Highway / Major Roads	Major
Minor / Local Roads	Moderate
Railway	Major
Airport	Moderate
Community Infrastructure	
Community Buildings / Halls	Minor
SLSC	Minor
Caravan Parks	Minor
Car Parks	Insignificant
Public Recreation (e.g. sport grounds)	Minor
Private Recreation Facilities	Minor
Amenities / Blocks / Sheds	Minor
Heritage	
Buildings and Other Potentially Flood Sensitive Items	Moderate
Non-flooding Sensitive Items / Sites	Minor
Natural Assets	
Beaches	Insignificant
Parks Reserves and Open Space	Minor
Environmental Protection Zones	Minor
Ecological Communities (low tolerance[1])	Major
Ecological Communities (medium tolerance[1])	Moderate
Ecological Communities (high tolerance[1])	Minor
Waterways	

Asset Category / Asset Name	Coastal Inundation Consequence Level
Rivers, Creeks, Lagoons	Insignificant

Table 7-7 Consequence of Coastal Erosion and Recession Hazard

Asset Category / Asset Name	Coastal Erosion and Recession Consequence Level
Rural, Primary Production, Forestry and Industry	
Village	Major
Rural Landscape	Moderate
Other Infrastructure / Services	
Flood Infrastructure	Minor
Wastewater Infrastructure	Major
Water Infrastructure	Major
Stormwater Infrastructure	Moderate
Wastewater Dune disposal	Major
Coastal Sand Aquifers	Major
Transport Infrastructure	
Highway / Major Roads	Major
Minor / Local Roads (no alternate access)	Major
Minor / Local Roads (general)	Moderate
Minor / Local Roads (requiring minor shortening only)	Minor
Community Infrastructure	
SLSC	Major
Caravan Parks	Major
Public Recreation (with built facilities, e.g. bowling clubs)	Major
Public Recreation (general)	Moderate
Car Parks	Moderate
Amenities / Blocks / Sheds	Moderate
Heritage	
Heritage Items (note: adjoining land affected only, not built items of significance)	Minor
Natural Assets	
Beaches	Catastrophic
Parks Reserves and Open Space	Moderate
Environmental Protection Zones	Moderate
Ecological Communities	Major

Asset Category / Asset Name	Coastal Erosion and Recession Consequence Level
Waterways	
Waterways (minimal impact to back beach waterway, i.e. entrance shortening only)	Minor
Waterways (impact on back beach waterways systems, and associated environment, i.e. channel breakthrough)	Moderate

A.1.4 Inundation impacts on Endangered Ecological Communities

Mapping of potential Endangered Ecological Communities (EECs) has been undertaken for the Kempsey Shire. The vegetation mapping program was conducted using high resolution digital imagery. The purpose of the program was to map plant community types for areas likely to contain EECs under the NSW *Threatened Species Conservation Act 1995* (TSC Act). Due to the specific determination criteria of EECs, which sometimes involves elevation, substrate and other environmental conditions, the map does not delineate the presence or absence of EECs but is designed to indicate vegetation types likely to contain EECs and assist with conservation and planning.

The absence of ground truthing of the potential EEC mapping contributes to uncertainty and again the risk approach is well suited as it can serve as a tool to highlight areas that could benefit from further assessment.

Some of the polygons within the GIS had the potential of containing three different EECs. Where this happened the lower tolerance and consequence of the three was adopted.

For the consequence scale in the risk mapping, an assessment of each EEC's tolerance for periodic inundation and saltwater were used to determine the consequence of an inundation event.

Table 7-8 Inundation and salt tolerance for EEC's in the study area

Name	Inundation Tolerance	Saltwater Tolerance
Coastal Saltmarsh EEC	medium	high
Freshwater Wetland EEC	high	low
Littoral Rainforest EEC	low	low
Littoral Rainforest EEC	low	low
Lowland Rainforest EEC	low	low
Lowland Rainforest on Floodplain EEC	low	low
Mangrove	high	high
River-Flat Eucalypt Forest on Coastal Floodplains EEC	high	low
Sub-tropical Coastal Floodplain Forest EEC	low	low
Swamp Oak Floodplain Forest EEC	medium	medium
Swamp Sclerophyll Forest EEC	high	low

Name	Inundation Tolerance	Saltwater Tolerance
Themeda Grassland on Headland EEC	low	low

A.2 Risk Register

A variety of coastal "assets" representing various land uses, facilities and features (including environmental features) of the Kempsey coastal zone were identified based upon Geographical Information Systems (GIS) processing of:

- spatial mapping of land zoning, land tenure, cadastre and aerial photography;
- mapping of stormwater assets, wastewater and water supply assets, heritage items, parks, dune vegetation, public buildings (particularly surf clubs), roads (arterial through to minor / local roads), community services (e.g. child care centres, nursing homes, swimming pools, skate parks, cycleways, etc.), private recreation (e.g. bowling clubs), etc.; and
- details provided on assets through the Risk Assessment Workshop as described in Section 3.4.

The assets identified across the Kempsey coastal zone are listed in Section 5. A series of maps of coastal assets in Kempsey were also generated for use in assigning consequence values from coastal hazards (should they occur). These maps are also included in Section 5.

A.3 Existing Controls

Council is already undertaking various steps to manage some of the existing and future risks identified through this project. These controls are listed in Table 7-9.

Table 7-9 Existing Controls

Risk	Control
Erosion at Crescent Head	Additional rock placement – the rock wall has been recently added
Performance of large scale flood infrastructure with sea level rise	Audit of flood infrastructure
Saltwater intrusion into the coastal sand aquifers	**National Water Commission report Sustainable management of coastal groundwater resources and opportunities for further development** including a comprehensive monitoring data set that offers a useful baseline. This report is further discussed in Section 5.12.
Coastal Inundation	**Kempsey DCP 2013 Chapter B7 – Floodplain Management** The Flood Planning Level for any locality on the Macleay River Floodplain is determined by identifying the 1% AEP flood level (on Australian Height Datum) from the Council adopted flood record plus a freeboard of 0.5 metres. This level is used to set the minimum habitable floor level for residential buildings.
All Coastal	**Climate Change Adaptation Strategy for Nambucca, Bellingen and**

Risk	Control
Hazards	**Kempsey**. This report was prepared under the federal government Local Adaptation Pathway Program (LAPP) designed to support local government in risk assessing climate change and preparing adaptation strategies and resilience building actions. The impacts of sea level rise were a key consideration within the document. The Adaptation Strategy includes a number of recommendations that will be directly considered in the preparation of the Kempsey CZMP. The key relevant actions are: • Limit development and access in areas at high risk of flooding, • Identify suitable locations for the relocation and development of tourist assets (Caravan Parks) away from highly exposed locations, • Develop controls to limit Council's exposure to future legal challenges, • Update risk specifications for Council infrastructure.
Climate Change Impacts on Estuarine and Flood Plain Ecology	**Macleay River Estuary and Floodplain Ecological Study** This report summarises the distribution of mangroves, saltmarsh and seagrass in the Macleay Catchment and discusses the potential impacts of threats including Climate Change and Sea Level Rise on ecological values. Impacts on shorebirds and estuarine fauna are also discussed. Four key recommendations of the report are: • Design and implement monitoring programs for key ecosystems • Design and implement programs to protect and enhance ecosystems and biodiversity • Identify, protect and enhance wildlife corridors • Adjust the local planning framework to incorporate sea level rise predictions These recommendations have been included and expanded upon in the preparation of recommendations for the present report.

Appendix B Potential Management Options

The range of management options have been compiled from various sources including the NSW Coastline Management Manual (1990), NSW Guidelines for Preparing Coastal Zone Management Plans (OEH, 2013), the First Pass National Assessment of Climate Change Risks to Australia's Coast (2009), the NSW Coastal Planning Guideline: Adapting to Sea Level Rise (DP, 2010) and other coastal management plans and studies.

Risks associated with Future Development are different from risks to Existing Development, and therefore different management approaches are required. Figure 5-1 provides a conceptual framework for application of coastal management tools, as explained below. Following are detailed descriptions for the options considered for treating risks to Kempsey's coastline.

For **Future Development**, the management approaches are as follows:

Avoid the risk, by not permitting vulnerable developments within high-risk areas (considered over the full design life of the development);

Accommodate the risk by including provisions that reduce the consequence of impacts (e.g. having minimum floor levels to reduce property damage resulting from future coastal inundation); or

Accept the risk where appropriate to the level of risk over the design life of the development.

Existing development is typically much harder to manage as works and infrastructure are already in place that limits the opportunity for both 'avoiding' and 'accommodating' the risk. Thus, risk management options become either 'protecting' the land or asset, or 'accepting' the potential for damage or loss given the expected timeframe and likelihood of impact. Replacement structures should either be relocated landward, thus progressively retreating from high-risk areas; or redesigned to accommodate the risk, where appropriate. Options for managing existing development therefore include the following approaches:

Protect existing coastal development (private or public) from erosion and recession and / or wave overtopping. Protection may be in the form of hard structures (e.g. seawalls, groynes, offshore breakwaters / reefs, artificial headlands) or soft measures (e.g. beach nourishment). Some protection works can cause impacts to adjacent areas ('offsite impacts'), and therefore, the decision to implement a 'protect' option must consider all potential impacts.

Accommodate the risk, which aims to re-develop or retrofit existing infrastructure, public assets and private property in a manner that minimises losses from potential impacts (e.g. stronger foundations) or avoids losses from potential impacts (e.g. relocatable structures) through careful design; or

Retreat development, which aims to preserve beach amenity by allowing natural retreat due to coastal processes, particularly in response to future sea level rise. The options for existing development involve relocating or abandoning/sacrificing infrastructure, public assets or private property, if and when impacts occur. The retreat options may include compensation to private property owners where feasible and appropriate.

For existing development, it may be useful to identify 'trigger points' for future action rather than recommending immediate management action. This approach effectively defers action until an identified point or event in the future (such as a distance from an erosion escarpment, a frequency of inundation or water level etc.) whereby the appropriate action (protection, accommodation, or retreat) should then be implemented.

It must be noted that setting a trigger point is not an excuse to "do nothing", i.e. undertake no coastal management action at the present time. Planning controls, "no regrets" actions and preliminary investigations must still be undertaken to effectively reduce the scale and cost of risk treatment required in the future. That is, setting triggers without taking action in the present timeframe to reduce the intensity of assets and values within known risk areas only enhances the difficult and costly actions required from future generations. Setting triggers must be accompanied by actions now to prepare the funding and resources required and to reduce the scale or costs of impacts in the future.

No regrets and Preliminary Actions have been devised to support the implementation of existing development (P-A-R) and future development (A-A-A) options and their triggers over the immediate timeframe. Such options offer a range of assessments and works to provide further information (including approvals) required prior to implementing larger scale options for specific assets, particularly where a more costly or difficult option may be needed.

The 'no regrets' options also include activities that will improve resilience and preparedness for coastal risks, without limiting the ability to change a management approach and without negative long term impact should risks change in the future (for example, monitoring and community education).

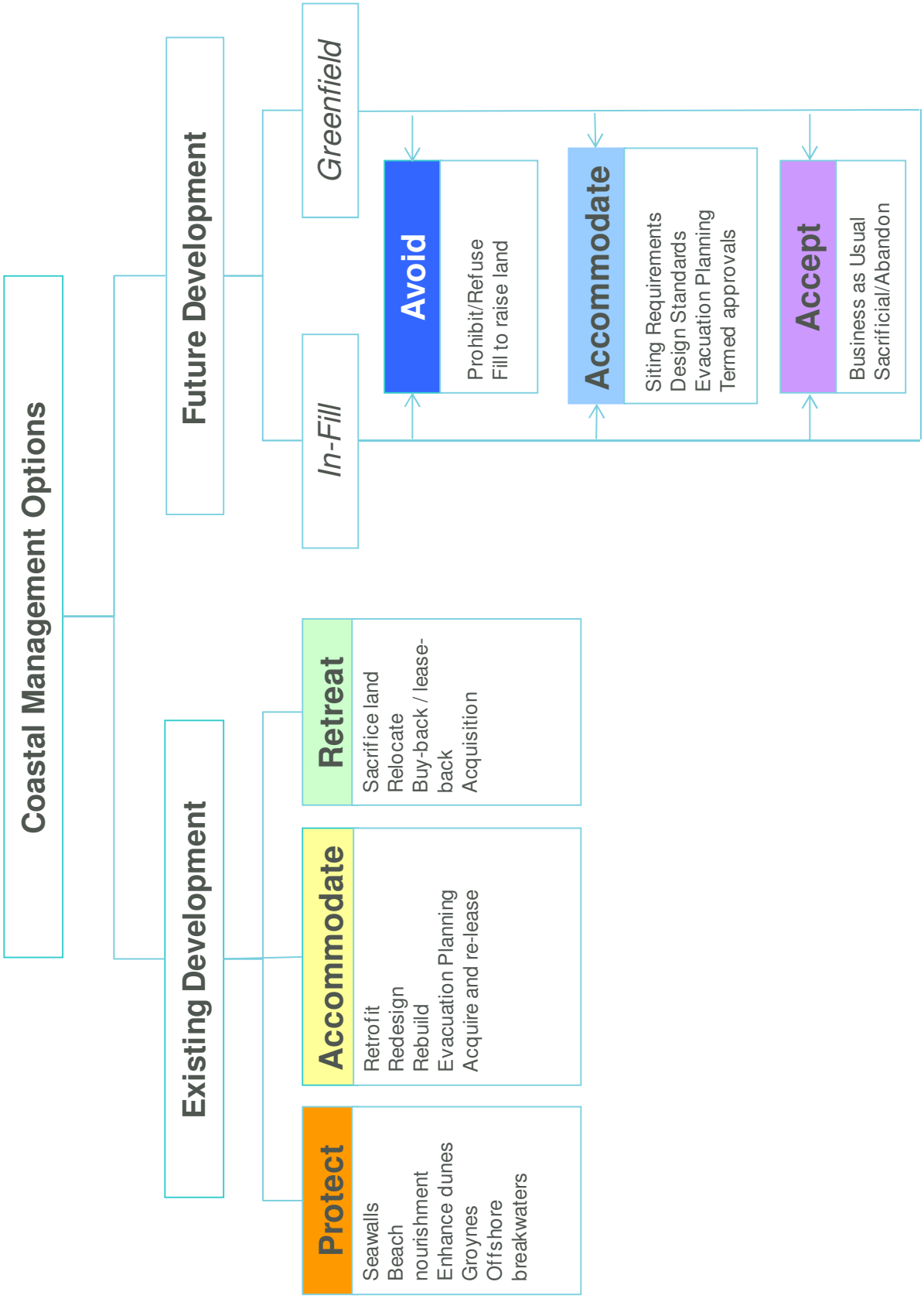

Figure B-1 Conceptual framework for application of management options to address coastal erosion, recession and inundation risks

B.1 Setting Triggers

It is apparent from the risk assessment that some intolerable risks are not expected to eventuate until 2050 or later. In this case, implementing a management action now, particularly where the option is difficult or costly, may be premature and cannot account for the uncertainty of when or to what extent the hazard may actually eventuate in the future.

While a decision regarding future intent is necessary at the present timeframe for intolerable risks, the action may not require implementation at present. Fisk and Kay (2010) provide a method for setting triggers for climate change adaptation actions along a time continuum. The trigger points are set to flag the 'level of acceptable change' where more pro-active or decisive actions must be implemented in order to avoid an undesirable impact. The trigger setting method is demonstrated in the Figure below.

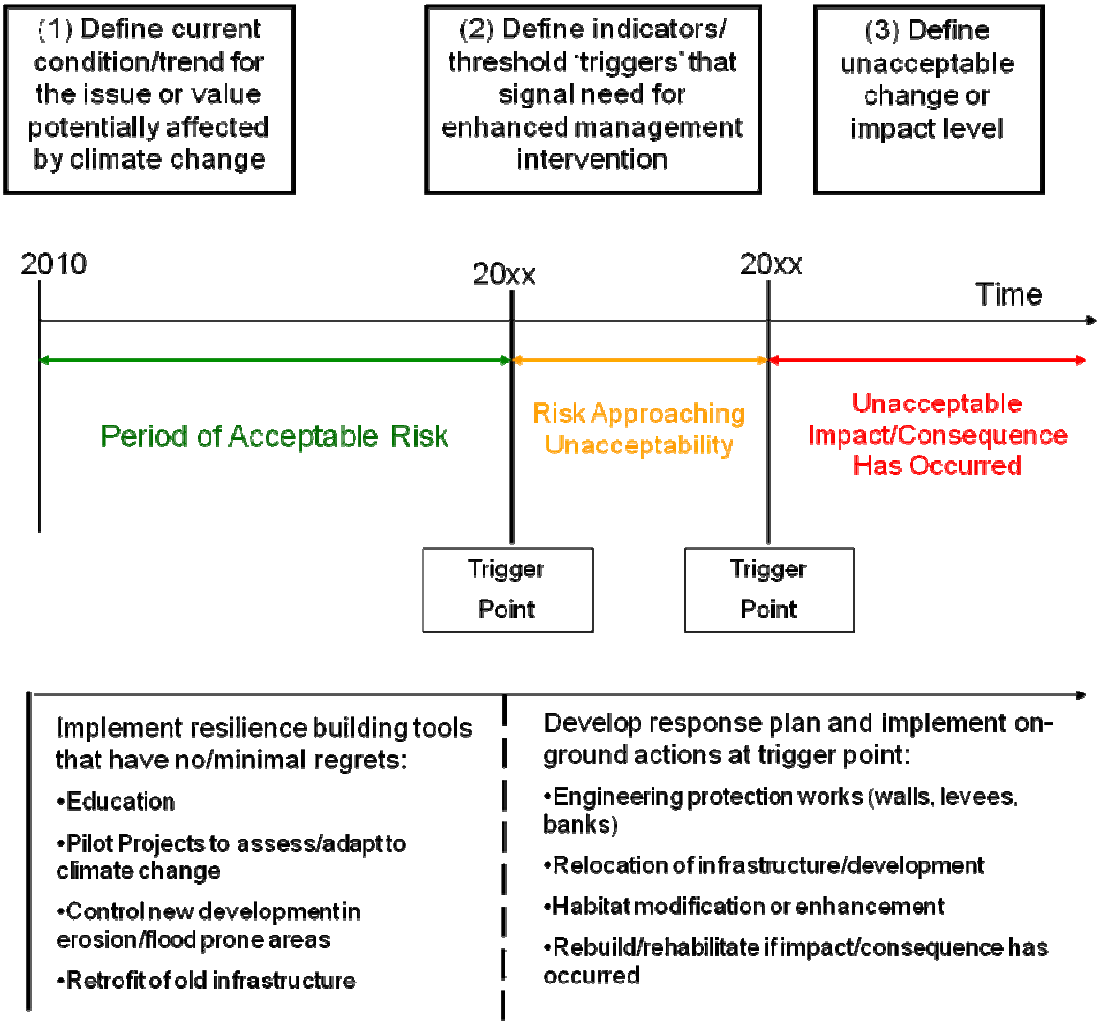

Figure 7-3 Continuum Model for Climate Change Adaption Action (Fisk & Kay, 2010)

Unlike flooding or coastal inundation risks which may occur at any time, recession and erosion tend to occur over years with preceding events giving warning of the approaching threat. Such time warnings can be used to advantage for implementing management options, particularly where the action may be costly or difficult for community to accept or implement.

A triggered approach avoids actions being implemented until it becomes necessary, with time in the interim to improve data/knowledge of the impact, source funding, prepare approvals and formulate designs. It also recognises that some hazard or climate change impacts may not eventuate. If this is the case, then the community has not been unnecessarily burdened by having to adopt costly management responses. Until the trigger is reached, 'No regrets' options should also be implemented to reduce the need for management by future generations (e.g. reducing the intensity of development in at risk areas). The approach adopted within this plan is therefore to apply 'No regrets' actions at the current timeframe and to set triggers for implementing actions for existing developments.

The majority of options suggested within this study are considered to be "No regrets" options, to assist Council in the period of acceptable risk to plan for future implementation of more substantial actions. For options such as the Asset Management Plan and Audit of Existing Assets, it has been recommended that a trigger be set by Council to initiate action. Setting the trigger as a measurable distance (in metres) between an erosion escarpment and an asset is recommended. The trigger distance is set to allow sufficient protection from a typical storm event and a reasonable buffer for an unlikely (infrequent) erosion extent. The buffer should be of a sufficient width to provide the desired treatment option a sufficient time to be funded and implemented, prior to the erosion hazard impacting on the existing asset. Using a distance between the shoreline and a structure is particularly useful for Council, as it does not tie the future action to a specified timeframe. This is particularly relevant to recession impacts due to sea level rise, for which exact timeframes are unknown.

Appendix C Draft Emergency Action Plan

BMT WBM

Kempsey Coastal Erosion Emergency Action Subplan – Final Report

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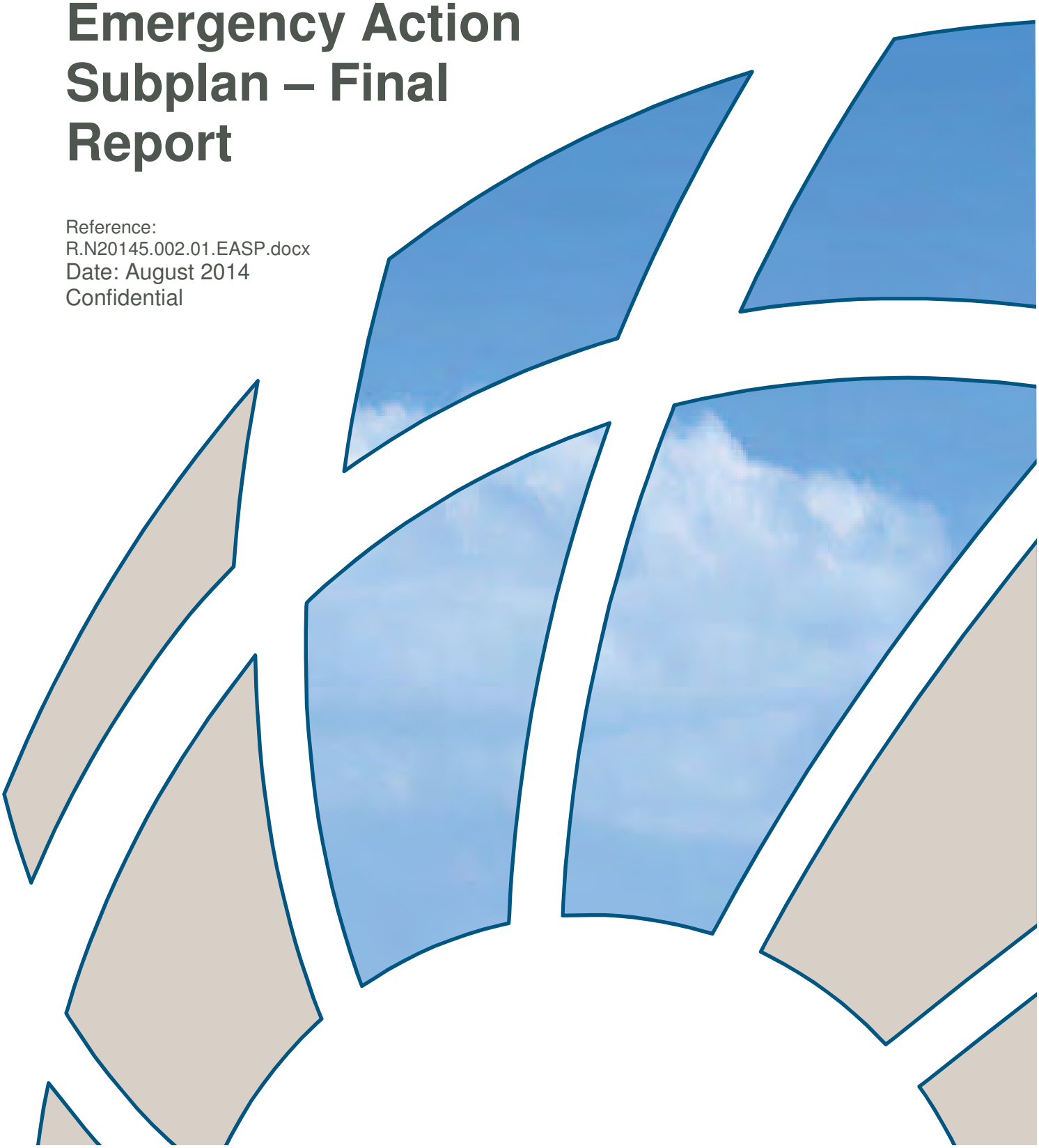

Kempsey Coastal Erosion Emergency Action Subplan – Final Report

Prepared for:	Kempsey Shire Council
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Synopsis: **This Kempsey Coastal Erosion Emergency Action Subpan forms an Appendix to the Kempsey Coastal Zone Management Plan. This subplan outlines actions to be performed before, during and after an erosion emergency event and the roles and responsibilities for coastal emergencies.**

REVISION/CHECKING HISTORY

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Acronyms

CP Act	*Coastal Protection Act 1979*
KSC	Kempsey Shire Council
EASP	Coastal Erosion Emergency Action Sub-plan
LEMC	Local Emergency Management Committee
LEMO	Local Emergency Management Officer
LEOCON	Local Emergency Operations Controller
OEH	Office of Environment and Heritage
SERM	State Emergency and Rescue Management
SERMA	*State Emergency and Rescue Management Act*

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1 Introduction

1.1 Coastal Zone Management Planning

The process for managing coastal hazards and coastal risks along the New South Wales coast is through the preparation of Coastal Zone Management Plans. Through the development and subsequent implementation of these plans, the coastal hazards are identified and, as appropriate, the risks are addressed through a range of planning, design and protection measures. The need for unplanned protection works to manage coastal erosion is reduced and the risk to life and property managed. In this way, the likelihood and consequence of emergencies resulting from erosion during storm events is minimised (as is consistent with the risk management approach including prevention and mitigation measures detailed in the Local Disaster Plan). The residual risks to properties, assets and life until such time as the key elements of the plan have been adopted or as a result of potential unforeseen outcomes or storm severity are covered by this Coastal Erosion Emergency Action Subplan (Coastal Erosion EASP).

The Coastal Erosion EASP is a required component of the preparation of a Coastal Zone Management Plan (CZMP) as set out in the NSW *Coastal Protection Act 1979* (the CP Act). Section 55C(1)(b) of the CP Act states a CZMP must provide for *'emergency actions carried out during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event'.* Section 4 of the CP Act states that the part of a CZMP that deals with the matters specified in Section 55C(1)(b) is an emergency action subplan (OEH 2011, page 1).

1.2 The Role of the Coastal Erosion Emergency Action Sub-plan

"The emergency action sub-plan forms an integral component of a CZMP. It outlines a council's intended response to a coastal erosion emergency and explains ways in which and where beachfront property owners can place emergency coastal protection works according to the Coastal Protection Act 1979 (CPA),"

"Section 55C(2)(a) of the CP Act requires that CZMPs ***must not*** *include matters dealt with in any plan made under the State Emergency and Rescue Management Act 1989 (SERMA) in relation to emergency responses." (OEH 2011, page 1).*

The roles and responsibilities of government agencies, councils and other relevant organisations during severe storm events (including events that cause erosion) are detailed in Section 2.19 of the NSW State Storm Plan (SES, 2013)..

1.3 Extent of the Coastal Emergency Action Sub-plan

The OEH Guide (2011) advises that *"The minimum area to be covered by an emergency action sub-plan would be either:*

- *any area defined by a direction from the Minister according to Section 55B of the CP Act; or*
- *all beachfront margins where erosion is likely to threaten public and private infrastructure or assets.*

The sub-plan may also cover areas of the coastline accessed or utilised by the general public where there is an identified threat posed by erosion, e.g. walking tracks through coastal parkland."

No direction has been issued under Section 55B for the Kempsey Local Government Area (LGA) coastal zone. The extent of this CEEAS is, therefore defined as the coastal margins of the ocean beaches and headlands within the LGA boundaries, extending from Point Plomer (including Big Hill) in the south to Middle Head (including Middle Head Beach) in the north.

1.4 Minimum Requirements for Emergency Action Sub-plans

The Coastal Erosion EASP must be consistent with and not duplicate or contradict any plans prepared under the *State Emergency and Rescue Management Act 1989* (*SERM Act*). The relationship between these two planning frameworks is indicated in Table 1 which has been adapted from OEH, 2011 (page 14).

Table 1-1 Contents of CEEAS and SERM Act plans (adapted from OEH, 2011)

Coastal Erosion EASPs	SERM Act Plans
Any coastal protection works or other actions to be carried out by council when coastal erosion is imminent or occurring, or in recovering from coastal erosion.	Actions in relation to the prevention of, preparation for, response to and recovery from emergencies, excluding permanent or temporary coastal protections works.
Any additional; requirements for landowner placement of temporary coastal protection works beyond those in the *Coastal Protection Act 1979* (e.g. constraints on access and the location of works)*	Actions are consistent with the NSW State Disaster Plan and the State Storm Subplan.

IMPORTANT NOTE* *No locations for temporary coastal protection works in accordance with the CP Act and the Code of Practice associated with temporary works are currently identified in the Kempsey LGA. Council will need to review the revised Code of Practice with future revisions. Should there be permissible locations for landowners to place temporary protection works in Kempsey LGA, this Coastal Erosion EASP will need to be updated after direct consultation with the identified landowners.*

The minimum requirements for a Coastal Erosion Emergency Action Subplan are set out in the NSW Government Guideline (OEH, 2011) which reflects the requirements expressed in the CP Act. These are:

- describing intended emergency actions to be carried out during periods of beach erosion, such as coastal protection works for property or asset protection, other than matters dealt with in any plan made under the *State Emergency and Rescue Management Act 1989* relating to emergency response (sections 55C(1)(b) and (g) of the CP Act *1979*); and
- describing any site-specific requirements for landowner emergency coastal protection works describing the consultation carried out with the owners of land affected by a subplan.

2 Emergency Planning and Responsibility Hierarchy

2.1 Response Operations by the NSW State Emergency Service

There is a clear hierarchy in planning and responsibility that applies to emergency management in NSW, including those emergencies resulting from a storm or disaster as defined at clause 6.1.3 of the NSW State Storm Plan (September, 2013).

The various roles and responsibilities are defined in the NSW Storm Plan and within the Local Disaster Plan (DISPLAN) for the Kempsey Shire, February 2007. Responsibilities for various hazards relating to the open coast are as follows:

- The combat agency for Flood / Storm / Tsunami Hazards is defined in the DISPLAN in Section 8 (Page 21) to be the NSW State Emergency Service (SES), with reference to also be given to the local Flood Plans;
- As the lead combat agency, response operations by the NSW State Emergency Services will begin on the receipt of an Australian Government Bureau of Meteorology (BoM) watch or warning (e.g. Severe Thunderstorm Warning, Tropical Cyclone Watch), or following impact of a storm not covered by a formal warning;
- The NSW SES Region and Local Controllers are responsible for ensuring, as detailed in SES region and Local Flood Plans, that the residents of the region and local areas are aware of the flood, tsunami or severe storm threat and how to protect themselves against it;
- Although NSW SES is the combat agency for storms, they are not responsible for commanding, controlling and conducting physical mitigation works (clause 2.2.32 of the NSW State Storm Plan (September 2013)), which is the responsibility of Council;
- The Local Emergency Operations Controller (LEOCON) or the responsible combat agency can activate response arrangements detailed in the DISPLAN.

Therefore, the DISPLAN informs this Coastal Erosion Emergency Action Subplan (i.e. the Coastal Erosion EASP is a subplan to the DISPLAN).

The role of Council in a storm emergency is to command, control and conduct physical mitigation works that may be requested by the SES to assist with the emergency relief or to activities (including protection works) to protect assets under local Government Council control. Where any proposed protection works to manage coastal erosion emergency events require development approval, Council must only undertake such works during an emergency where the consent has been obtained in advance. Where the works are exempt (such as minor works or emergency works to protect a road or stormwater system under SEPP (Infrastructure) 2007), Council must first undertake an assessment to determine that the works will not result in a significant adverse environmental impact. Before undertaking any works, Council must also confirm that the works proposed are in accordance with the currently gazetted or adopted Coastal Zone Management Plan. *Note: there are no protection works proposed for emergency management purposes under this Coastal Erosion EASP that require development consent.*

Following the emergency, Council is involved in the remediation of damage or hazards and the reinstatement of the dunes, beaches and accessways in an appropriate and safe manner. This will include works of varying priorities and timeframes in accordance with usual Council maintenance procedures.

2.2 Other Coastal Erosion Emergency Response Operations

Where a coastal erosion emergency arises from storm events other than those outlined in Section 2.1, the responsibility to manage rests with Council. Such an event could arise, for example, from a period of high tides and large swell which result in substantial erosion to the back of the beach. For these conditions, it is likely that the resulting erosion would be substantially less than that which would result from a severe declared storm event (unless such an event was to occur immediately following a severe storm event).

It is not possible to determine a trigger for such an occurrence, and therefore, the determination to invoke this Coastal Erosion EASP (in this case by Council) would need to be based on monitoring of the beach state (and assessment by Council officers). In such a case, the Coastal Erosion EASP would be implemented following a request from the designated Council Officer.

2.3 Assets and Development at Threat

The extent of coastal hazards within the Kempsey LGA coastal zone is defined in the Kempsey Coastal Processes and Hazards Definition Study (BMT WBM, 2013). This study maps the landward extent of erosion hazards that may be anticipated for various planning timeframes. Specifically, the landward extent of erosion hazards for the immediate planning horizon are defined in maps included in Appendix B and Appendix D of BMT WBM (2013) and form the basis for defining the extent of the erosion hazard at present.

Within the Kempsey LGA coastal zone the extent of beach erosion at present is typically restricted to the sandy beach, incipient dunes and foredune crest of the beaches. Significant encroachments of the storm erosion extent threatening existing development are limited to township of Hat Head. At this location, development and areas that may be impacted during an erosion emergency generally consist of the:

- southernmost end of Hat Head Beach (including sand dunes);
- Bay Street and defined beach access paths under the control of Council;
- beach vehicle access under care and control of Council;
- Hat Head Surf Club;
- sewerage (pipeline) infrastructure; and
- low-lying parts of Hat Head National Park which include coastal foredune vegetation and estuarine wetland habitat areas.

These exist within an area of known high hazard and are either designed to accommodate the erosion events, or are temporarily affected by erosion, limiting their use by the community (such as beaches and access ways). In each case the opportunity to protect the asset prior to an erosion

event is low and the risk to life during an event is low. Similarly, the opportunity to undertake emergency works during an event is low and the preferred approach is to identify impacts, assess and repair the asset following the event. In most instances this becomes a routine maintenance role.

The landward extent of the erosion hazard as considered in this Coastal Erosion EASP may increase into the future as sea level rises. The impacts on the future revisions of the Coastal Erosion EASP should take this into account at each plan review.

3 Emergency Responses

3.1 Communication

3.1.1 Storm Emergency

Where coastal erosion is anticipated as a result of a watch or warning issued by the BoM, the responsibility for communicating the potential hazards defaults to the SES as the combat agency.. Activation of the DISPLAN would trigger this Coastal Erosion EASP. Council would assist in the provision of information on the current state of beaches as well as potential for impacts on beach access. Internally, Council staff with relevant responsibilities should be placed on standby and commence monitoring the impacts. As described in Section 2.19 of the SES (2013), Local Surf Life Saving Clubs (SLSC) should be contacted with a view to distribute advice contained in the Bureau's weather warnings to people on Surf Life Saving patrolled beaches when dangerous surf conditions are predicted and to close patrolled beach water areas when dangerous conditions caused by storms occur.

As the emergency progresses Council is required to continue monitoring these areas and updating information through the LEOCON as appropriate. Where specific hazards are resulting in damage, Council will provide this information to the SES and for distribution through the media or directly to community as appropriate.

Following the emergency, Council is responsible for advising the current state of beaches and recreation areas in the Council area (when/if they are re-opened for the public). Where residual hazards remain to be addressed, Council should take appropriate action to convey this to local communities including the use of closures, signage and the release of media bulletins via the SES.

3.1.2 Non Storm Erosion Emergency

Where the emergency does not trigger the State Storm Plan or DISPLAN, Council is responsible for initially monitoring the potential progress of erosion and subsequently implementing this Coastal Erosion EASP. The roles and responsibilities of Council in communicating the emergency to the community remain the same except that information needs to be provided by Council directly through the media rather than through the SES as outlined in Section 3.1.1 above.

3.2 Landowner Initiated Actions

Property owners within the immediate erosion hazard line (if present), are permitted to submit development applications to install permanent protection works, provided such works are consistent with the adopted Kempsey CZMP.

Where property owners wish to install permanent protection works (either prior to or during a coastal erosion emergency):

- they must submit a development application for the works;
- they must have a valid approval;

- they must comply with all conditions of consent applying to that approval, before proceeding with the works; and
- Any illegal works placed by a property owner may result in prosecution of the person and removal of the works.

A property owner may be able to undertake minor works to minimise damage to their property and/or dwelling where such works do not require development approval and do not result in adverse impacts. The types of things permitted without consent are unlikely to provide significant protection from any coastal erosion that is occurring but may limit consequent damage, for example: sealing of the space at the bottom of a doorway to limit water entry, repair/replacement of damaged windows, cladding or roofing, clearing of drains, pumping of ponded water, removal of objects from proximity to an escarpment (such as fences, sheds, furniture), etc.

The owner of a property has the right to undertake a wide variety of activities/maintenance in relation to their property which may or may not result from damage during a storm event and which, generally are of a minor nature. As with all activities there is a common law obligation not to cause a nuisance to neighbours or damage to adjacent properties. Generally those works resulting in structural alterations to a building (including demolition or removal), or significant construction (such as a retaining wall or underpinning a structure) or significant earthworks (excavation or placement of fill) would require prior development/building approval.

Temporary coastal protection works are only permitted under the CP Act at locations listed in Schedule 1 of the Code of Practice accompanying the CP Act, none of which exist in Kempsey LGA. Schedule 1 of the Code of Practice accompanying the CP Act was revised in April 2013, in line with the recent amendments to CP Act implemented by the *Coastal Protection Amendment Act 2012*. As part of that revision, the following main changes were made:

- updating the authorised locations where temporary works can be placed to reflect all areas where properties are currently known to be at risk from erosion;
- removal of safety requirements, as landowners should manage safety risks to meet the requirements under the NSW Work Health and Safety Act 2011;
- increasing the allowable height of the works from 1.5 to 2.2 metres;
- allowing temporary works to be placed in front of any existing works (previously prohibited);
- relaxing the specifications for the sand used in sandbags; and
- requiring all sandbags to have a volume of 0.75 cubic metres when filled and to be made from geotextile fabric (no longer allowing smaller woven polypropylene bags), as the smaller bags previously permitted may be too readily damaged and become dangerous.

There are no properties within the immediate erosion hazard lines for the Kempsey LGA and therefore landowner initiated actions are not likely to be required. However, Council is advised to update this Coastal Erosion EASP in consultation with relevant landowners if the erosion hazard increases and/or if any further changes to the code of practice occur in the future.

3.3 Council Actions Prior to a Coastal Erosion Emergency

The following activities would be undertaken by Council prior to the emergency:

- Contribute to community storm education initiatives, and assist the NSW SES with community awareness programs to ensure people in locations potentially threatened by coastal erosion understand the threat and its management;
- Provide NSW SES with copies of coastal hazard studies and management plans to assist with emergency planning and intelligence development;
- Where the likelihood of an emergency event is identified (e.g. Storm warnings or damaging wave warnings from the BoM), the local Lifeguards (or appropriate council representative) will inform the local Surf Life Saving Clubs. The Council Lifeguards and / or the local SLSCs will then take the appropriate action in terms of closing the beaches and/or access roads;
- Where difficulties/damage are known to exist on beach accessways and these are likely to be exacerbated by storm erosion, then Council at their discretion may close those walkways and place appropriate signage;
- Commence monitoring the effects of the erosion on assets and development potentially at threat; and
- As appropriate, the Council Coastal Erosion EASP controller (CEEASP Controller) will initiate the Coastal Erosion EASP.

3.4 Council Actions During a Coastal Emergency

The following activities would be undertaken by Council during the emergency:

- Subject to the availability of adequate resources, assist NSW SES with reconnaissance to identify storm damage; traffic management on Council managed roads; resources (e.g. plant, equipment and personnel); and removal of tree and other debris from Council managed road and public land during clean-up operations;
- Distribute advice contained in weather warnings to people on beaches when dangerous surf conditions are predicted via Council lifeguards;
- Close beach water areas when dangerous conditions caused by storms occur and notify the NSW SES and Surf Life Saving NSW;
- Council activities during a coastal erosion emergency should focus on the safety of Council staff who may be working under adverse weather conditions;
- Where damage to walkways is identified and/or reported to Council, as practical take appropriate action to close off the accessways by installing temporary fencing / signage and/or advising the local community of the hazards at the first opportunity;
- Where damage to assets is identified through monitoring, assess the damage and any opportunities for limiting further damage that may be appropriate during the event. This may include consideration of constructing emergency physical mitigation works to protect public property in accordance with the *Environmental Planning and Assessment Act 1979* and as

detailed in Councils Coastal Zone Management Plan and Coastal Erosion Emergency Action Subplan;

- Where repairs are permissible and may be readily and safely undertaken, this will be done at the first opportunity; and
- At the appropriate time the CEEASP controller will determine that the emergency has passed and that the remediation stages of the plan are to commence.

Note that no actions undertaken by Council during a coastal emergency event should conflict with other agency actions, such as those SES.

3.5 Council Actions Following the Cessation of a Coastal Erosion Emergency

The following activities would be undertaken by Council following the emergency, within their usual maintenance programs:

- Following the erosion emergency, Council will undertake an inspection of all beach accessways, beaches and dunes to establish any damage to the access or dangers to the public in accessing and using the beach and dune areas;
- Where an accessway is considered unsafe, action will be taken to close the access (top and/or bottom) and to place appropriate signage warning the access is unsafe for use;
- Prioritise the work required to repair and reopen any damaged or unsafe beach accessways in accordance with the Council maintenance works schedule;
- Where an erosion escarpment has been created at the back of the beach (height greater than 1.5 m[1]), document the extent of the escarpment and at the earliest opportunity undertake a risk assessment of the likely hazard to beach users (both to persons on the beach and to persons on the dune above the scarp) from collapse of the erosion scarp (for example, onto children digging into the scarp base);
- Where the risk is deemed unacceptable, at the earliest opportunity undertake appropriate mitigation works which may include:
  - regrading the escarpment to a stable slope (following approval from Council's Design section);
  - fencing and signposting escarpments, to discourage public access (top and/or bottom) until such time as the beach recovers naturally; and
  - keeping the beach closed until such time as the risk has reduced to an acceptable level.
- At the appropriate time the CEEASP controller will declare the emergency has finished and the Coastal Erosion EASP is no longer operative.

[1] A height of 1.5 m is specified due to the public safety risk (for example, from a fall or trip from this height or scarp collapse). The action required may simply be to fence off the escarpment until such time as the beach recovers naturally.

4 Responsibilities

Specific responsibilities under the Coastal Erosion EASP are tabulated in Table 4-1.

Council (through the nominated CEEASP controller) must tabulate relevant Council positions and responsibilities for implementation and execution of the Coastal Erosion EASP. This will require an up-to-date list (names and contact numbers) for relevant contacts to be maintained by Council and updated as positions or responsibilities change. This list is to be readily available within Council and communicated to each of the nominated contact persons following any update.

Table 4-1 Specific Responsibilities for Implementation of the CEEAS

Position	Responsibilities
Combat Agency NSW State Emergency Service	Facilitate damage control for storms and with the legislative requirement to protect people from danger, to maintain their safety and health and manage the media during severe weather events.
Local Council	Responsible for commanding, controlling and conducting physical mitigation works. This includes assisting NSW SES with reconnaissance, installing fencing and signage in areas affected by erosion resulting in unsafe conditions, and construction of emergency mitigation works during or after a storm event in accordance with the *Environmental Planning and Assessment Act 1979* (NSW).
Local Emergency Operations Controller (LEOCON)	Execution of the Local DISPLAN, including aspects relating to coastal erosion.
Council Coastal Erosion EASP Controller (CEEASP Controller)	Liaison with LEOCON during storm emergency. Implementation of the Coastal Erosion EASP during non-storm erosion emergency.
Council Recreation Services Manager	Monitoring repair of beaches, dunes and local access roads. Closure of beaches as appropriate. Post storm remediation.
Council Media Liaison Officer	Distribution of warnings and closures to the media via the SES.

5 Plan Review

This coastal erosion emergency management plan should be maintained as required and reviewed at intervals not exceeding 5 years from its initial adoption. Earlier review may be triggered by:

- occurrence of a coastal erosion emergency that exceeds the defined hazard extent as outlined in the Kempsey Coastal Processes and Hazards Definition Study (BMT WBM, 2013) to redefine the extent of the area covered by the Plan;
- revision of the NSW State Storm Plan, the Local DISPLAN (revised each five years) or the Coastal Protection Legislation and associated guides, to ensure the plan remains consistent with their objectives;
- unsatisfactory outcomes or concerns following a coastal erosion emergency; or
- proposed changes to the adopted Coastal Zone Management Plan.

6 References

BMT WBM 2013, Kempsey Coastal Processes and Hazards Definition Study, final report prepared for Kempsey Shire Council by BMT WBM, June 2013.

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SES, 2013. New South Wales Storm Emergency Sub Plan. Volume 1 of the NSW State Storm Plan, September 2013.

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Appendix D

D.1 Risk Based Prioritisation of Options for Large Scale Infrastructure

The Kempsey coastline contains a number of large scale infrastructure and assets that provide for flood mitigation, dune wastewater disposal and aquifer water extraction. The likelihood of impacts on these assets were informed by hazard mapping as described in Section A.1, while the consequences was determined through the Risk Assessment Workshop described in Section 3.4). The results of the risk assessment for the large scale infrastructure is presented in Table 7-10.

Table 7-10 Risk Ranking for Large Scale Assets and Infrastructure

Large Scale Infrastructure Description	Erosion and Recession			Coastal Inundation		
	Immediate	By 2050	By 2100	Immediate	By 2050	By 2100
Floodplain Drainage	Low	Unknown	Unknown	Low	Unknown	Unknown
Big Hill Cut Flood Gate	Low	High	High	Low	Low	Low
Ryans Cut	Low	Low	Low	Low	Low	Low
Rowes Cut	Low	Low	Low	Low	Low	Low
Coastal Sand Aquifers	Low	High	High	Low	High	High
Wastewater Dune Disposal	Low	Low	Low	Medium	Medium	Medium

Appendix E Risk Assessment of Community Use and Amenity Considerations

As well as the threats to the assets along the coast from erosion, recession and inundation into the future, consideration has been given to options aiming to address community use and management issues. These issues were discussed and assessed at the Risk Assessment Workshop. It is anticipated that the CZMP will include a number of actions to address these issues.

E.1 Risk Assessment of Community Use and Amenity Considerations

As discussed in Chapter Appendix A, the standard risk management approach defines the magnitude of risk as a combination of 1) the likelihood of a risk event occurring, and 2) the consequence if such an event does occur.

A slightly modified approach has been used for the amenity and community use issues. This is because in some cases the objective is to address management of existing threats that already have a 'frequency' of occurrence, as opposed to future / unrealised risks that have a 'likelihood' of occurrence. The steps involved in the risk assessment are described below:

- Establish the frequency of occurrence of existing threats. The likelihood was applied by the study team from the scale illustrated in Table 7-11.;
- Establish the likelihood of occurrence for projected future threats at the given time frames (refer A.1.2);
- Establish the consequence of the impact of the threats upon the values of the coast.
- The frequency (or likelihood) and consequence are then combined to determine the level of risk to the coastal values (via a risk matrix, see Table 7-12).

The consequences were identified and ranked by a workshop attended by the Coast and Estuary Management Committee and key Council personnel (described in Section 3.4).

Table 7-11 Frequency Scale used to assess Community Use and Amenity Issues

Scale	Frequency Descriptor
1	Almost Never
2	Rare
3	Infrequent
4	Occasionally
5	Often / continuous

Table 7-12 Risk Assessment Matrix

FREQUENCY (or LIKELIHOOD)	*Risk Assessment Matrix*	CONSEQUENCE				
		1	2	3	4	5
	1	Low	Low	Medium	Medium	Medium
	2	Low	Low	Medium	Medium	High
	3	Low	Medium	High	High	High
	4	Low	Medium	High	High	Very High
	5	Low	Medium	High	Very High	Very High

The resulting risk rating for community use and amenity issues is shown in Table 7-13 As discussed the consequence was established through expert opinion at the risk assessment workshop (refer to section 3.4). The CZMP will focus on the Very High and High risks. There are some minor issues included in the table that were not discussed in detail in the text above.

Table 7-13 Community Use and Amenity Issues Risk Rating

Issue	Risk Rating
Erosion and accretion impact on South West Rocks Surf Club Foreshore Lands	High
Short term erosion and accretion impaction on Grassy Head Beach Access and viewing platform	Very High
Sand accumulation at Hat Head Boat Ramp at Korogoro Creek	High
Fractured Management Across agencies	Medium
Inadequate public access facilities across the LGA coastal zone	Low
Surf Zone Access at Crescent Head	Medium
Trial Bay Boat Ramp Access / conflicts	High
Aboriginal Heritage threatened by inappropriate beach use	UNKNOWN-
Marine Mammals and Shorebirds threatened by inappropriate beach use	UNKNOWN-
Use of ramp upstream in Back Creek (South West Rocks) for Ocean Boat Access	Medium

Issue	Risk Rating
Peak Holiday recreational usage pressure	High
Dogs on beaches	UNKNOWN
Threats to natural rugged coastline values from Crescent Head south to Point Plomer	High
Degradation of dune protection fencing	Low
Lack of disability access	High
Bitou control and maintenance of ecological health of dune vegetation	Medium
Commercial Beach Haulage Activities	High
Recreational four wheel driving	High
Arsenic and Antimony contamination in the coastal zone	UNKNOWN
Seasonal Mutton Bird Carcases on Beaches	Medium
Red Microalgae events at Crescent Head	Medium

Where there is a both the frequent and consequence are largely unknown, the threat will be managed as if it is high, with a focus on actions that increase knowledge of the potential threat.

E.2 Existing Controls

There are a number of existing plans, policies, works and strategic initiatives that already address some of the risks associated with the community use and amenity issues, as listed in Table 7-14.

Table 7-14 Relevant Existing Controls for Community Use and Amenity Issues

Threat	Existing Controls
Commercial fishing activities on beaches	NSW Ocean Hauling Fishery Commercial Fishers Code of Practice for Hauling Activities- this is a voluntary code of practice
Weed invasion in coastal dune areas	Dune Care Aerial spraying
4WD impacts on beaches	Permit system and information brochure
Various	National Parks POM
Threats to the Aboriginal cultural significance	Cultural Management Plan by National Parks
Erosion at Crescent Head	Additional rock placement

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