Ordinary Council Meeting
23 June 2020

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CCL 23/06/2020 - ENDORSEMENT OF THE DRAFT STOCKTON COASTAL MANAGEMENT PROGRAM

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CCL 23/06/2020 - ENDORSEMENT OF THE DRAFT STOCKTON COASTAL MANAGEMENT PROGRAM

ITEM-30	**Attachment A:**	Final Draft Stockton Coastal Management Program.

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FINAL DRAFT

Stockton Coastal Management Program

June 2020

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City of Newcastle

Acknowledgment

City of Newcastle acknowledges that we operate on the grounds of the traditional country of the Awabakal and Worimi peoples.

We recognise and respect their cultural heritage, beliefs and continuing relationship with the land and waters, and that they are the proud survivors of more than two hundred years of dispossession.

Council reiterates its commitment to address disadvantages and attain justice for Aboriginal and Torres Strait Islander peoples of this community.

Disclaimer

City of Newcastle has prepared this document with financial assistance from the NSW Government through its Coastal Management Program. This document does not necessarily represent the opinions of the NSW Government or the Department of Planning, Industry and Environment.

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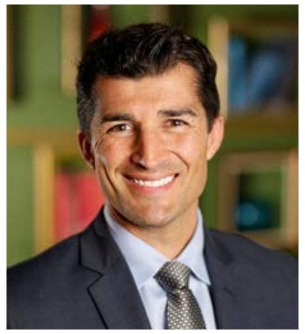
 

We are pleased to bring you the Stockton Coastal Management Program (CMP), a long-term plan for addressing erosion, shoreline recession and other hazards along Stockton's coastline between the northern breakwater of the Hunter River and Meredith Street.

Erosion at Stockton has over time had a devastating effect on the local community and in recent years particularly affected many residents' sense of place in their home suburb.

That's why the Stockton CMP has been developed in partnership with the local community. It is the culmination of more than a decade of community engagement and two years' of working closely with the Stockton Community Liaison Group on ensuring that the management actions proposed to return beach amenity and protect coastal assets, meet community expectations.

With 74% of submissions made during the 28-day public exhibition period supportive of the draft Stockton CMP, the CMP before you is one which both addresses the need to protect assets at immediate risk while allowing for a pathway to mass, offshore sand nourishment in the near future.

Stockton beach is of intrinsic value to the Stockton and Newcastle community, and visitors. There is a strong desire to preserve and protect its natural environment and character whilst responding to a changing climate. We'd like to thank all those who have taken the time to write into us, share their suggestions and help us to form the Stockton CMP. The supportive response we have received will help us to work towards ensuring Stockton beach is enjoyed by the current community and future generations to come.

Lord Mayor Nuatali Nelmes &
City of Newcastle CEO Jeremy Bath

Executive Summary

Local Governments across NSW are preparing Coastal Management Programs in line with State Government legislation to outline the long-term strategy for managing the coastal zone.

Management of the coastal zone presents various and significant challenges, including increasing development pressure and use of the coastal zone, increased impacts from urban pollution on coastal and oceanic environments and the effects of a changing climate on both beach areas and adjoining urban areas.

In response to coastal erosion and relocation of assets, on 17 February 2020 the Minister for Local Government issued a direction under Section 13 of the *Coastal Management Act 2016* (CM Act) that City of Newcastle (CN) submit a draft Coastal Management Program in accordance with the requirements under Division 2 of the CM Act for the coastline at Stockton Beach, to the Minister administering the CM Act, by 30 June 2020 (refer **Supporting Document A**). CN was assisted by the NSW Department of Planning, Industry and Environment (DPIE) during the development of the Stockton Coastal Management Program (Stockton CMP). CN engaged Royal HaskoningDHV to assist with the preparation of the Stockton CMP. Bluecoast Consulting Engineers were also engaged to prepare the Sediment Transport Study, Coastal Hazard Assessment and Cost-Benefit Analysis as supporting documentation.

The Stockton CMP presents a long-term plan for the management of the Stockton coastline that reflects community input, the objectives of CN, and the CM Act, delivering sustained benefits of amenity and coastal protection for the area between the Northern Breakwater of the Hunter River and Meredith Street. The coastal management strategy within the Stockton CMP has been developed using current scientific and economic investigations, which provides an iterative program of adaptable risk mitigation actions to address identified threats and issues that are feasible, viable and acceptable for CN and the community.

The Stockton CMP outlines the strategic aims that guide the management, preservation, improvement, promotion, and rehabilitation of Stockton Beach, and provides specific actions to mitigate identified threats and issues that are to be implemented over the next five years. The CM Act requires Coastal Management Programs to be reviewed at least once every ten years, however, due to the significant hazards identified at Stockton Beach within a five year planning horizon, the Stockton CMP will be reviewed by 2025 to ensure that actions to manage Stockton Beach remain current and relevant.

The intent of the Stockton CMP is to establish a pathway for the delivery of mass sand nourishment to the Stockton area, while simultaneously planning and delivering on the urgent protection of critical public assets in the short-term. This mass nourishment is designed to both return amenity and access to the Stockton coastal zone, while also establishing a sand protection buffer between the ocean and public assets, avoiding the need to build a buried terminal line of defence. To achieve this will require agreement and collaboration from all levels of government.

A sediment transport study for the full Stockton Bight was underway at the time CN received the Ministerial Direction. While not due for completion until late 2020, this study has been able to provide detailed and updated targeted output for the Stockton CMP area.

Targeted analysis from the sediment transport study have shown that the ongoing sand deficit rate within the Stockton CMP area is approximately 112,000 m^3 per year which is significantly higher than previously estimated, and likely to increase with time. This output plays a significant role in the understanding of coastal management along the coastal zone and has been pivotal in defining a sustainable solution.

A probabilistic coastal hazard assessment was undertaken using the targeted findings of the sediment transport study of sediment transport as inputs, which concluded that the Stockton CMP area is currently at high to extreme risk, with public assets at immediate threat requiring urgent protection, as well as private assets at threat over the longer term. This information has formed the basis for the development of the coastal management strategy and actions within the Stockton CMP.

Large scale (mass) sand nourishment has been identified as the only technically feasible solution that sustainably meets CN and the community's objectives of asset protection, beach amenity over the long term. Mass nourishment, with a 10 yearly renourishment period, would provide adequate coastal protection to eliminate the need for coastal protection structures beyond the immediate term.

The volumes of nourishment required to achieve coastal protection range from 1.8 million to 4.5 million m^3 depending on source and renourishment period. If using terrestrial sources, these volumes are neither available, or environmentally, socially or economically viable. Offshore marine sources would provide the most economically feasible solution; however, sand extraction under the *Offshore Minerals Act* 1999, requires authorisation through a mining licence. An applicant cannot apply for a mining licence without the Minister responsible for the *Offshore Minerals Act 1999* inviting applications.

The NSW Deputy Premier has announced the formation of a Taskforce of government agencies, CN and community representatives, to work together to address Stockton's erosion issues, and to consider options to fund long-term solutions. CN is committed to working with the Deputy Premier's Taskforce and the NSW Government to explore all opportunities to source sand for beach nourishment that is affordable and suitable (i.e. meet the technical specifications of CN's Sand Management Guidelines). This includes the permissibility of accessing marine sand, with the goal of mass nourishment to protect and preserve Stockton Beach.

Recognising the objective to provide beach amenity, access and the immediate need to address existing risks, CN will commit $4 million to beach nourishment from terrestrial (or other permissible) sources on Stockton Beach and construct limited buried terminal structures to protect threatened public assets.

Further protection may be required to maintain public assets prior to the resolution of mass nourishment investigations and permissibility, if coastal recession continues. CN will monitor recession and if threshold foreshore widths are reached this will trigger consideration of adaptive risk mitigation strategies including temporary structures, protection structures, managed retreat and opportunistic sand nourishment. CN views protection structures as an unfavourable fall-back plan, if mass nourishment is not achieved, as it would not meet the objectives of the CM Act to protect and enhance natural coastal processes and coastal environmental values, nor maintain public access, amenity, use and safety.

The sediment transport study for the full 32 km Stockton Bight will be completed in late 2020, and will inform the broader Newcastle Coastal Management Program (Newcastle CMP) which will encompass the entire Local Government Area (LGA) from Glenrock State Conservation Area in the south to the Northern boundary of the Stockton Cemetery, and is not due for completion until December 2021 in accordance with the *CM Act*.

The coastal management strategy and actions in the Stockton CMP will be reviewed during development of the Newcastle CMP, and opportunities to further enhance or improve coastal management of Stockton Beach will be identified. CN will endeavour to use other adaptive risk mitigation strategies until the outcome of mass nourishment is a surety or the Newcastle CMP is complete in 2021 and replaces the Stockton CMP.

1. Introduction

Stockton Bight is located to the north of the Hunter River and stretches from the Northern Breakwater (the Breakwater) of the Hunter River entrance, to Birubi Point. Forming the largest Holocene coastal dune system in New South Wales, Stockton Bight extends for a distance of 32 km and across the local government area (LGA) boundaries of City of Newcastle (CN) and Port Stephens Council (PSC) as shown in Figure 1. Stockton Beach and the adjacent Hunter River has been modified over the course of European settlement. Modifications that have impacted the beach response include the construction of the Hunter River breakwaters, capital and maintenance dredging of the navigation channel, revetment construction, beach nourishment, beach scraping and temporary and emergency protection works.

Figure 1: Sediment compartment from Stockton to Birubi Point and Newcastle LGA and Port Stephens LGA boundary

The northern section of Stockton Bight, within Port Stephens local government area, is mainly managed by the Worimi traditional owners in partnership with the NSW National Parks and Wildlife Service, while the southern 4.5 km section is located within the CN local government area (CN LGA).

The residential suburb of Stockton is located on a peninsula at the southern tip of Stockton Bight. The suburb is within the CN LGA with the boundary of the local government area north of the Stockton Centre located at 342 Fullerton Street, Stockton. The northern end of Stockton Beach within the CN LGA is a low-density mixture of land uses including a disability services facility (Stockton Centre), former defence services facility (Fort Wallace), former Hunter Water Corporation (HWC) sewage infrastructure facility, recreation area (Corroba Park) and residential housing.

The central section of Stockton Beach is dominated by the Mitchell Street seawall, which was jointly funded by CN and the NSW Government, between Pembroke Street and Stone Street in 1990-91. The seawall was constructed to protect residential development and infrastructure west of the beach. The central section of Stockton is primarily residential development with public recreation areas south of the Mitchell Street seawall.

The southern section of Stockton is primarily residential with community facilities along the former hind dune areas of the beach south of the Stockton Surf Life Saving Club (SLSC) seawall built and funded in 2016 by CN. These community facilities include the SLSC, Stockton Beach Amenities Building, Lexie's Café Building, Lynn Oval, Tennis Courts, Stockton Bowling Club, and the Stockton Beach Holiday Park. A vegetated dune system was established seaward of the Stockton Beach Holiday Park in the mid-1990s after storm events in 1994 (January and December) and 1995 (March). The Breakwater is located to the south of this dune system. Little Beach is located between the Breakwater and a smaller rock groyne to the south.

The Stockton Beach coastal zone is subject to impacts from coastal hazards such as beach erosion, shoreline recession, coastal and tidal inundation, end effects of existing protection structures and slope instability. Coastal hazards pose a risk to the ongoing use of coastal areas and facilities by the community, as well as amenity and use of Stockton Beach, now and into the future. Other management issues include on-going pressures on the coastal environment from urban development and sea level rise.

1.1 Stockton Coastal Management Plan Area

The purpose and vision for the Stockton CMP follow the Newcastle Coastal Management Program Scoping Study (Scoping Study) (CN 2019).

Direction from the Minister for Local Government on 17 February 2020 (refer **Supporting Document A**) requires CN to submit a draft CMP by 30 June 2020 for the coastline at Stockton Beach. Due to the shortened time frame available for the completion of the Stockton CMP, the spatial extent has been truncated to the coastal zone from the Breakwater extending north to Meredith St on the southern boundary of Corroba Oval, as shown in **Figure 2**. The coastal zone incorporates the coastal foreshore in public ownership and lands affected by coastal hazards. The immediate offshore environment is also included.

It is important to note that the area to the north of Meredith Street Stockton to the LGA boundary will be addressed in the broader Newcastle CMP to be completed by 2021. It is expected that actions within the Stockton CMP will be reviewed and appropriately addressed within the Newcastle CMP, which will replace the Stockton CMP.

Figure 2: Stockton CMP area spatial extent

Purpose

The purpose of the Stockton CMP is to provide an adaptive, integrated and long-term approach to coastal management to address identified risks and ensure developing opportunities can be taken, assessed on their merit and be implemented if advantageous. The Stockton CMP is intended to be subject to regular review to assess the effectiveness of recommended actions.

The Stockton CMP will aim to protect and enhance the coastal zone while balancing the diversity of needs of the community.

Vision

Our coastal environment is protected, enhanced and resilient while maintaining the recreational amenity and sense of identity the coast provides to the community. Through sustainable and integrated management, the coastal zone will provide a liveable and distinct urbanism that strengthens community connections and wellbeing.

Management will be responsive and adaptable to current and future coastal hazard risks, including climate change, to ensure the continued community use and enjoyment of our unique coastal area.

1.2 Time Frame Covered by the Stockton CMP

The Stockton CMP considers a range of timeframes and planning horizons both in completing the risk assessment for known threats, and in terms of the management actions to address these threats both now and into the future.

For certain threats that are likely to change over time, the following future timeframes were considered:

- 2040-2050, where 20 years from present (i.e. 2040) is a regularly applied "short(er)" planning timeframe, and 2050 is and was a commonly applied timeframe for strategic planning purposes;
- 2070-2120, where 50 years from present (i.e. 2070) is a regularly applied planning timeframe, 2120 is a commonly applied timeframe for strategic planning purposes, and consideration of timeframes beyond 2100 is also provided because processes such as sea level rise will continue for many hundreds of years.
- Coastal vulnerability assessments such as storm event, coastal erosion, long term recession and sand losses were based on probabilistic models with set timeframes, providing revised immediate hazard lines and the 1% Annual Exceedance Probability (AEP) hazard line for the immediate (2020), 2025, 2040, 2060 and 2120 planning periods (Bluecoast, 2020a & 2020b).

Management actions were developed as a priority for threats considered to be high or extreme at the present timeframe. Management actions were also developed for future high to extreme threats where the future threat is well accepted and requires planning intervention now in order to adequately manage the future threat.

The CM Act requires Coastal Management Programs to be reviewed at least once every ten years, however, due to the significant hazards identified at Stockton Beach within a five year planning horizon, the Stockton CMP will be reviewed by 2025 to ensure that actions to manage Stockton Beach remain current and relevant.

1.3 NSW Coastal Management Framework

Local councils and public authorities are required to manage their coastal areas and activities in accordance with relevant legislation, and state and regional policies and plans.

The framework for managing the NSW coast as shown in **Figure 3** includes:

- Coastal Management Act 2016 (CM Act)
- State Environmental Planning Policy (Coastal Management) 2018 (CM SEPP)
- Coastal Management Programs (CMPs) prepared in accordance with the NSW Coastal Management Manual.

Other NSW legislation is relevant to the management of the environmental, social and economic values of the coastal zone, including:

- Environmental Planning and Assessment Act 1979 (EP&A Act)
- Local Government Act 1993 (LG Act)
- Crown Land Management Act 2016
- National Parks and Wildlife Act 1974
- Fisheries Management Act
- 1994 Marine Estate Management Act 2014
- Local Land Services Act 2013
- Biodiversity Conservation Act 2016

The relevant regional plans and policies prescribed by these regulations include;

- Hunter Regional Plan 2036 (DPE, 2016). Contains the land use priorities for the Hunter region. It identifies increasing growth in tourism due to local coastal attractions and highlights the need for community preparedness regarding coastal hazards and climate change. The coastal management strategy outlined within the Stockton CMP allows adaptation pathway for coastal hazards and climate change that preserves the recreational value and amenity of the beach as a tourist destination.
- Greater Newcastle Metropolitan Plan 2036 (DPE, 2018). Identifies catalyst areas or dedicated zones for increased population, housing and employment growth. The Stockton CMP area is not identified within this as a catalyst area.
- Local Planning Strategy provides guidance to inform amendments to the *Newcastle Local Environmental Plan 2012.*
- Newcastle Community Strategic Plan 2030. This outlines the main priorities and planning for the LGA for the following ten years. Further detail is provided in **Section 2.1.**
- Fern Bay and Stockton North Strategy 2020. The Strategy seeks to identify opportunities for Fern Bay and North Stockton to create a pedestrian focused place which offers housing diversity, a mixed-use town centre, connected open spaces and community facilities. While outside the Stockton CMP area the plan supports the goals open space and community facilities, and tourism.
- The Stockton CMP is in line with the *Newcastle LEP 2012* which guide the infrastructure, housing, commercial, recreational and conservation land use directions.

Greater detail regarding these strategies is contained within the Newcastle Coastal Management Program – Scoping Study **(Supporting Document B).**

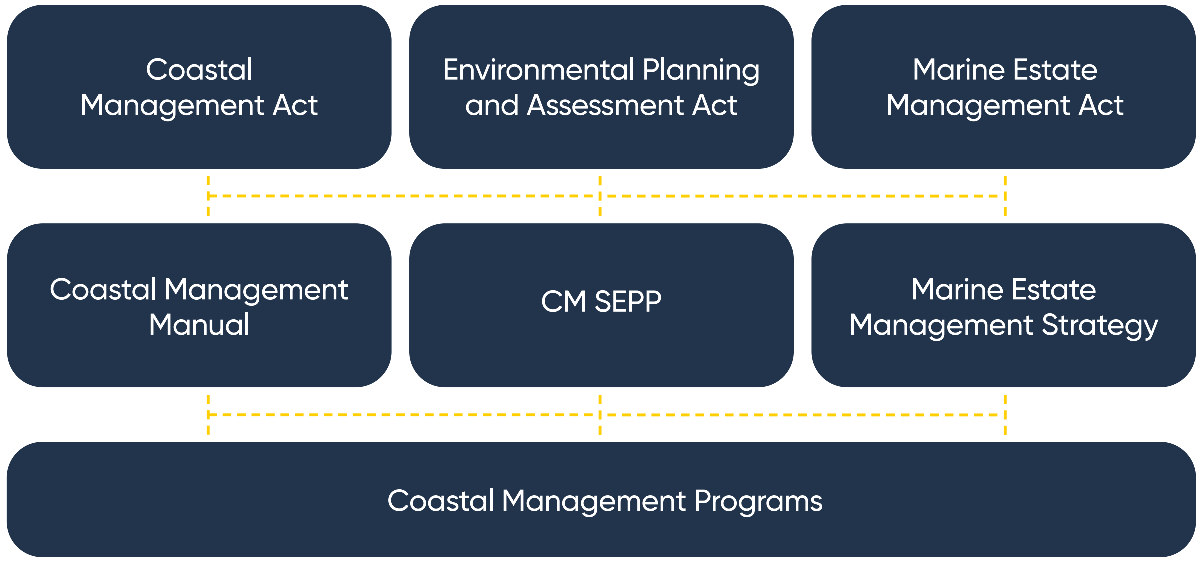


Figure 3: NSW Coastal Management Framework (NSW Coastal Management Manual Part A)

To reduce social conflict and improve effective management of coastal and marine resources beyond existing marine parks, the NSW Government introduced the Marine Estate Management Act 2014 (MEM Act). The MEM Act provides for strategic and integrated management of the whole marine estate. The marine estate includes all marine waters, estuaries and coastal areas. The NSW Government also established a new advisory Marine Estate Management Authority (MEMA).

MEMA has undertaken a state-wide Threat and Risk Assessment (TARA) to consider and prioritise the social, economic and environmental threats to community benefits of the marine estate. The Marine Estate Management Strategy has been prepared to allow a holistic approach to dealing with the cumulative threats to the marine estate. Consistency between the Marine Estate Management Strategy and CMPs is an essential element listed in the Coastal Management Manual (OEH, 2018). Although the state-wide MEMA threat and risk assessment was undertaken at a much broader scale than Stockton Beach, information from the MEMA background reports has been reflected during development of the actions within the Stockton CMP. The Stockton CMP also considers the priority threats identified in the Marine Estate TARA as described in Section 2.2 and within the scoping study **(Supporting Documentation B)**.

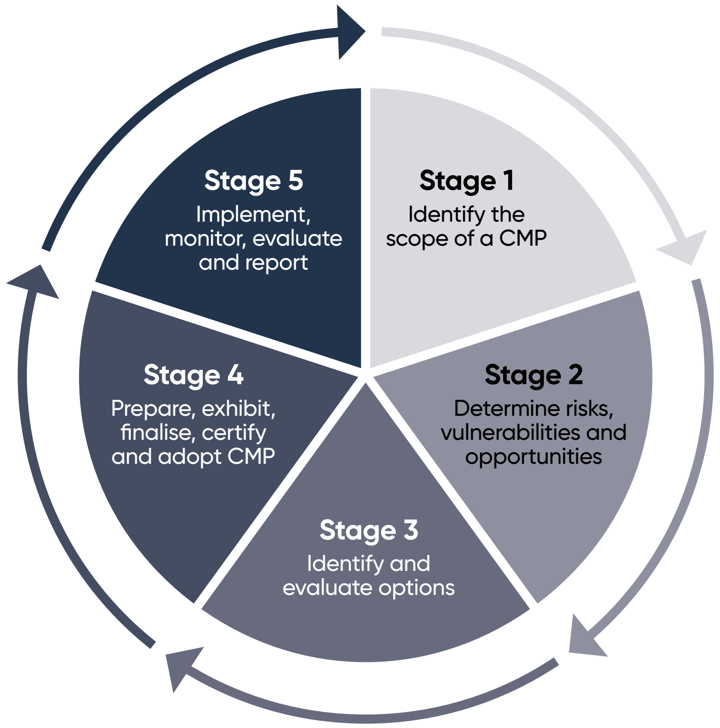


Figure 4: Stages for Preparation of a Coastal Management Program (NSW CMM Part A)

Stockton Beach has been managed under the Newcastle Coastal Zone Management Plan 2018 Part A – Stockton (CZMP), which was prepared under the savings provisions of the Coastal Protection Act 1979 (CP Act) (now repealed). CN's elected Council adopted the CZMP on 24 July 2018, which was certified by the Minister for the Environment on 24 August 2018, however under provisions of the Coastal Management Act 2016 (CM Act), the CZMP will cease on 31 December 2021.

Councils in locations identified as significant open coastal hazards, such as Stockton Beach, may apply for funding throughout the year under the NSW Coast and Estuary Grants Program. Funding is available for works that directly reduce/mitigate coastal hazards related to a significant open coastal hazard site.

The Stockton CMP has been prepared in accordance with the requirements under Division 2 of the CM Act, the provisions of the State Environmental Planning Policy (Coastal Management) (CM SEPP), and the NSW Coastal Management Manual Part A (The Manual) (OEH, 2018).

Many of the Objects and objectives of the Coastal Management Act 2016 (Section 3 of the CM Act) have been considered and promoted via the CMP scoping study (**Supporting Document B**). These have been included as part of the vision of the CMP described in **Section 2**, seeking to protect and enhance natural coastal processes and coastal environmental values including natural character, scenic value, biological diversity and ecosystem integrity and resilience.

A key driving factor during development of the Stockton CMP has been recognising that the local and regional scale effects of coastal processes, and the inherently ambulatory and dynamic nature of the shoreline, may result in the loss of coastal land to the sea, and providing actions to manage coastal use and development accordingly. Through the proposed management actions, CN seek to support the social and cultural values of the coastal zone and maintain public access, amenity, use and safety.

The management actions described in **Section 4** further reflect and promote the Objects and objectives of the CM Act. Particularly; working to ensure coordination of the policies and activities of government and public authorities relating to the coastal zone and to facilitate the proper integration of their management activities, seeking to mitigate current and future risks from coastal hazards, while taking into account the effects of climate change. Plans and strategies within the Stockton CMP seek to improve the resilience of coastal assets to the impacts of an uncertain climate future including impacts of extreme storm events. These includes development of the Stockton Coastal Zone Emergency Action Subplan, described in **Section 7** and included as **Appendix A**.

Council have not identified any requirements for the acquisition of land within the Stockton CMP, as the majority of the coastal zone at immediate risk in Stockton is already owned or managed by public authorities. A table outlining how the Stockton CMP addresses the Mandatory Requirements and Objects of the CM Act, CM SEPP and Manual is provided in **Supporting Document H**, with additional description provided in **Section 5**.

The Stockton CMP identifies priorities and recommends specific actions to manage the coast within the Stockton CMP area from the Breakwater to Meredith Street, Stockton, over a five year timeframe (2020 to 2025). (see **Figure 2**).

Part A of the Manual recommends that councils follow a five-stage risk management process for preparation and implementation of a CMP as shown in **Figure 4**: Stages for preparation of a Coastal Management Program (NSW Coastal Management Manual Part A).

Figure 5: Spatial extent of the Coastal Management Program Scoping Study

During 2019, following the guidance of the NSW Coastal Management Manual Part B: Stage 1 - Identify the scope of a coastal management program, CN developed a Scoping Study for the wider Newcastle LGA that includes the coastal area shown in **Figure 5**. The focus of the Scoping Study area was the coastline and the lower part of the Hunter River estuary, including the Throsby Creek catchment within the coastal zone, and is included as **Supporting Document B**. The Stockton CMP addresses a subset of the area considered within the Scoping Study, and draws heavily on the relevant information provided within the Scoping Study (see **Figure 2**).

Technical studies to analyse sediment transport and coastal processes with the entire Stockton Bight as well as to develop an updated hazard assessment for the Stockton area within the Newcastle LGA in accordance with NSW Coastal Management Manual Part B: Stage 2 – Determine risks, vulnerabilities and opportunities (OEH 2018), were commenced on 14 January 2020. Following the Ministerial Direction on 17 February 2020, outputs of these studies relevant to the Stockton CMP area were prioritised in order to facilitate options analysis (**refer Supporting Document C**).

Stage 2 studies for the Newcastle CMP continue and will be incorporated, when complete, later in 2020.

Investigation and assessment of coastal management opportunities to address coastal hazards within the CMP area were undertaken in accordance with the NSW Coastal Management Manual Part B: Stage 3 – Identify and evaluate options (OEH 2018). Consideration has been given to risks to environmental, social and economic values and benefits through preparation of a Cost Benefit Analysis (Bluecoast 2020b) which are further described in **Section 3.3.1** and included as **Supporting Document F**.

1.4 Community and Stakeholder Engagement

Stakeholder and community consultation regarding the management of the Stockton Coastal Zone has been ongoing for over a decade.

A summary of the key consultation undertaken to date includes:

Year	Consultation Activities
2008	• Community workshop on the Stockton Coastline Management Study
2014	• Consultation with the Newcastle Coastal Technical Working Group on the Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)) and the Newcastle Coastal Zone Management Study (BMT WBM, 2014(b)
2016	• Community workshops during the preparation of the Newcastle Coastal Zone Management Plan • Public exhibition of the Newcastle Coastal Zone Management Plan
2018	• Town hall meeting at Stockton RSL Club venue attended by more than 200 people • Formation of the Stockton Inter-agency Advisory Committee • Public exhibition of Newcastle Coastal Zone Management Plan – Part A Stockton
2018 - 2020	• Formation of Stockton Community Liaison Group and subsequent focus groups – meetings held on an ongoing and regular basis
2018 - 2020	• Formation of the Newcastle Coastal Planning Working Group • Town hall meeting and drop-in session at Stockton RSL Club venue • Public exhibition of the draft Stockton CMP was delivered between 13 May 2020 - 10 June 2020, utilising tools and processes that ensured consultation requirements were meet within the constraints of social distancing and regulated business operations during COVID 19 pandemic. Copies of the draft Stockton CMP were distributed to members of the Stockton Community Liasion Group, accessed via postal requests for hard copies, websites downloads and via local bowling club

Picture 1: Community Consultation – Town Hall Meeting at the Stockton RSL Club

1.4.1 Stockton Community Liaison Group

The Stockton Community Liaison Group (CLG) was formed by the Lord Mayor in February 2018. It consists of a group of leading locals that joined together to share community views and knowledge of local issues with CN and seek a long-term solution to erosion at Stockton Beach. Other NSW Government representatives have attended CLG meetings on an invitation basis. Including Office of Environment and Heritage (now Department of Planning, Industry and Environment), Hunter Water Corporation, Crownland, Worimi Aboriginal Land Council and Port of Newcastle.

The CLG has been meeting frequently since 2018 and continues to meet regularly and advise CN during development of the Stockton CMP. Stockton community representatives of the CLG, including representative from Worimi Local Aboriginal Land Council, provide an information network between CN and the Stockton community to better understand the concerns of the community and provide meaningful feedback towards the development of long-term management solutions to the erosion at Stockton Beach as contained within this Stockton CMP.

Ward 1 Councillors, State MLAs and MLCs, and other agencies are also invited to attend these meetings. The CLG has been integral to CN during the development of the Stockton CMP.

1.4.2 Newcastle Coastal Planning Working Group

The Newcastle Coastal Planning Working Group (NCPWG) was formed in 2019 to provide strategic guidance to the preparation of the Newcastle Coastal Management Program (Newcastle CMP).

The NCPWG comprises members from key government and community stakeholders including representatives from:

- City of Newcastle
- Community representatives (5)
- Department of Planning, Industry and Environment
- Crown Lands
- Hunter Water Corporation
- Transport for NSW
- Port of Newcastle
- NSW National Parks and Wildlife Service
- Awabakal Local Aboriginal Land Council
- Worimi Local Aboriginal Land Council
- Port Stephens Council
- Lake Macquarie City Council
- Other stakeholders are invited to attend as required

1.4.3 Government Agency Stakeholder Liaison

In line with CM Act (2016) statutory provisions consultation has been ongoing with key agency stakeholders throughout the development of the CZMP (2018) and the Stockton CMP (2020). This has included ongoing consultation with Port Stephens Council in relation to the management of the Stockton Bight Sediment compartment.

The following government agencies and key stakeholders have provided feedback to CN throughout the development of the Stockton CMP:

- Department of Planning, Industry and Environment
- Department of Planning, Industry and Environment – Crownland
- Hunter Water Corporation
- Worimi Local Aboriginal Land Council
- Port of Newcastle
- Port Authority of NSW
- NSW National Parks and Wildlife Service
- Defence Housing Australia (re Fort Wallace & former Fern Bay rifle range)
- Department of Family and Community services (Stockton Centre)
- Geological Survey of NSW
- Department of Agriculture, Water and the Environment
- Transport NSW
- Heritage NSW
- Port Stephens Council
- NSW Department of Primary Industries – Fisheries

Additional agencies were consulted in relation to the development of Stockton Coastal Zone Emergency Action Subplan (SCZEAS) 2020 through the Local Emergency Management Committee (LEMC) this included:

- NSW Police
- Ambulance Service
- NSW State Emergency Service (SES)
- Fire and Rescue NSW
- Hunter Local Land Services
- Environmental Protection Authority
- Hunter New England Health
- Surf Life Saving NSW

1.5 Natural Connection Program

Community consultation has been complemented and supported by broader community coastal education and awareness projects under CN's Natural Connection Program. These programs have focused on improving the community's appreciation and understanding of the coastal environment.

CN's Natural Connection Program delivers a range of activities that connects the community to Newcastle's unique natural areas. Since 2016 the issues of coastal processes have been incorporated through engagement, education and community partnership activities. Stockton was a focus of a month of coastal activities as part of Newcastle's World Environment Day 2018 program.

1.6 Community and Stakeholder Engagement Strategy for the Stockton CMP 2020

Effective community engagement and communication are important aspects of the CMP. Engagement with both stakeholders and members of the community has be undertaken through the development of the Stockton CMP in accordance with CN's Community Engagement Policy (CN, 2018(c), in addition to the requirements of the CM Act (2016) and NSW Coastal Management Manual Mandatory Requirements.

The Community Engagement Policy recognises and abides by the best practice principles developed by the International Association for Public Participation (IAP2). IAP2 promotes the values of involving the public in the Government decision making process. CN has adopted the IAP2 Public Participation Spectrum (Table 59) as a core tool to help identify and select the appropriate level of public participation, select methods of engagement, and identify how the public will be involved in the process.

A community and stakeholder engagement strategy considered CN's response to COVID-19 and associated impacts on the community engagement program.

The key communication principles of the Stockton CMP engagement program were to:

- Communicate clearly the complexities of coastal erosion and coastal processes
- Provide accessible options for the community and stakeholders to share their feedback
- Educate the community on the CMP process and the opportunities available to provide their feedback
- Ensure members of the community without computer access or unable to leave their households to be able to share their feedback
- Encourage feedback from the local Stockton community in addition to the Hunter community and stakeholders

The community engagement program was delivered in 3 stages:

- **Stage 1** - Prior to the onset of the community exhibition period commencing on 13 May 2020
- **Stage 2** - During the community exhibition period from 13 May – 10 June 2020 (28 days)
- **Stage 3** - After the closure of the community exhibition period on 10 June 2020 ahead of the Stockton CMP being considered for certification

The following methodology was utilised through stage 1 (pre-exhibition);

- Printed materials – Flyer and frequently asked questions (FAQ)
- Stakeholder Meetings – Agency and CLG and focus group meetings
- Online – Website Updates and 'Ask an Expert' Coastal Education videos
- Media Release

A summary of the engagement methodology utilised during stages 2 and 3 is contained within **Section 10** and **Supporting Document G**.

In March 2020, the NSW Deputy Premier announced the formation of a Taskforce of Government Agencies, CN and community representatives, to work together to address Stockton's erosion issues and to consider options to fund long-term solutions. Further, the Taskforce is intended to look at options for sand nourishment, including from marine sources, as well as provide solutions to inter-agency approvals processes.

2. A Snapshot of Issues

2.1 Community Values and Issues

The Newcastle 2030 Community Strategic Plan (CN 2018) was adopted by CN on 26 June 2018 and includes seven strategic directions for the future of the Newcastle LGA. While all seven strategic directions have relevance to coastal zone management three directions are particularly pertinent and guide CN's coastal planning and management documents, being: protected environment; vibrant, safe and active public places, and liveable built environment. How the Stockton CMP management actions address the goals and objectives of the Newcastle 2030 Community Strategic Plan is outlined in the business plan in **Section 6.**

Strategic Direction: Protected Environment

The protected environment strategic direction is supported by the Newcastle Environmental Management Strategy 2013 (NCC 2013), which outlines three objectives and the strategies to achieve these:

- Greater efficiency in the use of resources
- Our unique environment is maintained, enhanced and connected
- Environment and climate change risks and impacts are understood and managed

Strategic Direction: Vibrant, Safe and Active Public Places

The vibrant, safe and active public places strategic direction is supported by the Parkland and Recreation Strategy (NCC 2014) which includes four strategic directions, and an action plan to deliver

each of these:

- Equitable provision and development of facilities
- Efficient management of facilities
- Partnership development
- Promotion of facilities and opportunities

A key planning document for the coastal zone as part of the vibrant, safe and active public places strategic direction is the Newcastle Coastal Revitalisation Strategy Master Plan (Urbis, 2010).

Strategic Direction: Liveable Built Environment

The liveable built environment strategic direction is supported by the Local Planning Strategy (NCC, 2015), which in turn informs the Newcastle LEP 2012. Heritage management within the coastal zone is supported by the Heritage Strategy 2013-2017 (NCC 2014).

As **Section 1.4** outlines consultation has been ongoing within the Stockton community for over ten years.

Through these activities CN has identified strong opinions regarding Stockton Beach that have been incorporated in **Section 3**, including:

- The beach is highly valued and represents a critical asset to the local community
- The preference to maintain a clean beach area providing enough width for recreational space, including uses such as nippers, and which supports the current foreshore amenity and character
- Stockton has a strong surf culture with a desire to maintain surf amenity nearby the residential areas
- The preference to ensure any nourishment programs utilise sand that matches the existing visual profile of Stockton Beach
- The preference to maintain beach connectivity along the entirety of the beach

The consistent issue that has been raised by the community (and that has been identified in the CZMP) is the replenishment of sand on Stockton Beach to address beach erosion events and shoreline recession including repair and remediation of beach access and beach amenity.

The priority management objectives have not changed since the CZMP was completed in 2018. The coastal management strategy and actions within the Stockton CMP have been developed to be an iterative program that reflects the objectives of CN, the community, and the CM Act, delivering long term benefits of coastal protection and amenity.

The purpose of the Stockton CMP is to outline proposed long-term actions that will be implemented to further address the following six key issues:

- Coastal hazards
- Coastal environment
- Beach access
- Beach amenity
- Recreational use of the coastal zone
- Culture and heritage

2.1.1 Social and Cultural

The residential suburb of Stockton is located on the peninsula at the southern end of the larger embayed section of sandy coast known as Stockton Bight. Stockton's sense of identity is strongly connected to the community's relationship and ability to interact with the beach and coastline. The beach is heavily utilised for both passive and active recreation for residents and visitors. The ongoing loss of the beach is felt acutely by all levels of the community and represents a deep-seated concern.

The suburb comprises 360 hectares of land area and a population of 4,179 with a population density of 12.32 per hectare (CN, 2019). A forecast model was used to analyse the potential population and dwelling growth for the Newcastle Coastal Management Program - Scoping Study **(Supporting Document B)**. While the Newcastle coastal zone is projected to increase in population by 10,368 people in the period 2018-2041, the Stockton CMP area has not been identified as an area for high growth (CN, 2019). This model is supported by the Greater Newcastle Metropolitan Plan 2036 that does not identify the Stockton CMP area for significant changes in population, land use or employment.

The measurement of income provides a potential indicator of wealth within communities. Data from the 2016 census illustrated that despite being a beachside suburb the median weekly household income for Stockton ($1,226/week) which is below the medium income for the Newcastle coastal zone ($1,426/week). However, Stockton has the highest rate of dwelling ownership at 30% (CN, 2019).

CN anticipates that the coastal public land parcels and assets will see recreational demand in line with projected population growth. The southern section of Stockton is primarily residential and accommodates the beach front Stockton Beach Holiday Park. Community facilities exist along the former hind dune areas of the beach, including the Stockton Surf Life Saving Club, Lexie's Café building and Lynn Oval. The beach is popular for primarily locals and visitors from the Hunter Valley for activities including swimming, fishing, nippers, beach going and surfing. Visitation data for Stockton Beach is limited but based on a seasonal head count conducted by CN's Aquatic Services and projected population growth it is estimated that approximately 100,000 people currently utilise the beach annually. In addition, no beach user survey information (e.g. frequency, duration, purposes, expenditure, etc.) was available for this study. The Stockton CMP will support the current and projected use of these recreational assets.

Newcastle has two archaeological management plans, prepared in 1997 (Suters Architects) and 2003 (Higginbotham and Associates) for the Newcastle area. As an early colonial settlement, there are multiple historical shipwrecks along the Stockton Peninsula area, and some of these sites have recently been exposed off Stockton Beach (e.g. *Durisdeer* and *Berbice*). The North Stockton Breakwater was built over the remains of at least 11 wrecks (including the *Adolphe*). There is also a large offshore ships graveyard (where vessels were deliberately scuttled) located off Newcastle. Other historical items are the tanks traps associated with the defence of Stockton Beach along with the multiple Royal Australian Army amphibious vehicles (LVT4A tanks and DUKWs) which are located offshore of Stockton Beach (Heritage NSW, 2020).

Aboriginal people's connections to the coastal area are long-standing and involve a complex interaction of spiritual links, customary obligations to care for Country and the sustainable use of resources. *Sea Countries of NSW: A benefits and threats analysis of Aboriginal people's connections with the marine estate (Sue Feary, 2015)* outlines historical and contemporary benefits derived from the coastal area from various Aboriginal communities in NSW.

There are no Native Title claims under the Native Title Act 1993 (Cwlth) within the Stockton CMP area. However, within the Newcastle scoping study area there are 51 Aboriginal lands claim under the Aboriginal Land Rights 1983 (NSW). These Aboriginal land claims include portions of terrestrial Crown Land at Stockton and aquatic areas including the seabed off Stockton Beach.

2.1.2 Environmental

The coastal environment has been heavily modified within Stockton by historical activities and construction of infrastructure and dwellings. Dune systems remain along the coastline to the north of the former HWC sewage treatment plant at 310 Fullerton Street, but are owned by various State Government departments. These dune systems mainly comprise sand scrub vegetation including Coast Banksia (Banksia integrifolia), Coast Tea-Tree (Leptospermum laevigatum) and Old Man Banksia (Banksia serrata) with the shoreline predominantly consisting of Beach Spinifex (Spinifex sericeus).

South of the former HWC sewerage treatment plant the coastal vegetation community is highly modified with urban parklands and open spaces dominated by exotic grasses and planted landscape species such as Norfolk Island Pine (Araucaria heterophylla). Dune system vegetation has been re-established east of the Stockton Beach Holiday Park and at Pitt Street Reserve at the back beach area of Little Beach. The extent and condition of vegetation within CN owned and managed properties on Stockton Bight are detailed in the City of Newcastle Coasts and Estuary Vegetation Management Plan (Umwelt Pty Ltd, 2014).

CN has also undertaken an ecological audit of the beach environment (UoN, 2018). This study included the Stockton CMP area and will continue to inform further beach management approvals and activities, such as beach scraping.

Picture 2: Stockton SLSC Interbranch Event 2018. Stockton Beach

2.2 Initial Risk Assessment

The CMP Scoping Study completed an initial risk assessment for 160 locations across the Newcastle coastal zone. Section 9 of the CMP Scoping Study provides an assessment and evaluation of cumulative risks to assets across the Newcastle LGA, with reference to the previous risk assessment undertaken in the Newcastle Coastal Zone Management Study (BMT WBM, 2014(b)) and assessment by CN staff. The risk assessment was adapted from the Threat and Risk Assessment Framework for the NSW Marine Estate (MEMA, 2015) that was applied in the NSW Marine Estate Threat and Risk Assessment Report (BMT WBM, 2017(b)). The risk assessment considered priority threats from the NSW Marine Estate Threat and Risk Assessment Report (BMT WBM, 2017(b)) and coastal management issues as part of the overall assessment.

Threats were classified from minimal to high at three time periods; immediate, 2050 and 2100. The following table describes the coastal management issues with higher risk identified for Stockton.

Location	Coastal management issues	Comments
Stockton Beach – Northern end	Beach erosion and shoreline recession	Coastal erosion represents an immediate high risk for properties such as the Barrie Crescent Reserve and the former Hunter Water sewage treatment plant. Ongoing erosion will increase potential properties at risk into the future
	Invasive species	Species such as Bitou Bush are rated as a moderate risk
Stockton Beach – Central section	Beach erosion	An increasing risk of beach erosion is identified at the buried terminal ends of the Mitchell Street seawall in particular the dune system between Mitchell Street seawall and Memorial Reserve and Dalby Oval
	Coastal inundation	Coastal inundation is reasonably understood with emergency actions detailed in the Coastal Zone Emergency Action Subplan within the Stockton CMP
Stockton beach – Southern end	Beach erosion	High environmental and economic risks to the dune system seaward of the Stockton Beach Holiday Park. The risk profile is minimal or low for properties landward of the recently constructed seawall at the Stockton Surf Life Saving Club
	Coastal inundation	Coastal inundation is reasonably understood with emergency actions detailed in the Coastal Zone Emergency Action Subplan within the Stockton CMP

Table 1: Risk profile overview (Scoping Study)

2.3 Coastal Processes and Hazard Assessment

In line with the Coastal Management Act 2016 and the Manual, a probabilistic coastal hazard assessment for Stockton Beach has been undertaken. CN engaged Bluecoast and their sub-consultants Salients to undertake the coastal hazard assessment. The hazard assessment is limited to the area north of the Breakwater (northern training wall of the Hunter River), and the northern boundary of the Stockton Centre, which marks the boundary of CN's Local Government Area (see **Figure 2**).

Relevant sections of the coastal hazard assessment are discussed throughout the Stockton CMP, and the full report is included in **Supporting Document C**.

The hazard assessment for Stockton Beach (Part B) was undertaken concurrently to a sand transport study for Stockton Bight (Part A), namely the 'Stockton Bight Study'. During Stage 1 of the Newcastle Coastal Management Program (CMP) processes, CN identified the need for these two investigations. The two studies are being delivered as part of Stage 2 of the Newcastle CMP.

In addition, a cost benefit analysis (CBA) has been undertaken for the Stockton CMP informed by findings of the Part A and Part B investigations (Bluecoast, 2020c). Due to the time constraint imposed by Ministerial direction to prepare a CMP for Stockton Beach, the CBA was fast-tracked and undertaken concurrently to the Part A and Part B investigations incorporating information readily available during the study time frame.

Furthermore, the studies were undertaken during State and Federal Government enforced restrictions on public gatherings, in response to the COVID-19 pandemic. This has meant, for example, that a proposed stakeholder workshop could not be completed to inform the risk assessment. However, during the public exhibition period CN undertook extensive consultation through social media and direct mail out that generated 175 submissions and these have been documented in **Supporting Document G.**

Necessary assumptions were made through desktop review of previous hazard assessments and relevant literature, and are described in more detail where relevant to this report.

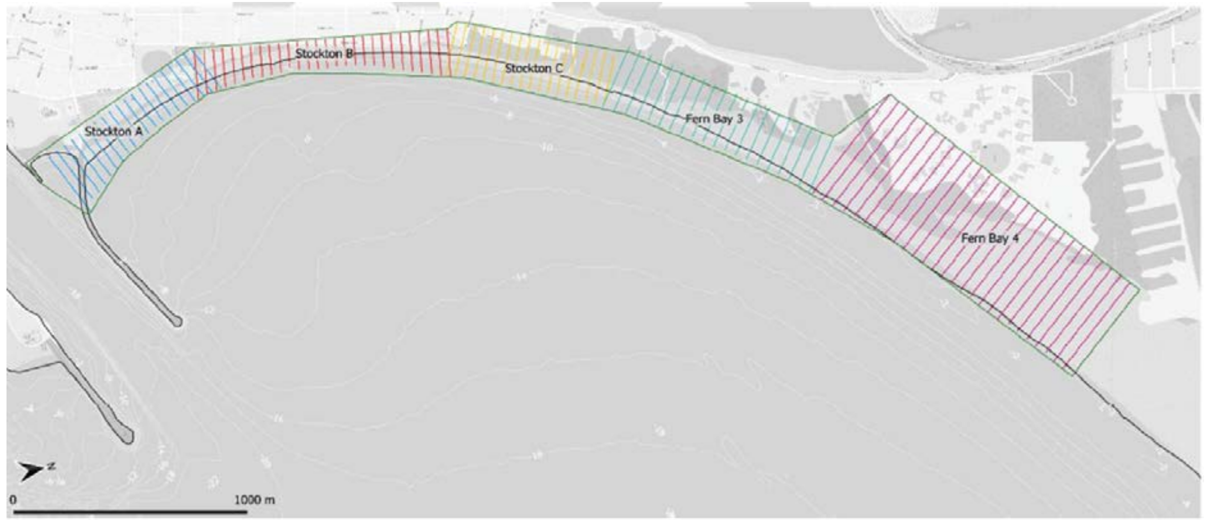


Figure 6: Coastal hazard assessment study area and NSW photogrammetry blocks and transects (coloured lines) at Stockton Beach.

2.3.1 Previous Hazard Assessments

A deterministic coastal hazard assessment for Stockton Beach was undertaken by DHI in 2006 and a reassessment of the 2050 and 2100 hazard lines by DHI in 2011. More recently, an LGA-wide Coastal Hazard Assessment was undertaken for CN by BMT WBM in 2014. This study mapped coastal hazards using a risk-based approach that defines the likely extent of the hazards for 2014, 2050 and 2100 planning periods.

However, the likelihoods for the erosion hazard were qualitatively assigned by combining estimated storm erosion and long-term recession values. The storm erosion extent was adopted as the most-eroded profile in the photogrammetry data while long-term recession was determined using a simplified numerical modelling approach and analysis of photogrammetry data (see **Figure 6**).

The probabilistic assessment that informs the Stockton CMP includes the following updates to the hazard assessment approach:

- A detailed, quantified coastal processes investigation as part of the Part A - Stockton Bight Study
- Being undertaken in parallel (Bluecoast, 2020a)
- Recommendations set out in the Manual (OEH, 2019)
- Probabilistic modelling approach to account for uncertainties in the coastal processes definitions and provide robust risk levels (likelihoods), i.e. not qualitatively assigned
- Use of high quality 2020 and 2018 topography data as baseline
- Latest sea level rise projections
- Consideration of built coastal protection structures

2.3.2 Stockton Bight Study

Beach erosion processes and quantitative sediment transport estimates for the coastal zone within the Stockton Bight sediment compartment are currently being assessed as part of the Stockton Bight Study (Part A) in Bluecoast (2020a) (refer **Supporting Document C**). A brief summary of the relevant findings to inform the Stockton CMP, as discussed in **Section 1.3**, is presented in the following paragraphs.

Stockton Beach and the adjacent Hunter River has been modified over the course of European settlement. Modifications that have impacted the beach response include the construction of the Hunter River breakwaters, capital and maintenance dredging of the navigation channel, revetment construction, beach nourishment, beach scraping and temporary and emergency protection works.

Stockton Beach has been the subject of numerous studies to assess coastal processes. However, further investigation has been identified as necessary to underpin the identification of appropriate options for management of coastal hazards on the Stockton coastline. Based on the Stage 2 sediment transport studies completed at this time, a summary of the most relevant processes is provided below.

A key knowledge gap identified in the Scoping Study (CN, 2019) was to determine the changes in the sub-aqueous part of the coastal profile. An assessment of the change in the sand volume in the Stockton Beach area was undertaken. This assessment found both the sub-aqueous and sub aerial profiles to have changed. The combined rate of long-term sand loss from the Stockton CMP area is recommended as 112,000m^3/year, which is based on the historical observations of:

- 12,000m^3/year of sand loss from sub aerial part (i.e. the land-based part above 0m AHD) of the coastal profile in Block A, Block B and Block C (refer **Figure 11**) between 1985 and 2020
- 100,000m^3/year of sand loss from sub aqueous part (i.e. the part below the water approximated by 0m AHD) of the coastal profile in Compartment 4 and Compartment 5 (refer **Figure 9**) between 1988 and 2018

These rates do not account for placement of dredged material by Port of Newcastle (PoN) in the nearshore zone. Between 2009 and 2019 approximately 33,000m^3/year of sand dredged from so-called Area E near the entrance to the port was placed off Stockton Beach. Had this sand not been placed as beach nourishment the rate of sand loss from these compartments would have been higher.

A timeseries showing the sub-aqueous sand volume change in Compartments 4 and 5, offshore of Stockton Beach is shown in **Figure 7**. Over the 152-year record, over 8 million cubic metres of sand has been lost from Compartments 4 and 5.

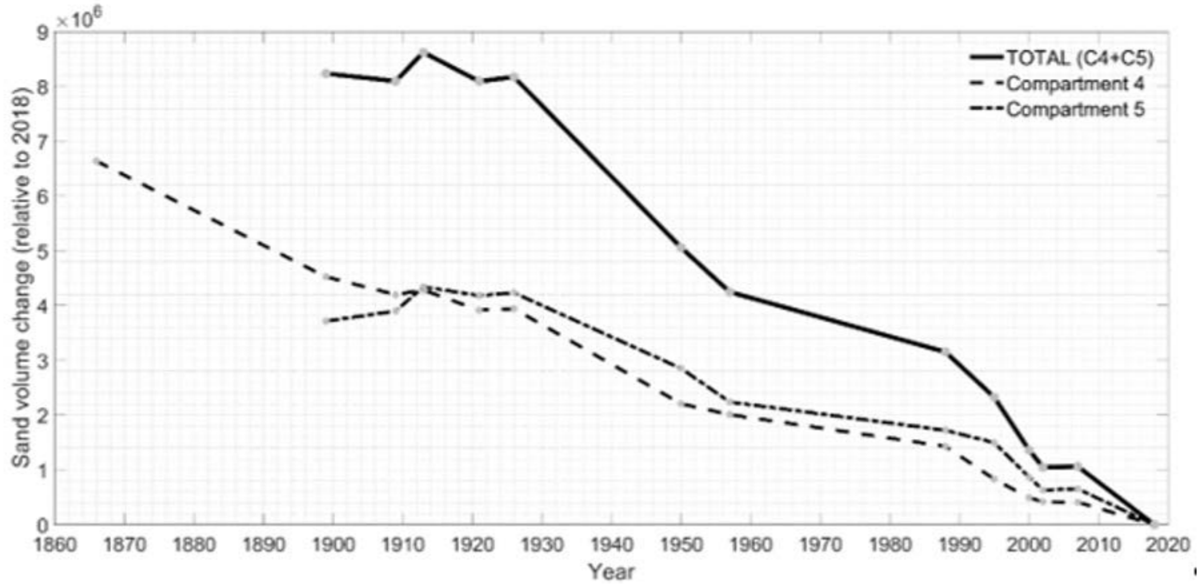


Figure 7: Long-term sand volume change at Stockton Beach (Compartments 4 and 5).

Figure 8 provides an example plot of the coastal profiles observed in selected surveys from 1816 to 2018 at a profile located near Meredith Street.

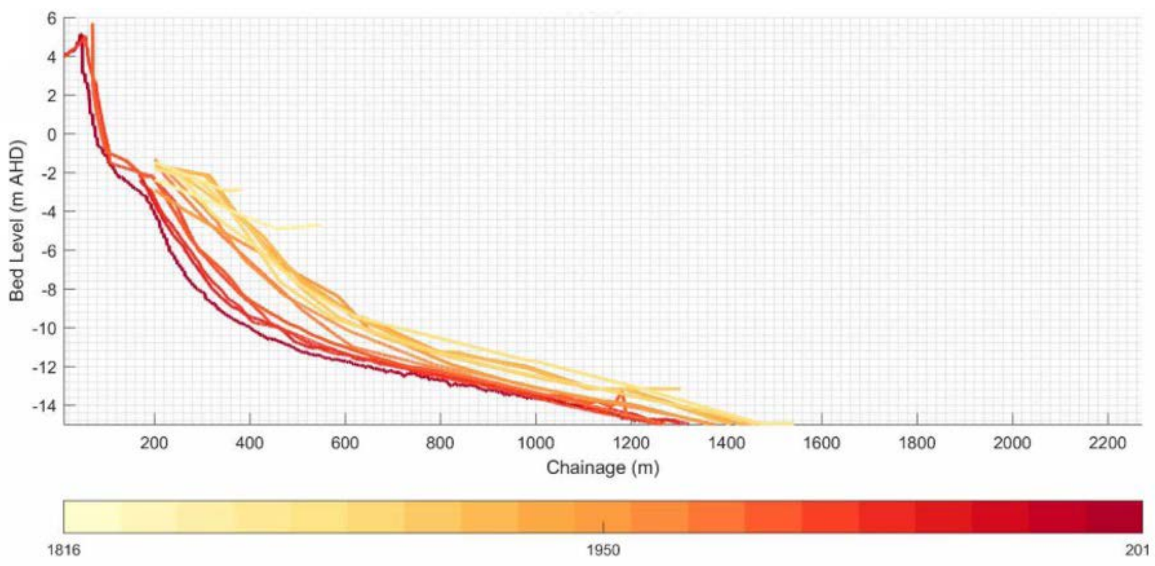


Figure 8: Historical coastal profiles historical bathymetric surveys at profile location near Meredith Street.

Maps of the changes in seabed levels relative to 2018 were produced for selected surveys with an example from 1988 to 2018 shown in **Figure 9**. In these maps, red indicates areas where the seabed has eroded and blue areas indicate areas of accretion.

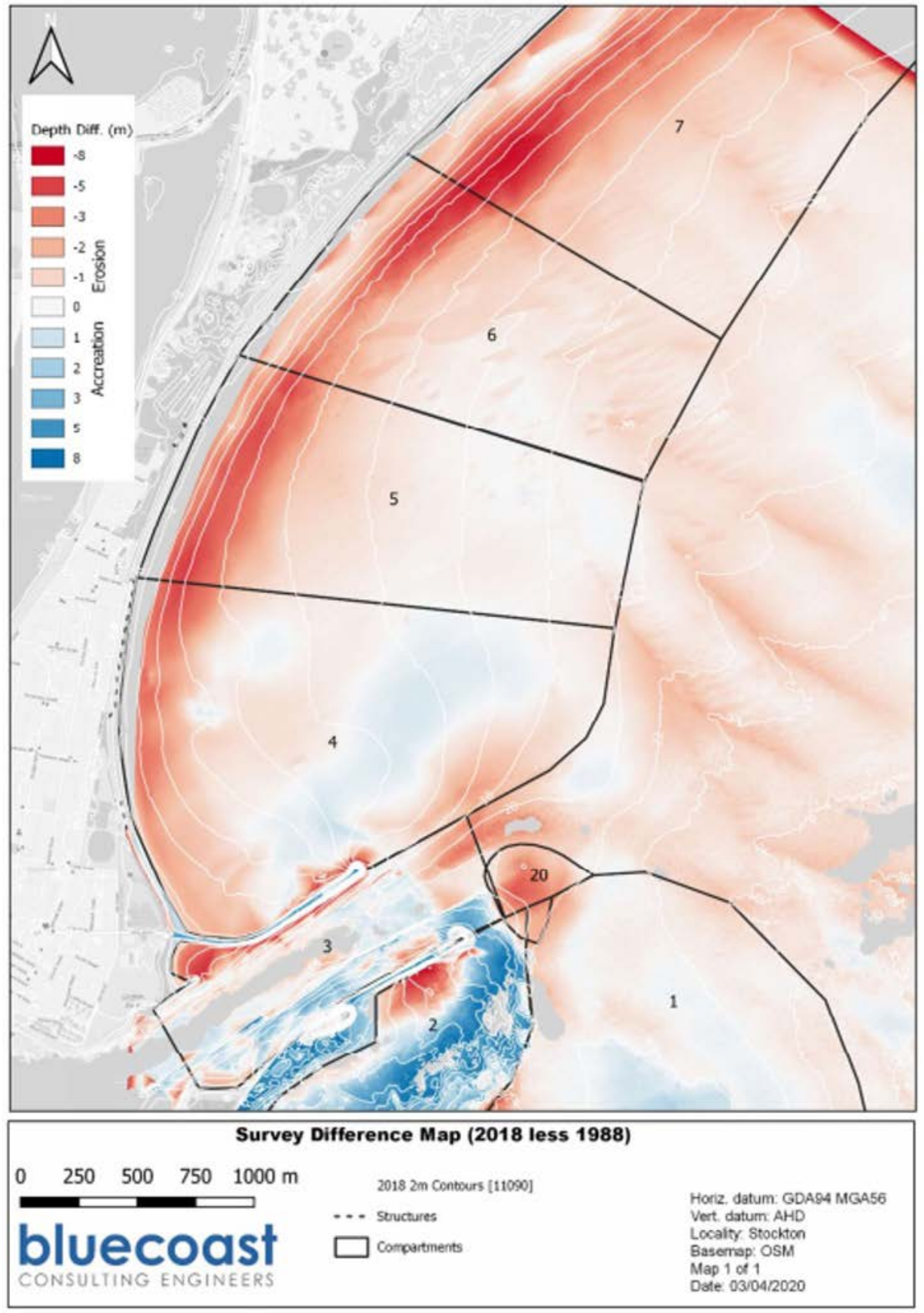


Figure 9: Survey difference map for 1988 relative to 2018.

The approach for estimating the long-term sand loss rate from the coastal profile in the CMP area is reasonable and valid. However, it is acknowledged that there is inherent uncertainty associated with the assumptions underlining the estimates as well as the comparative volumetric analysis of available survey data. The estimated sand loss rates are therefore subject to the accuracy of these surveys, noting that most recent surveys are more accurate.

Further investigations are underway to review the key coastal processes and quantify the sediment transport pathways that adequately explain these observations.

2.3.3 Key Coastal Hazards

The assessment relates to risks arising from coastal hazards as defined by the *Coastal Management Act 2016*. A simplistic assessment would see beach erosion as comprising that hazard relating to the erosion and recovery of a beach around a stable 'equilibrium' position. However, these beach fluctuations are often superimposed on a trend of ongoing shoreline recession or gradual adjustment of the shoreline location with time. Additional shoreline recession is expected to result from future sea level rise along the NSW coast. Hazard lines reported herein incorporate the following hazards as required by that Act:

- Long term recession (sometimes referred to as underlying recession) – historic shoreline recession due to deficits in longshore sediment transport
- Sea level rise and associated recession – future shoreline recession as a result of projected sea level rise
- Beach erosion – upper beach erosion as a result of large wave events and high-water levels
- Coastal slope instability – selecting the Zone of Reduced Foundation Capacity (ZRFC) following the schema published by Nielsen et al. (1992), the ZRFC represents the extent landward behind an eroded beach where special considerations would need to be adopted when designing footings for structures

2.3.4 Long Term Recession

The NSW beach profile (photogrammetry) data (DPIE, 2020) for Stockton Beach was analysed to determine appropriate input parameters for long-term recession for the probabilistic hazard assessment. The adopted analysis period included photogrammetry data collected between 1955 and 2018.

Where survey extents allowed, the photogrammetry record was extended to February 2020 using recent drone survey data collected by CN. The variation in estimated recession rates for each profile within the analysis blocks and over the study area is demonstrated in **Figure 10**. Estimated average shoreline change rates for the period 1985 to 2020 are shown in **Figure 11**.

Overall, the trends identified in this analysis were verified with volumetric changes in the full coastal profile as observed in bathymetric analyses undertaken as part of Part A (Bluecoast, 2020a). The results of both recession analyses agree reasonably well as a long-term volumetric rate of sand loss over the full beach profile was estimated at 112,000m^3/year between the Northern Breakwater and the Hunter Water site (Block C).

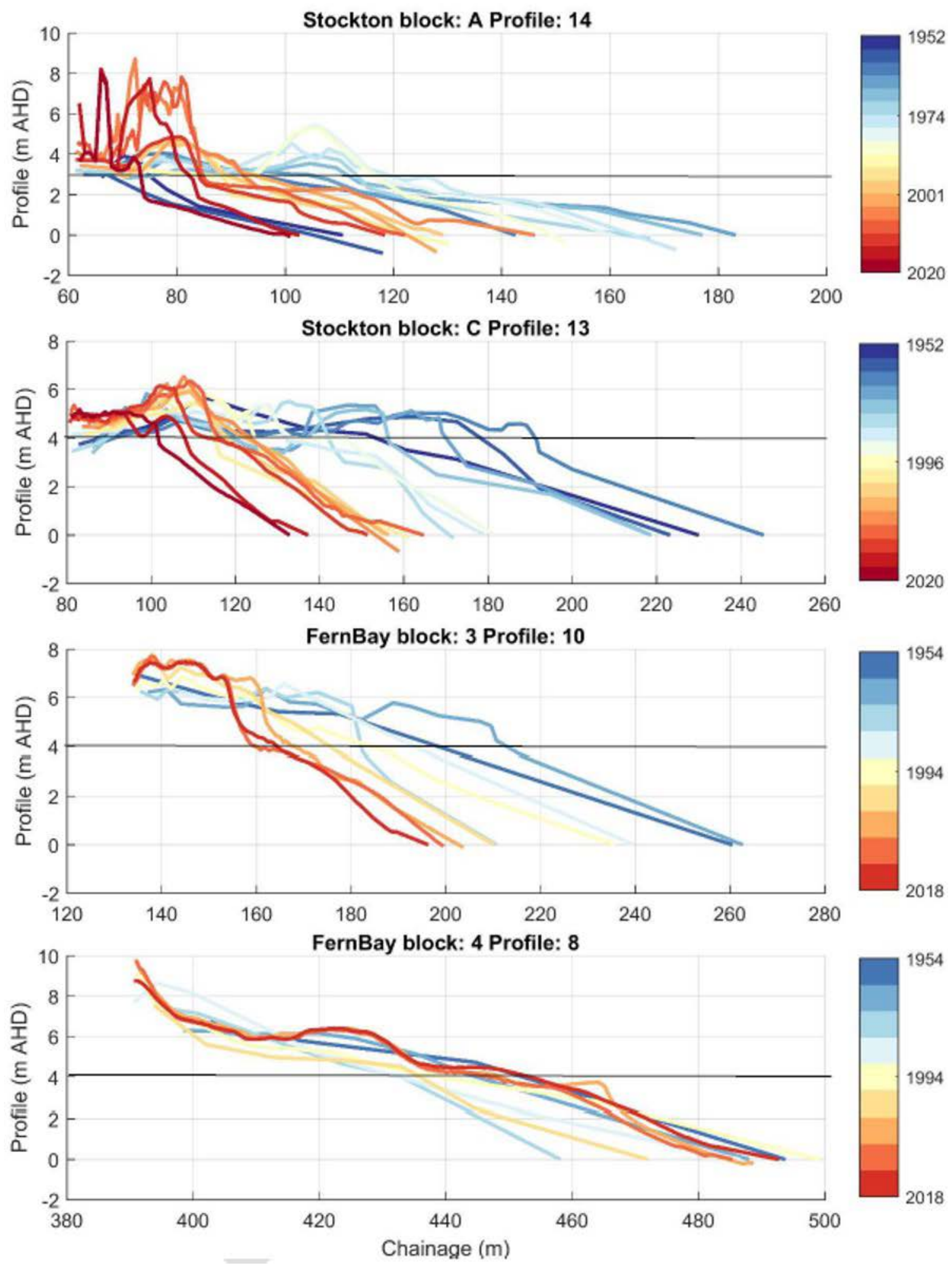


Figure 10: Example photogrammetry profiles at blocks Stockton A to Fern Bay 4.

The contour elevation adopted for recession analysis is shown in black

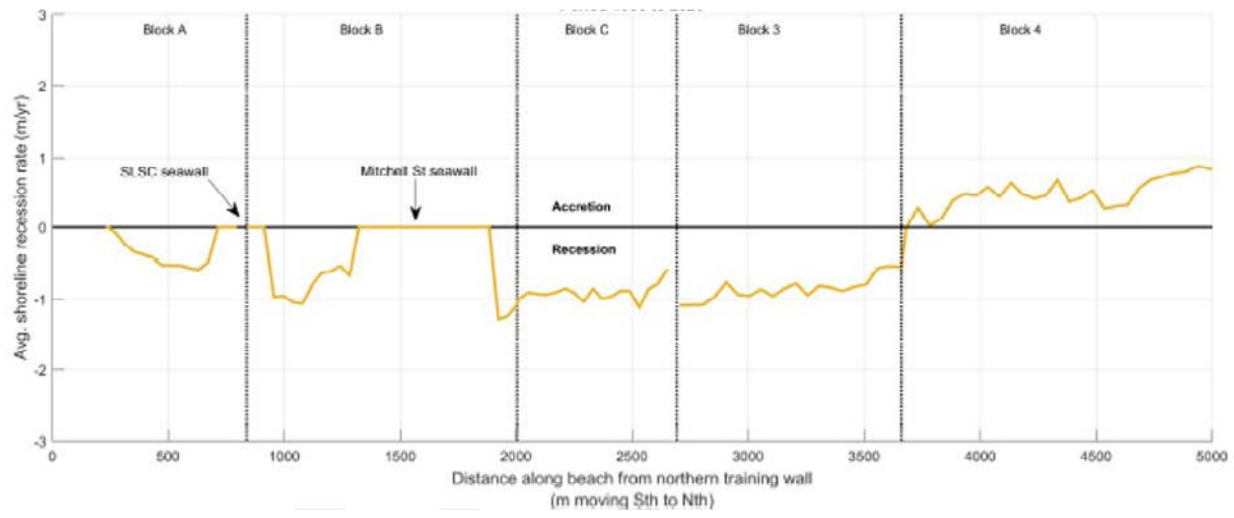


Figure 11: Estimated average shoreline change rates for the period 1985 to 2020.

2.3.5 Sea Level Rise and Associated Recession

The latest advice from IPCC (2019) on sea level rise calls for increases to the allowances in previous documents. The latest global SLR (above 1986 - 2005 baseline) projections for the 'likely' scenario are 0.43m and 0.84m (i.e. 0.1m higher than AR5 projections in IPCC, 2013) by 2100 for RCP2.6 and RCP8.5, respectively. Sea-level rise contributes to coastal erosion and inundation of low-lying coastal regions, particularly during extreme sea-level events.

2.3.6 Beach Erosion

Historical measurements of beach erosion volumes due to major storm events, or a series of storms in succession, at Stockton Beach are limited to recent drone surveys and approximate values that can be obtained from the photogrammetry profiles. Potential short-term erosion for Stockton Beach was analysed by DHI (2006) using a dune erosion model and application of storm conditions from May and June 1974, as well as a storm in June 1999 that arrived from a more easterly direction. Both historical measurements and DHI's dune erosion modelling indicate that the extent of storm erosion experienced at Stockton Beach increases from south to north in line with increased wave exposure from southerly storms. However, the alongshore distribution of storm erosion is sensitive to storm wave direction with more easterly or northerly storms leading to higher storm demands in the southern parts of the beach, as occurred in February 2020.

Stockton Beach is experiencing long term recession, and therefore it is difficult to separate short term events from the long-term recession signal in beach survey and photogrammetric data. The maximum erosion estimates in major storm events adopted by DHI (2006) ranged from 5 m at the Stockton Holiday Park to 17 m at Meredith Street, and 24.5 m at the LGA boundary. The deepening of the sub-aqueous profile due to an on-going sediment deficit in the Stockton Beach compartment is likely to increase storm erosion volumes into the future. DHI (2016) completed an analysis to determine the impact of deepening on dune face erosion. It was estimated that a further deepening of the nearshore zone by 1 m would increase erosion rates by 5%.

2.3.7 Hazard Assessment Approach

The probabilistic approach allows adopting probability distribution functions for each input parameter to the erosion hazard model. The adopted planning periods for which the coastal erosion hazards have been determined are present day (2020), 2040, 2060 and 2120. Full details of the input parameters can be found in **Supporting Document C.**

2.3.9 Probability Distribution Curves

Following the millions of Monte-Carlo simulations of combining the three hazards of long-term recession, sea level rise recession and storm erosion, probability curves of the position of the Zone of Reduced Foundation Capacity (ZRFC) at different time periods were produced.

2.3.9 Probabilistic Hazard Lines

For the purpose of mapping the erosion hazard, Bluecoast adopted the 1% exceedance probability hazard line, see **Figure 12**. According to Bluecoast **(Supporting Document C),** the associated lines represent the annual exceedance probability (AEP) of the landward end of the ZRFC. The 1% AEP is considered comparable to the 100-year annual recurrence interval (ARI) event for the presented years. Further presentation and mapping of the probabilistic hazard assessment results are provided in **Section 9**.

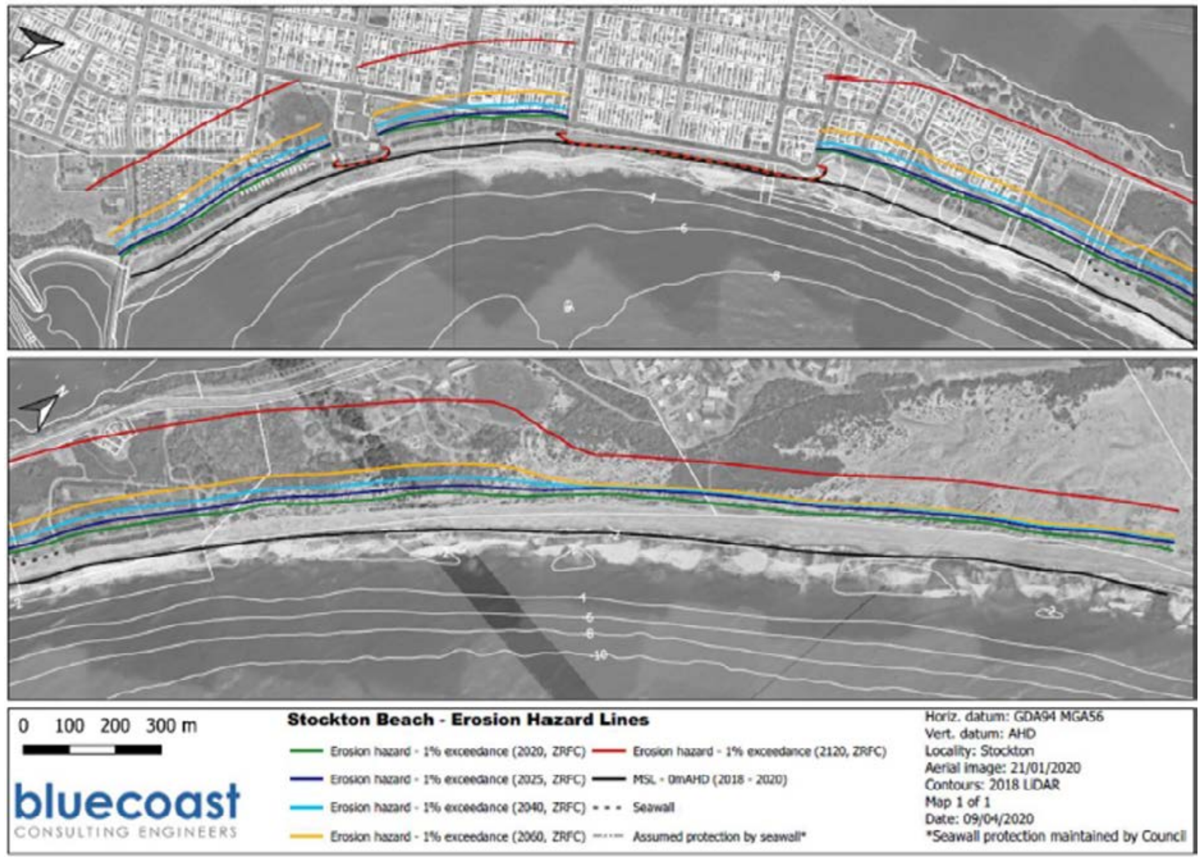


Figure 12: Hazard lines for the 1% AEP erosion hazard for various years in the planning period.

2.4 Risk Assessment Process

The risk assessment has been prepared using guidance provided by the international risk management standard, ISO 31000. That standard suggests the following steps for risk assessment:

- Establish the risk management context
- Identify the risks
- Assess the likelihood and consequences of those risks
- Evaluate the risks

Management strategies can then be suggested for those risks which are assessed as being unacceptable, with these later steps normally falling under the scope of subsequent studies to inform a CMP. The risk assessment presented here deals with the 'Base Case' of business as usual, involving the continued delivery of the actions in the certified CZMP.

2.4.1 Context of the Assessment

Consistent with the CBA (Bluecoast, 2020a), the extents of the hazard lines considered have certain probabilities of being exceeded (50%, 10% and 1% chance) are assessed at several time frames (present day (2020), 2040, 2060 and 2120). This represents an appropriate range of lines for consideration by stakeholders as part of risk assessment.

An important aspect of risk assessment context is understanding which stakeholders will suffer from the risks being assessed (noting that benefits may also result if risks eventuate) and who is best placed to take responsibility for those risks.

2.4.2 Risk Identification

Risks are going to arise from direct impacts of erosion on assets within and behind Stockton Beach, described as: *"There is a risk that ongoing coastal processes at Stockton will lead to the beach receding/eroding to such an extent that assets are either destroyed or their functionality compromised such that the value those assets provide to the community is permanently lost."*

2.4.3 Likelihoods

This study aligns with the risk management framework adopted by CN with the three hazard probabilities selected in accordance with CN's Likelihood Selection Table as presented in **Supporting Document C**. The hazard lines have been assigned based on the description of 'Likely' in CN's likelihood selection table as having a 50% to 80% chance of occurring over the time frames indicated by the frequency descriptors.

2.4.4 Hazard Lines

Hazard lines for planning use in the Stockton CMP were based on information including annual sand loss, shoreline recession rates, storm erosion and projected climate change. They identified Stockton's likely future risk exposure if the coast continues to recede, and no action is undertaken.

The processing of spatial data was completed to support the concurrent cost benefit analysis and three hazard lines ('Zone of Reduced Foundation Capacity (ZRFC))' for 1% likelihood, 10% likelihood, 50% likelihood) at four future time periods (2020, 2040, 2060, 2120). Maps showing the relevant lines for the four time periods are presented in **Section 9**.

2.4.5 Consequences

Spatial data were provided by CN, including value information where available, for several different classes of assets. Omissions from the data provided, includes public utility services (telecommunications, water and sewer, electricity, gas).

Similarly, to the likelihood descriptors, CN provided a table with its standard risk consequence categories as reflected in CN's risk management framework. There are seven risk impact categories considered:

- Financial
- Environmental
- Health and Safety
- Infrastructure / ICT Systems / Utilities
- Legislative Compliance
- Reputation / Image
- Service Delivery

Categories 2 through 7 were not included within the review due to the time constraints directed by the Minister for Local Government on completing the Stockton CMP. A preliminary consequences assessment has been completed using the financial category, and the valuation has adopted the results of analysis completed in developing the CBA (Bluecoast, 2020b).

The total financial loss has been calculated and categorised for the time periods and likelihoods adopted for the analysis, with results presented in **Table 2.**

Chance	Loss of Value by Year: ($M AUD)			
	2020	2040	2060	2120
50%	0.18 (Moderate)	9.1 (Severe)	37 (Severe)	117 (Severe)
10%	1.9 (Major)	18 (Severe)	44 (Severe)	157 (Severe)
1%	2.2 (Severe)	29 (Severe)	49 (Severe)	184 (Severe)

Table 2: Valuation and classification of coastal erosion hazard consequences

The hazard assessment identified the consequence is predominately comprised of significant impacts to public land, assets and services within the Holiday Park, Lynn Oval and roadways and car parking facilities, due to their location within public land generally seaward of Mitchell Street. **Table 3** summarises the estimated value of CN public land and assets at risk.

The assets which are covered in this summary have been compiled from Councils Asset Register and cover (but are not limited to) footpaths, road pavements, car parks, street furniture; buildings and structures such as shade shelters, monuments and seating, mains water distribution and irrigation, stormwater pit pipe and infiltration devices, and taps (refer **Supporting Document F).**

	2020		2040		2060		2120	
Council Land (m^2)	Units	Value	Units	Value	Units	Value	Units	Value
50%	8,955	$168,744	70,588	$3,496,601	87,227	$3,839,284	129,710	$4,641,428
10%	15,279	$932,018	76,635	$3,639,668	94,520	$3,976,710	139,250	$4,822,377
1%	28,023	$1,397,798	83,028	$3,760,159	100,990	$4,098,994	145,530	$4,947,497
Council Buildings and Structures (no.)	Units	Value	Units	Value	Units	Value	Units	Value
50%	1	$121,950	24	$5,145,694	33	$6,849,500	36	$7,777,971
10%	16	$2,881,800	28	$6,087,993	34	$7,534,851	37	$7,846,999
1%	18	$4,535,943	31	$6,889,041	34	$7,534,851	37	$9,326,999
Paved Areas (m^2)	Units	Value	Units	Value	Units	Value	Units	Value
50%	132	$8,059	6,004	$277,356	12,218	$468,085	28,381	$1,194,056
10%	1,622	$90,323	8,592	$345,263	14,579	$536,784	35,254	$1,481,975
1%	4,866	$224,239	11,131	$435,907	16,293	$593,655	47,189	$2,038,054
Stormwater Pipe (m)	Units	Value	Units	Value	Units	Value	Units	Value
50%		$-		$-	13	$7,922	371	$162,679
10%		$-		$-	29	$17,672	505	$209,297
1%		$-	4	$2,438	43	$26,204	840	$306,306
Public Shelter (no.)	Units	Value	Units	Value	Units	Value	Units	Value
50%		$-	3	$157,000	4	$164,500	6	$208,500
10%		$-	4	$164,500	5	$196,500	6	$208,500
1%		$-	4	$164,500	5	$196,500	7	$213,000
Expect Total Annual Loss		**$1,368,063**		**$8,043,182**		**$12,121,905**		**$13,992,286**

Table 3: Estimated value of CN land and Assets at Risk

A further overview of the assets at risk are reflected in the Coastal Zone Emergency Action Subplan **(Appendix A** Section 9 – Assets and Hazards by Zone)

2.4.6 Risk Evaluation

A risk matrix enables risk evaluation by combining likelihoods and consequences. The current and future financial risk levels at Stockton Beach have been determined as presented in **Table 4.**

Chance	Risk level by year			
	2020	2040	2060	2120
50% (Likely)	High	Extreme	Extreme	Extreme
10% (Unlikely)	High	High	High	High
1% (Rare)	High	High	High	High

Table 4: Assessed financial risk profiles at various time frames.

Results should be considered alongside a risk manager's level of 'risk tolerance'. When combined, these considerations govern the urgency with which risks should be treated. AS5334 (Australian Standards, 2013) regards that the following treatments are suitable when considering climate change risks for settlements and infrastructure:

- Low risks would typically be addressed through routine maintenance and day to day operations
- Moderate risks would require a change to the design or maintenance regime of assets
- High risks require detailed research and appropriate planning (or design)
- Extreme risks would require immediate action to mitigate

Prompt research, planning and design are presently indicated to manage coastal erosion at Stockton Beach. However, these risk levels must be interpreted recognising that only financial risks have been considered. There is a strong possibility that the present-day risk profile for the suburb of Stockton would be assessed as 'Extreme' if social and environmental values were also considered.

2.4.7 Impacts on Infrastructure, Environment and People

Complementing the risk assessment, this discussion is viewed as a precursor to inform other activities associated with coastal management for Stockton Beach. It includes a 'high level' overview of current and future coastal hazards which were not able to be included in the risk assessment but may warrant further consideration.

2.4.7.1 Impacts on Infrastructure

Several impacts on infrastructure have not been examined by this study including services such as:

- Water
- Sewer
- Gas (noting there is a gas pipeline that runs along Mitchell Street)
- Electricity
- Communications

The main issue relating to these services is that they commonly perform as a network and damage to one part of a network will degrade performance at other locations across the network.

The protection/retention of safe and well-maintained roads, as per Strategy 1.3(a) of the current Community Strategic Plan (CN, 2018) will help to protect much of the buried services networks across the suburb as they are most commonly located within the road reserve.

Over the 100-year (2120) time frame, there remains a small chance that Fullerton Street is made unsafe at the northern end of the Stockton residential area (see Figures 19 & 20 in **Appendix A**), effectively cutting off access to Stockton from the north. Clearly, this would have an impact on CN's ability to provide services to Stockton. Worth considering is that, even if buried terminal protective works were provided across northern Stockton as the sole strategy for mitigating against erosion risks, outflanking of the structure to the north could possibly threaten Fullerton Street in a more northerly location. This consideration will be included in the development of the Newcastle CMP.

2.4.7.2 Impacts on the Environment

Considering Strategic Direction 2 of CN's Community Strategic Plan, protection of the environment and natural areas is an important matter. Embedded within the table outlining that Strategic Direction is a strategy which encourages decisions and policy that support an up to date understanding and response to climate change.

An ongoing understanding of the potential for erosion to affect land is required. This can be maintained by revisiting and updating coastal hazard lines with reasonable regularity, as understanding improves, and climate change projections are revised. By ensuring information is up to date, impacts by severe coastal storms can be managed to ensure that appropriate emergency management strategies are in place.

The key environmental asset at Stockton is the beach. If the beach is lost, for example, by providing coastal protection infrastructure without ongoing nourishment and allowing the dry beach width to disappear, many of the environmental benefits derived from the beach are lost.

There are also values associated with remnant dune systems to the rear of the beach, although the remaining vegetated dunes are typically narrow and far less significant than the dune system which exists to the north of Stockton.

2.4.7.3 Impacts on People

The CBA (Bluecoast, 2020b) reports that approximately 100,000 people utilise Stockton Beach annually. The beach is popular for swimming, fishing, surf lifesaving, beachgoing and surfing.

Coastal erosion has the potential to threaten several of the Strategic Directions in CN's CSP.

Vibrant Safe and Active Public Places:

These include the beach, which is the first asset to be lost to erosion and potentially the parkland and facilities that are behind the beach.

Liveable Built Environment:

The loss of parkland and public spaces, services, and the road network present a serious risk to the overall 'Liveability' of Stockton. Of course, liveability can be affected before severe physical impacts occur. It could be argued that the liveability of Stockton is already being impacted even though the loss of facilities has been limited to date. A lack of confidence in the future viability of an area affects the sense of liveability.

Open and Collaborative Leadership:

This follows from the previous point and the 'sense of identity' of an area. The strategies around this direction relate to long term planning and financial sustainability. It is important that planning is as strategic as it can be to appropriately follow this Key Strategic Direction. This implies that planning should consider the longer term (say 100 year) time frame, to ensure viability, minimise any future financial shocks and to increase the confidence of the Stockton Community in the place where they live.

Health and Safety:

Through appropriate strategic planning, severe health and safety impacts from coastal erosion should be appropriately mitigated. At Stockton, it appears that the current risks are close to being considered 'very high to extreme'.

The safety of structures and people need to be maximised wherever possible. One limitation of the present risk analysis is that the risks associated with inundation hazards (e.g. wave overtopping of the foreshore) have not been considered as updated information on those hazards was not available within the required timeframe for completion of the Stockton CMP. The health and safety risks to people can be largely avoided through *Open and Collaborative Leadership and strategic planning.*

Unfortunately, legacy planning issues often remain in conflict with this strategic direction.

2.4.8 Intangible Values

Some of the values discussed in the immediately preceding sections have aspects that are intangible, or less amenable to valuation. Provided below are brief comments on some of the more intangible risks outlined in CN's standard Risk Consequence Table.

Legislative Compliance:

Compliance with legislation is largely a risk that needs to be borne by CN. In the context of coastal management, continued compliance with the requirements of the Coastal Management Act 2016, the Coastal Management Manual (NSW Government, 2018) and related directions from the relevant Minister, will assist CN in minimising these risks.

Reputation/Image:

These risks are primarily organisational and beyond the scope of this assessment.

2.5 Outcomes of Risk Assessment

On the consideration of the current risk profile for Stockton Beach, it is assessed as 'High', meaning that detailed research, planning and study are indicated. The probabilistic hazard assessment undertaken further concluded that the Stockton CMP area is currently at high to extreme risk, with public assets at immediate threat requiring urgent protection, as well as longer term threats to assets.

3. Selecting Coastal Management Options

3.1 Introduction

An evaluation and coarse filtering of all options for long-term coastal management within the Stockton CMP area has been undertaken in accordance with the NSW Coastal Management Manual to facilitate the preparation of the Stockton CMP (refer **Supporting Document D**). **Table 5** outlines the options that were considered in this initial assessment.

Table 5: Options Evaluated in Coarse Filter

Nourishment Options	Structural Solutions	Planned Retreat
Beach scraping	Seawalls	Relocate Assets
Beach Nourishment (from dredging)	Artificial Reef Breakwaters	Land Acquisition
Beach Nourishment (from terrestrial sources)	Groyne Field	Buy Back / Lease Scheme
Beach Nourishment (bypassing from Nobbys beach)	Large Single Artificial Headland	Sacrifice Land / Assets
	Multiple Small(er) Artificial Headlands	

**Provide protection to assets seaward of 2025 ZSA for 5% AEP*

The coarse filter was undertaken for each zone and considered the following criteria to evaluate options and determine a shortlist of options for assessment in the CBA:

- Addresses storm erosion
- Addresses long term recession
- Addresses beach amenity
- Capital cost/ Recurring costs
- Environmental or social impact
- Likely community acceptability
- Adaptability in future
- Long term effectiveness
- Approval risk
- Ease of implementation

Further investigation of the feasible management actions such as planned retreat, relocation of assets, sand nourishment or engineered structures to address beach erosion and shoreline recession was then conducted (refer **Supporting Document F**).

The Stockton CLG has, with input from the local community, identified sand nourishment as a preferred long-term option to address coastal hazards and improve beach amenity and access. Whilst nourishment using an offshore sand source is currently not permissible under NSW legislation without a mining licence, it has been included in the Stockton CMP as a potential future option via a sensitivity analysis in the CBA.

The NSW Deputy Premier in March announced the formation of a taskforce of community representatives, government agencies and CN, to work together to address Stockton's erosion issues, and to consider options to fund long-term solutions. CN is committed to working with the Deputy Premier's Taskforce and the NSW Government to explore all opportunities to source sand that are affordable and are suitable (meet the technical specifications of CN's Sand Management Guidelines). This includes the permissibility of accessing marine sand, with the goal of mass nourishment to protect and enhance Stockton Beach. The Stockton CMP has been prepared to include the potential for marine sand (or other potential sources) becoming available in the future.

3.2 Options for CBA

The sediment transport study (refer **Supporting Document C**) identified an ongoing sediment deficit leading to long term recession and increasing erosion. The probabilistic hazard assessment (refer **Supporting Document C**) identified that public assets were currently at high to extreme risk.

The community strongly view the beach as a critical asset to the local community and desire beach amenity, access and connectivity to be maintained. Many coastal management strategies were evaluated (refer **Supporting Document D**) to determine a shortlist of options to be assessed in the CBA including nourishment, protection structures and varying degrees of planned retreat.

The technically feasible solution that addresses the sediment deficit issue and achieves CN and the community's objectives of beach amenity, access and asset protection in the long term, requires mass sand nourishment. The volumes of sand required to achieve coastal protection are calculated to be 1.8 million to 4.5 million m^3 depending on source and re-nourishment period.

Terrestrial sand sources cannot supply sand on this scale. Potential marine sand sources have been identified however they currently have availability or permissibility impediments.

Hunter River capital dredging works are another potential source of sand though this is dependent on the proponent gaining appropriate approvals. The development of Sand Management Guidelines will enable CN to be agile in its response to this and other opportunities as they become available.

Potential sand sources are discussed further in **Supporting Document E**.

On the basis of the options assessment and giving consideration to the tight timeframe of the Stockton CMP development, a shortlist of options was progressed through to the CBA stage of the process. Nine different combinations of nourishment and protection works were developed to meet the technical and community objectives and were assessed in the CBA, and are summarised in **Table 6.**

A detailed outline of the development of these options is provided in **Supporting Document F**.

Due to the immediate risks to assets identified in the hazard assessment, all options included some limited buried terminal protection works (typically at the flanks of the existing coastal protection structures).

Table 6: Summary of options and sub-options assessed in CBA

Option	Sub-Option	Description	Sand Source	Initial nourishment volume (m^3)	Maintenance nourishment vol (m^3)	Maintenance nourishment frequency (years)	Buried Terminal Protection Structures (m)	
							Stage 1	Stage 2
1	1a	Mass nourishment for protection + amenity buried terminal protection works to address immediate erosion risk	Terrestrial**	4.5 million*	1.4 million*	5 years	458	0
	1b		Marine (offshore)	2.4 million	1.12 million	10 years		
	1c		Hunter River	1.8 million	560,000	5 years		
	1d	Option 3b adopted for first year, then mass nourishment as per Option 1b, with optimised stage 1 coastal protection work	Terrestrial** and marine	50,000 2.4 million	1.12 million	10 years	225	0
2	2a	Sand nourishment for improved beach amenity + staged buried terminal protection	Terrestrial**	525,000*	280,000*	Annual	458	995
	2b	Sand nourishment for improved beach amenity + 1 year ARI storm each year + staged buried terminal protection	Marine (offshore)	610,000	560,000	5 years	458	995
	2c	Sand nourishment for improved beach amenity + 1 year ARI storm each year + staged buried terminal protection	Hunter River	610,000	560,000	5 years	458	995
3	3a	Sand nourishment to maintain beach amenity (logistically feasible terrestrial volume) + staged buried terminal protection	Terrestrial**	200,000	200,000	annual	458	995
	3b	Reduced sand nourishment (economically feasible terrestrial volume) + optimised stage 1 and 2 buried terminal protection	Terrestrial**	50,000	50,000	annual	225	1186

** exceeds volume from terrestrial sources that can feasibly be placed on the subaerial beach*

*** terrestrial sources have an overfill factor of 2.5 to account for incompatibility of grain size and a sensitivity analysis has been undertaken for overfill factor of 1 (refer* **Glossary Section 12).**

Nourishment volumes were estimated by RHDHV for input into the CBA, with refinements made by Bluecoast based on models and outcomes of the Stage 2 Sediment Transport Study. It is noted that sand from local quarries is typically finer than native beach sand as it is from aeolian (wind-blown) dune sands. An overfill factor of 2.5 has been applied to terrestrial volumes to account for this incompatibility in grain size (refer Glossary in **Section 12**). A sensitivity analysis, adopting an overfill factor of 1, was also undertaken. Maintenance nourishment quantities were based on the long-term sediment deficit rate of 112,000m^3/yr determined by Bluecoast in the Stage 2 Sediment Transport Study. The annual sand deficit rate will be further reviewed by refining the sediment dynamics as part of the Stockton Bight Sediment Transport Study.

Further detail of the development, rationale and risks of each of the Options and sub-options is provided in **Supporting Document F**.

3.3 Cost Benefit Analysis

In accordance with the Coastal Management Act 2016 and the Manual and consideration of the Guidelines for using cost-benefit analysis (CBA) to assess coastal management options (OEH, 2018), a CBA for Stockton Beach was undertaken to provide an economic analysis of coastal management options (refer **Supporting Document F**). CN engaged Bluecoast and their sub-consultants Rhelm to undertake the CBA for the proposed Stockton CMP options.

The CBA assessed the nine identified coastal management options (and sub-options) for Stockton Beach outlined in **Section 3.2**. As the only currently readily available sand source is terrestrial, this was assumed to be the standard supply source for the options.

Recognising the potential for future marine sources of sand a sensitivity analysis was undertaken formass nourishment using offshore marine sources and Hunter River marine sources.

All cases were assessed relative to the Base Case of business as usual, involving the continued delivery of the actions in the certified CZMP. All of the options (and sub-options assessed for sensitivity analysis) are summarised in **Table 6.**

3.3.1 Methodology

The economic assessment considers the comparative costs and benefits of each of the three management options (and variations therein) against the base case scenario with consideration of population growth.

The economic merit of each option was determined by comparing the present value of the change in net economic benefits (compared with the base case) less the change in capital and operational and maintenance costs (compared with the base case). The key benefits incorporated within this cost benefit analysis (CBA) assessment were in the form of:

- Maintained beach area and associated non-use and use values
- Reduced loss of property and land to both private landowners and the CN

In conjunction with the CBA, a probabilistic erosion hazard assessment was undertaken by Bluecoast. A discussion of the approach and adopted input parameters to the probabilistic modelling are provided in **Supporting Document C**. In summary, appropriate ranges of long-term recession, sea level rise and storm demand were adopted to produce inputs that fed into a Monte-Carlo simulation of over one million scenarios.

In the development of the management strategy see **Section 4.1** CN adopted a distance of 20m from the 2025 ZSA 5% AEP hazard line as a foreshore recession threshold in line with the established 5 year planning horizon.

The ZRFC was adopted as the erosion hazard extent, which is the estimated unstable zone of a dune following a coastal erosion event in which it is not acceptable to locate foundations for coastal buildings and infrastructure unless suitable precautions are taken. The results from the probabilistic hazard modelling provide probabilities of exceedance (PoE) for the position of the ZRFC for every year in a 100-year planning horizon.

The capital, operational and maintenance costs were identified for each option with Net Present Value (NPV) of expenditure determined over a 50 year period (using discount rates of 7%, with 3% and 10% also calculated for sensitivity assessment).

The benefits considered included: beach amenity, avoid losses to private property, CN lands and CN assets, producer surplus and residual value.

Further detail of the methodology and assumption are in the CBA Report in **Supporting Document F**.

3.3.2 CBA Results

As noted above, the costs and benefits for each option relative to a Base Case, as outlined above, were compared through a CBA. The Benefit Cost Ratios (BCRs) resulting from the economic assessment, for each of the project options (based on a 7% discount rate), are provided in **Table 7**.

Table 7: Benefit Cost Ratios (BCRs) for each of the project options (based on a 7% discount rate)

Option	Description	BCR (@7%)
1a	Mass nourishment for protection + amenity, limited coastal protection works – terrestrial sand source	0.1
1b	Mass nourishment for protection + amenity, limited coastal protection works – offshore marine source	1.5
1c	Mass nourishment for protection + amenity, limited coastal protection works – Hunter River marine source	0.9
1d	Option 3b adopted for first year, then mass nourishment as per Option 1b, with no Stage 2 buried terminal protection	1.3
2a	Sand nourishment (from terrestrial sources) for improved beach amenity + staged buried terminal protection	0.1
	Sensitivity analysis for overfill ratio of 1	0.1
	Sensitivity analysis for overfill ratio of 1 and cost reduced to $50/m3	0.1
2b	Sand nourishment (from offshore marine sources) for improved beach amenity + staged buried terminal protection	0.4
2c	Sand nourishment (from Hunter River sources) for improved beach amenity + staged buried terminal protection	0.3
3a	Sand nourishment to maintain beach amenity (logistically feasible terrestrial volume) + staged buried terminal protection	0.1
3b	Reduced sand nourishment (economically feasible terrestrial volume) + minimised* stage 1 and 2 buried terminal protection	0.1

**Provide protection to assets seaward of 2025 ZSA for 5% AEP*

Of the nine options, only options 1b and 1d are seen to have a BCR greater than one at a 7 percent discount rate. For Option 1b, at a 7 percent discount rate the BCR is 1.5, implying for every $1 spent on the project, $1.50 is expected to be returned in economic benefits. The net benefit under this option is $19.4 million. For Option 1d at 7 percent discount rate the BCR is 1.3, implying for every $1 spent on the project, $1.30 is expected to be returned in economic benefits. The net benefit under this option is $11.3 million. Option 1b is the economically preferred option. However, as noted previously, there are currently a range of legislative and environmental issues associated with this option that would prevent its immediate implementation. Both options 1b and 1d depend upon access to a lower cost, higher volume and more compatible nourishment sand source to be available upon commencement of mass nourishment activities.

Options 2 and 3 do not generate positive results as they provide little to no amenity benefit in comparison to the base case, while incurring high upfront costs. While these options do provide protection of private assets, the risk of damage and loss of these assets is too far into the future to economically support investment in these options which rely upon physical infrastructure for asset protection. It is considered that seawall options are likely to improve in their economic feasibility over time (i.e. by 2040).

A sensitivity analysis for overfill ratio and cost/m^3 for terrestrially sourced sand indicated that these factors did not impact on the cost benefit analysis outcome for Option 2a and it remains economically unviable (BCR = 0.1).

3.3.3 Preliminary Distribution Analysis

From a distributional perspective the affected and benefiting parties varies over time. Under the base case scenario, it is CN and the users of the Stockton Beach Holiday Park that are likely to incur the greatest costs associated with this approach. The expected value of land and assets at risk to CN exceeds $8 million dollars within the next 20 years. Other community members will not be directly affected through impacts to property in the short term but are likely to experience the loss of beach amenity (although the beach width will likely remain relatively constant) as well as reduced associated foreshore amenity, loss of recreational spaces and sporting grounds. see **Supporting Document F.**

The short-term impacts to the Holiday Park are likely to be large and could ultimately lead to the closure of the Holiday Park. Tourists from outside the LGA will be required to choose alternate destinations for beach side camping (of which there are many within the areas to the north and south of Newcastle).

Beyond 2040, it is likely that some land owners near the beach will experience property damage.

Under all the options proposed, private property damages are avoided into the future. However, the options differ in the broader impacts to the communities. The mass beach nourishment options retain and enhance the value of the beach asset and are likely to add additional value to properties and the attractiveness of the Stockton Beach Holiday Park. This may also support increased economic activity through beach related commerce.

In contrast, Options 2 and 3 will ultimately lose public space adjacent to the beach as recession shifts back to the proposed Stage 2 buried terminal protection. While a beach area will be retained, the reduced area will alter the utilisation and desirability of the beach. Moreover, the construction of the seawall will require the removal of a significant portion of facilities at the Stockton Beach Holiday Park. A management strategy for the future for the Holiday Park will need to be undertaken to assess the future operational requirements.

3.4 CBA Outcome and Recommendation

Option 1b (mass nourishment from offshore marine sources) was identified as the economically preferred option, with a BCR of 1.5 and producing over $19 million in NPV to society. However as previously identified in **Section 3.1**, the permissibility and technical details of this option requires further investigation and resolution. These can be largely achieved through the proposed Deputy Premier's Taskforce and within the timeframe for the completion of the Newcastle CMP which will replace the Stockton CMP. As noted previously, option 3b (reduced sand nourishment from economically feasible terrestrial volume and minimised stage 1 and 2 buried terminal protection) is the only currently permissible option however the CBA has shown it is not economically feasible over 50 years due to the high cost of nourishment and Stage 2 buried terminal protection works (resulting in a BCR of 0.1). Option 1b, when combined with elements of 3b is a technically and economically viable option as it uses a 1 year program to address risk and amenity followed by mass nourishment from marine sources to provide ongoing protection and amenity. This strategy eliminates the need for the construction of future Stage 2 buried terminal protection works as the nourishment is able to provide coastal protection.

Given the positive BCR of 1.1, the hybrid of option 3b and option 1b (identified as option 1d) is the recommended way forward. As such it is recommended that further investigation of **option 1d be considered as a practical viable option**. It is noted that all the nourishment options identified are highly sensitive to the cost assumptions associated with access and delivery of nourishment material.

The sensitivity analysis undertaken indicates that should lower costs be realised, the economic performance of option 1d will significantly improve.

3.5 Potential Sources of Sand for Beach Nourishment

There are numerous potential sources of sand for beach nourishment at Stockton.

Supporting Document E outlines these potential sources and provides further information regarding availability, permissibility, methodology for extracting and other factors. Offshore local sand sources such as the lobe off Nobbys Beach and deposits further seaward provide potentially viable opportunities for large quantities of sand.

CN is committed to working with the Deputy Premier's Taskforce (see **Section 3.1**) and the NSW Government to investigate the permissibility and feasibility of accessing marine offshore sand.

Mining, Exploration and Geoscience (MEG) in Regional NSW recently carried out a desktop study to identify marine sand bodies that may be suitable for beach nourishment at Stockton Beach (MEG, 2020). Whilst some key historical sediment sampling data was not able to be sourced and included in this study, the main findings included:

- Sand suitable for the renourishment of Stockton Beach is likely to occur on the inner shelf plain, the lobe and possibly the dredge spoil dumps in Stockton Bight (refer **Figure 6**)
- The lobe and spoil dumps off Nobbys Head also contain sand that may be suitable. However, some data suggests the variability of the sand in these areas may not be as uniform as that on the inner shelf plain to the northeast
- The available data indicates that the medium-grained, quartzose sands of the Newcastle inner shelf sand sheet (ISSS) that are lying on the inner shelf plain[1] appear to be suitable for beach renourishment and represent the largest potential sand resource in Stockton Bight

In consideration of current legislation, MEG recommends that CN should seek to source sand from state waters (i.e. within 3 nautical miles of the NSW coast) in the first instance. It is evident that extensive areas of the ISSS lie within state waters and it is considered that adequate sand reserves are likely to be available in these areas to meet the volume requirements for mass nourishment at Stockton Beach (refer **Supporting Document E** for further information).

A comprehensive offshore sampling program is required to confirm the extent, thickness and continuity of the sand sheet and to identify the most suitable areas to source sand for renourishment.

Strategies identified for potential sources of sand for beach nourishment will require consideration of the potential impact on the Worimi Conservation Lands (WCL) and other lands gazetted under the National Parks and Wildlife Act 1974 (NPW Act). The WCL conserves a large proportion of the Stockton Bight mobile dune system.

Any increased extractive pressure on the dune system from adjoining extraction operations poses increased risk to the WCL. Risks need to be properly assessed and mitigated prior to any new operations or alteration to an existing sand extraction operation adjoining the WCL.

The implications of offshore marine sand extraction are relevant to the WCL and potentially marine fauna identified in the NPW Act. The consequences of any proposed offshore marine sand extraction on sediment movement and replenishment of the dune system in the WCL will need to be identified and assessed. The potential impact on marine fauna protected under the NPW Act of any proposed offshore sand extraction method and location will need to be identified and assessed.

Within the Hunter River there are also opportunities for sourcing dredged sand which would be further investigated. Terrestrial sand sources resulting from large tunnelling projects in Sydney are also possible opportunities.

Some of these opportunities such as Metro West tunnelling spoil in Sydney, and the recent dredging of the South Arm of the Hunter River may not have been realised, however others are still potentially available.

The proposed Newcastle GasDock LNG import terminal project would require capital dredging of around 4.0 million m^3 of material, a substantial proportion of which is likely to be sand.

Potential opportunities and synergies with the PoN could also be explored. Dredging of the North Arm (south of Stockton Bridge) may provide synergies with PoN operations (e.g. reduced maintenance dredging). Modification of the existing PoN Part 5 approval could be undertaken to investigate dumping dredged sand further inshore at Stockton. This modification of the approval could also potentially look at including an option to source material from the North Arm or other sources in the Hunter River.

The critical factor in securing sand from some of these opportunities will be having a pre-existing approval for the beach nourishment works under Part 5 of the EP&A Act in place to facilitate alternative disposal by a Contractor to Stockton Beach, which is discussed further in **Section 4.2** CN will advocate for this issue to be addressed with the assistance of the Deputy Premier's Taskforce and take initiatives to affect streamline processes that are able to deliver sand to Stockton. Without this, opportunities will continue to be missed.

[1] *The inner shelf plain is a seaward-sloping surface occurring between 20–65 m depth, between 1.5 km and 11 km wide with an average gradient of 0.05–0.42° (Boyd et al. 2004).*

4. Actions to be Implemented

4.1 Coastal Management Strategy

The purpose of the Stockton CMP is to provide an adaptive, integrated and long-term approach to coastal management to address identified risks and ensure developing opportunities can be assessed on their merit and be implemented if advantageous. The intention is to ensure that the coastal environment is protected, enhanced and resilient while maintaining the recreational amenity and sense of identity the coast provides to the community.

The Coastal Management Strategy and actions within the Stockton CMP have been developed to be an iterative program that reflects the objectives of CN, the community, and the CM Act, delivering long term benefits of coastal protection and amenity. To achieve this will require effective collaboration between the community, CN, and other relevant governments and agencies.

A sediment transport study for the whole-of-Stockton-Bight was underway at the time CN received the Ministerial direction to complete the Stockton CMP. While not due for completion until late 2020, this study has been able to provide targeted information to inform the Stockton CMP. Based on the latest available scientific data, the sediment transport study concluded that the ongoing sand deficit rate within the Stockton CMP area is approximately 112,000m^3 per year which is significantly higher than previously estimated. It is acknowledged that there is inherent uncertainty in this estimation, associated with the accuracy of surveys used in volumetric comparisons and the high degree of complexity in this coastal system. This quantity would be refined on the basis of the findings of the Stockton Bight Sediment Transport Study and used to inform the development of the Newcastle CMP.

A probabilistic coastal hazard assessment was undertaken using the findings of this analysis of sediment transport as inputs, which concluded that the Stockton CMP area is currently at high to extreme risk. The hazard assessment identified significant potential immediate impacts requiring urgent protection to public land, and essential assets and services including roads along the coastline, as quantified within **Section 2.4.5**. This coastline at immediate threat generally corresponds to the existing five locations where emergency sandbag works have been undertaken as detailed in **Appendix A**. Protection works will maintain the existing land use and the functionality of the associated essential assets and services to support current and future service delivery demands in line with projected growth in population and tourism. The probabilistic hazards assessment also identified the probable extent and impact of ongoing coastal erosion over time if no further action is taken.

4.1.1 Immediate Works

To assist in maintaining beach amenity as well as addressing immediate risk to assets, CN is committed to a $4 million sand nourishment campaign commencing in the first year using terrestrial or other permissible sources. In addition, the provision of essential buried terminal protection works along the 2025 ZSA 5% AEP hazard line would also commence in the first year to provide protection for identified public assets at immediate threat. This correlates to the formalisation of the existing sand filled geotextile bag emergency works in Zone 1, 2 and 4 of the Stockton CMP area (See **Figures 13, 14 and 16**). These works are located at the southern and northern end of both the SLSC and Mitchell Street seawalls as identified land parcels in **Table 8.**

Table 8: Location of essential buried terminal protection works

DP/Lot	Address	Description	Ownership
1249904/2	124 Mitchell St	Southern end SLSC seawall	Crownland – CN Reserve Trust Manager
1249904/ 2	126 Mitchell St	Northern end SLSC seawall	Crownland – CN Reserve Trust Manager
1146198/ 7300	260A Mitchell St	Southern end of Mitchell St seawall	Crownland
758929/18/40 758929/17/40 758929/15/40	2A Barrie Cr	Northern end of the Mitchell St seawall	Council

The Griffiths Street / Barrie Crescent intersection has been identified as an area where existing road pavement would be decommissioned, and alternative traffic management and access would be established as presented in **Figure 16**.

4.1.2 Mass Sand Nourishment

Of the options explored, marine offshore mass nourishment has been identified as the technically feasible and economically viable solution that meets CN and the community's objectives for the long-term sustainable management of beach amenity and coastal asset protection at Stockton. The desktop study to identify marine sand bodies potentially suitable for beach nourishment at Stockton Beach of historical data, completed by the Mining, Exploration and Geoscience (MEG) in Regional NSW in May 2020 identifies sand on the Newcastle inner-shelf sand sheet within Stockton Bight that is likely to be suitable for beach re-nourishment and represents the largest potential offshore sand source in the Stockton Bight (MEG, 2020).

To deliver this level of protection using beach nourishment a significant initial volume of sand is needed to establish the required beach width. To obtain the initial volume of sand required, economic and scientific investigations identified that 2.4 million m^3 of compatible sand from the offshore zone is the most effective strategy (with a 10 year renourishment).

To ensure the long-term protection strategy is successful, the beach width must be maintained. This would require an ongoing monitoring and renourishment program with an estimated quantity of 1.12 million m^3 over a ten-year period, that accommodated the evidence-based sand loss (112,000 m^3 annually) calculated for the Stockton CMP area.

4.1.3 Opportunistic Sand Sources

Under the *Offshore Minerals Act* 1999, sand extraction is not permissible in NSW coastal waters without being authorised by a mining licence. An applicant cannot apply for a mining licence without the NSW Minister responsible for the Offshore Minerals Act 1999 inviting applications. With reference to these restrictions, CN has undertaken a series of investigations to identify the potential volumes and associated costs of many sand source options as summarised in **Section 3.5**. Economic analysis performed during the Stockton CMP development noted that if the cost of sand (placed) is less than $40/m^3 then mass nourishment is more 'economical' than protection structures. Further, if the cost of sand (placed) is less than $11/m^3 then mass nourishment will be economically feasible (with a BCR>1).

CN have recognised that to be flexible and agile in securing sand sources, preparation will be essential. This preparation will include development of a Sand Management Guideline (SMG), building on **Supporting Document E,** to ensure CN can proactively acquire as well as react without delay should an opportunity arise to receive acceptable sand from any appropriate terrestrial or marine source (environmentally compatible with existing native sand). The SMG will provide a technical specification for nourishment sand and compatibility criteria to assist in the initial assessment of potential sand sources. The SMG will also outline an approval pathway that CN could pursue for conceptual approval for the beach nourishment works under Part 5 of the EP&A Act and State Environmental Planning Policy (SEPP) (Coastal Management) 2018. The approval could cover receiving material from a number of potential sources. The excavation, dredging or extraction of the source material would be covered by separate project approvals not by CN's beach nourishment Part 5 approval. The environmental assessment to be prepared with the Part 5 approval would need to consider impacts of a defined range or upper limit volume from a variety of sources. Different source material will have different physical properties resulting in different placement methods and or locations on the beach. The potential impacts of these options would need to be assessed in the environmental assessment document.

The SMG, the conceptual Part 5 approval for nourishment and the associated environmental assessment will be actioned in accordance with **Table 15** as an immediate response.

CN is committed to working with the Deputy Premier's Taskforce and with State Government and other agencies to explore, share information and problem-solve every opportunity to source sand that is technically compatible and economically feasible to enable initial mass nourishment and ongoing renourishment of Stockton Beach to be undertaken. Key areas of focus will include investigation of options for sand sourcing including onshore and offshore sources, actions to mitigate loss of community amenity from engineered solutions and seeking priority capital and operational funding required.

4.1.4 Adaptive Risk Mitigation Strategy

CN have developed an adaptive risk mitigation strategy to manage risk to assets not protected by the immediate buried terminal protection works, prior to the realisation of mass nourishment or the completion of the Newcastle CMP, as part of the Coastal Management Strategy outlined in **Section 4.1.**

The Adaptive Risk Mitigation Strategy will include:

Firstly, CN will continue to pursue opportunistic smaller renourishment campaigns as outlined in **Section 4.1.3**, to further address sand losses and maintain existing amenity. The identified buried terminal protection as per **Section 4.1.1** will address the areas at immediate risk. Potential impacts to the coastline outside these areas will be managed by the Coastal Zone Emergency Action Subplan.

Secondly, as a safeguard, CN has accepted a distance of 20 m from the 2025 ZSA 5% AEP hazard line as a foreshore recession threshold. This reflects the CMPs planning horizon. If this threshold foreshore width is reached, adaptive risk mitigation strategies will be considered and designed, on a site-specific basis, with reference to the following heads of consideration:

- Results of monitoring program
- Management Plan for areas such as Stockton Holiday Park (Zone 1)
- Existing recreational, access and amenity provisions
- Safety – person and property
- Projected sand renourishment frequency
- Stakeholder and community feedback
- Environment and asset infrastructure management implications

Based on this approach, CN will assess a range of adaptive risk mitigation measures including, but not limited to, opportunistic sand nourishment, managed retreat, beach scraping, temporary protection works, removable Rock Bags and built structures. This assessment aims to ensure a flexible and appropriate response is adopted once triggers are reached. The location and the design of these works will involve ongoing consultation with the community and all relevant stakeholders.

Finally, for most of the Stockton CMP foreshore it is considered unlikely that this threshold will be reached during the five-year planning horizon, once the initial buried terminal protection is in place. The Griffith Avenue / Barrie Crescent intersection, however, is a potential location where the threshold may be triggered and the above adaptive response may be required.

The Stockton CMP will be reviewed in 2025 to ensure the actions to manage Stockton Beach remain current and relevant, however it is anticipated that prior to 2025, the completion of the Sediment Transport Study for the full 32 km Stockton Bight will further inform the broader Newcastle CMP which is due for completion in December 2021.

4.1.5 Newcastle CMP

It is expected that the Coastal Management Strategy and actions in the Stockton CMP will be reviewed during the development of the Newcastle CMP. It is expected that the Stockton CMP will be replaced by the Newcastle CMP. This will provide opportunities to incorporate consideration of complementary management strategies north of Meredith Street (Zones 5, 6 and 7), within the Newcastle Harbour and south of the northern breakwater before December 2021 to further enhance or improve coastal management of Stockton Beach.

Ongoing community and agency consultation in the development of the Newcastle CMP will be facilitated through the NCPWG **(Section 1.4)** and other stakeholders as required. As an adaptive risk mitigation strategy CN may undertake coastal protection works such as the placement of additional rock, Rock Bags (subject to consent), and/or undertake further emergency coastal protection works (as outlined in **Appendix A)** to protect assets whilst allowing time for the Newcastle CMP to be completed and the outcome of mass nourishment investigations to be evident.

4.2 Implementation of Coastal Management Strategy

4.2.1 Key Issues

The most significant coastal management issues affecting the Stockton CMP area have been identified by the community in the CZMP (2018) and the CMP Scoping Study (CN, 2019), and as outlined in **Section 2.1,** are:

- Coastal hazards
- Coastal environment
- Beach access
- Beach amenity
- Recreational use of the coastal zone
- Culture and heritage

The actions required to address these coastal management issues have been developed in an evidence-based and strategic manner, as outlined in **Section 3.** Agreement for the inclusion of actions identified to be the primary responsibility of other public authorities has been received and is included in **Appendix B.**

4.2.2 Management Zones

The Stockton frontage was divided into seven zones for the CZMP to enable identification of the location of management actions within the CZMP area, and these zones have been adopted for use in the Stockton CMP. The seven zones are located from south to north along the Stockton coastline (refer **Figure 2**) and include:

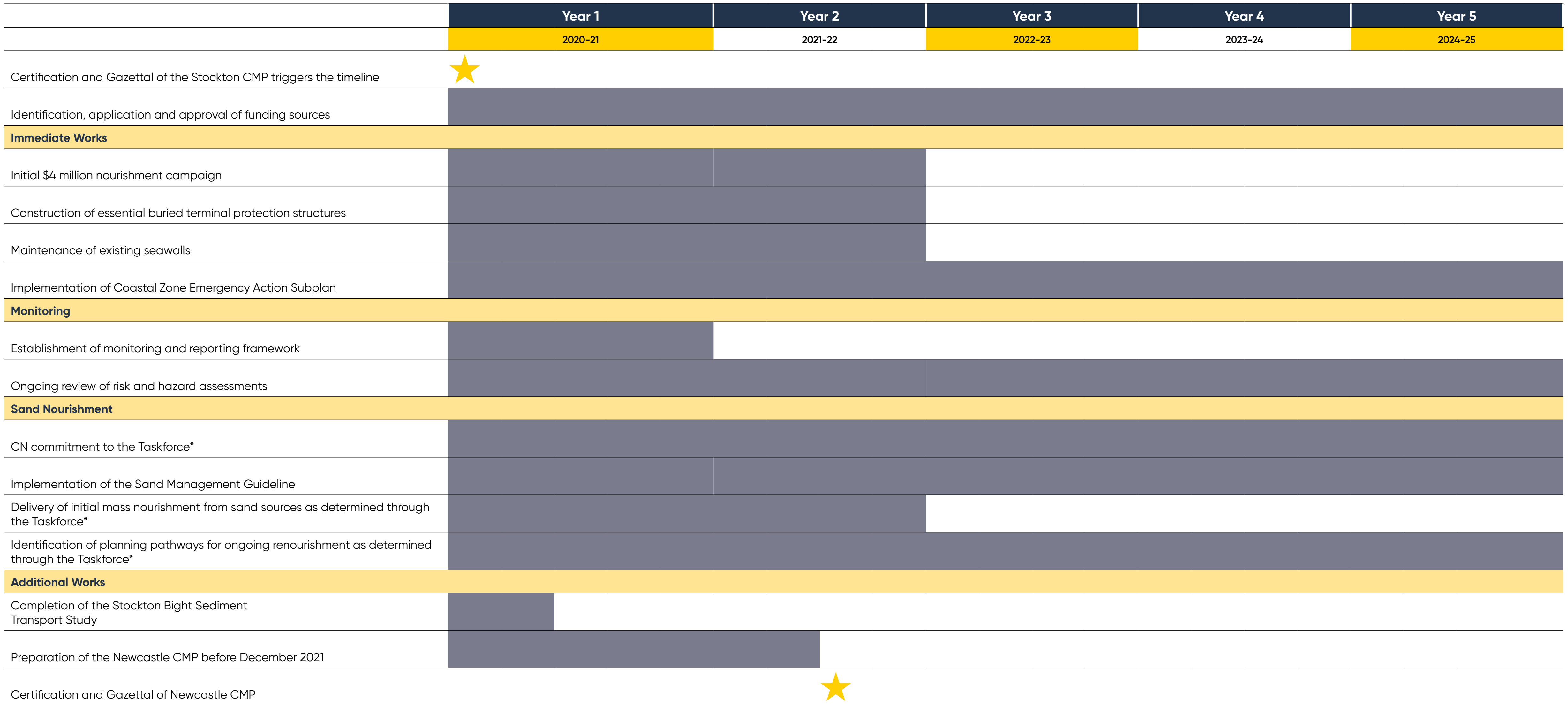
- Zone 1 - Holiday Park frontage from Northern Breakwater, to the Stockton Surf Life Saving Club revetment
- Zone 2 - Stockton Surf Life Saving Club revetment to the southern end of Mitchell Street revetment
- Zone 3 - Mitchell Street revetment extent
- Zone 4 - Northern end of Mitchell Street revetment to Meredith Street
- Zone 5 - Meredith Street to the northern boundary of Corroba Oval
- Zone 6 - Northern boundary of Corroba Oval to southern boundary of Fort Wallace (main land ownership by Hunter Water Corporation)
- Zone 7 - Southern boundary of Fort Wallace to CN local government boundary (main land ownership by Defence Housing Australia and Family and Community Services).

This Stockton CMP is limited to Zones 1 to 4 inclusive as outlined in **Section 1.1**. Zones 5 to 7 will be addressed in the broader Newcastle CMP due for completion by the end of 2021.

The implementation of the proposed Coastal Management Actions is outlined for each of the issues as listed above in **Table 9 to Table 14**. The Coastal Management Actions are illustrated for Zones 1 to 4 in **Figure 13 to Figure 16** respectively. Not all actions have been mapped, only those actions for which mapping is useful or relevant.

4.2.3 Delivery Timeline

The implementation of the Stockton CMP is projected over a five-year planning horizon. The following indicative timeline reflects the key deliverables (that are detailed in **Section 6, Table 15**).



Footnote - Year 1 start date based on certification

** In accordance with the Deputy Premier's Taskforce Terms of Reference whilst still in force*

ZONE 1 PLAN

1:1250 (A1)

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SAVED: 12-Jun-20

DIAL BEFORE YOU DIG www.1100.com.au

AUSTRALIAN HEIGHT DATUM

25 0 25 50 75 100 125m
1:2500 (A3) 1:1250 (A1)

FIGURE 13

Royal HaskoningDHV
Enhancing Society Together

City of Newcastle

Figure 13: Management Actions for Zone 1

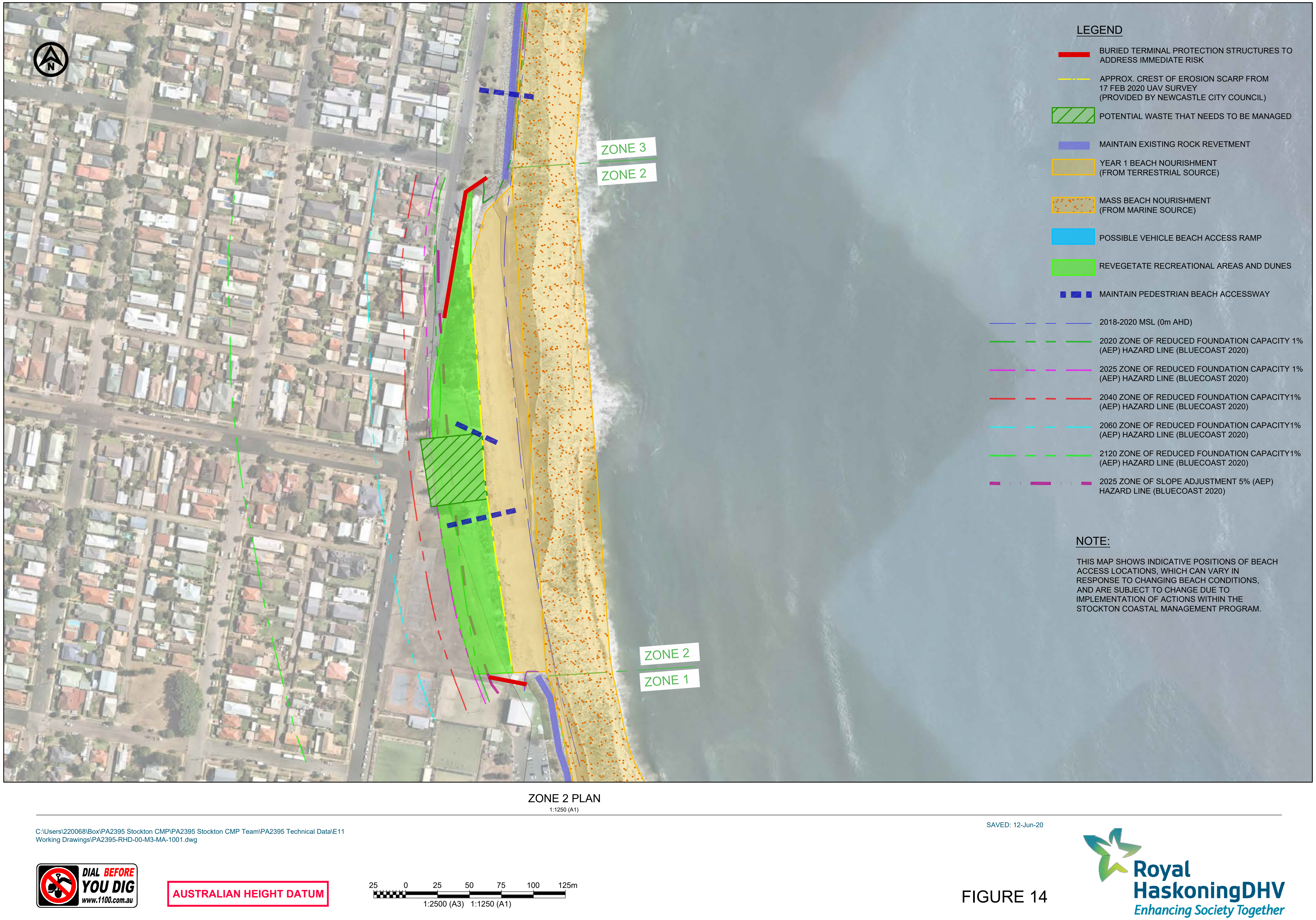

Figure 14: Management Actions for Zone 2

ZONE 3 PLAN
1:1250 (A1)

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SAVED: 12-Jun-20

DIAL BEFORE YOU DIG www.1100.com.au

AUSTRALIAN HEIGHT DATUM

25 0 25 50 75 100 125m
1:2500 (A3) 1:1250 (A1)

FIGURE 15

Royal HaskoningDHV Enhancing Society Together

Figure 15: Management Action Plan for Zone 3

ZONE 4 PLAN
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SAVED: 12-Jun-20

DIAL BEFORE YOU DIG www.1100.com.au

AUSTRALIAN HEIGHT DATUM

25 0 25 50 75 100 125m
1:2500 (A3) 1:1250 (A1)

FIGURE 16

Royal HaskoningDHV
Enhancing Society Together

Figure 16: Management Actions for Zone 4

Table 9: Management Actions to Address Coastal Hazards

Action #	Approach	Zone	Management Action	Primary Responsibility	Supporting Partners[1]	Cost Estimate (Funding Source)	Evaluation Method	Timeframe
CH1	Planning	1, 2, 4	Investigation, design and documentation of buried terminal protection structures to address immediate risks , including geotechnical and quarry investigations	CN		$100,000 (CN)	Completed investigation and design documentation	Short
CH2	Planning	1,2,4	Environmental Assessment and associated approvals of buried terminal protection structures at four locations	CN		$20,000 (CN)	Completed Environmental Assessment report and associated approvals	Short
CH3	On-ground works	4	Construction of Zone 4 buried terminal protection structures to address immediate risks at Stone St/Barrie Crescent (location1)	CN	DPIE	$1 million $20,000-$70,000/ annum maintenance (CN, State Government competitive grants funds)	Works complete.	Short- Medium
CH4	On-ground works	2	Construction of Zone 2 buried terminal protection structures to address immediate risks at Mitchell St (south end of Mitchell St revetment) and north end of SLSC (location 2 and 3)	CN	DPIE	$3.75 million $187,500 every 5 years Maintenance (CN, State Government competitive grants funds)	Works complete	Short- Medium
CH5	On-ground works	1	Construction of Zone 1 buried terminal protection structures to address immediate risks at Holiday Park (location 4)	CN	DPIE	$875,000 $43,750 every 5 years Maintenance (CN, State Government competitive grants funds)	Works complete	Short- Medium
CH6	Planning	1	Develop a management plan for the Holiday Park addressing the asset management requirements for the cabins and amenities block	CN		$10,000 (CN)	Plan developed	Short- Medium
CH7	On-ground works	1	Construction of new amenities block in Holiday Park	CN		$450,000 (CN)	New amenities building complete and commissioned	Short- Medium
CH8	On-ground works	1	Demolition of existing amenities block in Holiday Park	CN		$40,000 (CN)	Amenities building removed.	Short- Medium
CH9	On-ground works	1	Relocation of cabins as per the Holiday Park Management Plan	CN		$30,000 (CN)	Cabins in new permanent location	Short- Medium
CH10	Planning	1,2	Investigation, design, documentation and approvals for nourishment works at Holiday Park and Dalby Oval frontage from terrestrial or other opportunistic, permissible sand sources (for initial $4 million nourishment campaign) (including environmental assessment and monitoring plan)	CN		$150,000 (CN)	Contract documentation complete	Short- Medium
CH11	Planning	1,2,3,4	Facilitate delivery of sand nourishment from opportunistic sources as potentially identified by the Deputy Premiers Taskforce.,	CN	Deputy Premier's Taskforce	$150,000	Sand nourishment undertaken	Short-Medium*
CH12	On-ground works	1,2	Implementation of nourishment works from terrestrial (or other permissible sources) at Holiday Park and Dalby Oval frontages	CN		$4 million (CN, State Government competitive grants funds)	Sand placement complete	Short- Medium
CH13	Monitoring	1-7	Ongoing monitoring of nourishment works as per monitoring plan. Terrestrial and bathymetric surveys	CN		$100,000 per annum (CN, State Government competitive grants funds)	Surveys complete	Short- Medium
CH14	On-ground works		Port of Newcastle to place suitable sand from maintenance dredging activities from harbour entrance offshore of Stockton Beach in accordance with concurrence issued by Office of Environment and Heritage (to be revised February 2022)	Port of Newcastle	DPIE Roads and Maritime Services	Minimal. Maintenance dredging for navigational safety currently conducted by Port of Newcastle.	Placement of sand after dredging campaigns.	Short
CH15	Planning	LGA	Complete Newcastle CMP detailed investigations and other required studies	CN	DPIE	$150,000 (CN, State Government competitive grants funds)	Detailed studies completed and Coastal Management Program prepared and certified.	Short
CH16	Planning	LGA	Establish an expert panel to advise CN on coastal management matters.	CN		Minimal	Expert panel established	Short

Action #	Approach	Zone	Management Action	Primary Responsibility	Supporting Partners[1]	Cost Estimate (Funding Source)	Evaluation Method	Timeframe
CH17	Planning	LGA	Assess potential options for long-term management of coastal hazards in the broader Stockton study area through the development of a Newcastle Coastal Management Program in accordance with the Coastal Management Act 2016 and the NSW Coastal Management Manual.	CN	DPIE	$100 000 (CN, State Government competitive grants funds)	Newcastle CMP prepared and certified.	Medium
CH18	Planning	1-7	Consultation with stakeholders to the north of Stockton to identify coastal management opportunities to enhance coastal management actions proposed in the Newcastle CMP	CN	Hunter Water/ DHA / Worimi/ PSC/ FACS	Minimal	Agreement on preferred Newcastle CMP actions as required	Short
CH19	Planning	LGA	Consultation with stakeholders to identify options for coastal management within broader Newcastle CMP	CN	Various	Minimal	Agreement reached on preferred CM actions	Short
CH20	Monitoring	LGA	Monitor opportunities under grant programs and ensure grant applications are best positioned to deliver funding for Stockton CMP actions	CN	DPIE	Internal CN resources	Funding applications submitted.	Short-Medium
CH21	Monitoring	LGA	Alternative funding methods to be investigated and considered for Stockton CMP actions	CN		Minimal	Alternative funding sources investigated and advocated for	Short, Medium
CH22	Monitoring	3	Undertake condition assessment/scope of works for maintenance to SLSC and Mitchell Street seawalls.	CN		$20,000 (CN)	Condition assessment/scope of works completed.	Short- Medium
CH23	On-ground works	3	Undertake maintenance to Mitchell Street seawall identified in condition assessment report	CN		$4.5 million capital. $200 000 per annum maintenance. (CN)	Identified repairs to Mitchell Street seawall completed.	Short- Medium
CH24	On-ground works	3	Undertake maintenance to SLSC seawall identified in condition assessment report	CN		$400,000 capital. $36,000 per annum maintenance. (CN)	Identified repairs to SSLSC seawall completed.	Short- Medium
CH25	Planning	4	Design and consultation for road works at Griffiths Avenue and Barrie Crescent	CN		$40,000 (CN, State Government competitive grants funds)	Consultation and design documentation completed	Short- Medium
CH26	On-ground works	4	Undertake roadworks at seaward end of Griffiths Avenue/ Barrie Crescent intersection and construct traffic management devices.	CN		$150,000 (CN, State Government competitive grants funds)	Works constructed	Short- Medium
CH27	Planning		Adaptive risk mitigation strategy includes completing environmental assessment for opportunistic beach nourishment of varying scales	CN		$100,000 (CN)	Environmental Assessment complete	Short- Medium
CH28	Planning		Adaptive risk mitigation strategy including seeking approval for beach nourishment works under Part 5 of EP&A Act covering receiving material from a number of sources for opportunistic nourishment campaigns with reference to Sand Management Guideline. Also seek other permits required.	CN		$100,000 (CN)	Approval received	Short- Medium
CH29	Planning		Adaptive risk mitigation strategy including investigating potential sand sources/opportunities for maintenance nourishment of Stockton in accordance with Sand Management Guideline	CN		$10,000 (CN)	Nourishment source identified and placement strategy agreed.	Short- Medium
CH30	Planning		Participation in the Deputy Premier's Taskforce to seek to deliver mass nourishment (subject to ongoing investigations and resolution of permissibility)	CN	Deputy Premier's Taskforce	$10,000 (CN)	Permissibility confirmed and source identified	Short-Medium* (10 year re-nourishment period)
CH31	Planning		Investigate potential offshore sand sources / opportunities / methodologies and funding for mass nourishment at Stockton including identifying and undertaking sampling and surveying requirements.	CN/ Deputy Premier's Taskforce	CN	Variable as scope of studies yet to be confirmed. (CN, State Government competitive grants funds)	CN's participation in Deputy Premier's Taskforce. Permissibility confirmed funding and source identified, sampling program complete.	Short-Medium*
CH32	Planning	1,2, 3, 4,	Facilitate the delivery of mass nourishment from offshore marine sources	CN / Deputy Premier's Taskforce		Funding source to be confirmed	Mass nourishment from offshore marine sources delivered	Short-Medium*

Action #	Approach	Zone	Management Action	Primary Responsibility	Supporting Partners[1]	Cost Estimate (Funding Source)	Evaluation Method	Timeframe
CH33	Planning	1, 2, 4	Adaptive Risk Mitigation Strategy including investigation, design and documentation of potential protection works against the adopted threshold, for Newcastle CMP consultation, including geotechnical investigations	CN		$100,000 (CN, State Government competitive grants funds)	Completed investigation and design documentation	Short-Medium
CH34	Planning	1,2,4	Environmental Assessment of designed protection works as at CH33	CN		$30,000 (CN, State Government competitive grants funds)	Environmental Assessment complete	Short-Medium
CH35	Planning	1,2,3,4	Prepare and adopt a Plan of Management (PoM) for dedicated or reserved Crown Land under CN care and control	CN	DPIE (Crown Lands)	$80,000 (CN)	PoM complete	Short
CH36	Planning	1	Undertake annual inspection of Northern breakwater as per the PON lease area and assess potential issues from coastal hazards	PoN	Transport for NSW	As required (PoN)	Visual inspection of rock armour, public pathway and ancillary infrastructure	Short
CH37	Planning, on-ground works	1-4	Continue beach and seawall monitoring program with cross section survey sites and utilising UAV and other monitoring methods, within the Stockton CMP area	CN		$10,000 per annum (CN)	Beach and seawall monitoring program, cross sections completed. Innovation in methodology undertaken	Short-Medium
CH38	Development controls		Review planning certificates to ensure properties potentially affected by coastal hazards contain an appropriate notation and reflect ability (or not) for complying development to be carried out on the land	CN		Minimal	Planning certificate notification reviewed	Short
CH39	Development controls		New subdivisions or greenfield development to be located landward of 2120 ZRFC coastal hazard line	CN		Minimal	Design of subdivisions or development landward of 2120 ZRFC coastal hazard line	Short-Medium
CH40	Planning	1-4	When the opportunity arises, Plans of Management, public domain plans and other master plan documents within the Stockton CMP area will be prepared or amended in consideration of the coastal hazards outlined in the Stockton CMP	CN	As required	Minimal	Coastal hazards incorporated into relevant plans	Short- Medium
CH41	Planning	1-4	Consider impacts of coastal hazards when renewing or constructing public assets within the Stockton CMP area. The design of assets should consider the coastal hazards outlined in the Stockton CMP	CN		Varied due to project undertaken, costing within project budget (CN)	Incorporation of coastal hazards into project design documents	Short-Medium
CH42	Planning, on-ground works	1-4	Incorporation of coastal hazards into CN's service asset plans and implement service asset plans	CN		$20,000 (CN)	Coastal hazard analysis included in service asset plans	Short-Medium
CH43	Planning, Engagement, On-ground works	1-4	Undertake planning, engagement and emergency works, if appropriate, to manage beach erosion before, during and after storm events in accordance with the Emergency Action Subplan contained in **Appendix A**	CN		$200,000 per annum estimate (5 year average) and varied based on extent of emergency works. $5000 annual monitoring budget (CN, State Government competitive grant funds)	Emergency response and subsequent grant funding applications lodged, in accordance with Subplan completed as required	Short-Medium
CH44	Planning	4	Adaptive risk mitigation strategy including design and approval of coastal protection works upon erosion triggers, for the identified risk potential at Griffith Ave and Barrie Cres. See Section 9 Mapping for potential locations for adaptive risk mitigation implementation.	CN		$35,000 (CN)	Design and approval of coastal protection works	Short-Medium
CH45	On-ground Works	4	Construction of approved coastal protection works upon reaching threshold, for the identified risk potential at Griffith Ave and Barrie Cres	CN		$100,000 initial budget Final budget variable	Construction of approved coastal protection works	Short-Medium
CH46	Partnerships		Continue to consult with Port of Newcastle and capital dredging proponents to request excess suitable sand from capital dredging projects is placed offshore of Stockton Beach	CN	PoN, Transport for NSW	Minimal	Excess suitable sand from capital dredging placed offshore of Stockton Beach	Short- Medium (project based)
CH47	Engagement		Conduct community engagement and education programs focusing on the Stockton CMP area environment and coastal processes including inundation and erosion hazards	CN		$25,000 per annum for coastal education program (CN)	Education programs developed and presented to community	Short-Medium

Action #	Approach	Zone	Management Action	Primary Responsibility	Supporting Partners[1]	Cost Estimate (Funding Source)	Evaluation Method	Timeframe
CH48	Engagement		Update and enhance CN's website with information about coastal processes, management of the coastal environment. Provide more information about coastal activities in conjunction with CH43, CH47 and on-ground works,	CN		Minimal	CN website updated	Short-Medium
CH49	On-ground works	1,2,4	Conduct beach management works, such as beach scraping and beach grooming, in areas south and north of the Mitchell Street seawall to increase dune volume	CN	DPIE	$100,000 per annum (CN, State Government competitive grant funds)	Identified beach scraping activities completed as conditions permit	Short-Medium
CH50	Planning	1-4	Resourcing the integrated delivery of on-ground works as detailed in this business plan	CN		$200,000 per annum (CN, State Government competitive grant funds)	2x Effective Full-Time staff engaged. integrated delivery the Stockton CMP works program	Short-Long

[1] Supporting partners are Government Agencies or stakeholders with ownership of land or an interest in the proposed management action and will be consulted at the time of project management.

**In accordance with the Deputy Premier's Taskforce Terms of Reference whilst still in force.*

Table 10: Management Actions to Address Coastal Environment

Action #	Approach	Zone	Management Action	Primary Responsibility	Supporting Partners[1]	Cost Estimate (Funding Source)	Evaluation Method	Timeframe
CE1	Monitoring	1-4	Continue to monitor coastal habitat and implement recommendations of monitoring program	CN		$5,000 (CN)	Monitoring program undertaken	Short-Medium
CE2	On-ground works	1-4	Undertake coastal revegetation works as outlined in Coast and Estuary Vegetation Management Plan (Umwelt, 2014). Options to control Bitou Bush and other invasive plant species included in revegetation works for dunes and recreational areas	CN		$15,000 per annum (CN)	Coastal revegetation works completed	Medium
CE3	Planning	1-3	Public domain works along the coastal section of the Stockton CMP area to include landscaping with native provenance species	CN		$10,000 (CN)	Public domain plan completed	Short-Medium
CE4	On-ground works	1-4	Implement beach stormwater outlet maintenance program to manage dunes and remove stormwater ponding, particularly after rain events	CN		$10 000-$15 000 per annum (CN)	Stormwater outlet areas on beach maintained	Short-Medium
CE5	Planning	1-4	Water Sensitive Urban Design (WSUD) principles to be included in Public Domain Plans (or other masterplan documents) within the Stockton CMP area	CN		Minimal		Short-Medium
CE6	On-ground works	1-4	Provide support and assistance to Landcare/volunteers when revegetation activities are undertaken in Stockton CMP area	CN		Minimal	Assistance to Landcare provided	On-going
CE7	Monitoring, Partnerships		Build capacity for community volunteers to undertake citizen science environmental monitoring	CN		Minimal	Community environmental program established	Medium
CE8	On-ground works	1, 2, 4	Undertake removal of historical buried waste along the erosion scrap	CN		Costed to project work	Rubbish removal as required	Short-Medium

Table 11: Management Actions to Address Beach Access

Action #	Approach	Zone	Management Action	Primary Responsibility	Supporting Partners[1]	Cost Estimate (Funding Source)	Evaluation Method	Timeframe
BA1	Risk assessment	1-4	Undertake an audit of beach access points to assess public safety issues and erosion potential. Access point data to be available in CN GIS program	CN	DPIE	$5,000 (CN)	Audit undertaken	Short
BA2	Monitoring	1-4	Identify beach access points for closure and/or replacement in consultation with relevant stakeholders and the community	CN	DPIE	Minimal	Access points identified for closure and/or replacement	Short
BA3	Planning	1-4	Design of new fencing and beach access points are undertaken in accordance with the Coastal Dune Management Manual (Department of Land and Water Conservation, 2001)	CN	DPIE	$10,000 (CN, State Government competitive grant funds)	Design drawings completed with reference to Coastal Dune Management Manual	Short-Medium
BA4	On ground works	1-4	Construction of new fencing and beach access points	CN	DPIE	$20,000 (CN, State Government competitive grant funds)	Fencing and access points complete	Short-Medium
BA5	On ground works	1-4,	Investigate, design and construct new access ways associated with, but not limited to, buried terminal protection structures to address immediate risks	CN	DPIE	$200,000 (CN, State Government competitive grant funds)	Accessways complete	Short-Medium

Note: Beach nourishment Actions have been listed in Coastal Hazard Action Table 6 though they also address beach access issues.

Table 12: Management Actions to Address Beach Amenity

Action #	Approach	Zone	Management Action	Primary Responsibility	Supporting Partners[1]	Cost Estimate (Funding Source)	Evaluation Method	Timeframe
B1	Planning	1-3	Investigate opportunities for landscaping within the Stockton CMP area as part of public domain plans	CN	DPIE	Minimal	Appropriate landscaping included within public domain plan	Medium
B2	On-ground works	1-4	Undertake beach maintenance program and continue dune rehabilitation works. This includes dune fencing, access controls, invasive species control and replanting native colonising species	CN	DPIE	$150,000 per annum (CN, State Government competitive grant funds)	Beach maintenance program undertaken	Short
B3	Planning, risk assessment	1-4	Undertake audit of stormwater discharge points onto Stockton coastline and assess water quality and erosion potential	CN	DPIE	Minimal	Stormwater audit undertaken	Short-Medium
B4	On-ground works	1-4	Undertake beach maintenance at stormwater discharge points on Stockton coastline after storm events to prevent additional erosion	CN		Minimal (included in operational costs)	Beach maintenance at stormwater discharge points undertaken where required	Short-Medium

Table 13: Management actions to Address Recreational Use

Action #	Approach	Zone	Management Action	Primary Responsibility	Supporting Partners[1]	Cost Estimate (Funding Source)	Evaluation Method	Timeframe
RU1	Planning	1-3	Prepare public domain plan for the Stockton CMP area in consultation with relevant land managers and stakeholders. Public domain plan will build upon the adopted Newcastle Revitalisation Strategy Master Plan	CN	DPIE	$30,000 (CN)	Public domain plan prepared	Medium (>5 years)

Table 14: Management Actions to Address Culture and Heritage

Action #	Approach	Zone	Management Action	Primary Responsibility	Supporting Partners[1]	Cost Estimate (Funding Source)	Evaluation Method	Timeframe
H1	Planning		Incorporate Aboriginal cultural information into CN projects and works within the Stockton CMP area	CN	Guraki Committee Worimi Aboriginal Land Council	Minimal	Aboriginal cultural information incorporated into CN projects	Short-Medium
H2	Planning		Implement dual naming of sites within the Stockton CMP area where appropriate	CN	Guraki Committee Worimi Aboriginal Land Council	Minimal	Dual naming sites determined	Short-Medium
H3	Planning		Ensure high quality interpretive treatments of heritage items or places that increase understanding of the heritage significance of these items or places in CN projects and works within the Stockton CMP area	CN		Cost to be determined as part of individual project	Heritage treatment incorporated into CN projects	Short-Medium
H4	Planning		Prepare Aboriginal Heritage Management Strategy to ensure due diligence processes are followed for CN projects and assessment of development applications	CN	Guraki Committee Worimi Aboriginal Land Council	$30 000 (CN, State Government competitive grant funds)	Aboriginal Heritage Management Strategy completed	Medium
H5	Planning		Interpretation of the history and heritage within the Stockton CMP area is to be integrated into Public Domain Plans	CN		Minimal	Heritage considerations included in Public Domain Plan	Medium
H6	Planning		Investigate protection of heritage listed items on public lands from coastal hazards	CN		Minimal		Short-Medium

Supporting partners are Government Agencies or stakeholders with ownership of land or an interest in the proposed management action and will be consulted at the time of project management.

5. CMP Recommended Changes to Relevant Planning Controls

As noted in Section 16 of the CM Act, before adopting a CMP, a local Council must consult on the draft program with the community. Furthermore, if the local Council's Local Government Area contains land within the coastal vulnerability area, it must also consult with any other local Council whose Local Government Area contains land within the same coastal sediment compartment (as specified in Schedule 1). For Stockton Beach this is the Stockton Bight sediment compartment, shared with Port Stephens Council.

The Ministerial direction requires CN to submit a CMP for Stockton Beach, and Stockton CMP identifies priorities and recommends specific actions to manage the coast at Stockton Beach from the Northern Breakwater to Meredith Street, Corroba Oval. The Stockton CMP does not provide management actions for the entire Stockton Bight sediment compartment.

It is important to note that a Newcastle CMP that addresses management of a wider spatial area is due for completion by December 2021, and that CN would consult with Port Stephens Council during its development. It is expected that the Stockton CMP will be replaced by the Newcastle CMP.

The Stockton CMP management area is mapped by the CM SEPP as containing Coastal Use and Coastal Environment Areas and is adjacent to (though not containing) Coastal Wetlands and Littoral Rainforest Area, as shown in **Figure 17 Figure 18 Figure 19.** A table outlining how the Stockton CMP addresses Mandatory Requirements and Objects of the CM Act, CM SEPP and Manual is provided in **Supporting Document H**, and further described below.

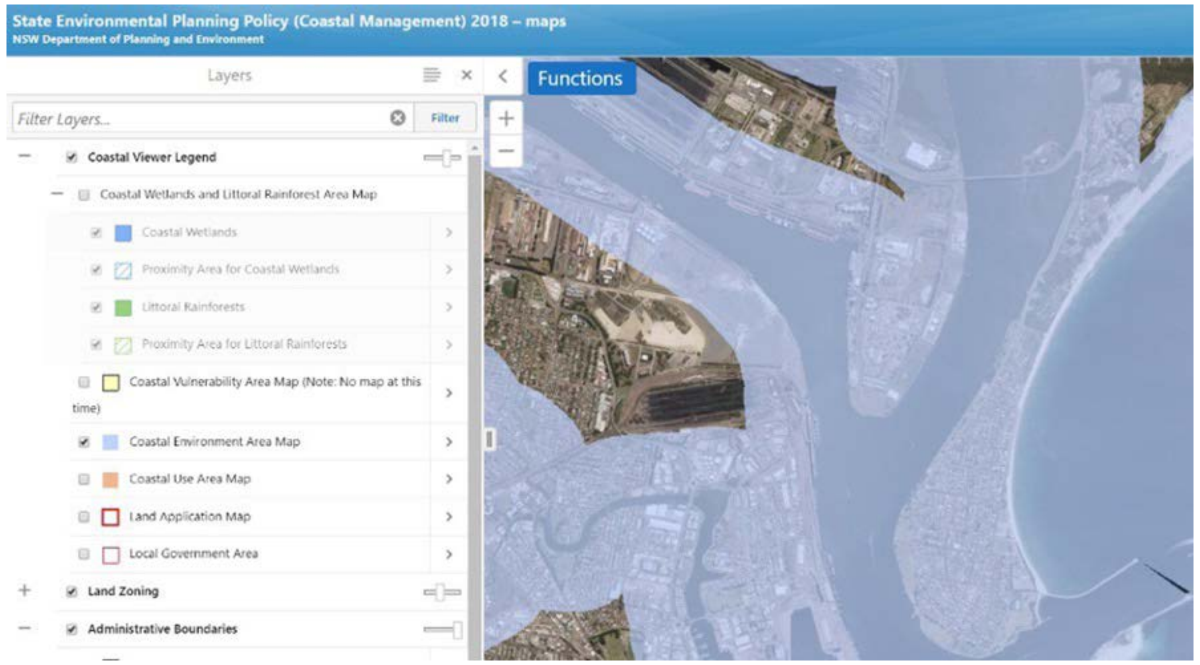

Figure 17: State Environmental Planning Policy (Coastal Management) 2018
Source: NSW Department of Planning and Environment Planning Portal (date: 21/04/20)

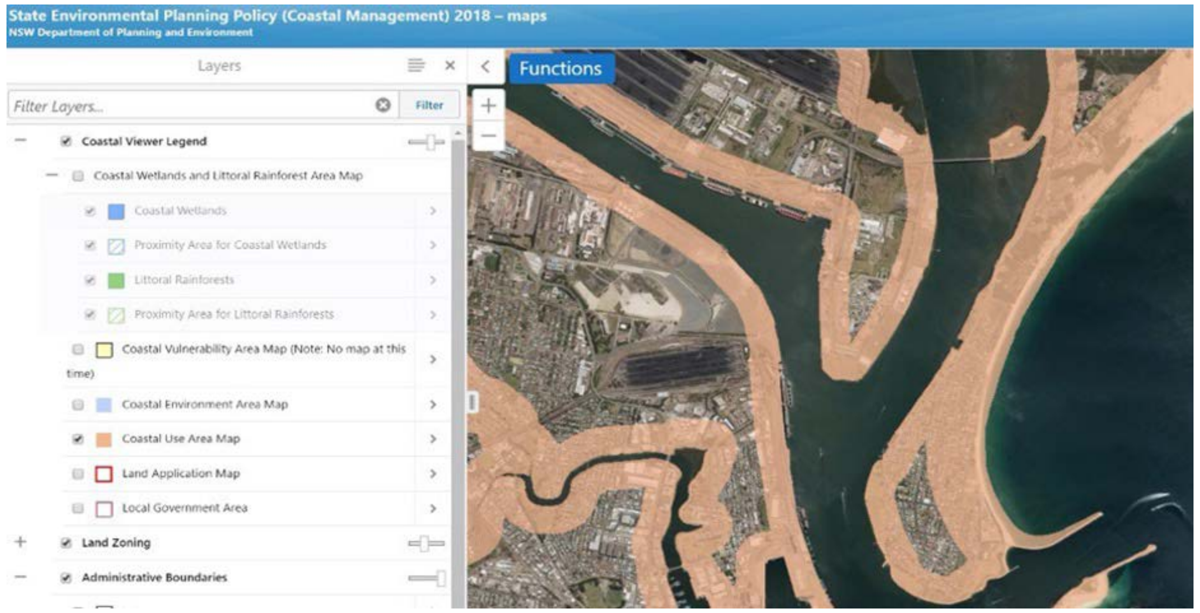

Figure 18: State Environmental Planning Policy (Coastal Management) 2018
Source: NSW Department of Planning and Environment Planning Portal (date: 21/04/20)

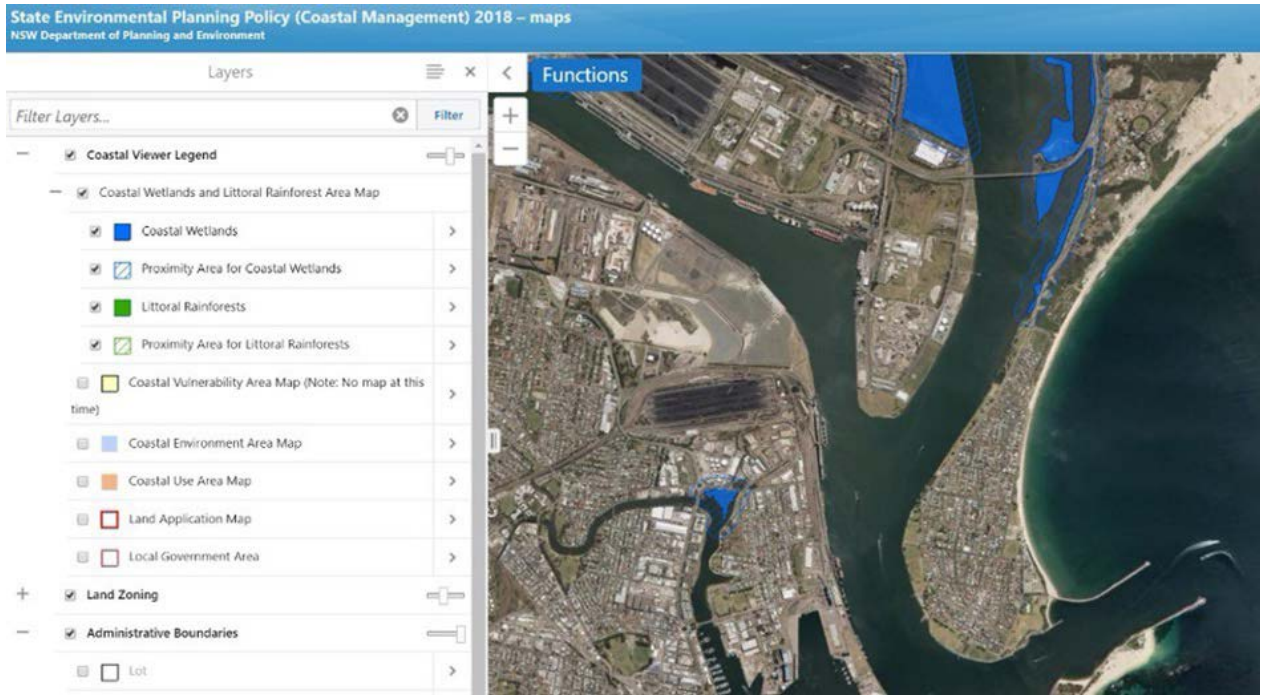

Figure 19: State Environmental Planning Policy (Coastal Management) 2018
Source: NSW Department of Planning and Environment Planning Portal (date: 21/04/20)

It is noted that at the commencement of CM SEPP, no Coastal Vulnerability Area Map was adopted and therefore no coastal vulnerability area has been identified. Suitable mapping does exist to prepare a coastal vulnerability area for Stockton, however CN has considered and decided not to pursue the option of a Planning Proposal to gazette a coastal vulnerability area for Stockton Beach, at this time.

Clause 12 of the CM SEPP only applies to coastal vulnerability areas where mapping for that area has been gazetted under the SEPP. Regardless, Clause 15 of the CM SEPP applies to all land within the coastal zone, and states that "development consent must not be granted to development on land within the coastal zone unless the consent authority is satisfied that the proposed development is not likely to cause increased risk of coastal hazards on that land or other land".

The Stockton CMP gives effect to the management objectives for a coastal vulnerability area (Section 7 of the CM Act) through the management actions proposed in **Section 4**, as well as:

- Via the CZEAS described in **Section 7** and **Appendix A**
- With coastal processes and climate change informing the hazard assessment and options evaluation undertaken
- Including a strong focus on the provision of beach amenity via maintaining the presence of a natural foreshore, and providing various actions to improve public access and use of the beach and foreshore
- In particular action CH40 (New subdivisions or greenfield development to be located landward of 2120 ZRFC coastal hazard line)
- Including a strong focus on the provision of beach nourishment to provide a degree of natural defence against coastal hazards
- Coastal protection structures are identified as a secondary means of reducing expose to coastal hazards should beach nourishment not prove sufficient of be implementable

The Stockton CMP gives effect to the management objectives for a coastal environment area (Section 8 of the CM Act) through the management actions proposed in **Section 4**, as well as:

- Including a strong focus on the provision of beach amenity and natural coastal processes via maintaining the presence of a natural foreshore
- Including a strong focus on the provision of beach amenity and natural coastal processes via maintaining the presence of a natural foreshore. It is noted that the CMP does not cover an area sufficiently large to have an appreciable impact on coastal waters or other water bodies
- The CMP does not cover an area where any actions would have an appreciable impact on water quality or estuary health
- Including a consideration of social and cultural values of the coast
- Various actions relating to improving access and amenity along the coast

The Stockton CMP gives effect to the management objectives for a coastal use area (Section 9 of the CM Act) through the management actions proposed in Section 4, as well as by including a strong focus on the provision of a natural foreshore adjacent to residential areas. A subsequent CMP proposed for completion in 2021 for the entire Newcastle coast is expected to further consider these objectives for the broader Newcastle LGA area.

The existing coastal inundation (storm event and tidal inundation) hazard information is already part of existing CN development assessment processes. The existing coastal hazard information is suitable to guide proponents in preparing development applications and to guide CN in providing consent or conditions regarding the potential coastal risk to proposed developments.

The Stockton CMP does not propose any amendments to planning controls, nor to the existing mapping of coastal management areas currently gazetted with the CM SEPP.

6. Business Plan

6.1 Management Action Approvals and Considerations

Coastal management actions in the Stockton CMP will potentially require approvals or authorisation from relevant landowners, or stakeholders with interest in the land, where the management action is proposed. As per existing management practices approvals and assessments or authorisations under various legislative instruments may be required and will be obtained prior to commencement of the management action. This includes but is not limited to assessment of European and Aboriginal heritage, environmental impacts and navigation.

Crown Reserve 79066, with reserve purpose of public recreation, port facilities and services; Gazetted 9 November 1956, runs along the open coastline of the Stockton CMP study area. Where management actions are proposed on Crown Land as per **Table 8** relevant authorisations and approvals may need to be obtained under the Crown Land Management Act 2016.

Management actions undertaken on Crown Land will also need to consider Aboriginal Land Claims lodged under the Aboriginal Land Rights Act 1983 as outlined in **Section 2.1.1**. Any works as a result of management actions will need to be compliant with the Native Title Act 1993 (Cwlth). The proposed actions have been reviewed by the Worimi LALC in relation to the undetermined land claims and consultation will continue to manage any potential impacts (as outlined in **Supporting Document B**).

Under the *Offshore Minerals Act* 1999, sand extraction is not permissible in NSW coastal waters without being authorised by a mining licence. An applicant cannot apply for a mining licence without the Deputy Premier inviting applications. CN recognises that there are still significant investigation, assessment, authorisation and approval requirements that are necessary to progress the mass nourishment component of the Coastal Management Strategy. This includes consideration of the requirement of the *Offshore Minerals Act 1999* that royalties be paid to the state for offshore sand extraction. Ongoing extensive consultation with relevant government, industry and community stakeholders will be an essential component of identifying and addressing extraction, placement and offsite impacts. This process will be informed by existing investigations that have been identified in **Section 2.**

CN has also undertaken an ecological audit of the beach environment (UoN, 2018). This study included the Stockton CMP area and will continue to inform further beach management approvals and activities, such as beach scraping.

6.2 CBA Distribution Analysis

As noted in **Section 3.4**, option 1b was identified as the economically preferred option, with a BCR of 1.5 and producing over $19 M in net present value to society. However, the permissibility and technical details of this option require further investigation and resolution.

It is recommended that option 1d be considered as a viable, feasible and acceptable option for the Stockton CMP. It is noted that all the nourishment options identified are highly sensitive to the cost assumptions associated with access and delivery of nourishment material. The sensitivity analysis undertaken indicates that should lower costs be realised, the economic performance of option 1d will significantly improve.

Delivery of the Stockton CMP is estimated to cost $26,540,250 over 10 years.

It should be acknowledged that if additional affordable sources of sand become available, and/or understanding of coastal processes changes, other management actions may become feasible and will be reviewed for inclusion in the Newcastle CMP.

Based upon the timeframes for actions and estimated costings, approximately $9.69M is required in Year 1 to implement specified actions, while a forecast of approximately $12.36M is estimated across Year 2 to 5 (inclusive) and approximately $4.4 M for years 6 to 10 (inclusive). The cost estimates and their breakdown across the specified years for delivery is provided in **Table 15.**

6.2.1 Benefit and Cost Distribution

The land parcels along the foreshore of Stockton Beach are either owned by CN, or managed by CN on behalf of other government agencies. The actions within the Stockton CMP seek to address the objects of the CM Act, including to protect and enhance natural coastal processes and coastal environmental values including natural character, scenic value, biological diversity and ecosystem integrity and resilience, as well as to support the social and cultural values of the coastal zone and maintain public access, amenity, use and safety.

The beneficiaries of the actions are considered to be the natural and built environment of Stockton Beach, residents of and visitors to the location, as well as ‘non-use’ values such as amenity.

As such, it is considered appropriate that the costs for the actions are principally borne by CN, however it is noted that a range of potential funding sources will be explored to support delivery of actions, and these are described in **Section 6.3**.

6.3 Funding Sources

Sustainable funding and financing arrangements for management actions will be established in consultation with key stakeholders. Funding for management actions may be gained from various sources, including CN internal funds, competitive State or Federal Government grant programs and local third parties.

6.3.1 Council Funding Mechanism

CN may fund management actions outlined in the Stockton CMP from revenue generated by ordinary rate income. The Integrated Planning and Reporting framework described in **Section 8** requires CN to develop a four year Delivery Program and annual Operational Plan to achieve the objectives and strategies detailed in the Newcastle 2030 Community Strategic Plan (NCSP 2030). Alignment of Stockton CMP management actions with the objectives of NCSP 2030 are shown in **Table 15**, and these actions will be incorporated into the Delivery Program and Operational Plan for funding through CN's working funds. Management actions may also be included into CN asset management plans for allocation of funding.

Under Section 496B(1) of the Local Government Act 1993 CN may levy a coastal protection service charge (CPSC) on a parcel of rateable land where either the current or previous owner has voluntarily:

- constructed or contributed to the cost of constructing long-term coastal protection works, such as seawalls, that benefit the land, or
- agreed to pay the charge relating to works that existed prior to the commencement of the Local Government Act 1993 amendments that introduced this charge

The CPSC covers a council's reasonable costs of providing coastal protection services to the land on which the charge is levied. The CPSC will provide for maintaining and repairing the works and mitigating any impacts (such as replacement of eroded beach sand). There are currently no properties within the Stockton Beach location that meet these criteria.

6.3.2 State Government Funding Mechanism

A number of competitive State Government funding mechanisms are currently available to support the management actions in the Stockton CMP. The provision of funding is subject to terms of eligibility, competitive funding rounds and assessment, and availability of funds for each respective program.

Funding mechanisms include:

- Grants under the NSW Coastal Management Program administered by the DPIE
- Crown Reserves Improvement Fund administered by the DPIE (Crown Lands)
- Environmental Education Grants administered by the DPIE
- NSW Environment Trust grants administered by the DPIE
- NSW Heritage Grants Program

The NSW Minister for Local Government declared Stockton Beach a Significant Open Coast Location on 30 September 2019. This declaration means that CN can apply for funding to implement actions in a certified plan under the CM Act at any time, especially in circumstances where that action cannot wait until the next funding round. It also means that approval of applications for funding are prioritised where there is an identified urgency. This enables the rapid approval of funding for CN to start emergency actions such as sandbagging and beach nourishment.

The Deputy Premier has also announced the formation of a Deputy Premier's Taskforce of Government Agencies, CN and community representatives, to work together to address Stockton's erosion issues, and to consider options to fund long-term solutions. It is anticipated that the Deputy Premier's Taskforce outcomes will inform the development of the Newcastle CMP, which is due for completion by December 2021, and will likely replace the Stockton CMP.

6.3.3 Federal Government Funding Mechanism

Federal Government funding mechanisms are available to support the management actions in the Stockton CMP including Building Better Regions Fund administered by the Department of Infrastructure, Regional Development and Cities.

Funding programs are regularly changing, and CN will maintain an awareness of appropriate funding opportunities as they arise.

6.3.4 Disclaimer

It is noted that all cost estimates provided in the Business Plan in **Table 15** are based on project experience and external inputs, are for budgetary purposes only, and shall not be relied upon for any other purpose.

Table 15: Business Plan for Stockton CMP

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe Subject to available funding and resources	Year 1 (estimate)	Year 2-5 (forecast estimate)	Year 6-10 (forecast estimate)	Benefit	Potential Funding Sources	Alignment with IP&R Framework
	Total Cost for Stockton CMP			$ 9,690,000	$ 12,364,000	$ 4,486,250			
Strategy 1 – Coastal Hazards									
CH1	Investigation, design and documentation of buried terminal protection structures to address immediate risks	$100,000	Short	$100,000	-	-	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 1.3 Strategy 1.3a Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a
CH2	Environmental Assessment and associated approvals of buried terminal protection structures at four locations	$20,000	Short	$20,000	-	-	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 1.3 Strategy 1.3a Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a
CH3	Construction of Zone 4 buried terminal protection structures to address immediate risks at Stone St/Barrie Cres (location 1)	$1 million construction $50,000 per annum maintenance	Short - Medium	$1,000,000	$200,000	$250,000	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 1.3 Strategy 1.3a Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a
CH4	Construction of Zone 2 buried terminal protection structures to address immediate risks at Mitchell St (south end of Mitchell St and north end SLSC seawalls) (location 2 and 3)	$3.75 million $187,500 every 5 years maintenance	Short - Medium	-	$3.75 million	$187,500	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 1.3 Strategy 1.3a Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a
CH5	Construction of Zone 1 buried terminal protection structures to address immediate risks at Holiday Park (location 4)	$875,000 $43,750 every 5 years maintenance	Short - Medium	-	$875,000	$43,750	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a
CH6	Develop a management plan for the Holiday Park addressing the asset management requirements for the cabins and amenities block	$10,000	Short - Medium	$10,000		-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 6.3 Strategy 6.3b Objective 7.1 Strategy 7.1a

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe Subject to available funding and resources	Year 1 (estimate)	Year 2-5 (forecast estimate)	Year 6-10 (forecast estimate)	Benefit	Potential Funding Sources	Alignment with IP&R Framework
CH7	Construction of new amenities block in Holiday Park	$450,000	Short - Medium	-	$450,000	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 3.1 Strategy 3.1b Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 6.3 Strategy 6.3b Objective 7.1 Strategy 7.1a
CH8	Demolition of existing amenities block in Holiday Park	$40,000	Short - Medium	-	$40,000	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 6.3 Strategy 6.3b Objective 7.1 Strategy 7.1a
CH9	Relocation of cabins as per the Holiday Park Management Plan	$30,000	Short - Medium	-	$30,000	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3b Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 6.3 Strategy 6.3b Objective 7.1 Strategy 7.1a
CH10	Investigation, design and documentation and approvals of nourishment works at Holiday Park and Dalby Oval frontage from terrestrial or other opportunistic, permissible sand sources (for initial $4 million nourishment campaign) (Including environmental assessment and monitoring plan)	$150,000	Short - Medium	$150,000		-	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 3.1 Strategy 3.1b Objective 5.4 Strategy 5.4b Objective 6.3 Strategy 6.3b Objective 7.1 Strategy 7.1a
CH11	Facilitate delivery of sand nourishment from opportunistic sources as identified by the Deputy Premier's Taskforce*	$150,000	Short - Medium	$75,000	$75,000		Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 3.1 Strategy 3.1b Objective 5.4 Strategy 5.4b Objective 6.3 Strategy 6.3b Objective 7.1 Strategy 7.1a
CH12	Implementation of nourishment works from terrestrial (or other permissible sources) at Holiday Park and Dalby Oval frontages	$4 million	Short - Medium then review	$2,000,000	$2,000,000	-	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 3.1 Strategy 3.1b Objective 7.1 Strategy 7.1a
CH13	Ongoing monitoring of nourishment works as per monitoring plan terrestrial and bathymetric surveys	$100,000 per annum	Short - Medium	$100,000	$400,000	$100,000	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 3.1 Strategy 3.1b Objective 7.1 Strategy 7.1a

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe Subject to available funding and resources	Year 1 (estimate)	Year 2-5 (forecast estimate)	Year 6-10 (forecast estimate)	Benefit	Potential Funding Sources	Alignment with IP&R Framework
CH14	Port of Newcastle to place suitable sand from maintenance dredging activities from harbour entrance offshore of Stockton Beach in accordance with concurrence issues by Office of Environment (to be revised Feb 2022)	Minimal. Maintenance dredging for navigational safety currently conducted by PoN.	Short	-	-	-	Public	Port of Newcastle	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 3.1 Strategy 3.1b Objective 7.1 Strategy 7.1a
CH15	Complete Newcastle CMP detailed investigations and other required studies	$150,000	Short	$150,000	-	-	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 7.1 Strategy 7.1a
CH16	Establish an expert panel to advise CN on coastal management matters	Minimal	Short	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 7.1 Strategy 7.1a Objective 7.3 Strategy 7.3b
CH17	Assess potential options for long-term management of coastal hazards in the broader Stockton area through the development of a Newcastle CMP in accordance with the CM Act 2016 and the NSW Coastal Management Manual	$100,000	Medium		$100,000	-	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 3.1 Strategy 3.1b Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH18	Consultation with stakeholders to the north of Stockton to identify coastal management opportunities to enhance coastal management actions proposed in the Newcastle CMP	Minimal	Short	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.3 Strategy 7.3a
CH19	Consultation with stakeholders to identify options for coastal management within broader Newcastle CMP	Minimal	Short	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.3 Strategy 7.3a
CH20	Monitor opportunities under grant programs and ensure grant applications are best positioned to deliver funding for Stockton CMP actions	Internal CN resources	Short - Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 7.1 Strategy 7.1b
CH21	Alternative funding methods to be investigated and considered for Stockton CMP actions	Minimal	Short - Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 7.1 Strategy 7.1b

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe Subject to available funding and resources	Year 1 (estimate)	Year 2-5 (forecast estimate)	Year 6-10 (forecast estimate)	Benefit	Potential Funding Sources	Alignment with IP&R Framework
CH22	Undertake condition assessment/scope of works for maintenance to SLSC and Mitchell Street seawalls	$20,000 per annum	Short - Medium	$20,000	$80,000	$100,000	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 1.3 Strategy 1.3a Objective 2.3 Strategy 2.3a Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH23	Undertake maintenance to Mitchell Street seawall identified in condition assessment report	$4,500,000 capital $200,000 per annum maintenance	Short - Medium	$4,500,000	$800,000	$1,000,000	Public	CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 1.3 Strategy 1.3a Objective 2.3 Strategy 2.3a Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH24	Undertake capital and maintenance works to SLSC seawall identified in condition assessment report	$400,000 capital $36,000 per annum maintenance.	Short	$400,000	$144,000	$180,000	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 1.3 Strategy 1.3a Objective 2.3 Strategy 2.3a Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH25	Design and consultation for roadworks at Griffiths Ave and Barrie Cres	$40,000	Short - Medium	$40,000		-	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 1.3 Strategy 1.3a Objective 2.3 Strategy 2.3a Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH26	Undertake roadworks at seaward end of Griffiths Ave and Barrie Cres intersection and construct traffic management devices	$150,000	Short - Medium	-	$150,000	-	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 1.3 Strategy 1.3a Objective 2.3 Strategy 2.3a Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH27	Adaptive risk management strategy includes completing environmental assessment for opportunistic beach nourishment at varying scales	$100,000	Short - Medium	$100,000	-	-	Public	CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 2.3 Strategy 2.3a Objective 3.1 Strategy 3.1b Objective 5.1 Strategy 5.1a Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH28	Adaptive risk mitigation strategy including seeking approval for beach nourishment works under Part 5 EP&A Act	$100,000	Short - Medium	$100,000	-	-	Public	CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 2.3 Strategy 2.3a Objective 3.1 Strategy 3.1b Objective 5.1 Strategy 5.1a Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe Subject to available funding and resources	Year 1 (estimate)	Year 2-5 (forecast estimate)	Year 6-10 (forecast estimate)	Benefit	Potential Funding Sources	Alignment with IP&R Framework
CH29	Adaptive risk mitigation strategy including investigating potential sand sources/ opportunities for maintenance nourishment of Stockton in accordance with Sand Management Guidelines	$10,000	Short - Medium	$10,000		-	Public	CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 2.3 Strategy 2.3a Objective 3.1 Strategy 3.1b Objective 5.1 Strategy 5.1a Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH30	Participation in the Deputy Premier's Taskforce to seek to deliver mass nourishment (subject to ongoing investigations and resolution of permissibility)*	$10,000	Short - Medium (min. 10 year renourishment)	$10,000	$10,000	-	Public	CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 3.1 Strategy 3.1b Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH31	Investigate potential offshore sand sources/ opportunities/ methodologies and funding for mass nourishment at Stockton including identifying and undertaking sampling and surveying requirements*	Variable	Short - Medium	variable	variable	-	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 2.3 Strategy 2.3a Objective 3.1 Strategy 3.1b Objective 5.1 Strategy 5.1a Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH32	Facilitate delivery of sand nourishment from opportunistic sources, including marine mass nourishment*	Variable	Short - Medium	variable	variable	-	Public	Funding source to be confirmed as per the Deputy Premiers Taskforce ToR	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 2.3 Strategy 2.3a Objective 3.1 Strategy 3.1b Objective 5.1 Strategy 5.1a Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH33	Adaptive risk mitigation strategy including investigation, design and documentation of potential protection works against adopted threshold for Newcastle CMP consultation including geotechnical investigations triggered at adopted threshold	$100,000	Short - Medium	-	$100,000	-	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 3.1 Strategy 3.1b Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH34	Environmental Assessment of designed protection works as at CH33.	$30,000	Short - Medium	-	$30,000	-	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 3.1 Strategy 3.1b Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH35	Prepare and adopt a PoM for dedicated or reserve Crown Land under CN care and control	$80,000	Short (by 20 June 2021)	$80,000	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 3.1 Strategy 3.1b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe Subject to available funding and resources	Year 1 (estimate)	Year 2-5 (forecast estimate)	Year 6-10 (forecast estimate)	Benefit	Potential Funding Sources	Alignment with IP&R Framework
CH36	Undertake annual inspection of Northern Breakwater as per the PON lease area and assess potential issues from coastal hazards	As required	Short (annual basis)	-	-	-	Public	Port of Newcastle	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH37	Continue beach and seawall monitoring program with cross section survey sites and utilising UAV and other monitoring methods within the Stockton CMP area	$10,000 - $15,000 per annum	Short - Medium	$10,000	$40,000	$50,000	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH38	Review planning certificates for properties potentially affected by coastal hazards contain an appropriate notation and reflectability (or not) for complying development to be carried out on the land	Minimal	Short	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 7.1 Strategy 7.1a Objective 7.3 Strategy 7.3b
CH39	New subdivisions or greenfield development to be located landward of 2120 ZRFC coastal hazard line	Minimal	Short - Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.3 Strategy 7.3b
CH40	Plans of Management, public domain plans and other master plan documents prepared or amended in consideration of the coastal hazards outlined in the Stockton CMP	Minimal	Short - Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH41	Consider impacts of coastal hazards when renewing or constructing public assets within the Stockton CMP area. The design of assets should consider the coastal hazards outlined in the Stockton CMP	Varied due to project undertaken, costing within project budget	Short - Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH42	Incorporation of coastal hazards into CN's service asset plans and implement service asset plans	$20,000	Short - Medium	-	$20,000	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH43	Undertake planning, engagement and emergency works, if appropriate, to manage beach erosion before, during and after storm events in accordance with the Emergency Action Subplan contained in **Appendix A**	Varied based on extent of emergency works, approx. $200,000 for works and $5,000 monitoring (annually)	Short - Medium	$200,000	$800,000	$1,000,000	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Federal Government Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.1 Strategy 5.1b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe Subject to available funding and resources	Year 1 (estimate)	Year 2-5 (forecast estimate)	Year 6-10 (forecast estimate)	Benefit	Potential Funding Sources	Alignment with IP&R Framework
CH44	Adaptive Risk Mitigation Strategy including design and approval of coastal protection works upon reaching threshold for the identified risk potential at Griffith Ave and Barrie Cres. See **Section 9** Mapping for potential locations for adaptive risk mitigation implementation	$35,000	Short - medium	$35,000			Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.1 Strategy 5.1b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH45	Construction of approved coastal protection works upon reaching threshold, for identified risk potential at Griffiths Ave and Barrie Cres	$100,000 initial budget. Final budget variable	Short - medium	$100,000			Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.3 Strategy 2.3a Objective 2.3 Strategy 2.3b Objective 5.1 Strategy 5.1b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH46	Continue to consult with PoN and capital dredging proponents to request excess suitable sand from capital dredging projects is placed off shore from Stockton Beach	Minimal	Short - Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 2.3 Strategy 2.3a Objective 3.1 Strategy 3.1b Objective 5.1 Strategy 5.1a Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH47	Conduct community engagement and education programs focussing on the Stockton CMP area environment, and coastal processes including inundation and erosion hazards	$25,000 per annum	Short - Medium	$25,000	$100,000	$125,000	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 1.3 Strategy 1.3a Objective 2.2 Strategy 2.2a Objective 2.3 Strategy 2.3a Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH48	Update and enhance CN website with information about coastal processes, management of the environment. Provide more information about coastal activities in conjunction with CH43, CH47 and on-ground works	Minimal	Short - Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 1.3 Strategy 1.3a Objective 2.2 Strategy 2.2a Objective 2.3 Strategy 2.3a Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH49	Conduct beach management work such as beach scraping and beach grooming in areas south and north of Mitchell Street seawall to increase dune volume	$100,000 per annum	Short - Medium	$100,000	$400,000	$500,000	Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 1.3 Strategy 1.3a Objective 2.2 Strategy 2.2a Objective 2.3 Strategy 2.3a Objective 5.1 Strategy 5.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CH50	Resourcing the integrated delivery of on-ground works as detailed in this business plan	$200,000 per annum	Short - Long	$200,000	$800,000		Public	NSW Coastal and Estuary Management Program CN (Ordinary Rates, Revenue) Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 3.1 Strategy 3.1a Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b

**In accordance with the Deputy Premier's Taskforce Terms of Reference whilst still in force.*

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe Subject to available funding and resources	Year 1 (estimate)	Year 2-5 (forecast estimate)	Year 6-10 (forecast estimate)	Benefit	Potential Funding Sources	Alignment with IP&R Framework
Strategy 2 – Coastal Environment									
CE1	Monitor coastal habitat	$5,000 per annum	Short - Medium	$5,000	$20,000	$25,000	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 7.1 Strategy 7.1a
CE2	Undertake coastal revegetation works including dunes and recreational areas	$15,000 per annum	Short - Medium	$15,000	$60,000	$75,000	Public	CN (Ordinary Rates, Revenue) NSW Coastal and Estuary Management Program Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 2.2 Strategy 2.2b Objective 3.1 Strategy 3.1a Objective 7.4 Strategy 7.4b
CE3	Public domain works along the coastal section of the Stockton CMP area	$10,000	Short - Medium	-	$10,000	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 3.1 Strategy 3.1a Objective 3.1 Strategy 3.1b Objective 3.2 Strategy 3.2a Objective 4.2 Strategy 4.2a
CE4	Implement beach stormwater outlet maintenance program	$10,000 - $15,000 per annum	Short - Medium	$15,000	$60,000	$75,000	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CE5	Include WSUD principles in planning documents for the Stockton CMP area	Minimal	Short - Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 2.2 Strategy 2.2b Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
CE6	Provide support and assistance to Landcare/volunteers for revegetation activities in the Stockton CMP area	Minimal	Short - Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 2.2 Strategy 2.2b
CE7	Build capacity for community volunteers to undertake citizen science environmental monitoring	Minimal	Short - Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 2.2 Strategy 2.2b
CE8	On-ground works zones 1,2 and 4 to undertake removal of historical buried waste along the erosion scarp	Costed to project work	Short - Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 2.2 Strategy 2.2b Objective 3.1 Strategy 3.1a Objective 7.4 Strategy 7.4b
Strategy 3 – Beach Access									
BA1	Beach access audit	$5,000	Short	$5,000	$20,000	$25,000	Public	CN (Ordinary Rates, Revenue)	Objective 2.2 Strategy 2.2a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a
BA2	Identify beach access points for closure and/or replacement	Minimal	Short	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 4.1 Strategy 4.1c Objective 4.2 Strategy 4.2a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe Subject to available funding and resources	Year 1 (estimate)	Year 2-5 (forecast estimate)	Year 6-10 (forecast estimate)	Benefit	Potential Funding Sources	Alignment with IP&R Framework
BA3	Design of new fencing and beach access points	$10,000	Short - Medium	-	$10,000	-	Public	CN (Ordinary Rates, Revenue) NSW Coastal and Estuary Management Program Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 4.1 Strategy 4.1c Objective 4.2 Strategy 4.2a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
BA4	Construction of new fencing and beach access points	$20,000	Short - Medium	-	$20,000	-	Public	CN (Ordinary Rates, Revenue) NSW Coastal and Estuary Management Program Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 4.1 Strategy 4.1c Objective 4.2 Strategy 4.2a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
BA5	Investigate, design and construct new access ways associated with the immediate protection works	$200,000	Short - Medium	$100,000	$100,000	-	Public	CN (Ordinary Rates, Revenue) NSW Coastal and Estuary Management Program Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 4.1 Strategy 4.1c Objective 4.2 Strategy 4.2a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
Strategy 4 – Beach Amenity									
B1	Investigate opportunities for landscaping as part of public domain plans	Minimal	Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	Objective 2.2 Strategy 2.2a Objective 3.1 Strategy 3.1a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a
B2	Undertake beach maintenance program and continue dune rehabilitation works	$150,000 per annum	Short - Medium	$150,000	$600,000	$750,000	Public	CN (Ordinary Rates, Revenue) NSW Coastal and Estuary Management Program Council will seek funding from a range of sources in accordance with Section 6.3.2	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 3.1 Strategy 3.1a Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
B3	Undertake audit of stormwater discharge points and assess water quality and erosion potential	Minimal	Short	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a Objective 7.4 Strategy 7.4b
B4	Undertake beach maintenance at stormwater discharge points after storm events	In operational budget	Short - Medium	-	-	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 2.2 Strategy 2.2a Objective 7.4 Strategy 7.4b
Strategy 5 – Recreational use of the coastal zone									
RU1	Prepare public domain plan for the Stockton coastal zone study area in consultation with relevant land managers and stakeholders. Public domain plan will build upon the adopted Newcastle Revitalisation Strategy Master Plan.	$30,000	Medium	-	$30,000	-	Public	CN (Ordinary Rates, Revenue)	NCSP 2030 Objective 3.1 Strategy 3.1a Objective 3.1 Strategy 3.1b Objective 3.2 Strategy 3.2a Objective 4.2 Strategy 4.2a Objective 5.4 Strategy 5.4b Objective 7.1 Strategy 7.1a

Action ID	Action	Estimated cost of actions (subject to available funding)	Timeframe Subject to available funding and resources	Year 1 (estimate)	Year 2-5 (forecast estimate)	Year 6-10 (forecast estimate)	Benefit	Potential Funding Sources	Alignment with IP&R Framework
Strategy 6 – Culture and Heritage									
H1	Incorporate Aboriginal cultural information into CN projects and works	Minimal	Short - Medium				Public	CN (Ordinary Rates, Revenue) Heritage Grants Program	NCSP 2030 Objective 3.2 Strategy 3.2a Objective 3.2 Strategy 3.2b Objective 4.1 Strategy 4.1a
H2	Implement dual naming of sites where appropriate	Minimal	Short - Medium				Public	CN (Ordinary Rates, Revenue) Heritage Grants Program	NCSP 2030 Objective 3.2 Strategy 3.2a Objective 4.1 Strategy 4.1a
H3	Ensure high quality interpretive treatments of heritage items or places that increase understanding of the heritage significance of these items or places	Cost to be determined as part of individual project	Short - Medium				Public	CN (Ordinary Rates, Revenue) Heritage Grants Program	NCSP 2030 Objective 3.2 Strategy 3.2a Objective 3.2 Strategy 3.2b Objective 4.1 Strategy 4.1a Objective 4.1 Strategy 4.1b Objective 4.1 Strategy 4.1c
H4	Prepare Aboriginal Heritage Management Strategy to ensure due diligence processes are followed for CN projects and assessment of development applications	$30 000	Medium		$30 000		Public	CN (Ordinary Rates, Revenue) Heritage Grants Program	NCSP 2030 Objective 3.2 Strategy 3.2a Objective 3.2 Strategy 3.2b Objective 4.1 Strategy 4.1a Objective 5.1 Strategy 5.1a
H5	Interpretation of the history and heritage within the Stockton area is to be integrated into Public Domain Plans.	Minimal	Medium				Public	CN (Ordinary Rates, Revenue) Heritage Grants Program	NCSP 2030 Objective 3.2 Strategy 3.2a Objective 3.2 Strategy 3.2b Objective 4.1 Strategy 4.1a Objective 4.1 Strategy 4.1b
H6	Investigate protection of heritage listed items on public lands from coastal hazards	Minimal	Short - Medium				Public	CN (Ordinary Rates, Revenue) Heritage Grants Program	NCSP 2030 Objective 4.1 Strategy 4.1a Objective 4.1 Strategy 4.1b Objective 5.1 Strategy 5.1a

6.4 Outstanding Issues and Risks

The coastal management actions and implementation plan outlined in the preceding sections aims to address the critical issues identified (refer **Section 2**). It is acknowledged however, that there will inherently be a number of issues or risks that have not been fully addressed either due to the compressed timeframe for the Stockton CMP preparation or the necessary truncation of the spatial extent of the Stockton CMP. It is important to recognise and record these risks to ensure they are addressed in either the Newcastle CMP, or more detailed investigations associated with the detailed design of the elements proposed.

These issues/risks are identified below:

1. Mass nourishment for coastal protection has inherent risks in terms of protection of assets. When beach nourishment is intended for asset protection without buried terminal protection structures, assets would potentially be at risk if any of the following occurred:

- More than one design storm occurs within the renourishment period, or a series of storms with a cumulative impact exceeding the design storm
- A storm larger than the design storm occurs
- Long-term beach recession (underlying recession) exceeds estimated values
- Sea level rise and associated beach recession exceeds estimated values
- Sufficient sand supply cannot be sourced

Other risk considerations include:

- Will a dredger be available when wanted at a future time? What will mobilisation/demobilisation costs be if needed at short notice?
- Will funds be available at a future time?

Risks associated with the calculated mass nourishment volumes (refer **Appendix C** of the CBA Report in **Supporting Document F**). In this assessment it was concluded that at the end of the 10 year nourishment period for the 2.4 M m^3 initial campaign, there would remain sufficient sand volume to accommodate a >200 year ARI storm at the southern end of the beach and a 50 year ARI storm at the northern end of the study area.

It is noted that this risk can be reduced through more frequent smaller renourishment campaigns to avoid the beach becoming depleted at the end of a long renourishment period. Smaller scale more frequent renourishment campaigns from marine sources are generally not economically viable due to mobilisation/demobilisation costs though if a strategic alliance with other existing dredging operations can be created these costs can potentially be offset.

2. The buried terminal protection structures to address immediate risks in the proposed coastal management option (3b) provide protection to assets seaward of the 2025 Zone of Slope Adjustment (ZSA) for the 5% Annual Exceedance Probability (AEP) (rather than assets seaward of the 2025 1% AEP Zone of Reduced Foundation Capacity (in accordance with established 2025 hazard lines).

CN has accepted a distance of 20m from the 2025 ZSA 5% AEP hazard line as a foreshore recession threshold triggering consideration of a range of adaptive risk mitigation strategies in line with the heads of consideration as outlined in **Section 4.1**. The range of adaptive risk mitigation strategies includes emergency works (sand filled geotextile bags), rock bags, built structures, managed retreat and opportunistic sand nourishment. Based on this approach, CN will progress the designs for protection using a range of methodologies to ensure a flexible and appropriate response once triggers are reached.

The 20m trigger distance provides a minimum volume approximately equivalent to the storm erosion demand of an 8 year ARI event. Assuming if deemed necessary it would take a maximum of 3 years from triggering the need for further protection works to completing them, there would be about a 33% chance of that event occurring in that 3 year period putting assets at risk, prior to completion of the protection structures. If any structures or further nourishment can be completed within a shorter timeframe the probability of the storm event occurring and assets being at risk reduces e.g. there is a 24% chance of the 8 year ARI event occurring in a 2 year period.

Buried terminal protection to address immediate risk is not proposed for the Barrie Crescent/Griffiths Avenue intersection road head, rather the creation of traffic management changes in consultation with the community, at the northern end of Barrie Crescent and the eastern end of Griffiths Avenue is proposed to maintain access to all residences. A 4m wide pedestrian pathway adjacent to residential property boundary in this location (refer **Figure 16**) would be incorporated in the design of future works in response to the foreshore recession threshold being met.

3. The results of the 2019 beach nourishment trial showed that sand delivered by terrestrial sources did not match the colour of native beach material at Stockton. This was poorly received by a minority of the Stockton community and has been raised as a concern in the CLG. It is noted that sand delivered to the inner surf zone would be expected to naturally mix with native sand and not show marked colour differences. Nourishment sand colour would be assessed on a case by case basis in line with the Sand Management Guideline.

4. Sand placed in the nearshore off the Stockton CMP area has been assumed to be dispersed in a northerly direction, hence the need for on-going nourishment. The sand lost from the Stockton CMP area may have a benefit in potentially slowing the erosion to the north.

5. Overtopping and coastal inundation as they relate to buried terminal protection structures have not been assessed in detail due to time limitations for the preparation of the Stockton CMP. The buried terminal protection structures proposed are adaptive to accommodate future sea level rise and this risk would be assessed further within the broader Newcastle CMP due for completion in 2021.

6. A shoreline control structure (e.g. a longer groyne or artificial headland) aimed at reducing the rate of sand loss in the Stockton CMP area has not been considered as an option in the Stockton CMP. DHI's (2009) study indicated that such a structure would serve this purpose but would create downdrift impacts. DHI's (2009) study indicated that the optimum location for such a headland would be to the north of the Hunter Water land i.e. outside the current study area. It is noted that the proposed management actions do not preclude this option and that it would provide the additional potential benefit of reducing the rate of loss of nourishment sand and thereby reduce the maintenance nourishment requirements. This option would be assessed within the broader Newcastle CMP due for completion in 2021.

7. The sediment transport study has identified a significant lowering of sub-aqueous beach profile caused by a long-term sediment deficit. This has resulted in an increase in wave energy reaching the shoreline. Without intervention in the form of additional sand, the ongoing sediment loss, beach profile lowering, and subsequent increase in wave energy, is predicted to continue. This will cause accelerated erosion and result in significant and irreversible issues with the existing coastal protection structures as they become undermined and outflanked, hence the need for mass sand nourishment for the protection and amenity of the Stockton CMP area.

7. Coastal Zone Emergency Action Subplan

The CM Act identifies specific emergency management considerations associated with beach erosion, coastal inundation and cliff instability. The CM Act (section 15(1)(e)) outlines that a Coastal Zone Emergency Action Subplan (CZEAS) must be included in a CMP if the local council's Local Government Area contains land within the Coastal Vulnerability Area (CVA), and beach erosion, coastal inundation or cliff instability is occurring on that land.

It is noted that at the commencement of the State Environmental Planning Policy (Coastal Management) 2018 (CM SEPP), no Coastal Vulnerability Area Map was adopted and therefore no coastal vulnerability area has been identified. However, it is recognised that Stockton Beach has been impacted by coastal erosion on numerous occasions and it is considered appropriate to develop a CZEAS for this location.

Mandatory requirements for a CMP, including the preparation of a CZEAS where required, have been identified in Part A of the Coastal Management Manual (OEH 2018). Further direction on the preparation of a CZEAS is provided in the 'Guideline for preparing a coastal zone emergency action subplan' (DPIE 2019).

The Stockton Coastal Zone Emergency Action Subplan (Stockton CZEAS) **Appendix A** has been developed in accordance with this guidance and with the agreement of the LEMC**.**

The purpose of the Stockton CZEAS is to outline the roles and responsibilities of all public authorities (including CN) in response to emergencies immediately preceding or during periods of beach erosion, coastal inundation or cliff instability, where the beach erosion, coastal inundation or cliff instability occurs through ocean storm activity or an extreme or irregular ocean event. All identified public authorities were represented on the LEMC and consulted as part of the development of the CZEAS.

The CZEAS is an accompanying document to the CN Local Emergency Management Plan 2019 (Newcastle EMPLAN), which sets out the responsibilities of combat agencies including the NSW Police, City of Newcastle, NSW Ambulance Service, State Emergency Service (SES), Fire and Rescue NSW (FRNSW) and others.

The Stockton CZEAS replaces Part A, Appendix D of the Newcastle CZMP (2018), the Stockton Coastal Erosion Emergency Action Subplan, however does not replace Part B, Appendix D of the Newcastle CZMP (2018), Newcastle Coastline South of the Harbour Coastal Erosion Emergency Action Subplan, which remains in force.

Picture 3: Emergency Sandbag Protection Works at the Southern End of the Mitchell Street Seawall. May 2020

8. Monitoring Evaluation and Reporting Program

CN is required to implement a monitoring, evaluation and reporting (MER) program as part of the Stockton CMP. The MER identifies key indicators, trigger points and thresholds as measures of success of actions in reducing the threats and maintaining the values of Stockton Beach, as well as mitigation actions should the actions not achieve the desired outcomes.

The CM Act requires CMPs to be reviewed at least once every ten years, however due to the significant hazards identified at Stockton Beach within a five year planning horizon, the Stockton CMP will be reviewed by 2025 to ensure that actions to manage Stockton Beach remain current and relevant.

CN is developing the Newcastle CMP that will encompass the entire Local Government Area (LGA) from Glenrock State Conservation Area in the south to the Northern boundary of the Stockton Cemetery, which is due for completion by December 2021. It is anticipated that actions to mitigate identified threats and issues to Stockton Beach will be included within the Newcastle CMP, triggering replacement of the Stockton CMP upon gazettal of the Newcastle CMP.

CN must maintain sufficient information and records about its management of the relevant parts of the coastal zone to demonstrate how the Stockton CMP has been implemented, and what has been achieved in connection with the Stockton CMP. This includes whether coastal management actions have been carried out within the timeframes identified in the Stockton CMP.

The Integrated Planning and Reporting (IP&R) framework as shown in **Figure 20** is a legislative requirement for councils under the *Local Government Act 1993*. IP&R considers the longer term future of an area and is based around a Community Strategic Plan which reflects the community's aspirations and needs for the future.

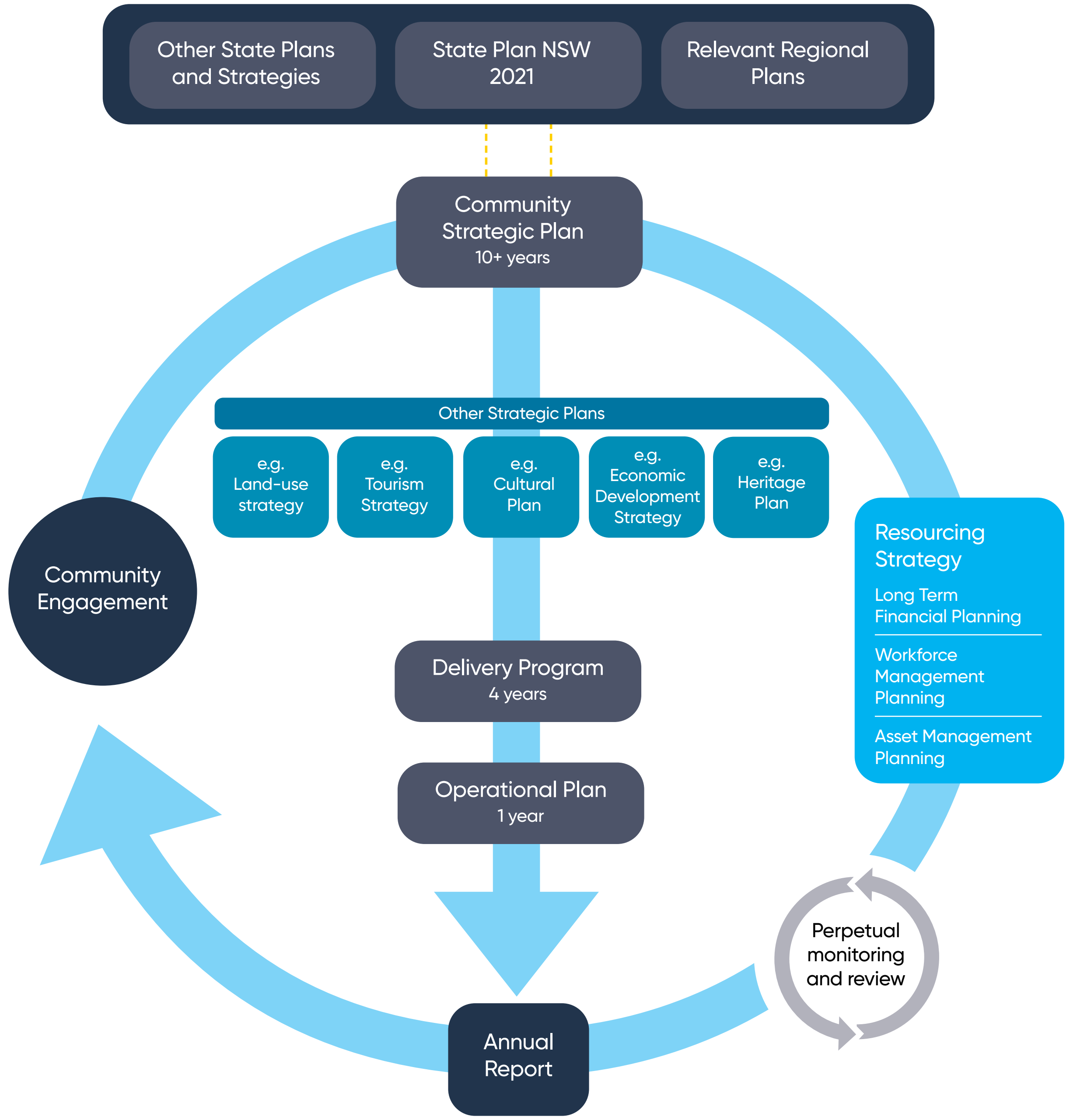

Figure 20: The Integrated Planning and Reporting (IP&R) framework

The IP&R framework consists of four layers of plans:

- The Community Strategic Plan
- The Resourcing Strategy is a 10-year plan describing the resources that council will use to achieve the objectives and strategies detailed in its CSP
- The Delivery Program is a four-year program outlining the commitments and key partnerships required and measures to monitor success in achieving the Strategies
- The Operational Plan outlines in more detail the individual Actions that council will undertake in a financial year in order to meet the commitments made in the Delivery Program

In accordance with the CM Act, the Stockton CMP needs to align with CN's IP&R Framework. This aims to mainstream coastal management into CN's overall service delivery and asset management responsibilities. It is also likely that integrating actions from the Stockton CMP into the service delivery and asset management processes of CN will improve implementation of the Stockton CMP. Generally, the Operational Plan and Delivery Program are updated on a yearly basis (as the Delivery Program is a rolling four-year program), and it is at this stage that actions from the Stockton CMP can and should be incorporated into these documents.

Integrated Planning & Reporting requires the preparation of a Delivery Program that sets out a four-year plan to achieve the objectives of the Newcastle 2030 Community Strategic Plan (NCC, 2018(a)) and supporting strategies such as the Newcastle Environmental Management Strategy 2013 (NCC, 2013). The business plan in **Section 6** outlines how the management actions within the Stockton CMP will meet the objectives and strategies of the Newcastle 2030 Community Strategic Plan.

To support the integration of the Stockton CMP with the day to day operations of CN, it is recommended that 12 months after the Stockton CMP is certified, and at yearly intervals until superseded, a workshop is held between key staff responsible for its implementation and regional DPIE Coastal representative(s), to assess implementation and current status of the Stockton CMP.

CN delivers an Annual Report which demonstrates progress in implementing the Delivery Program and Operational Plan activities over each financial year, and it is recommended that this report provides the main reporting mechanism for the MER program.

Performance measures are included for each action in the Operational Plan, which can be used to gauge whether the Stockton CMP actions have been implemented or not, which can then be reported in the Annual Report. This provides for a yearly evaluation of the implementation status of each action in the Stockton CMP.

Where actions have not been included in the IP&R Framework, a yearly evaluation of those CMP actions by the officer(s) responsible for facilitating implementation of the Stockton CMP is recommended. This may be undertaken through the annual review of the Business Plan or as a separate process.

If an action has not being implemented within the proposed timeframe, CN staff must determine the cause for delay and address as appropriate, e.g. if funding based, seek alternative sources of funding; if resource limited, seek additional assistance from internal or external agencies. Consideration may be given to modifying the timeframe or business case within the CMP, subject to endorsement by all relevant stakeholders.

The Stockton CMP Business Plan (refer **Section 6**) should be updated on an annual basis.

The Business Plan reflects the expected cost of the Stockton CMP over the coming financial year and details the resourcing and financing arrangements to meet these costs, including the contribution from successful grant funding applications to undertake specific actions, and any contribution required from CN.

9. Maps

The following section contains a series of figures presenting modelled beach erosion and shoreline recession hazard areas, for the Stockton CMP area for 2020, 2040, 2060 and 2120 (Bluecoast, 2020a). Figure 21, 22, 23 and 24 are shown below. Figure 25 below indicates the area of Stockton coastline where potential emergency protection works may be required. This represents areas vulnerable to erosion events after the initial immediate risk protection works are completed, at either end of the two existing seawalls.

Stockton Beach - Erosion Hazard Lines
Immediate (2020)

0 100 200 m

bluecoast
CONSULTING ENGINEERS

Bluecoast endeavours to ensure that the information provided in this map is correct at the time of publication. Bluecoast does not warrant, guarantee or make representations regarding the currency and accuracy of the information contained in this map.

- 1% exceedance
- 10% exceedance
- 50% exceedance

Seawalls
- Assumed protection by seawall*

Horiz. datum: GDA94 MGA56
Vert. datum: AHD
Locality: Stockton
Aerial image: Nearmaps 23/04/2020
Map 1 of 4
Date: 11/06/2020
*Seawall protection maintained by Council

Stockton Beach - Erosion Hazard Lines
2040 Planning Period

0 100 200 m

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Seawalls
- Assumed protection by seawall*

Horiz. datum: GDA94 MGA56
Vert. datum: AHD
Locality: Stockton
Aerial image: Nearmaps 23/04/2020
Map 2 of 4
Date: 11/06/2020
*Seawall protection maintained by Council

Stockton Beach - Erosion Hazard Lines
2060 Planning Period

0 100 200 m

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Seawalls
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Aerial image: Nearmaps 23/04/2020
Map 3 of 4
Date: 11/06/2020
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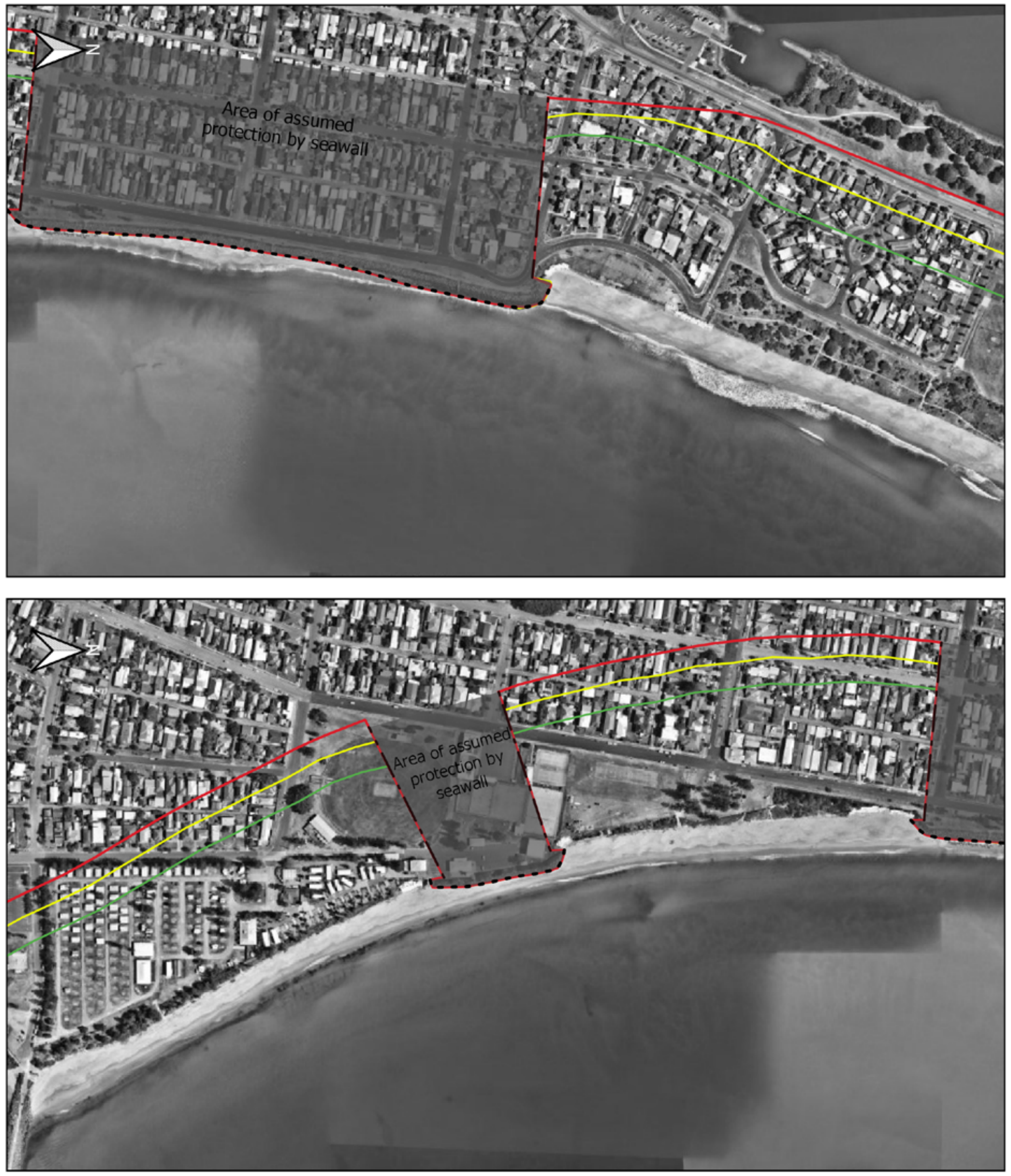

Stockton Beach - Erosion Hazard Lines
2120 Planning Period

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Map 4 of 4
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*Seawall protection maintained by Council

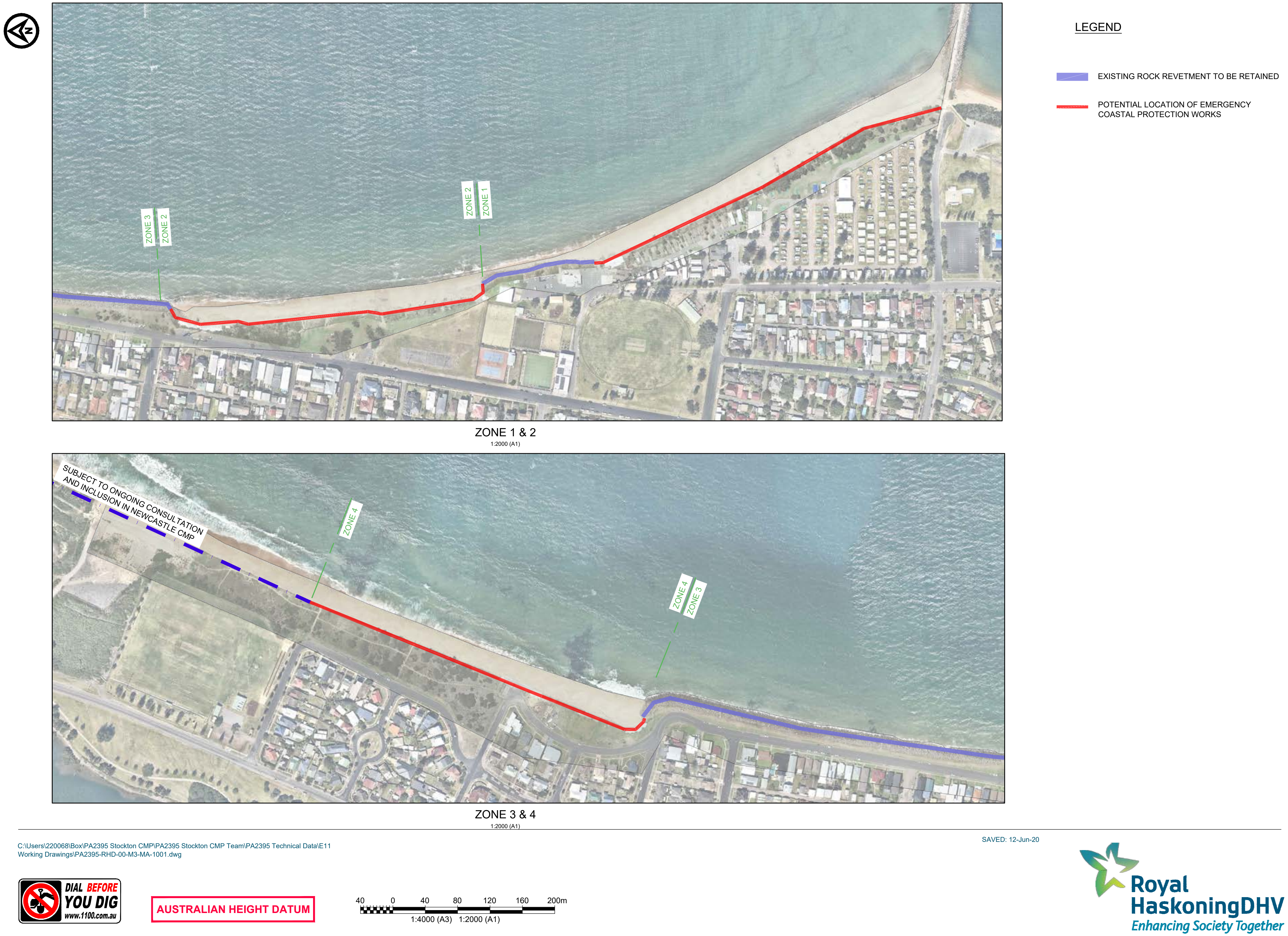

Figure 25: Potential Location of Emergency Coastal Protection Works

10. Consultation

10.1 Community Consultation

On 12 May 2020 Council resolved to place the draft Stockton Coastal Management (CMP) on public exhibition. The draft Stockton CMP was placed on public exhibition for four weeks, from Wednesday 13 May until 5pm on Wednesday 10 June 2020. In total, CN received 155 community submissions with 10 key themes and 18 issues raised along with 20 agency submissions. CN used a variety of methodologies to ensure the community was informed of the public exhibition period including print and online digital advertising. CN also worked closely with industry stakeholders and the Stockton Community Liaison Group (CLG) to ensure they were provided with accurate and simplified information to update community members on how to provide their feedback. Face to face engagement was not possible due to public health orders enforcing social distancing designed to limit the spread of the global pandemic COVID-19.

There was overwhelmingly support received (73%) for the draft Stockton CMP and an even higher support of 75% amongst Stockton residents. The City presented comprehensive information on the draft CMP on its website, including an animation, videos featuring Stockton Community Liaison Group (CLG) Members, and the full report, together attracting more than 3,000 visitors, over 27,000 views and 436 downloads of the report over the exhibition period. In addition, 2000 information packs including a summary of the plan, Frequently Asked Questions (FAQs) and a reply-paid feedback form and envelope were sent to each property in Stockton to ensure everyone had a chance to have their say. A total of eight posts relating to the Stockton CMP were featured on City of Newcastle's Facebook page during exhibition. All up, they had a combined reach of 77,241 and the posts had a total engagement (people clicking, commenting, liking) of 2,851.

The following update provides a summary of the public exhibition feedback received on the draft Stockton CMP.

10.1.1 Engagement Strategy

The key communication principles of the draft Stockton CMP were to:

- Communicate clearly the complexities of coastal erosion and coastal processes
- Provide accessible options for the community and stakeholders to share their feedback
- Educate the community on the CMP process and the opportunities available to provide their feedback
- Ensure broad sections of the community, including those without computer access or unable to leave their households, were able to access information and share their feedback
- Encourage feedback from the local Stockton community along with the broader Hunter community and stakeholders.

As outlined earlier in **Section 1.4** of the draft Stockton CMP the engagement program was undertaken in three stages. This section is a summary of the engagement outcomes of Stage 2 during the exhibition period of the engagement program.

The engagement strategy for the draft Stockton CMP was developed with consideration for the guidelines for community and stakeholder engagement in coastal management and in accordance with the relevant provisions within the Coastal Management Manual.

Consultation has been undertaken with DPIE on a regular basis to ensure the development of a certifiable draft Stockton CMP in accordance with the legislative requirements of the *Coastal Management Act 2016* and Part A of the Coastal Management Manual. A summary of how the draft Stockton CMP meets these requirements is at Attachment E. The following additional stakeholders were identified as key agencies or organisations that must be consulted throughout the development of the draft Stockton CMP:

- Family and Community Services (FACS)
- Defence Housing Australia
- Hunter Water Corporation
- Crown Lands
- Worimi Local Aboriginal Land Council (LALC)
- Port of Newcastle
- Port Authority of NSW
- Geosurvey of NSW
- NSW Department of Agriculture, Water and the Environment
- NSW Department of Primary Industries – Fisheries
- Transport for New South Wales (TNSW)
- National Parks and Wildlife Service (NPWS)
- Port Stephens Council

CN continued to consult and meet with the Stockton CLG throughout the exhibition period to seek their feedback, listen to the community sentiment expressed by the Stockton CLG members and answer any questions they had. Monitoring of social media was also used to develop relevant content for the regular FAQs information leaflet.

Picture 4: Lord Mayor Nuatali Nelmes & Stockton CLG Members

Additional consultation was undertaken with those agencies and organisations responsible for the delivery of actions under **Appendix A** Coastal Zone Emergency Action Subplan of the Stockton CMP, including:

- NSW Police Service
- NSW State Emergency Service (SES)
- Fire and Rescue

10.1.2 Engagement Outcomes

During the public exhibition period, a Have Your Say webpage was set up to receive submissions and enable downloading of the draft Stockton CMP, supporting documentation, community summary of the CMP, FAQs and interactive Storyboard tool.

This Have your Say webpage was also publicised using social media (Facebook and LinkedIn), through NovoNews, CN intranet and webpages, and with digital and print advertising in the Newcastle Herald.

Hard copies of the draft Stockton CMP were also made available to community members upon request. To respond to COVID-19 restrictions an exhibition copy could be viewed at the Stockton Surf Life Saving Club (SLSC). Members of the Stockton CLG could also collect a copy of the draft Stockton CMP from the Stockton Bowling Club.

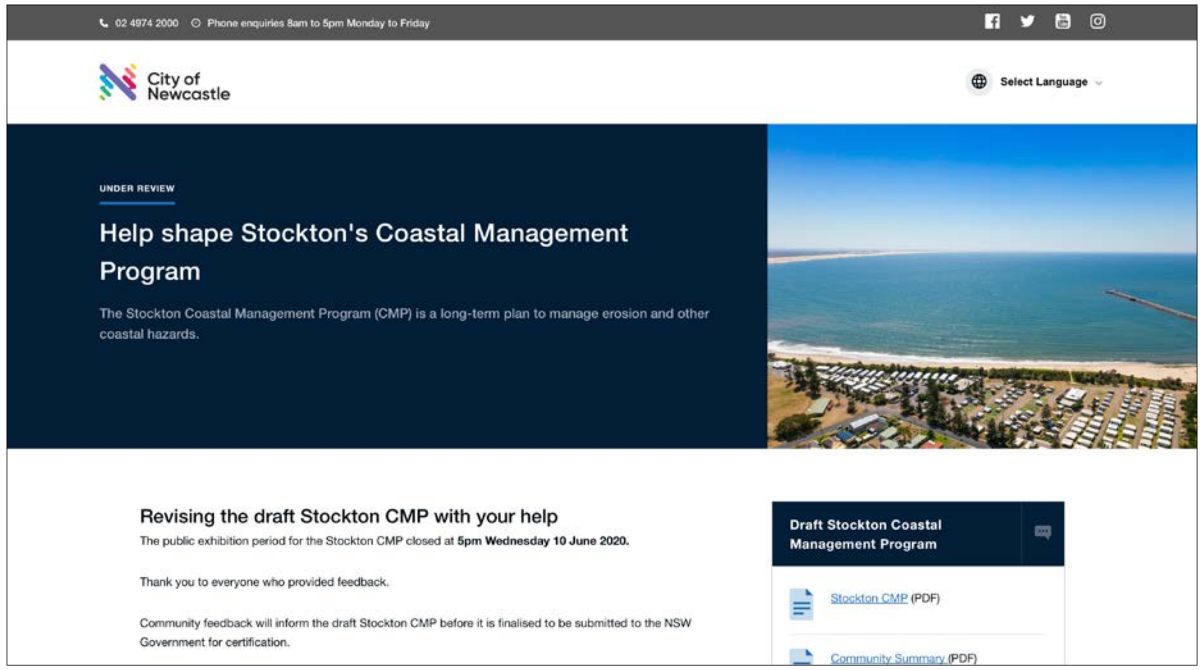

Figure 26: Stockton CMP Have Your Say webpage

10.1.3 Engagement methodology

A comprehensive community engagement program for the public exhibition of the draft Stockton CMP was undertaken, including measures to address the COVID-19 social distancing and isolation measures. Opportunities for information and submissions receipt included:

__1.__ Postal pack of information, feedback form and return mail to all 2,000 Stockton residences and businesses;

Figure 27: Examples of hand-written submissions received

__2.__ Hard copies of the CMP delivered to Stockton residents and businesses and available for collection from the Stockton RSL;

__3.__ Website and by phone;

__4.__ Animation;

Figure 28: Animation on the option presented within the CMP

__5.__ Storyboard;

Figure 29: Storyboard

6. Stockton CLG member group video and individual member videos;

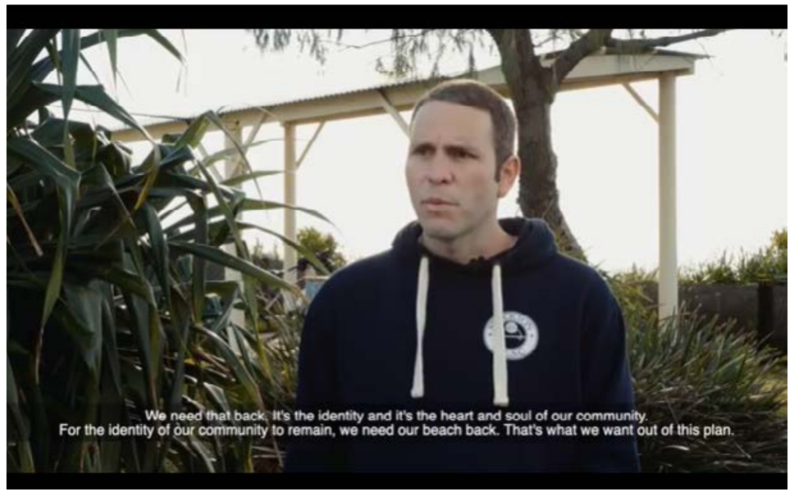

Figure 30: Stockton CLG Member Callan Nickerson

Figure 31: Stockton CLG Chair Barbara Whitcher

7. Coastal processes educational videos and "Ask an Expert" with Questions & Answers by experts in a series of short videos;

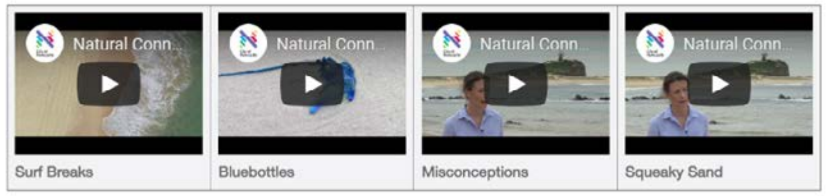

Figure 32: Natural Connection "Ask and Expert" videos

8. Frequently Asked Questions (FAQs), posters, corflutes and community notice boards;

Figure 33: Frequently Asked Questions (FAQs)

Figure 34: Corflute encouraging the community in Stockton of the Public Exhibition

Figure 35: Poster encouraging the community in Stockton of the Public Exhibition

9. Interest group distribution of materials and local newsletters stories;

10. Council meeting briefings;

11. Agency and stakeholder briefing sessions;

12. Print advertising and radio interviews, including numerous print editorials and stories.

Figure 36: Announcement of State Government Taskforce Social Distancing during COVID-19

13. An exhibition copy of the draft Stockton CMP was displayed at the Stockton SLSC.

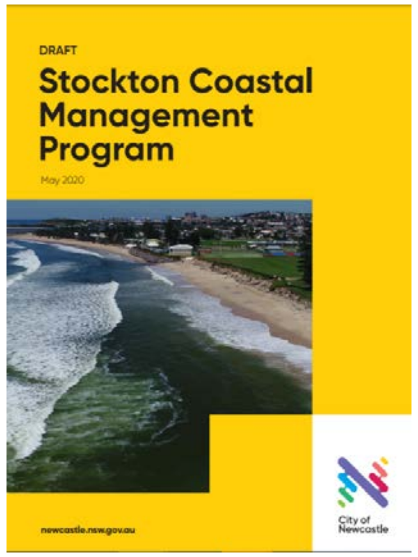

Figure 37: Draft Stockton CMP

To assist community members to easily understand the complexities of coastal planning and the draft Stockton CMP inclusions a range of digital communication tools were used.

Engagement methods were varied and a summary of the reach of these is detailed below.

Printed materials

Community information pack
2,000 Stockton residents and businesses

Draft Stockton CMP
7 hard copies delivered to community members

City News update
Distributed to 90,000 letterboxes on 19 May

Online/social media

Stockton CMP video **18.7K** views

Stockton Beach Taskforce **3.3K** views

Animation **2.2K** views

Stockton CLG members **2K** views

8 posts on City of Newcastle Facebook page relating to the Stockton CMP

77,241 combined reach

2,851 total engagement (people clicking, commenting, liking)

1 post on LinkedIn

846 impressions

16 likes

Over 3,000 Stockton web page views

485 downloads of the draft Stockton CMP

773 Storyboard views

(Between 13 May to 10 June 2020)

Meetings/consultation

6 Stockton CLG and focus group zoom meetings (held between 1 March - 10 June 2020)

2 Broad agency stakeholder zoom sessions

Figure 38: An overview of the engagement methods and communication tools used including their reach

Media releases and media monitoring

4
media releases

35
media mentions by media platforms
(newspaper/online news, television, and social media)

Figure 39: Media releases and media monitoring

Feedback Summary

In total, CN received 155 community submissions on the draft Stockton CMP.

The Stockton CMP has been guided by the community via submissions received online and hard copy feedback forms. Feedback from industry has been received online after numerous meetings with agency groups including the Newcastle Coastal Planning Working group (NCPW).

Submissions overview

175 total submissions

155 community submissions received

20 agency submissions received

15 postal submissions

140 received online or via email

73% submissions were supportive of the draft Stockton CMP

81% submissions were received from Stockton residents

75% of Stockton residents were supportive of the draft Stockton CMP

Figure 40: An overview of the submissions received

The themes identified as priorities in community submissions are: mass sand nourishment, alternative protections works and recreational assets. The issues raised for each of these theme areas reflect the aspirations for Stockton's coastline derived from the community during the consultation.

Themes overview

- **Mass sand nourishment**
- **Alternative protection works**
- **Recreational assets**

Figure 41: Themes raised in submissions overview

10.1.4 Community Submissions overview

The community submissions brought a valuable and relatively homogenous set of issues to the draft Stockton CMP review process. There was a genuine sense of excitement coming through the submissions, that a viable long-term solution was being presented that was aligned with the community's aspirations.

The majority of stated supportive submissions agreed on mass nourishment as a central delivery mechanism for protection and amenity for Stockton Beach. Many community members wanted to fast track the approvals processes to ensure mass nourishment from offshore sources could be implemented as soon as possible, and in recognition of this time constraint, supported the need for the proposed works to address immediate current risks.

There was also a number of submissions wanting structures to reduce wave intensity, and/or to allow sand to bypass the harbour walls or trap sand to the north or offshore of Stockton. Some of these issues were addressed in **Supporting Document D**, others that are currently out of this CMP area extent will be collated and referred to Newcastle CMP.

Those unsupportive submissions wanted immediate resolution of such matters as: confirmation of mass nourishment funding mechanisms, changes to legislation and approvals, alternate structural options previously assessed as inappropriate or not supported by the majority e.g. seawalls aligned to erosion scarp or artificial reefs, and alternate sand sourcing for nourishment from currently unavailable sources. Where possible and appropriate these matters were noted for collation and referral to the Newcastle CMP.

Whether supportive or unsupportive, many submissions suggested sand sourcing options. This provided guidance on the need for CMP amendments to provide clarification of the proactive and reactive sourcing of sand to maximise the outcomes of the proposed initial $4M nourishment campaign action from terrestrial (land) sand or other permissible sources. There were also many comments on the positive step the establishment of the Deputy Premier's Beach Taskforce offered, though confirmation of mandate, membership, and timeframes was a source of concern. These details were released during the Public Exhibition period and have now been included in the Final Draft CMP. The provision of recreational assets such as footpaths, beach accessways and open space improvements reflected the need for an overall plan for future works, rather than inclusion on a project by project basis and is included in management actions as well as referred to Newcastle CMP.

A high percentage of submissions acknowledged the constricted timeframes imposed on CN in developing the CMP by June 30 due to the Ministerial direction and the restrictions this placed on CN. The extents of where the Stockton CMP were targeted to was where CN could be confident in the technical integrity of the plan in the time available. It was clear from the submissions that in-lieu of the completed, wider-reaching studies originally intended to inform the Newcastle CMP and further statements of the limitations of the data that was available at the time should be included in the CMP. These larger and more detailed environmental investigations into sediment transport mechanisms and hazards within the Stockton Bight are ongoing and due for completion later in 2020 and for incorporation into the Newcastle CMP.

For an overview of the top issues raised through community submissions see Table 1 and 2 in **Supporting Document G**.

A sample of some of the feedback received is below:

> I agree with your CMP plan of actions. As someone who has watched the waves at Stockton large and small for over 40 years I agree with sand nourishment and repairs to the ends of the current seawall. But in conjunction with an artificial reef in front of where the North Stockton Childcare once stood and another in front of the Pines, 300 metres off shore as without them the next large North East swell will wash away the sand you have spent the time and money installing. The two reefs will reduce the power and energy of the waves coming in, long term they will provide fishing and surfing opportunities.

> Love the plan overall. Would suggest a last line of defence wall implemented both North and South of the current Mitchell Street seawall. Great work!

> We now have the Council and State Government recognising the problem created by the Stockton breakwater. Its man made. Its great to have the Lord Mayor properly enunciating the cause of the problem.

> We need to all work together as a strong voice to make it happen! Stockton is an untapped beautiful tourist destination which once tapped could generate a healthier economy. Our restored beach is what we need back to make it happen!

> The City of Newcastle (CN) is to be commended for providing a proficient and professional draft CMP on a very complex issue in a very short time frame.

> The City of Newcastle has correctly identified the Stockton community's desire for mass sand nourishment as the preferred solution for the coastal erosion at Stockton and highlighted this requirement in the draft CMP.

> There should be investigation into alternative funding structures...A solution for Stockton Beach could prove to be a pilot for the mitigation of the erosion for many other beaches in Australia. There is an opportunity to work with other stakeholders to find a solution.

> There's no point in replenishing sand if you do not address the underlying issue for the sand loss.

> I look forward seeing the Newcastle CMP, which I hope addresses the integration of the Fort Wallace housing development and privatisation of the Stockton Centre into the Stockton CMP.

The content of the Supporting Documentation A-H prepared for CN has also been professionally constructed and correctly identifies many of the problems, the relevant data and potential solutions to the coastal erosion problem at Stockton.

..... wishes to support the City of Newcastle Coastal Management Program plan to place sand on the beach seaward of Dalby Oval, and to extend the protection structure at the northern end of the Surf Club seawall.

I am extremely thankful that something will be done to protect our home and community. I am concerned with the stated 10 year period before review assessment. If only the lower quantity of sand is pumped on for nourishment this likely to be completely eroded and the beach back to the current state before further nourishment.

Incorporating a cycle/walk path along the top of a seawall running from the break-wall to past the old preschool would become an asset for the future, please look a little deeper than just sand because the trucks will kill our quiet community. Sand nourishment is a short sighted approach to a big problem, we need long term solutions put in place to reduce the effects created by the break wall.

I like the Stockton Coastal Management Plan. I strongly support the Sand Nourishment Scheme. It is the most economically feasible scheme that has the acceptance of the Stockton residents. The beach is one of our most important amenities and we treasure it. Property also is at risk along the coastline. Work needs to start now if we are going to protect our beach.

While the report is thorough and detailed in many ways it lacks a wider review of other possible solutions like the implementation of groins (small 50m break walls a few hundred metres apart) or placing a bombie / artificial reef 200 metres from the shore to take some of the energy out of the large waves.

Stockton is an important part of Newcastle. It has significant tourism and historical value to the city of Newcastle. I fully support the sand nourishment plan.

As a Stockton resident, the only way forward is sand nourishment via offshore dredging!

Submissions received by location

Most community submissions were received by Stockton residents. Overall 73% of received submissions were in support of the Stockton CMP.

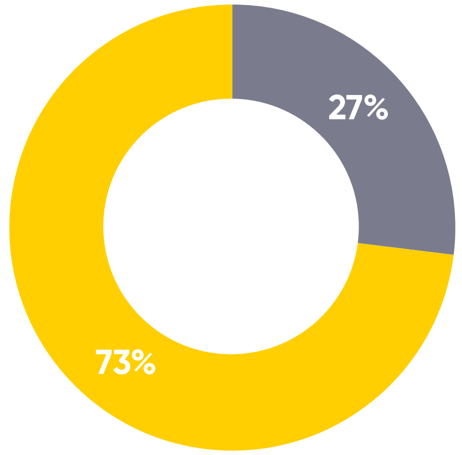

Figure 42: Stockton CMP Supportive community submissions

The majority of submissions (81%) received were from Stockton residents with only 19% of submissions received from outside of Stockton.

Stockton CMP Submissions (Total vs Stockton)

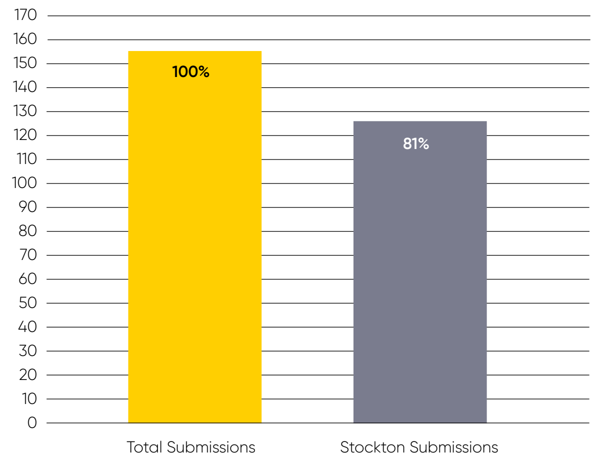

Figure 43: Geographic location of community submissions received

Most submissions were received from Stockton residents and 75% of Stockton residents were supportive of the draft Stockton CMP.

Stockton CMP Supportive Submissions (Suburb - Stockton)

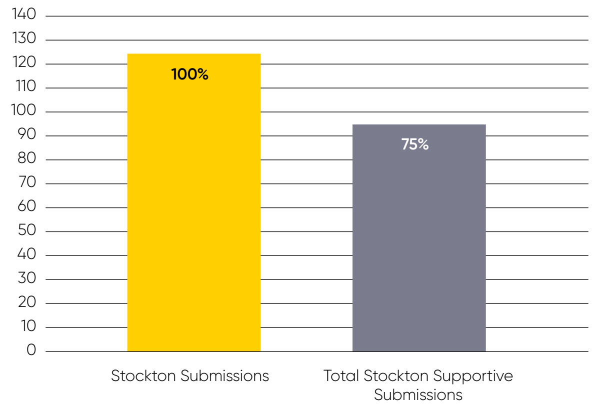

Figure 44: Geographic location of community submissions that received an indication of support

10.1.5 Agency Submission Summary

Consultation and cooperation with relevant government agencies has been ongoing throughout the development of the CMP. Extensive valuable feedback was received from 20 relevant agencies. It must be highlighted in recognition of the restricted timeframe most agencies reviewed and supplied their feedback within the first two weeks of the exhibition period. This is a testament to the professionalism and ongoing positive relationship CN holds with each agency.

All submissions received were supportive of the adaptive approach to coastal management proposed by the Stockton CMP. CN was recognised for the volume of work undertaken in three months to produce a document that would normally take 1-2 years to deliver. As a consequence, there was also wide acknowledgement that the investigations and analysis was based on the best available technical information and any assumptions were valid within the constricted timeframe. Feedback enabled CN to improve the technical integrity of the document and, highlighted and reinforced many considerations that will be address with the completion of the wider Sediment Transport Study and the Newcastle CMP.

All comments focused on improving and supporting the document to achieve and communicate the proposed coastal management strategy. There was general recognition of the importance of sand nourishment to delivering the intended outcomes for Stockton, but caution at the significant work yet to be undertaken to secure ongoing sources of sand particularly in relation to offshore marine. Clarification of roles, responsibilities, funding, assessment and approval requirements were supplied. Submissions reinforced the need for ongoing consultation in the development of options for the area to the north of the Stockton CMP in the Newcastle CMP and the delivery of its proposed actions. All agencies are committed to continuing to assist CN in this process.

An overview of the key themes raised within agency submission comments and any corresponding changes that have been made within the draft Stockton CMP are detailed within Table 4 in Supporting Document G.

10.1.6 Changes made to the draft Stockton CMP in response to community and agency comments

As a result of the feedback supplied from both the community and government agencies, the draft Stockton CMP Section updates summarised in Table 2 & 3 below have substantially improved the clarity, accuracy and compliance of the draft Stockton CMP, in particular:

- The alignment of the draft Stockton CMP with the objects and objectives CM Act and the Mandatory requirements as outlined by the Coastal Management Manual; mandatory requirements and their reflection in the final draft Stockton CMP;
- Reinforcement of the community sense of place and values as a beachside suburb;
- Expanded the background of hazard assessment and risk assessment undertaken. This is reflected in a new "Maps" section;
- Considered acknowledgement of the time constraints imposed by the Ministerial direction to complete the CMP by June 30 was recognised within most submissions, along with credit to CN for meeting such a demanding timeframe with a robust technical and planning outcome. Further clarification of any uncertainty was also included in the final draft Stockton CMP amendments and supporting documents where relevant, as an acknowledgement of this time constraint and the fact that the Stockton CMP was limited to the area where CN could be technically confident in the plan, while the full Stockton Bight sediment transport and hazard assessment studies continue to be progressed for incorporation in the Newcastle CMP;
- Updated the Options Assessment process to include improved, though insignificant change in BCR for option 2, and include benefit distribution for the final Business Plan;
- Amended sand sourcing for nourishment Supporting Document E and in a number of sections of the CMP, to ensure clarity in opportunities that are incorporated in CMP actions. This included recognition of the desk top review undertaken by Geological Survey NSW into potential offshore sand sources;
- The Management Strategy was edited to remove any ambiguity in relation to protection structures and reinforce the rationale of the associated actions. This reflected the level of support for mass nourishment protection and amenity outcomes over the 5-year planning period from submissions.
  No material difference to CMP strategy and actions was required;
- Clarification of approval requirements and assessment considerations in the implementation of works;
- Clarification of the roles and responsibilities;
- Deputy Premier's Stockton Beach Taskforce announcements during the exhibition period have been included and further support CMP strategy and actions.
- Public consultation and exhibition outcomes now included in Section 10.

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12. Glossary

The contents of this glossary are included with acknowledgement of the Coastal Management Glossary developed by State of NSW and Office of Environment and Heritage (2018).

This glossary provides definitions of terms that are in common use when describing coastal processes and coastal management. It is not a comprehensive dictionary of coastal terminology. It supplements definitions provided in the *Coastal Management Act 2016* (CM Act) and State Environment Planning Policy (Coastal Management) 2018 (CM SEPP).

The definitions used in the glossary are sourced from the US Army Corps of Engineers and from glossaries provided in relevant Standards, as well as from other coastal management guidelines in current use in Australia.

Acceptable risk – a risk that, following an understanding of the likelihood and consequences, is sufficiently low to require no new treatments or actions to reduce risk further. Individuals and society can live with this risk without feeling the necessity to reduce risks further. Positive and negative risks are negligible or so small that no risk treatments are needed.

Accretion – as the build-up of sediments to form land or shoaling in coastal waters or waterways. It may be either natural or artificial. Natural accretion is the build-up of land on the beach, dunes, or in the water by natural processes, such as waves, current and wind. Artificial accretion is a similar build-up of land resulting from built structures such as groynes or breakwaters, or activities such as filling and beach nourishment, or also aggradation. (USACE)

Adaptation – adjustment in natural or human systems in response to actual or expected climate change or its effect, to moderate harm or to take advantage of beneficial opportunities.

Alongshore or Longshore – parallel to and near the shoreline.

Ambulatory – in relation to the coastal foreshore, this means the movement of the foreshore seaward or landward over time, in response to coastal processes and sediment budgets. The movement of the foreshore may occur at different rates or in different directions along a beach or within a sediment compartment.

Annual Exceedance Probability (AEP) – the probability (expressed as a percentage) of an exceedance (e.g. large wave height or high water level) in a given year.

Artificial nourishment – see 'beach nourishment'

Asset – something of value and may be environmental, economic, social, recreational or a piece of built infrastructure.

Audit – independent appraisal of social, financial and environmental performance.

Average Recurrence Interval (ARI) – the average time between which a threshold is reached or exceeded (e.g. large wave height or high water level) of a given value. Also known as Return Period.

Back beach or back shore – the zone of the shore or beach lying between the foreshore and the coastline comprising the berm or berms and acted upon by waves only during severe storms, especially when combined with exceptionally high water.

Bathymetric data – measurements of the shape of the bed or the depth of a body of water.

Beach – the CM Act defines beach as an area that is generally composed of sand or pebbles or similar sediment that extends landward from the lowest astronomical tide to the line of vegetation or bedrock or structure.

Beach erosion – refers to landward movement of the shoreline and/or a reduction in beach volume, usually associated with storm events or a series of events, which occurs within the beach fluctuation zone. Beach erosion occurs due to one or more process drivers; wind, waves, tides, currents, ocean water level, and downslope movement of material due to gravity.

Beach fluctuation zone – CM Act defines beach fluctuation zone as 'the range of natural locations a beach profile occupies from its fully accreted condition to its fully eroded condition, with a landward limit defined by the escarpment resulting from the erosion associated with a 1% storm event or a more extreme event of record, whichever is the greater landward limit, and a seaward limit that is the 40m depth seaward of the highest astronomical tide for the open coast and 10m depth seaward of the highest astronomical tide for estuaries or tidal coastal lakes.'

Beach material – granular sediments, usually sand or shingle moved by the sea.

Beach nourishment – beach restoration or augmentation using clean dredged or fill sand. Dredged sand is usually hydraulically pumped and placed directly onto an eroded beach or placed in the littoral transport system. When the sand is dredged in combination with constructing, improving, or maintaining a navigation project, beach nourishment is a form of beneficial use of dredged material.

Beach plan shape – the shape of the beach in plan; usually shown as a contour line, combination of contour lines or recognisable features such as beach crest and/or the still water line.

Beach profile – a cross-section taken perpendicular to a given beach contour; the profile may include the face of a dune or seawall, extend over the backshore, across the foreshore, and seaward underwater into the nearshore zone.

Beach ridge – a nearly continuous mound or ridge of beach material (including sand, shell, coral and gravel) that has been shaped by wave or other action. Beach ridges may occur singly or as a series of approximately parallel deposits. A beach ridge plain is composed of a series of parallel beach ridges. The ridges may be of different heights and spacing. They provide evidence of changes to deposition and erosion rates over time.

Beach scraping – also referred to as 'nature assisted beach enhancement' (NABE) is a mechanical intervention to speed up the natural processes of berm and foredune recovery after a storm event.

Beach system – the CM Act defines as 'the processes that produce the beach fluctuation zone and the incipient foredunes and foredunes landward of the relevant beach'. In general, this means coastal lands, composed of sand, gravel or shell, between a seaward limit of 40 metres depth in the State coastal waters and a landward limit at the lee side of the dunes.

Bedrock – a general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material.

Beneficial uses – placement or use of dredged material for some productive purpose. May involve either the use of the dredged material or the placement site as the integral component of the use.

Benthic – of, pertaining to, or related to, the bottom of a stream or other body of water.

Berm – on a beach, a nearly horizontal plateau on the beach face or backshore, formed by the deposition of beach material by wave action or by means of a mechanical plant as part of a beach renourishment scheme. Some natural beaches have no berm, others have several.

Breaker zone – the zone within which waves approaching the coastline commence breaking, typically in water depths of between five and 10 metres for ocean coasts, but sometimes in shallower water.

Breakwater – a man-made structure protecting a shore area, harbour, anchorage or basin from waves.

Bruun Rule – a commonly used method for estimating the response of a sandy shoreline to rising sea levels.

Bypassing, sand – hydraulic or mechanical movement of sand from the accreting up–drift side to the eroding down-drift side of an inlet or harbour entrance. The hydraulic movement may include natural movement as well as movement caused by humans.

Catchment area – the area which drains naturally to a particular point on a river, thus contributing to its natural discharge.

Cliff – a high, steep face of rock; a precipice.

Climate – the characteristic weather of a region, particularly regarding temperature and precipitation, averaged over some significant interval of time (years).

Climate change – occurs naturally in response to long-term variables, but often used to describe a change of climate that is directly attributable to human activity that alters the global atmosphere, increasing change beyond natural variability and trends.

Closure depth – do not detect vertical seabed changes, generally considered the seaward limit of littoral transport (collected over several years). The depth can be determined from repeated cross-shore profile surveys or estimated using formulas based on wave statistics. Note that this does not imply the lack of sediment motion beyond this depth.

Coast – a strip of land of variable width that extends from the shoreline inland to the first significant landform that is not influenced by coastal processes (such as waves, tides and associated currents).

Coastal asset – includes natural features of the coastal zone, including landforms, ecosystems and species; and built assets such as infrastructure, public and private buildings or structures.

Coastal dune – vegetated and unvegetated sand ridges built-up at the back of a beach. They comprise dry beach sand that has been blown landward and trapped by plants or other obstructions. Stable sand dunes act as a buffer against wave damage during storms, protecting the land behind from salt water intrusion, sea spray and strong winds. Coastal dunes also act as a reservoir of sand to replenish and maintain the beach at times of erosion.

Coastal engineering – a branch of civil engineering that applies engineering principles specifically to projects within the coastal zone (nearshore, estuary, marine, and shoreline).

Coastal environment – the landscape, functions and communities in the coastal zone.

Coastal environment area – land identified in the CM Act as land containing coastal features such as coastal waters of the State, estuaries, coastal lakes, coastal lagoons and land adjoining those features, including headlands and rock platforms. The CM SEPP maps the extent of the coastal environment area for planning purposes.

Coastal forcing – the natural processes which drive coastal hydro and morpho-dynamics (e.g. winds, waves, tides, etc.).

Coastal hazard – defined in the CM Act to mean the following:

- beach erosion
- shoreline recession
- coastal lake or watercourse entrance instability
- coastal inundation
- coastal cliff or slope instability
- tidal inundation

erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters.

Coastal inundation – coastal inundation occurs when a combination of marine and atmospheric processes raises the water level at the coast above normal elevations, causing land that is usually 'dry' to become inundated by sea water. Alternatively, the elevated water level may result in wave run-up and overtopping of natural or built shoreline structures (e.g. dunes, seawalls).

Coastal Management Area – any one of four areas that make up the coastal zone as defined in the CM Act. These are the coastal wetlands and littoral rainforests area, coastal vulnerability area, coastal environment area, and the coastal use area.

Coastal management objectives – specific objectives identified in the CM Act for each of the four coastal management areas.

Coastal management program – a long-term strategy for the coordinated management of land within the coastal zone, prepared and adopted under Part 3 of the CM Act.

Coastal management units – may be identified for the purposes of coastal management at a local or community level. They are sections of the coast that are affected by similar coastal hazards and risks or have several important social and economic features in common.

Coastal model – model of a coastal area. Often a movable bed model used to reproduce coastal sediment transport; or a model of estuary circulation.

Coastal processes – marine, physical, meteorological and biological activities that interact with the geology and sediments to produce a particular coastal system.

Coastal protection works – the CM Act defines coastal protection works as:

- beach nourishment
- activities or works to reduce the impact of coastal hazards on land adjacent to tidal waters, including (but not limited to) seawalls, revetments and groynes.

Coastal risk – a risk that relates to the likelihood and consequences of coastal hazards or threats affecting coastal values.

Coastal sediment compartment – an area of the coast defined by its sediment flows and landforms. Coastal sediment compartments may be mapped at primary, secondary or tertiary (local) scales.

Boundaries are generally defined by structural features related to the geologic frameworks that define the planform of the coast.

Coastal threat – a process or activity that is putting pressure on or impacting on the health or function of a coastal ecosystem, or on the amenity and social or cultural value of the coastal landscape. Examples include the discharge of effluent or poor-quality stormwater into coastal lakes and lagoons, discharges from acid sulfate soils, or the spread of invasive species. High recreational demand can also be a threat to coastal ecosystem health.

Coastal use area – land identified by the CM Act and CM SEPP as being land adjacent to coastal waters, estuaries, coastal lakes and lagoons where development is or may be carried out (now or in the future). The CM SEPP maps the extent of the coastal use area for planning purposes.

Coastal vulnerability area – defined in the CM Act as land subject to seven coastal hazards.

Coastal wetland – wetlands are areas that are inundated cyclically, intermittently or permanently with fresh, brackish or saline water and have soils, plants and animals in them that are adapted to, and depend on, moist conditions for at least part of their lifecycle. Coastal wetlands include marshes, mangroves, swamps, melaleuca forests, casuarina forests, sedgelands, brackish and freshwater swamps and wet meadows.

Coastal zone – as defined in the CM Act and CM SEPP: the area of land comprised of the following coastal management areas: the coastal wetlands and littoral rainforest area, the coastal vulnerability area, the coastal environment area and the coastal use area.

Coastal zone (general) – the transition zone where the land meets water, the region that is directly influenced by marine and lacustrine hydrodynamic processes. Extends offshore to the continental shelf break and onshore to the first major change in topography above the reach of major storm waves. On barrier coasts, includes the bays and lagoons between the barrier and the mainland.

Coastal zone management – the integrated management of issues affecting the coastal zone. Coastal zone management is not restricted to coastal protection works, but includes also development and activities to manage the economical, ecological, cultural and social values of the coast.

Coastal zone management plan – a management plan for the open coast, an estuary or a coastal lake, prepared under the *Coastal Protection Act 1979*.

Community objectives – local scale objectives for management of the coast, based on the aspirations and priorities of local communities. When included in a coastal management program, these objectives will be based on, and must align with, the objectives expressed in a council's Community Strategic Plan.

Conceptual model – a simplified representation of the physical hydro-geologic setting. This includes the identification and description of the geologic and hydrologic framework, media type, hydraulic properties, and sources and sinks of flow.

Consequence – the outcome or impact of a hazard or threat.

Cost analysis – evaluation of the specific cost elements of a contract or proposal to appraise their statutory compliance, distribution, and reasonableness.

Cross-shore transport – refers to the sediment moved in a cross-shore direction to the coastline induced by water motions due to waves and currents.

Current, coastal – one of the offshore currents flowing generally parallel to the shoreline in the deeper water beyond and near the surf zone; these are not related genetically to waves and resulting surf, but may be related to tides, winds, or distribution of mass.

Current, littoral – any current in the littoral zone caused primarily by wave action; e.g. longshore current, rip current.

Current, longshore – the littoral current in the breaker zone moving essentially parallel to the shore, usually generated by waves breaking at an angle to the shoreline.

Cusp (or beach cusp) – one of a series of short ridges on the foreshore separated by

crescent-shaped troughs spaced at more or less regular intervals. Between these cusps are hollows. The cusps are spaced at somewhat uniform distances along beaches. They represent a combination of constructive and destructive processes.

Design storm – a hypothetical extreme storm with waves that coastal protection structures will often be designed to withstand. The severity of the storm (i.e. return period) is chosen in view of the acceptable level of risk of damage or failure. A design storm consists of a design wave condition, a design water level and a duration.

Design wave – in the design of harbour works, coastal protection works etc., the type or types of waves selected as having the characteristics against which protection is desired.

Diffraction of water waves – the phenomenon by which energy is transmitted laterally along a wave crest. When a part of a train of waves is interrupted by a barrier, such as a breakwater, the effect of diffraction is manifested by propagation of waves into the sheltered region within the barrier's geometric shadow.

Drowned river valley – a type of wave-dominated estuary, usually a deep bedrock embayment, with a wide, deep mouth.

Dune – underwater: flow-transverse bedform with spacing from under one metre to over 1000 metres that develops on a sediment bed under unidirectional currents.

Dune – subaerial (see coastal dune).

East Coast Low – an intense low-pressure system that occurs off the east coast of Australia, bringing storms, high waves and heavy rain. East coast lows generally occur in autumn and winter off NSW, southern Queensland and eastern Victoria.

Economic evaluation – an assessment that helps decision-makers to understand the socioeconomic implications of adopting alternative management options and to make choices that will provide net benefits to the community. Cost-benefit analysis is a type of economic evaluation that considers and evaluates a wide range of costs and benefits associated with a proposal, in qualitative or quantitative (monetary) terms (with future costs and benefits reduced to today's prices), compared with a base case. It may be used in conjunction with other criteria (such as technical feasibility, community acceptance or environmental impact) to select optimal management responses. A multi-criteria assessment is not an economic evaluation but may assist decision-making in other ways.

Ecosystem – the living organisms and the non-living environment interacting in an area, encompassing the relationships between biological, geochemical, and geophysical systems; or a community and its environment including living and non-living components.

El Niño southern oscillation (ENSO) – a year to year fluctuation in atmospheric pressure, ocean temperatures and rainfall associated with El Niño (warming of the oceans in the equatorial eastern and central Pacific). El Niño tends to bring below average rainfall.

Environment – surroundings, the physical and biological system supporting life, including humans and their built environment. Includes cultural features of archaeological or historical interest.

Eolian or Aeolian processes – pertaining to the wind, especially used with deposits such as loess and dune sand, and sedimentary structures like wind-formed ripple marks.

Erosion – the wearing away of land by the action of natural forces. On a beach, the carrying away of beach material by wave action, tidal currents, littoral currents, or by deflation.

Escarpment (storm bite) – the landward limit of erosion in the dune system caused by storm waves. At the end of a storm the escarpment may be nearly vertical; as it dries out the sand slumps to a typical slope of one vertical to 1.5 horizontal.

Essential infrastructure – CM Act defines to include infrastructure for the following purposes: electricity generation, transmission and distribution, telecommunications, rail, roads, gas, sewerage systems, water supply systems or stormwater management systems, airports, ports shipping and harbours.

Essential services – those services that are considered essential to the life of communities and include energy, transport, health services, sanitation services, water and welfare institutions *(State Flood Plan and Essential Services Act 1988)*.

Essential utilities – those services that are considered essential to public safety and organised communities. Such services include electricity, gas, water, sewerage, sanitation, telecommunications and waste collection *(State Flood Plan and Essential Services Act 1988)*.

Estuary – CM Act defines as any part of a river, lake, lagoon, or coastal creek whose level is periodically or intermittently affected by coastal tides, up to the highest astronomical tide.

Estuary inundation – flooding around the shoreline of an estuary or coastal lake, by a mixture of tidal water and catchment flood water.

Exposure – the potential for assets to be impacted by a hazard based on data or modelling of the hazard.

Extreme storm event – storm for which characteristics (wave height, period, water level etc.) were derived by statistical 'extreme value' analysis. Typically, these are storms with average recurrence intervals (ARI) ranging from one to 100 years.

Fit for purpose – right for the job it is intended to do. A fit for purpose assessment considers the level of data detail and the types of consultation required to make a reasonable management decision. In general, the detail and consultation required will increase with risk, complexity and impact.

Foredune – the larger and more mature dune lying between the incipient dune and the hind-dune area. Foredune vegetation is characterised by grasses and shrubs. Foredunes provide an essential reserve of sand to meet the erosion demand during storm conditions. During storm events, the foredune can be eroded back to produce a pronounced dune scarp.

Foreshore – the part of the shore, lying between the crest of the seaward berm (or upper limit of wave wash at high tide) and the ordinary low water mark, that is ordinarily traversed by the uprush and backrush of the waves as the tides rise and fall; or the beach face, the portion of the shore extending from the low water line up to the limit of wave uprush at high tide. The CM Act defines the foreshore as 'the area of land between highest astronomical tide and the lowest astronomical tide'.

Gabion – steel wire mesh basket to hold stones or crushed rock to protect a bank or bottom from erosion; or structures composed of masses of rocks, rubble or masonry held tightly together usually by wire mesh to form blocks or walls. Sometimes used on heavy erosion areas to retard wave action or as a foundation for breakwaters or jetties.

Geomorphology – that branch of physical geography which deals with the form of the earth, the general configuration of its surface, the distribution of the land, water, etc.; or the investigation of the history of geologic changes through the interpretation of topographic forms.

Geotechnical investigations – subsurface investigation of soils, rock, and other strata for the purposes of engineering design.

Geotextile – a synthetic fabric which may be woven or non–woven and used as a filter.

Global warming – the increase in the earth's temperature due to the emissions of greenhouse gases.

Groyne – a shore protection structure built (usually perpendicular to the shoreline) to trap littoral drift or retard erosion of the shore; or a narrow, roughly shore normal structure built to reduce longshore currents, and/or to trap and retain littoral material. Most groynes are of timber or rock and extend from a seawall, or the backshore, well onto the foreshore and rarely even further offshore.

Hard defences (protection) – general term applied to impermeable coastal defence (protection) structures of concrete, timber, steel, masonry, etc., which reflect a high proportion of incident wave energy.

Hazard – a process, or activity that affects an asset or value. See also 'coastal hazards' which are the specific hazards defined in the CM Act.

Highest astronomical tide (HAT) – the highest level which can be predicted to occur under average meteorological conditions and any combination of astronomical conditions. In Australia HAT is calculated as the highest level from tide predictions over the tidal datum epoch (TDE), this is currently set to 1992 to 2011.

The HAT and the **Lowest Astronomical Tide (LAT)** levels will not be reached every year. LAT and HAT are not the extreme water levels which can be reached, as storm surges may cause considerably higher and lower levels to occur.

Holocene – an epoch of the Quaternary period, from the end of the Pleistocene, about 8000 years ago, to the present time.

Hydrodynamic – relates to the specific scientific principles that deal with the motion of fluids and the forces acting on solid bodies immersed in fluids, and in motion relative to them.

Impacts – include damage, harm or losses to exposed communities, property, services, livelihoods, access, use and amenity, heritage, ecosystems and the environment because of exposure and sensitivity. Impacts may also be positive.

Incipient dune – the most seaward and immature dune of the dune system. Vegetation characterised by grasses such as spinifex. On an accreting coastline, the incipient dune will develop into a foredune.

Inshore zone – in beach terminology, the zone of variable width extending from the low water line through the breaker zone.

Interdecadal Pacific Oscillation (IPO) – an irregular interdecadal sea surface temperature in the Pacific Ocean that modulates the strength and frequency of the El Niño Southern Oscillation.

Intertidal – that land area between mean low water and mean high water that is inundated periodically by tides.

King tides – any high water level that is well above the average, commonly applied to two spring tides that are the highest for the year, one during summer and one in winter.

La Niña – the opposite state to El Niño, occurring when the SOI is positive. La Niña tends to bring above average rainfall over much of Australia.

Lagoon – a shallow body of open water, partly or completely separated from the sea by a coastal barrier or reef. Sometimes connected to the sea via an inlet.

Likelihood – the chance of something happening, whether defined, measured or determined objectively or subjectively, qualitatively or quantitatively, and described using general terms or mathematically (such as a probability or a frequency over a given time period).

Littoral – of or pertaining to a shore, especially of the sea. Often used as a general term for the coastal zone influenced by wave action, or, more specifically, the shore zone between the high and low water marks.

Littoral transport rate – rate of transport of sedimentary material parallel or perpendicular to the shore in the littoral zone. Usually expressed in cubic metres per year. Commonly synonymous with longshore transport rate.

Local council – for the purposes of the coastal management manual, a council that is wholly or partly within the coastal zone of NSW.

Longshore transport (littoral drift) – refers to the sediment moved along a coastline under the action of wave-induced longshore currents (Dean and Dalrymple, 2002). The net drift is the sum of the positive (conventionally northwards direction in NSW) and negative (southwards in NSW) direction. The gross drift is the sum of the drift magnitudes (absolute values). The differential drift is the difference between the net drift into and out of a coastal compartment. Both gross and net drift are typically averaged over a year and expressed in m^3/yr.

Macro-invertebrates – large invertebrates which may be found in waterways and consisting largely of larval insects, worms, and related organisms.

Maintenance dredging – the recurrent dredging of sediment from a waterway, including existing navigation channels, approaches and berths, to allow safe navigation by commercial or recreational boating traffic.

Managed retreat – also referred to as managed realignment or planned retreat. For the coastal zone (generally the coastal vulnerability area), managed retreat allows the shoreline to migrate landward unimpeded. It allows an area that was not previously exposed to coastal processes and hazards to become exposed, for instance by removing or breaching coastal protection works. Managed retreat may involve the relocation landward, out of a coastal risk area, of homes and infrastructure under threat from coastal erosion, recession or inundation. It may also involve the deliberate setting back (moving landward) of the existing line of sea defence to obtain engineering or environmental advantages. During a managed retreat process, a new foreshore area or new intertidal habitat may be created.

Marine sediment – sediment originating from the sea.

Mean high water mark – the line of the medium high tide between the highest tide each lunar month (the springs) and the lowest tide each lunar month (the neap) averaged over out over the year. In NSW, the methods for determining the position of the MHWM are outlined in the Crown Directions to Surveyors - No. 6 Water as a Boundary.

Mean sea level – the arithmetic mean of hourly heights of the sea at a tidal station, observed over a long period of time.

Multi-criteria analysis – a logical and structured decision-making tool for complex problems involving multiple factors or criteria, where a consensus is difficult to achieve. It may involve processes such as ranking, rating (with relative or ordinal scales) or pairwise comparisons. The process allows participants to consider, discuss and test complex trade-offs among alternatives

Natural character – includes all-natural aspects of the land and sea, including the underlying ecological, hydrological and geomorphological processes that shape landforms (including underwater features) and the natural movements of water and sediment. Natural character also includes aspects of the environment that affect human experience including the natural darkness of the night sky, the sounds and smell of the coast, and the context and setting of natural places.

Natural coastal processes – the coastal processes over which people have no control, such as wind, waves and tides.

Natural heritage – the natural living and non-living components, that is, the biodiversity and geodiversity, of the world that humans inherit.

Near shore – the area of ocean close to the coast that is affected by waves, tides and longshore currents.

NSW Coastal Council – established under Part 4 of the CM Act. A group of three to seven coastal experts, appointed by the Minister to provide advice on coastal management issues.

Outflanking or end effects – erosion behind or around the land-based end of a groyne, jetty or breakwater or the terminus of a revetment or seawall, usually causing failure of the structure or its function.

Overfill ratio - also known as the **overfill** factor, describes the volume of borrow sediment that, in theory, will ultimately yield a residual unit volume of sediment on the beach, after grain sorting and losses.

Overwash – the part of the wave uprush that runs over the crest of a berm or structure and does not flow directly back to the ocean or lake. When waves overtop a coastal protection structure, they often carry sediment landwards which is then lost to the beach system. Also defines a process in which waves penetrate inland of the beach, which is common on low barriers.

Pollution – the condition caused by the presence of substances of such character and in such quantities that the quality of the environment is impaired; or the human-induced alteration of the chemical, physical, biological or radiological integrity of an aquatic ecosystem.

Probabilistic hazard assessment – a risk-based approach to managing coastal hazard that takes uncertainty into account by considering both the likelihood and consequence of hazard occurrence. It applies a stochastic simulation to evaluate coastal processes. The technique uses a distribution of values for each parameter to account for expected variation, or uncertainty, rather than single values.

Parameters are then combined by a monte-carlo technique to produce a probabilistic forecast of future shoreline position. This is quite different to traditional deterministic hazard assessments that produce single values for beach erosion and shoreline recession.

Probabilistic model – mathematical model in which the behaviour of one or more of the variables is either completely or partially subject to probability laws.

Progradation – the building forward or outward toward the sea of a shoreline or coastline (as with a beach, delta, or fan) by nearshore deposition of river-borne sediments or by continuous

accumulation of beach material thrown up by waves or moved by longshore drifting.

Public Authority – defined in the CM Act as a Minister of the Crown of the State, a State-owned corporation, an electricity supply authority, a department or instrumentality of the State, a local council and any other public or local authority constituted by or under any Act and includes any prescribed body.

Recession – a continuing landward movement of the shoreline; or a net landward movement of the shoreline over a specified time.

Reflection – the process by which the energy of the wave is returned seaward.

Refraction – the process by which the direction of a wave moving in shallow water at an angle to the contours is changed. The part of the wave advancing in shallower water moves more slowly than that part still advancing in deeper water, causing the wave crest to bend toward alignment with the underwater contours; or the bending of wave crests by currents.

Residual risk – the risk which remains after managing and reducing risks. It may include for example, risks due to very severe storms or from unexpected hazards.

Resilience – the ability of a system (human or natural) to adapt to changing conditions (including hazards or threats, variability and extremes), and rapidly recover from disruption due to emergencies. Resilient systems or communities have the capacity to 'bounce back' after a disrupting event such as a major storm or an extended heat wave, to moderate potential damages, take advantage of opportunities, maintain or restore function or to cope with the consequences.

Revetment or seawall – a type of coastal protection work which protects assets from coastal erosion by armouring the shore with erosion–resistant material. Large rocks/boulders, concrete or other hard materials are used, depending on the specific design requirements.

Rip – a narrow, strong shore normal current in the nearshore area of most wave-dominated beaches (i.e. most beaches along the open coast of NSW). They are fed by along shore feeder currents initiated by the deflection of waves at the shoreline. There are diverse types of rip on NSW beaches and they affect beach safety.

Riparian – pertaining to the banks of a body of water, such as an estuary.

Risk – effect of uncertainty on planning and management objectives, usually characterised by reference to potential hazards, their consequence and their likelihood. Consequence combines the concepts of magnitude, sensitivity and duration.

Sand drift – the movement of sand by wind. On the coast, this generally describes sand movement resulting from natural or human-induced degradation of dune vegetation, resulting in either nuisance or major sand drift (dune transgression).

Sea level rise – an increase in the mean level of the oceans. Relative sea level occurs where there is a local increase in the level of the ocean relative to the land, which might be caused by ocean rising, the land subsiding, or both. In areas with rapid land level uplift (e.g. seismically active areas), relative sea level can fall.

Sediment cells (tertiary) – small and relatively contained sediment compartments. A tertiary sediment cell may apply to a single beach/embayment.

Sediment transport – the process whereby sediment is moved offshore, onshore or along shore by wave, current or wind action.

Sensitivity – the degree to which a built, natural or human system is directly or indirectly affected by changes in hazards, threats or climate conditions.

Shoreline recession – refers to continuing landward movement of the shoreline, that is, a net landward movement of the shoreline, generally assessed over a period of several years. As shoreline recession occurs the beach fluctuation zone is translated landward.

Southern Oscillation Index – the normalised mean atmospheric pressure difference between Tahiti and Darwin, measured at sea level. The SOI is negative during El Niño and positive during La Niña.

Stakeholder – a person or organisation with an interest or concern in something.

State objectives – the state's objectives for the coast are set out in the CM Act.

Storm surge – the increase in coastal water level caused by the effects of storms. Storm surge consists of two components – the increase in water level caused by the reduction in barometric pressure and the increase in water level caused by the action of wind blowing over the sea surface (wind set-up).

Storm tide – an abnormally high water level that occurs when a storm surge combines with a high astronomical tide. The storm tide must be accurately predicted to determine the extent of coastal inundation.

Strategic management of the coast – planning and management that is wide-ranging, considers multiple issues at multiple spatial scales and multiple timeframes. It identifies the opportunities and constraints of different broad options to achieve

big-picture objectives and defines the best way forward.

Surf zone – defined in CM Act as the area from the line of the outer most breaking waves to the limit of wave run-up on the beach.

Sustainable management – develops and implements proposals that meet the needs of present communities without compromising the ability of future generations to meet their own needs.

Swash zone – the zone of wave action on the beach, which moves as water levels vary, extending from the limit of run down to the limit of run-up.

Swell waves – ocean waves that travel beyond the area where they are generated.

Threats – see Coastal threats. In the coastal management context, a threat is a process or activity which puts pressure on one or more coastal assets or values. Threats may include land uses (e.g. urban, recreation), land management, climate change, industrial discharges, stormwater runoff, overfishing, invasive species as well as the pressures from coastal hazards.

Threshold – can be identified for aspects of coastal systems, to highlight tipping points for irreversible change.

An ecological threshold is the point at which there is an abrupt change in the structure, quality, or functioning of an ecosystem or where external changes produce large and persistent responses in an ecosystem. A species threshold may disrupt aspects of the species population, productivity, reproduction, or habitat in response to a stressor.

Such 'tipping points' can lead to unwanted changes in ecosystems and may slow the recovery of ecosystems or limit their ability to achieve more resilient states following a disturbance.

Similarly, a social or economic threshold of change in a coastal community indicates the point at which the structure, function, social connectedness, equality or economic activity of the community changes beyond recovery.

Thresholds can also be defined for coastal water levels as they relate to the resilience of certain types of development.

Tidal channel – a major channel followed by tidal currents, extending from offshore into a tidal marsh or a tidal flat; tidal inlet.

Tidal circulation – the movement of fresh water and seawater that are mixed by currents and flows in an estuary, in response to ocean tides.

Tidal delta – where an inlet of a barrier estuary or open coastal lake is dominated by tidal processes, a flood tide delta develops inside the entrance, as tidal currents transport marine sand into the estuary. Ebb tide deltas may also occur, outside the mouth of an estuary.

Tidal inundation – the inundation of land by tidal action under average meteorological conditions and the incursion of sea water onto low lying land that is not normally inundated, during a high sea level event such as a king tide or due to longer-term sea level rise.

Tidal limit – the maximum upstream location on a watercourse at which a tidal variation in water level is observed.

Tolerable risk – a risk that, following an understanding of the likelihood and consequences, is low enough to allow the exposure to continue, and at the same time high enough to require new treatments or actions to reduce risk. Society can live with this risk but believe that as much as is reasonably practical should be done to reduce the risks further. Note that individuals may find this risk unacceptable and choose to take their own steps, within reason, to make this risk acceptable. Residual risks are considered tolerable only if risk reduction is impractical.

Training walls – walls constructed at the entrances of estuaries and rivers to improve navigability.

Trigger – pre-negotiated decision-making points and commitments, so that action on coastal risks is taken when necessary, and when it is most convenient and affordable for the affected community

Tropical cyclone – intense low-pressure system in which winds of at least 63km/hour whirl in a clockwise direction, in the southern hemisphere around a region of calm air.

Tsunami – a long period water wave caused by an underwater disturbance such as a volcanic eruption or earthquake. Sometimes (incorrectly) called a 'tidal wave'.

Unacceptable risk – a risk that, following an understanding of the likelihood and consequences, is so high that it requires actions to avoid or reduce the risk. Individuals and society will not accept this risk and measures should be put in place to reduce risks to at least a tolerable level.

Vulnerability – a function of exposure and sensitivity of assets to a hazard, which determines the potential impacts of the hazard. For instance, the vulnerability of coastal assets may be influenced by the extent and impact of environmental, social and economic factors such as saline contamination of soils from flooding, erosion of built-up and natural areas, loss of vegetation, disruption to use, or access, or continuity of service, or loss of amenity, corrosion of built structures, undermining of foundations or damage to contents. Vulnerability also considers the adaptive capacity which is the capacity to adapt or the resilience in the system to manage the impacts and changes.

Wave amplitude – the magnitude of the displacement of a wave from a mean value. An ocean wave has an amplitude equal to the vertical distance from the still water level to wave crest. For a sinusoidal wave, amplitude is one–half the wave height. (USACE).

Wave climate – the seasonal and annual distribution of wave height, period and direction.

Wave-dominated coast – the coast of south eastern Australia is a wave-dominated system. This affects the beach type and the types of estuaries that occur in the landscape.

Wave energy – the capacity of waves to do work. The energy of a wave system is theoretically proportional to the square of the wave height; a high–energy coast is characterised by breaker heights greater than 50 centimetres and a low–energy coast is characterised by breaker heights less than 10 centimetres. Most of the wave energy along equilibrium beaches is used in shoaling and in sand movement. The NSW coast is a high wave energy coast.

Wave run-up – the vertical distance above mean water level reached by the uprush of water from waves across a beach or up a structure.

Wave set-up – the rise in the water level above the still water level when a wave reaches the coast. It can be very important during storm events as it results in further increases in water level above the tide and surge levels.

Wind waves – ocean waves resulting from the action of the wind on the surface of the water.

Zone of profile fluctuation – the area within which the subaerial beach profile can be expected to fluctuate under the current patterns of climate and weather conditions (i.e. including storms and decadal scale cycles).

Zone of slope adjustment – the area landward of an escarpment cut by storm bite, which may be affected by slumping to the angle of repose of the sand as it dries.

13. Abbreviations

Abbreviation	Meaning
CM Act	Coastal Management Act 2016
CM SEPP	State Environmental Planning Policy (Coastal Management) 2018
CMP	Coastal Management Program
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CZMP	Coastal Zone Management Plan (a plan prepared under the former Coastal Protection Act 1979)
DPIE	NSW Department of Planning, Industry and Environment
GIS	Geographical Information System
IAP2	International Association of Public Participation
IP&R	Integrated Planning and Reporting (in accordance with the Local Government Act 1993)
ISO	International Organisation for Standardization
LGA	Local Government Area
OEH	NSW Office of Environment and Heritage
SEPP	State Environmental Planning Policy

Appendix A

Stockton Coastal Zone Emergency Action Subplan

City of Newcastle

June 2020

Acknowledgment

City of Newcastle acknowledges that we operate on the grounds of the traditional country of the Awabakal and Worimi peoples.

We recognise and respect their cultural heritage, beliefs and continuing relationship with the land and waters, and that they are the proud survivors of more than two hundred years of dispossession.

Council reiterates its commitment to address disadvantages and attain justice for Aboriginal and Torres Strait Islander peoples of this community.

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1. Introduction

In response to coastal erosion and relocation of assets at Stockton Beach, on 17 February 2020 the Minister for Local Government issued a direction under section 13 of the Coastal Management Act 2016 (CM Act) that City of Newcastle Council submit a draft Coastal Management Program in accordance with the requirements under Division 2 of the CM Act for the coastline at Stockton Beach, to the Minister administering the CM Act by 30 June 2020.

The CM Act identifies specific emergency management considerations associated with beach erosion, coastal inundation and cliff instability. The CM Act (section 15(1)(e)) outlines that a Coastal Zone Emergency Action Subplan (CZEAS) must be included in a Coastal Management Program (CMP) if the local council's Local Government Area contains land within the Coastal Vulnerability Area (CVA), and beach erosion, coastal inundation or cliff instability is occurring on that land.

While noting that at the commencement of the State Environmental Planning Policy (Coastal Management) 2018 (CM SEPP), no Coastal Vulnerability Area Map was adopted and therefore no coastal vulnerability area has been identified, it is recognised that Stockton Beach has been impacted by coastal erosion on numerous occasions and it is considered appropriate to develop a CZEAS for this location.

Mandatory requirements for a CMP, including the preparation of a CZEAS where required, have been identified in Part A of the Coastal Management Manual (OEH 2018). Further direction on the preparation of a CZEAS is provided in the "Guideline for preparing a coastal zone emergency action subplan" (DPIE 2019). The Stockton Coastal Zone Emergency Action Subplan (Stockton CZEAS) has been developed in accordance with this guidance.

The purpose of the Stockton CZEAS is to outline the roles and responsibilities of all public authorities, including the City of Newcastle (CN) in response to emergencies immediately preceding, during and after periods of beach erosion, coastal inundation or cliff instability, where the beach erosion, coastal inundation or cliff instability occurs through storm activity or an extreme or irregular event.

The Stockton CZEAS is intended to be a supporting document to the City of Newcastle Local Emergency Management Plan 2019 (Newcastle EMPLAN). The Newcastle EMPLAN sets out the responsibilities and coordinating arrangements for a range of emergencies, between combat agencies including the NSW Police, CN, Ambulance Service, New South Wales State Emergency Service (NSW SES), Fire and Rescue NSW and others.

Part A, Appendix D of the Newcastle Coastal Zone Management Plan 2018 (CZMP) contains the Stockton Coastal Erosion Emergency Action Subplan, which was written to meet the requirements of the CM Act and NSW Coastal Management Manual, Part B (the Manual) . The CZMP was certified and gazetted in August 2018 and encompasses the entire coastline of the Newcastle Local Government Area.

Annexure D of the Newcastle EMPLAN lists the Stockton Coastal Erosion Emergency Action Subplan from the CZMP as a supporting document. Additional draft Stockton Erosion Consequence Guidelines (2019) have been developed internally to guide Council's own emergency management actions.

The Stockton CZEAS replaces both Part A, Appendix D of the Newcastle CZMP (2018), the Stockton Coastal Erosion Emergency Action Subplan, and the draft Stockton Erosion Consequence Guidelines (2019), for Zones 1 – 4 of Stockton Beach (prefer to Section 6 for a map and description of the Zones). However, both Part A, Appendix D of the Newcastle CZMP (2018), the Stockton Coastal Erosion Emergency Action Subplan, and the draft Stockton Erosion Consequence Guidelines (2019) remain in force for Zones 5 – 7. The Stockton CZEAS does not replace Part B, Appendix D of the Newcastle CZMP (2018), Newcastle Coastline South of the Harbour Coastal Erosion Emergency Action Subplan, which remains in force for the coastline south of Newcastle Harbour.

2. Objective

The purpose of the Stockton CZEAS is to identify and facilitate the implementation of appropriate emergency responses for emergencies related to coastal hazards that will:

- Protect human life and public safety
- Minimise damage to property and assets
- Minimise impacts on social, environmental and economic values
- Not create additional hazards or risks

Actions in the Stockton CZEAS aim to reduce risk:

- In areas where CN has chosen not to implement other coastal protection works to reduce coastal hazard risks, which have been evaluated as tolerable or acceptable
- Where coastal hazard risks have not been reduced or eliminated because an agreed action in the Stockton Coastal Management Program (Stockton CMP) has not yet been implemented
- Where coastal hazard risks remain after other actions have been implemented (residual risk)
- When rare and very large or unexpected events occur, outside the design criteria or capacity of agreed management actions in the Stockton CMP

3. Planning and Legislative Context

3.1 State Emergency and Rescue Management Act 1989

The overarching framework for emergency management in New South Wales is established by the *State Emergency and Rescue Management Act 1989 (SERM Act).*

The SERM Act defines an emergency as follows:

(1) *In this Act: emergency means an emergency due to an actual or imminent occurrence (such as fire, flood, storm, earthquake, explosion, terrorist act, accident, epidemic or warlike action) which:*

> ***(a)*** *endangers, or threatens to endanger, the safety or health of persons or animals in the State, or*
>
> ***(b)*** *destroys or damages, or threatens to destroy or damage, property in the State, or*
>
> ***(c)*** *causes a failure of, or a significant disruption to, an essential service or infrastructure, being an emergency which requires a significant and coordinated response.*

(2) *For the purposes of the definition of emergency, property in the State includes any part of the environment of the State. Accordingly, a reference in this Act to:*

> ***(a)*** *threats or danger to property includes a reference to threats or danger to the environment, and*
>
> ***(b)*** *the protection of property includes a reference to the protection of the environment.*

The SERM Act outlines roles and responsibilities for all emergency management in New South Wales.

The Act specifies:

- That emergency management committees are established at the state, regional and local levels
- That emergency management plans (EMPLANs) are prepared and reviewed at the state, regional and local level
- Arrangements for controlling emergency operations
- Responsibilities of emergency operations controllers

Arrangements established by the SERM Act are explained in Emergency Management Arrangements for NSW (NSW Government 2016) and on the NSW Emergency website. The NSW State Emergency Management Plan 2018 (NSW EMPLAN) describes the NSW approach to emergency management, the governance and coordination arrangements, and roles and responsibilities of agencies.

The objectives of the NSW EMPLAN are to:

- Provide clarity as to command and control, roles and coordination of functions in emergency management across all levels
- Emphasise risk management across the full spectrum of prevention, preparation, response and recovery
- Emphasise community engagement in the development and exercise of plans as well as in their operational employment
- Ensure that the capability and resourcing requirements of these responsibilities are understood

The NSW SES is the designated combat agency for management of floods, tsunami and storms, including severe storms which can be associated with coastal erosion.

The NSW SES prepare the State Storm Plan, State Flood Plan and State Tsunami Plan, which are subplans to the NSW EMPLAN.

Coastal erosion caused by storm activity is within the scope of the NSW Storm Plan (2018); which clarifies the respective roles of the NSW SES and local government in relation to coastal erosion; as follows:

- Local Government is to activate Coastal Zone Erosion Emergency Action Sub Plans as required (Action 5.2.10)
- Local Government is to implement emergency works - including construction of physical works (Action 5.3.6.b)
- NSW SES coordinate the protection (relocation/removal) of readily moveable household and commercial contents where time and resources permit when property is at risk from coastal erosion (Action 5.3.6.a)
- NSW SES will control and coordinate the evacuation of affected communities/properties when there is a risk to public safety (Action 5.7.2)

Under Action 1.4.3 of the NSW Storm Plan, the emergency management of coastal erosion that is not caused by storm activity will be controlled and coordinated by the Local Emergency Operations Controller (LEOCON).

3.2 Coastal Management Act 2016

The CM Act identifies specific emergency management considerations associated with beach erosion, coastal inundation and cliff instability. The CM Act (section 15(1)(e)) outlines that a Coastal Zone Emergency Action Subplan (CZEAS) must be included in a CMP if the local council's Local Government Area contains land within the coastal vulnerability area (CVA), and beach erosion, coastal inundation or cliff instability is occurring on that land.

While noting that at the commencement of the State Environmental Planning Policy (Coastal Management) 2018 (CM SEPP), no Coastal Vulnerability Area Map was adopted and therefore no coastal vulnerability area has been identified, it is recognised that Stockton Beach has been impacted by coastal erosion on numerous occasions and it is considered appropriate to develop a CZEAS for this location.

Mandatory requirements for a CMP, including the preparation of a CZEAS where required, are identified in Part A of the Coastal Management Manual (OEH, 2018). Further direction on the preparation of a CZEAS is provided in the "Guideline for preparing a coastal zone emergency action subplan" by the Department of Planning, Industry and Environment (DPIE, 2019).

Relevant statutory provisions from the CM Act 15 Matters to be dealt with in coastal management program

(1) *A coastal management program must:*

> *(e) if the local council's Local Government Area contains land within the coastal vulnerability area and beach erosion, coastal inundation or cliff instability is occurring on that land, include a coastal zone emergency action subplan.*

(3) *A coastal zone emergency action subplan is a plan that outlines the roles and responsibilities of all public authorities (including the local council) in response to emergencies immediately preceding or during periods of beach erosion, coastal inundation or cliff instability, where the beach erosion, coastal inundation or cliff instability occurs through storm activity or an extreme or irregular event. For the purposes of this subsection, those roles and responsibilities include the carrying out of works for the protection of property affected or likely to be affected by beach erosion, coastal inundation or cliff instability.*

(4) *A coastal management program must not include the following:*

> ***(a)*** *matters dealt with in any plan made under the State Emergency and Rescue Management Act 1989 in relation to the response to emergencies*
>
> ***(b)*** *proposed actions or activities to be carried out by any public authority or relating to any land or other assets owned or managed by a public authority, unless the public authority has agreed to the inclusion of those proposed actions or activities in the program*

Relevant mandatory requirements of the Coastal Management Manual Part A Requirements for preparing a CMP which includes a proposed or mapped coastal vulnerability area

10. *Where coastal hazards have been identified in a coastal management area, a CMP must identify proposed coastal management actions for those hazards.*

11. *If the CM Act requires that a coastal zone emergency action subplan be prepared, it must identify any requirements for how emergency coastal protection works, within the meaning of the CM SEPP, are to be carried out.*

Note: Clause 19(4) of the CM SEPP defines emergency coastal protection works to mean *'works comprising the placement of sand, or the placing of sandbags for a period of not more than 90 days, on a beach, or a sand dune adjacent to a beach, to mitigate the effects of coastal hazards on land'.*

3.3 City of Newcastle Local Emergency Management Plan 2019

Annexure C of the City of Newcastle Local Emergency Management Plan 2019 (Newcastle EMPLAN) provides a summary of hazards that have risk of causing loss of life, property, utilities, services and/or the community's ability to function within its normal capacity, i.e. identified as having the potential to create an emergency.

The risk associated with coastal erosion is described as "Major beach erosion certain and dunal recession likely. Potentially dangerous inundation of eastern areas of Stockton, possible building damage or collapse as a result of undermining of foundation or wave action". Coastal erosion is rated as "Likely", with "Major" consequence, resulting in a "High" risk prioritisation.

The probabilistic hazard assessment undertaken for Stage 2 of the Stockton CMP, in accordance with the Manual, indicates that Stockton Beach is currently at high to extreme risk, with public assets at immediate threat requiring urgent protection.

Annexure D of the Newcastle EMPLAN contains a table which lists eight supporting documents, including:

- The Stockton Coastal Erosion Emergency Action Subplan, as prepared by CN for the CZMP (2018)
- The City of Newcastle Flood Emergency Subplan (2013) prepared by the NSW SES

It is recommended that these documents are reviewed and updated as necessary, including reference to the Stockton CZEAS.

4. Criteria for Initating Coastal Erosion Response

Both the Newcastle EMPLAN (p17, 2018) and the City of Newcastle Flood Emergency Sub Plan 2013 (SFESP) reiterate that during periods of coastal erosion, Council will 'activate the Coastal Zone Management Plan – Emergency Action Plan'. This is consistent with the NSW State Storm Plan (2018, action 5.2.10).

This is consistent with the NSW State Storm Plan (2018, action 5.2.10) and the New South Wales State Flood Emergency Sub Plan (2018, action 3.3.2). Action 1.4.3. of the same plan indicates that the emergency management of coastal erosion that is not caused by storm activity will be controlled and coordinated by the Local Emergency Operations Controller (LEOCON). Action 4.2.2.c requires the NSW SES to develop review and maintain storm Sub Plans and Local Flood Plans which include local level emergency response planning for coastal erosion and/or coastal inundation where required.

The New South Wales State Flood Emergency Sub Plan (2018) (SFESP) sets out the state level emergency management arrangements for prevention, preparation, response and initial recovery for flooding at the strategic level. In this plan a flood is defined as a relatively high water level which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves (including tsunami) overtopping coastline defences.

The SFESP describes agreed roles, responsibilities, functions, strategies and management for the preparation for, and conduct of, flood operation. The SFESP also covers arrangements for the management of coastal erosion in the LGA, and identifies the NSW State Emergency Service as the Combat Agency primarily responsible for controlling emergency responses.

The Bureau of Meteorology (BOM) provide severe weather warnings for potentially hazardous or dangerous weather include damaging or destructive winds, heavy rain, abnormally high tides, damaging waves and blizzards in Alpine areas. When the waves are expected to be powerful enough to cause damage to property or significant erosion to beaches the BOM will issue a Severe Weather Warning for Damaging or Dangerous Surf.

The BOM specifies the following thresholds for issuing warnings for 'severe storms':

- Rainfall of sufficient intensity to cause flash flooding (generally equal to or exceeding the one in 10-year average recurrence interval)
- waves equal to or exceeding five metres height in the surf zone
- storm surge (see Section 2.2.8 of the 2018 State Storm Plan)

Section 3.3.2 of the SFESP identifies that emergency response operations will be initiated by the NSW SES City of Newcastle Local Controller:

- On receipt of a BOM Preliminary Flood Warning, Flood Warning, Flood Watch, Severe Thunderstorm Warning or a Severe Weather Warning for flash flooding or severe ocean conditions
- When other evidence leads to an expectation of flooding or coastal erosion within the Council area.

If an emergency has developed and neither of these warnings have been issued it is expected that CN will contact NSW SES with a request to be on standby to provide assistance with matters where NSW SES has jurisdiction.

Section 10 describes actions to be undertaken in the prevention phase to align any SES NSW evacuation plans with Council intelligence around warnings and triggers for emergency response. These will be updated within CN's accompanying Stockton Emergency Management Operational Procedures.

In the absence of a BOM severe weather warning, and prior to contacting NSW SES to initiate response to a potential coastal emergency, CN must consider:

- Predicted wave conditions (height, direction, period, duration and set-up)
- Predicted tidal range and tidal anomaly generated by storm surge
- Condition of the beach
- Condition of dune vegetation
- Presence and influence of adjacent headlands and coastal protection structures

5. Roles and Responsibilities

5.1 NSW State Emergency Service

- The role of the NSW SES in emergencies is outlined in Annexure B of the Newcastle EMPLAN, and includes:
- To protect persons from dangers to their safety and health, and to protect property from destruction or damage, arising from floods, storms and tsunamis
- To act as the Combat Agency for damage control for storms and to co-ordinate the evacuation and welfare of affected communities

Action 5.3.6 of the NSW State Storm Plan (2018) gives the NSW SES the role to coordinate the protection (relocation/removal) of readily moveable household and commercial contents where time and resources permit when property is at risk from coastal erosion. Action 5.7.2 of the NSW State Storm Plan (2018) outlines that the NSW SES will control and coordinate the evacuation of affected community properties or potentially dangerous places created by coastal erosion.

Both the State Emergency Service (SES) and CN are noted in Annexure C of the Newcastle EMPLAN (2019) as the Combat Agencies with responsibilities in relation to coastal erosion hazards.

As noted in Section 4, the SES are identified in the SFESP as the primary Combat Agency, and that the NSW SES City of Newcastle Local Controller is responsible for initiating coastal erosion emergency response operations.

The SES is not authorised to undertake coastal emergency protective works (such as placement of rocks or sand filled geotextile containers) of any form.

5.2 City of Newcastle

City of Newcastle (CN) is the designated coastal authority with responsibility for care of public land within its care, control and management. The carrying out (or authorising and coordinating) of emergency coastal protective works to protect public assets from coastal erosion and inundation is the role of CN, if measures are elected to be undertaken.

CN may choose to undertake physical erosion protection measures to protect public assets from coastal erosion and inundation if considered appropriate (assuming appropriate environmental assessment and approval has been obtained).

Private landholders are responsible for their own land parcels and CN does not have a positive obligation to take particular action to protect private property from erosion events. However, CN has a statutory obligation to consider development applications for coastal protection works lodged by property owners.

CN is noted in Annexure C of the Newcastle EMPLAN (along with the SES) as the Combat Agency primarily responsible for controlling the response to a coastal erosion emergency. As further described in Annexure B, during a coastal erosion emergency CN is to:

- Establish and maintain a Local Emergency Operations Centre (LEOC) for the Local Emergency Operations Controller (LEOCON – see Section 4.3)
- Provide support staff for the LEOC
- Provide human resources, plant, equipment, materials and services, as required in dealing with an incident or emergency
-

  Provide support to combat agencies and functional area agencies as required including:

  reconnaissance of the area effected by the emergency
- post disaster damage assessment
- Assist, at their request, the Police Service, Fire and Rescue NSW, Ambulance Service and NSW SES in dealing with any incident or emergency
- Assist in any other emergency management prevention, preparedness or recovery operations, including emergency management training, for which the CN's training and equipment is suitable
- At the request of the LEOCON, coordinate disaster recovery operations, excluding welfare assistance to disaster victims for whom Department of Family and Community Services – Community Services is responsible

Provide engineering resources required for response and recovery operations including:

- damage assessment
- clear and re-establish roads and bridges demolish and shore-up buildings
- remove debris
- construct and maintain temporary levees and evacuation routes, when appropriate
- erection of barricades and fences for public protection
- Provide a liaison officer and executive support to the LEOC and LEOCON or Combat Agency Controller
- Provide an appropriately qualified officer to assist the District Environmental Functional Area Coordinator in relation to environmental emergency management matters

If a "Severe Weather Warning for Damaging Surf" or "Severe Weather Warning for Storm Tides" has been released, or NSW SES was mobilised in some other manner as the combat agency, CN would assist NSW SES as required, or as resources permit.

There are four possible scenarios described below under which coastal erosion may occur without a severe weather warning being issued, which in turn does not trigger the EMPLAN and the NSW SES are not mobilised. In these situations, there is no designated combat agency, but CN would be the lead agency to manage the response.

Heavy Swell – Swell formed at a distance from the coast may impact on coastline with little or no warning. May result in damaging surf producing large scale erosion and/or inundation. Long-range swell may erode the dune system resulting in landward recession of the erosion escarpment.

Depleted Beach Profile – Following beach erosion events the local beach profile may be depleted such that a low or moderate swell coinciding with a high tide may erode the dune system resulting in landward recession of the erosion escarpment.

Slumping of Erosion Escarpment – Following erosion of the dune system a sheer and rear vertical erosion escarpment may remain. As the sand dries the escarpment will slump to a more stable slope. Natural processes may further flatten the escarpment.

Slumping of Coastal Protection Works – Large coastal erosion events may undermine the structural stability of coastal protection works. Slumping of works may occur some time after the event has passed and may result in landward recession of the erosion escarpment.

CN may undertake some of the activities that would otherwise by conducted by NSW SES (where resources allow though not obligated), but CN cannot order evacuation. If required, CN could request NSW SES take on a combat agency role if an emergency is occurring.

Typical tasks that CN may undertake (where required) before, during and after a coastal erosion/inundation event (besides considering the need for and potentially implementing protective works on public land) are outlined in **Section 10**.

5.3 Local Emergency Operations Controller

As noted in the Newcastle EMPLAN, the Local Emergency Operations Controller (LEOCON), appointed by the Regional Emergency Operations Controller (REOCON), is a police officer stationed within the region in which the Local Government Area is located.

The LEOCON is responsible, when requested by a combat agency, to co-ordinate the provision of resource support. LEOCONs would not normally assume control from a combat agency unless the situation can no longer be contained. Where necessary, this should only be done after consultation with the REOCON and agreement of the combat agency and the appropriate level of control.

Under the NSW Storm Plan (2018), Action 1.4.3. indicates that the emergency management of coastal erosion that is not caused by storm activity will be controlled and coordinated by the LEOCON. As described in Section 5.2, CN would provide a range of support for the LEOCON.

5.4 NSW Police

As described in Annexure B of the Newcastle EMPLAN, during a coastal erosion emergency the NSW Police Force is responsible for the following functions:

- Is the designated Combat Agency for law enforcement
- Is the designated Combat Agency for search and rescue
- As necessary, control and coordinate the evacuation of victims from the area affected by the emergency
- Maintain law and order, protect life and property, and provide assistance and support to a Combat Agency, Functional Areas, and other Organisations as required. This may include:
    - Reconnaissance of the area effected by the emergency
    - Traffic control, and crowd control, including the control of evacuations if required
    - Access and egress route security and control
    - Identifying the dead and injured, and notifying next of kin
    - Establishing temporary mortuaries
    - Maintaining the security of property
    - Statutory investigative requirements
    - Preparation of a Public Information and Inquiry Centre capable of providing general information on incidents and emergencies to members of the public
- Respond accredited "rescue units" to general and specialist rescue incidents, and control and coordinate rescue operations
- As determined by the State Rescue Board, provide accredited "rescue units"
-

Some members of the NSW Police may also be appointed as Emergency Operations Controllers. Police would typically become involved in a coastal erosion event as follows

- Assisting NSW SES where required (e.g. controlling and coordinating evacuation) when NSW SES was acting in its combat agency role
- If NSW SES was not mobilised, Police may undertake or coordinate activities such as evacuation, barricading, removal of the contents of buildings and the like

In either case (if NSW SES was or was not the combat agency) it is possible that Police may act according to their statutory powers to protect life and property including authorising emergency protective works. However, it is expected that in making such a decision, Police would need to recognise the combat agency's authority (if applicable), ensure appropriate approvals are in place for any proposed works, and seek proper advice prior to acting.

5.5 Fire and Rescue NSW

As described in Annexure B of the Newcastle EMPLAN, Fire and Rescue NSW (FRNSW) has a Memorandum of Understanding with the NSW SES and would have a support role during a coastal erosion emergency, providing the following functions:

- Provide Primary and Secondary Accredited General Land Rescue Units as determined by the State Rescue Board
- Assist in any other response or recovery operations for which the FRNSW training and equipment is suitable, for example, the provision of emergency water supplies and pumping equipment
- During flood and storm provide assistance to the NSW SES in accordance with the Memorandum of Understanding between FRNSW and SES
- Provide a liaison officer to the LEOC or Combat Agency Operations Centre as appropriate

5.6 Department of Primary Industry and Environment

The Department of Primary Industry and Environment (DPIE) is the NSW Government authority responsible for advising on coastal zone management.

5.7 Bureau of Meteorology

The Bureau of Meteorology (BOM) is Australia's national weather, climate and water agency, and provides regular forecasts, warnings, monitoring and advice including drought, floods, fires, storms, tsunami and tropical cyclones.

The release of "Severe Weather Warning for Damaging Surf" or "Severe Weather Warning for Storm Tides" by the BOM is a key trigger for initiation of response operations for a coastal erosion/inundation event (see Section 4).

6. Physical Extent of the Stockton CZEAS

The Stockton CZEAS builds upon the previous CZMP, and adopts the same spatial extent for seven coastal zones so that emergency actions can be coordinated in both a holistic and site-specific manner. Please note that the Stockton CZEAS applies to Zones 1 – 4 of Stockton Beach. Part A, Appendix D of the Newcastle CZMP (2018), the Stockton Coastal Erosion Emergency Action Subplan, and the draft Stockton Erosion Consequence Guidelines (2019) remain in force for Zones 5 – 7, shown in Figure 1, and described as:

- Zone 1 – Breakwater to Surf Life Saving Club (SLSC) revetment
- Zone 2 – SLSC to Mitchell Street revetment
- Zone 3 – Mitchell Street revetment
- Zone 4 – Barrie Crescent and Eames Avenue frontage (Stone Street to Meredith Street)
- Zone 5 – Griffiths Avenue to Corroba Oval (northern boundary)
- Zone 6 – Hunter Water
- Zone 7 – Hunter Water (northern boundary) to LGA boundary

Figure 1: Coast Zones for Stockton CZEAS, with zones managed within the Stockton CZEAS bordered in green.

7. Definition of Coastal Emergencies

7.1 Beach Erosion

Beach erosion occurs when wind, waves, currents or elevated ocean water levels are removing the sediment that comprises the beach and frontal dune system, landward of the fully accreted condition.

Storm driven beach erosion may result in:

- Erosion on sandy beaches, including berms and frontal dunes, either directly because of undermining, or indirectly because the foundation capacity of the remaining dune adjacent to the eroded area has been reduced
- High, unstable, near-vertical back-beach erosion escarpments
- Damage to poorly designed or maintained coastal protection works

Beach erosion can create risks to public and private assets and present public safety risks. Not all beach erosion occurring during a storm event will trigger a coastal emergency.

7.2 Coastal Inundation

Coastal inundation occurs when a combination of marine and atmospheric processes raises water levels at the coast above normal elevations, causing land that is usually 'dry' to be inundated by seawater. It is often associated with storms resulting in elevated still water levels (storm surge), wave set-up, wave run-up and over-wash flows.

Overtopping and inundation can occur on:

- Beaches and coastal dunes, causing erosion, slumping or movement of large objects
- Seawalls, revetments and entrance training structures (breakwaters), causing structural instability and safety issues with the movement of large objects
- Cliffs and bluffs (in extreme storm conditions)

Storm surge and powerful waves can also penetrate estuaries giving rise to strong currents or seiching. This may result in inundation of roads and low-lying land adjacent to estuaries and waves created by vehicle movement in these locations.

7.3 Cliff Instability

Cliff instability refers to a variety of geotechnical processes on coastal cliffs and bluffs, including rock fall, slumps and landslides. It may be driven by coastal processes such as wave undercutting and overtopping, or by differential weathering of rock layers in cliffs and bluffs or by surface and groundwater flows. Instability may occur during or following a coastal storm event but may also occur at other times. There may be very little warning that a cliff instability incident is imminent.

These hazards may endanger life and property at the site of the process (e.g. through collapse of a lookout platform or walking track, or undermining of dwellings), and at the toe of the cliff or bluff (rock platform or beach). They may result in risks to boaters and fishers in adjacent marine areas.

Note: Cliff instability is not a consideration for this Stockton CZEAS.

8. Approvals Required for Coastal Protection Works

Section 27 of the CM Act contains provisions dealing with the granting of development consent to development for the purpose of coastal protection works, while Section 4 (1) of the CM Act defines coastal protection works to mean:

> **(a)** beach nourishment activities or works, and
>
> **(b)** activities or works to reduce the impact of coastal hazards on land adjacent to tidal waters, including (but not limited to) seawalls, revetments and groynes.

Section 19 of the CM SEPP states that development for the purpose of coastal protection works may be carried by or on behalf of a public authority;

> **(a)** without development consent—if the coastal protection works are;
>
> > **(i)** identified in the relevant certified Coastal Management Program (or Coastal Zone Management Plan), or
> >
> > **(ii)** beach nourishment, or
> >
> > **(iii)** the placing of sandbags for a period of not more than 90 days, or
> >
> > **(iv)** routine maintenance works or repairs to any existing coastal protection works, or
>
> **(b)** with development consent—in any other case.

The CM SEPP also provides that development for the purpose of emergency coastal protection works is exempt development if it is carried out by or on behalf of a public authority in accordance with a Coastal Zone Emergency Action Subplan. Emergency coastal protection works means works comprising the placement of sand, or the placing of sandbags for a period of not more than 90 days, on a beach, or a sand dune adjacent to a beach, to mitigate the effects of coastal hazards on land.

If proposed public or private works do not fit into any of these categories a development application would be required, and a Joint Regional Planning Panel with coastal expertise would be the consent authority.

9. Assets and Hazards by Zone

9.1 Emergency Hazards

Typical hazards relevant to most zones of the Stockton frontage include:

- Unstable vertical dune erosion scarps (that can collapse suddenly creating a hazard to persons/property at crest and near toe of scarp)
- Public safety in areas of wave overtopping/inundation
- Unsafe beach accessways due to erosion
- Vehicles driving on sealed surfaces e.g. roadway/carpark were founding material has been eroded or undercut
- Trees destabilised by erosion
- Submerged objects e.g. tank traps

The sections below outline the built assets and infrastructure in each zone that are within the identified 2025 Zone of Reduced Foundation Capacity (ZRFC) hazard line (Bluecoast 2020). The main emergency hazards associated with these assets and infrastructure are also identified.

CN's accompanying Stockton Emergency Management Operational Procedures will contain maps and asset information for a number of the assets and infrastructure items listed in the zones below, and will be updated as necessary.

9.2 Zone 1 – Northern Breakwater to SLSC

Zone 1 comprises the following coastal assets and infrastructure in the ZRFC:

- Holiday Park frontage
- Office, residence and commercial building (previously "Lexie's")
- The carpark and civil drainage
- Beach access ways
- SLSC amenities/storage facility
- The SLSC building

The main emergency hazards in the zone are:

- Erosion of dunes fronting Holiday Park and oceanic inundation threatening cabins/vans/facilities;
- Outflanking of the SLSC revetment threatening temporary and permanent buildings at the southern end
- Overtopping of SLSC revetment affecting carpark
- Loss of beach accessways
- Loss of civil drainage infrastructure
- Loss of dune habitat and native vegetation

9.3 Zone 2 – SLSC to Mitchell Street Revetment

Zone 2 comprises the following coastal assets and infrastructure in the ZRFC:

- The Hereford Street Monument and associated loop roadway/parking area
- Private property
- Beach accessways
- Mitchell Street roadway

The main emergency hazards in this zone are:

- Erosion of dunes and oceanic inundation
- Exposure of historic civil infrastructure and infill material
- Outflanking of the SLSC revetment threatening SLSC building/areas of Dalby Oval at the northern end
- Erosion of dune and outflanking of Mitchell Street revetment threatening Mitchell Street roadway / parking area adjacent to revetment and private property
- Loss of beach accessways
- Loss of dune habitat and native vegetation

9.4 Zone 3 – Mitchell Street Revetment

Zone 3 comprises the following coastal assets and infrastructure in the ZRFC:

- The Mitchell Street rock revetment
- Timber access stairways connecting the Mitchell Street
- Footpath to the revetment
- Mitchell Street roadway and footpath
- Recreational furniture

The main emergency hazards in this zone are:

- Overtopping of revetment causing damage behind the revetment
- Damage or outflanking of Mitchell Street revetment
- Loss of beach accessways

9.5 Zone 4 – Barrie Crescent and Eames Avenue frontage (Stone Street to Meredith Street)

Zone 4 comprises the following coastal assets and infrastructure in the ZRFC:

- Barrie Crescent roadway
- Carpark, road drainage
- Dune systems at the end of Griffiths Street
- Beach accessways
- Beach accessways and dune fencing

The main emergency hazards in this zone are:

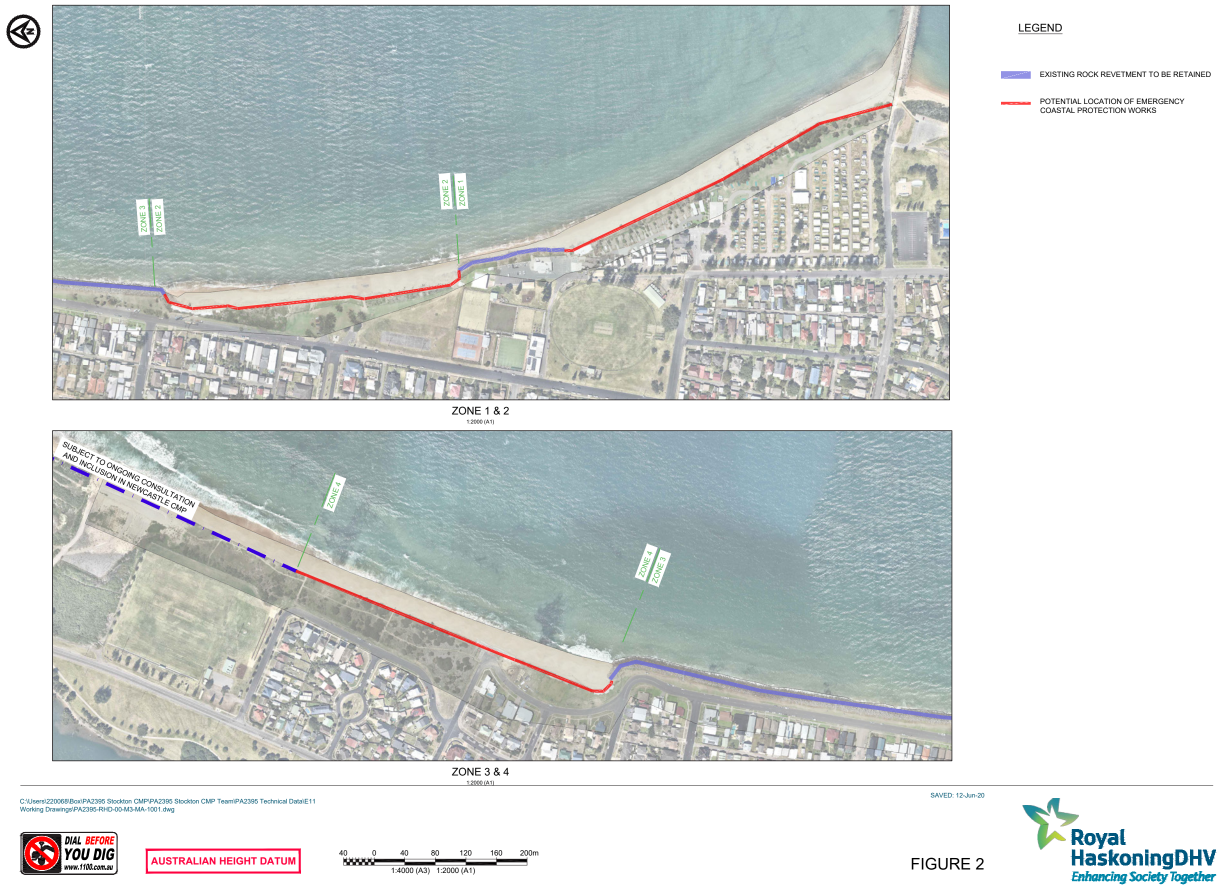
- Outflanking of Mitchell Street revetment threatening Barrie Crescent and Stone Street roadway adjacent to revetment
- Erosion of dune and destabilisation open space
- Private property
- Erosion and collapse of seaward end of Griffiths Street and associated civil drainage systems
- Loss of beach accessways and dune fencing

Loss of dune habitat and vegetation

10. Action Plan

Potential locations for placement of emergency coastal protection works are shown in Figure 2. The exact location(s) requiring placement of Emergency Coastal Protection Works during an event will be dependent on a range of variables including (but not limited to) swell size, swell direction, current state of the beach, etc.

Figure 2 – Potential location of Emergency Coastal Protection Works



As noted in Section 8, the CM SEPP provides that development for the purpose of emergency coastal protection works is exempt development if it is carried out by or on behalf of a public authority in accordance with a Coastal Zone Emergency Action Subplan. Emergency coastal protection works means works comprising the placement of sand, or the placing of sandbags for a period of not more than 90 days, on a beach, or a sand dune adjacent to a beach, to mitigate the effects of coastal hazards on land.

In addition, the Stockton CMP describes potential use of alternative coastal protection measures, including the placement of rock and/or large rock filled bags at locations shown on **Figure 2**. If consent has been sought and granted, these works may be permissible under SEPP Coastal Management 2018.

Tables 1 to 4 outline the timelines, triggers and management actions for the following phases of an emergency:

1. Prevention
2. Preparation
3. Response
4. Recovery

Table 1 includes preventative actions to improve capability and capacity for emergency response and resilience. The implementation of actions detailed in Tables 1 to 4 are dependent on a number of factors including ensuring the WH&S requirements of personnel, available resources, obtaining necessary agreements and approvals, budget and time constraints. All factors will be considered in determining whether the emergency actions will be reasonable and feasible to implement.

Detailed information and spatial data to operationalise the actions outlined in Tables 1 to 4 will be included within CN's accompanying Stockton Emergency Management Operational Procedures. These procedures will set out internal delegations for actions within the Tables below against current roles within the organisation, and will be reviewed and updated as necessary.

Prevention and mitigation measures in relation to infrastructure works, asset management, land use and development controls are assessed and implemented in accordance within the Stockton Coastal Management Program (2020). They are not within the scope of Stockton CZEAS.

Table 1 – Emergency Response Actions Phase 1 – Prevention

Action ID	Timing	Responsibility (Support)	Action /Reporting
1.1	Within 12 months	LEMO	Through the Local Emergency Management Committee: Work with NSW SES / Police / NSW FRS to develop, align and review agency specific emergency incident action'; evacuation and communication plans for Stockton, to be consistent with this Stockton CZEAS. Keep a revision log for the next scheduled review of the Newcastle EMPLAN (2018)
1.2	Within 12 months	LEMO	Investigate feasibility of adopting the principles of the Australasian Inter-service Incident Management System (AIIMS) within CN emergency systems.
1.3	Ongoing	Assets and Projects Manager (LEMO)	Maintain CN's internal Stockton Emergency Management Operational Procedures to guide CN's response to coastal hazards and events across the disaster management cycle. This procedure will include specific spatial and asset data, set out internal delegations, resourcing, training, testing and post action reviews and documentation to support any Common Operating Platform for CN. Monitor and evaluate the implementation of the Operational Procedures after an emergency event and amend where necessary.
1.4	Within 3 months and ongoing	Manager - Major Events and Corporate Affairs (MECA) (Support Asset Services – Coordinator Environment; LEMO)	Prepare communications strategy that provides information to the community before, during and after emergency events This strategy is to: • Establish CN contacts and roles for the strategy • Confirm internal authorisation arrangements for media/spokesperson roles • Setout how and when consultation with other agencies will occur – including operational contacts (email, mobile number) to LEMO for EMPLAN events. Prepare templates and draft collateral to enable ready deployment of this strategy to provide timely public safety and emergency information, including CN's intended emergency responses to coastal erosion. Provide ongoing information to residents and property owners about safe recreational usage, coastal erosion and inundation hazards. Promote a clear single point of contact and information source for all public enquiries.
1.5	Within 6 months	Strategic Planning	Advise owners of affected properties that their dwellings may be at risk in a severe storm event.
1.6	Within 12 months	Assets and Projects Manager or delegate	Investigate partnering with NSW SES to provide general information to Stockton residents and owners about coastal erosion and inundation hazards. Investigate partnering with NSW SES to engage with subset of potentially impacted residents build local community resilience, e.g. by supporting residents to have their own household and neighbourhood emergency plans.
1.7	Ongoing	Assets and Projects Manager or delegate	Support leaseholders of CN properties to prepare emergency response and /or business continuity plans. Provide best available coastal hazard and warning information to leaseholders for the purposes of these plans.

Table 2 – Emergency Response Actions Phase 2 – Preparation

Action ID	Timing	Responsibility (Support)	Action /Reporting
2.1	Ongoing	Assets and Projects Manager or delegate	Weekly monitoring of conditions including weather (measurements, warnings and forecasts), wave forecasts (height and direction), water level (tidal) predictions, real time wave data (height, period and direction), real time water level data (including consideration of elevated water levels due to storm surge), and beach behaviour (extent of erosion, beach width, understanding of historical beach behaviour at times of storms). Monitor and assess the erosion escarpment in relation to development at key locations. Report significant change in condition and/or weather forecast to management.
2.2	Every 6 months	LEMO	Maintain and distribute up to date contact list with after-hours emergency phone contacts for early warning purposes in case of a storm event (including but not limited to; internal CN contacts, NSW SES, NSW Police, FRNSW, Stockton SLSC, Holiday Park, Hunter Water, DPIE, designated Public Information Officer or similar contact details).

2.3	Ongoing	Assets and Projects Manager or delegate	Maintain procedures and guidance for monitoring, emergency inspection, damage assessments, "make safe" and reactive works to ensure public and worker safety including:
			
			• site inspections of relevant assets and hazard areas (Section 9)
			• management of storm debris (potentially containing asbestos)
			• installing, monitoring, maintaining exclusion zones and other "make safe" measures (barriers, fences and signage):
			    • public accessways to the beach and dune fencing
			    • beach facilities and open space
			    • roads and footpaths
			    • emergency works sites
			• removal and dismantling of the above exclusion and "make safe" measures

2.4	Ongoing	Assets and Projects Manager or delegate	Maintain the portfolio describing relevant details of all properties and assets adjacent to Stockton Beach, including Lot and DP, ownership, foundation type and depth, and notation of which properties and assets may require evacuation.
2.5	Ongoing	Assets and Projects Manager or delegate	Ensure site suitable barriers, fencing and signage are available and ready for deployment to effectively close or "make safe" CN managed: • public accessways to the beach • beach facilities and open space • roads and footpaths • emergency works sites
2.6	Within 12 months	Assets and Projects Manager or delegate	Undertake necessary environmental assessments and approvals for potential emergency coastal protection works.
2.7	Every 6 months	Assets and Projects Manager or delegate	Prepare logistics and supply chain contingency plans for likely resources needed to implement potential emergency works, for example, geo-textile products, sandbags and ancillary equipment and sand. Review the list of suppliers for, and availability of, non-stockpiled materials which may be required for intended emergency actions, such as sand or rock.

Table 3 – Emergency Response Actions Phase 3 – Early Warning and Response

Trigger	Action ID	Responsibility (Support)	Action /Reporting
BOM issues a "Severe Weather Warning for Damaging Surf" OR "Severe Weather Warning for Storm Tides" OR CN staff identify a likely coastal erosion event	3.1	Assets and Projects Manager or delegate	Undertake regular monitoring and reporting of weather, wave forecasts and beach conditions.
	3.2	Assets and Projects Manager or delegate	Undertake regular on-ground monitoring of environmental conditions and beach behaviour and close all potentially impacted areas.
	3.3	Assets and Projects Manager or delegate (LEMO)	In accordance with Stockton Emergency Management Operational Procedures: Notify relevant internal staff that coastal erosion event is possible or likely. Confirm availability of labour, resources for "make safe" arrangements and inspections for duration of the event, including early warning, response and early recovery phases. Confirm and circulate emergency contact details.
	3.4	MECA	Deliver early warning and response components of communications strategy as situation develops. Consultation with LEMO/other agencies as required.
	3.5	Assets and Projects Manager or delegate	Identify areas where "make safe" measures are needed and deploy. Consider where potential emergency coastal protection measures may be required (such as pre-emptive sandbag revetments in high risk areas), and deploy as necessary. Note: approval processes already prepared.
Significant erosion escarpment forms and predicted increase in storm threat Note: Actions as a result of this trigger are to be applied to all trigger responses below	3.6	Assets and Projects Manager or delegate	Increase frequency of web-based monitoring and keep records of any weather warnings/reports of erosion.
	3.7	Assets and Projects Manager or delegate	Gather evidence of erosion escarpment. Evidence to be provided to coordinator. Respond with "make safe" or site management as required and practical.
	3.8	Assets and Projects Manager or delegate	If access is required to facilitate emergency actions or actions under the direction of the Combat Agency, implement necessary temporary access works.
	3.9	Assets and Projects Manager or delegate	Monitor and assess roads, and if considered unsafe organise temporary closure through barricades and safety signage.
	3.10	Assets and Projects Manager or delegate	Notify all appropriate stakeholders – including LEMO – with request to be on standby for possible emergency meeting.

Table 3 – Emergency Response Actions Phase 3 – Early Warning and Response (continued)

Trigger	Action ID	Responsibility (Support)	Action /Reporting
Top of erosion escarpment within 20m of built asset with predicted increase in storm threat, OR Wave overtopping/coastal inundation is affecting private or public land, OR Predicted increase in storm threat by BoM (waves exceeding 7m and tides exceeding 1.6m or storm surge greater than 0.6m)	3.11	Assets and Projects Manager or delegate (LEMO)	Notify all appropriate stakeholders including LEMO to gather for emergency meeting.

Top of erosion escarpment within 15m of a built asset with a predicted increase in storm threat, OR
 	
Significant wave overtopping/coastal inundation is affecting private or public land
	3.12	Assets and Projects Manager or delegate
		
		(LEMO, MECA)
			If the EMPLAN is invoked, and as required:
			• establish and maintain a Local Emergency Operations Centre (LEOC) for the Local Emergency Operations Controller (LEOCON – see **Section 4.3**)
			• provide support staff for the LEOC
			• provide human resources, plant, equipment, materials and services, as required in dealing with an incident or emergency
			• provide support to combat agencies and functional area agencies as required including:
			  • reconnaissance of the area effected by the emergency
			  • post disaster damage assessment
			• assist, at their request, the Police Service, Fire and Rescue NSW, Ambulance Service and NSW SES in dealing with any incident or emergency
			• assist in any other emergency management prevention, preparedness or recovery operations, including emergency management training, for which the CN's training and equipment is suitable
			• at the request of the LEOCON, coordinate disaster recovery operations, excluding welfare assistance to disaster victims for whom Department of Family and Community Services – Community Services is responsible
			• provide engineering resources required for response and recovery operations including:
			  • damage assessment
			  • clear and re-establish roads and bridges
			  • demolish and shore-up buildings
			  • remove debris
			  • construct and maintain temporary levees and evacuation routes, when appropriate
			  • erection of barricades and fences for public protection
			• provide a liaison officer and executive support to the LEOC and LEOCON or Combat Agency Controller
			• provide an appropriately qualified officer to assist the District Environmental Functional Area Coordinator in relation to environmental emergency management matters

Table 3 – Emergency Response Actions Phase 3 – Early Warning and Response (continued)

Trigger	Action ID	Responsibility (Support)	Action /Reporting
	3.13	Assets and Projects Manager or delegate (LEMO)	Gather evidence and/or coastal and geotechnical engineering advice from suitably qualified person(s) where required, of erosion escarpment/inundation including location and other appropriate information. Evidence to be provided to emergency meeting stakeholders (3.12).
	3.14	Assets and Projects Manager Manager, Property and Facilities) and delegates (LEMO)	Hold emergency meeting with relevant stakeholders to determine whether Evacuation Plan or actions should be triggered / implemented for private / Council buildings
	3.15	Assets and Projects Manager or delegate (LEMO, MECA)	Inform residents/occupants of the issue Commence evacuation of all persons from buildings determined by stakeholder meeting to be at risk; and in accordance with any evacuation plan arrangements.
	3.16	Assets and Projects Manager or delegate	Revisit need to trigger or update emergency access (3.7) or road closures (3.8).
	3.17	Assets and Projects Manager or delegate Manager, Property and Facilities) and delegates	Contact utility service providers to request disconnection of electrical services to the affected area; plus sewage/water if required.
	3.18	Manager, Property and Facilities	Liaise with managers of NRMA Stockton Beach Holiday Park to: • assist with barricading and fencing the caravan park's beach accesses • assist with traffic management • authorise closure and opening of caravan parks in coordination with caravan park managers • assist the NSW SES/Police, if requested, in the evacuation of residents as required.
Decision is made during emergency meeting to implement emergency coastal protection works	3.19	Assets and Projects Manager or delegate	Transport all necessary materials and equipment for "make safe" erosion control or inundation protection to locations where emergency response works are required.
	3.20	Assets and Projects Manager or delegate	Restrict public access where emergency coastal protection works are to be implemented.
	3.21	Assets and Projects Manager or delegate	Implement temporary emergency coastal protection works (this may include Crown Land with appropriate permissions) to facilitate emergency actions or actions under the direction of the Combat Agency if required, and record all actions taken. Placement of measures are to be undertaken in consultation with suitably qualified coastal or geotechnical engineer. Temporary access works may include a range of activities e.g. placing sand filled geotextile bags, erecting temporary barriers, emergency vehicle access etc.

Table 4 – Emergency Response Actions Phase 4 –Recovery

Tigger	Action ID	Responsibility (Support)	Action /Reporting
Storm and erosion event has abated and safe to conduct post-storm activities	4.1	Asset Services Coordinators-Support and Environment and delegates	Built and natural asset inspections and damage assessments. Define clean-up needs and workorders including for: • beach debris • updated "make safe" works requests (including signage/exclusion) • short and medium repairs to damaged infrastructure and assets, access ways • short and medium term repairs to dune systems and vegetation Seek professional advice as needed. Scope and implement short - medium term remedial actions as required. Implement once safe /coastal system has sufficiently recovered, with reference to preventative works under the Stockton CMP.
	4.2	Asset Services Coordinators-Support and Environment and delegates	Monitor performance of emergency coastal protection works and tasks identified in 4.1. Take remedial action where required.
	4.3	MECA	Deliver early and medium term recovery components of communications strategy. Release warnings of any persisting hazards e.g. high, unstable or near vertical erosion escarpments collapsing without notice.
	4.4	Assets and Projects Manager	Ensure power, sewerage and water services are safely reconnected within Council facilities.
		Property and Facilities Manager and delegates	Contact utility service providers to request reconnection of electrical services to the affected area.
	4.5	Assets and Projects Manager	Request written damage assessments by suitably qualified professionals to confirm any evacuated CN facilities are safe.
		Property and Facilities Manager and delegates	Co-ordinate return of evacuated people and belongings to CN facilities and areas deemed safe.

Tigger	Action ID	Responsibility (Support)	Action /Reporting
Storm and erosion event has abated and safe to conduct post-storm activities	4.6	Assets and Projects Manager or delegate	Restock emergency materials and supplies for future erosion events.
	4.7	Assets and Projects Managerr or delegate LEMO	Post event debrief with emergency response team, review lessons learned, opportunities for improvement.
	4.8	MECA	Communicate with the community on further outcomes and actions to be undertaken.
Review of emergency actions	4.9	LEMO (Assets and Projects Manager and delegates)	Post emergency review of SCZEAS and CN Stockton Emergency Management Operational Procedures; track and update documents as required.
	4.10	Assets and Projects Manager or delegate	Review and collate records of the event, actions taken, issues identified and retain for reporting or future reference.

11. Communication Before, During and After an Emergency Event

If an event is anticipated, CN will liaise with the NSW SES and other emergency services to ensure consistent messages are being delivered by all to reinforce public safety advice. CN's emergency communication strategy will identify how CN staff will liaise with the combat agency. If an event occurs each combat agency and CN are each responsible for their own external media.

Before and during an emergency event CN will erect appropriate signage, including where temporary access works, barricades and fencing are in place, and provide information to the community, including community groups, visitors and tourists, regarding:

- The nature and extent of the emergency
- Risks associated with the emergency e.g. collapse of sand dunes, wave overtopping
- Likely impacts e.g. closure/loss of beach access
- CN's emergency actions
- Ways to minimise risk to personal and public safety e.g. avoid the hazard areas, heed safety warnings
- It is envisaged that the following media/outlets will be utilised, depending on their suitability at the time:
- CN's website and social media posts
- Local radio
- Local newspapers
- Signage
- Hard copy fact sheets/brochures
- Community group contacts

After an emergency event, CN will participate in a debrief with the emergency response team to review lessons learned and note opportunities for improvement. CN will provide information to the community as to the recovery process, including further outcomes and actions to be undertaken; and ongoing need for "make safe" arrangements.

12. Stockton CZEAS Implementation and Review

This Stockton CZEAS applies from the date of gazettal of the Stockton CMP. CN will monitor and evaluate the implementation of the Stockton CZEAS after an emergency event, and amend where necessary.

Operational changes and adjustments will be made to CN's accompanying Stockton Emergency Management Operational Procedures – as set out in **Section 10**.

13. References

City of Newcastle Flood Emergency Sub Plan (2013) (SFESP)

NSW State Emergency Service

Newcastle Coastal Zone Management Plan 2018 (CZMP)

City of Newcastle

Newcastle Local Emergency Management Plan (2019) (Newcastle EMPLAN)

City of Newcastle

New South Wales State Emergency Management Plan (2018) (NSW EMPLAN)

State Emergency Management Committee

New South Wales State Flood Plan (2018)

State Emergency Services

New South Wales Storm Plan (2018)

State Emergency Management Committee

Appendix B

Letters of Support

City of Newcastle

WORIMI LOCAL ABORIGINAL LAND COUNCIL

ABN: 51 352 201 603

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Tanilba Bay NSW 2318

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Williamtown NSW 2318

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Fax: 02 4033 8899

info@worimi.org.au

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09th June 2020

Chief Executive Officer
Attn: Project Management Engagement – Coastal Management
City of Newcastle, PO Box 489
NEWCASTLE NSW 2300

Via email: mail@ncc.nsw.gov.au

RE: WLALC submission to the CN – 'draft' 2020 Draft Stockton CMP

Thank you for the opportunity to provide feedback on the 'draft' Stockton Coastal Management Plan. Having reviewed the draft; we provide the following comments however in doing so, acknowledge the complexity of issues and highlight that CN have communicated these exceptionally well, providing a comprehensive CMP for public consideration.

First and foremost; we agree with the identified need for mass sand nourishment (as a solution for the coastal erosion at Stockton) and expect that numerous submissions will provide an opinion and/or recommendations on the topic including but not limited to, budgets and offshore dredging and terrestrial resources (i.e. from the northern end a.k.a the Worimi Conservation Lands).

Sand Nourishment and Resources:

We refrain from making any direct suggestion at this time; other than to note our acceptance of the requirement and, in doing so highlight the following concerns:

1. Resources from the Worimi Conservation Lands (i.e. a northern supply) is a 'conflict of interest' to the WLALC and any consideration is a discussion for Registered Worimi Aboriginal Owners, NPWS and the WLALC collectively;
2. Marine Sand / offshore dredging poses potential risk to the destruction of Aboriginal artefacts and we request consultation with the Registered Aboriginal Parties;
3. Current sand extraction operations owned by the WLALC have strict planning controls and limits and is unlikely to be a viable resource however, this is a discussion for our community Members; &
4. We have little objection to resources being acquired from the Port of Newcastle and/or other identified resources *acquired from 'off country'* however, recommend that CN liaise with the Aboriginal Community stakeholders and/or Land Councils, within other key identified areas.

Undetermined Aboriginal Land Claims

The WLALC currently has three (3) undetermined Aboriginal Land Claims situated within the draft Stockton CMP footprint, located in Zones 4 & 5 (see imagery and schedule below):

Aboriginal Land Claim Schedule:

Claim No	Land	Date of Claim	Status
19383	Lot 1 Sec 41 DP758929	24 August 2009	Undetermined
19564	Lot 1 Sec 42 DP758299	24 August 2009	Undetermined
5720	Closed road off Meredith St and lot 1 DP178933	16 November 1995	Undetermined

We give attention to Section 4 and the proposed Stage 1 buried protection works.

In our view; the initial Stage 1 works DO NOT impact on the land(s) directly other than to suggest, that they do not go far enough to offer any confidence of the land assets and interests being adequately protected.

Nonetheless; we do not have any objections to the Stage 1 – Buried Terminal Protection Structures, being proposed, nor do we oppose any proposal to complete a road closure at the adjoining points of Griffith Avenue and Barrie Crescent (should this be deemed necessary).

In respect to **Stage 2 Sand Nourishment** and project activities (i.e. truck movements and other machinery, including barricade etc), these items 'are likely to have an impact on the undetermined Aboriginal Land Claims' and (if so) we request that we be notified of the proposed works (methodology) so that we clearly understand the impacts. In doing so; we recognise the need for the works to commence (sand nourishment) and (should it be necessary), may be in accordance with the Crown Lands Act Schedule 2 Part 2 'Land Subject to Aboriginal Land Claim (ALC).

Stockton Caravan Park – Cabin Relocation (Lot 2 in DP1249904)

Although this issue is not in direct correlation to the draft Stockton CMP; it is a serious matter that needs to be addressed and resolved immediately (was created as a result of the Stockton erosion issues).

During a site meeting with CN Mayor and key CN staff, it was agreed that the cabins would be removed from the temporary site (better known as Lot 2 in DP1249904).

Recent site inspections identified that the Cabins have not been relocated and we request a response to explain CN's actions? The WLALC demonstrated an 'act of good faith' with CN and has not (to date) sought any Penalty Infringement for the 'illegal actions' undertaken. Short of a reasonably response to our query and concerns; we are considering reinitiating our complaint with the Dept. Planning.

We wish CN all the success as you navigate these challenging and unprecedented times and we respect the commitment and desire to correct the Stockton Beach erosion issues.

Yours sincerely,

Andrew Smith
Chief Executive Officer
Worimi Local Aboriginal Land Council

Stockton Coastal Management Program 2020 - Comments Port Stephens Council

JM Jessica Morris <Jessica.Morris@portstephens.nsw.gov.au>
To Official Mail
Cc Philippa Hill

Reply | Reply All | Forward | ...

Fri 5/06/2020 9:19 AM

This message was AutoForwarded.

Thank you for the opportunity to comment on the Stockton Coastal Management Program. Port Stephens Council has reviewed the CMP and, as the area of interest finishes well before the Port Stephens LGA boundary, has no concerns in regard to any possible impacts to our shared sediment compartment or managed lands.

As a key stakeholder for the Stockton CMP, we reiterate our commitment to ongoing engagement and our interest in the studies that will underpin the final CMP. As an adjacent Council with a shared sediment compartment, we look forward to seeing the outcomes of the planned sediment transport study to be completed as part of the broader Newcastle CMP.

Overall, Port Stephens Council is happy to support the management option of the Stockton CMP that the City of Newcastle and their community find to be most feasible. We look forward to collaborating further on both the Port Stephens CMP and Greater Newcastle CMP to fulfil our management responsibilities with regard to the Stockton Bite.

PORT STEPHENS COUNCIL
Jessica Morris
Environmental Officer
p 02 4988 0288 | w portstephens.nsw.gov.au

City of Newcastle

Internal Memo

TO: Draft Stockton Coastal Management Program public submission, c/o City of Newcastle

FROM: Jeremy Bath, Chair - Local Emergency Management Committee

DATE: 15 June 2020

SUBJECT: Draft Stockton Coastal Zone Emergency Sub Plan

The draft Stockton Coastal Zone Emergency Action Sub Plan (Plan) was distributed to the Local Emergency Management Committee (LEMC) on 24 April 2020 as per the following email:

> **Subject:** For Urgent Review: Draft Coastal Erosion Emergency Action Subplan
>
> Hi LEMC members,
>
> Attached is the draft version of the Coastal Erosion Emergency Action Subplan for Stockton. I appreciate it's a tight turn around however can you please provide any feedback or comments by 4 May 2020 so that the document can go on public exhibition.
>
> We appreciate everyone's focus on COVID-19 however this subplan is important to ensure appropriate preparedness and community engagement for the ongoing erosion issues at Stockton.
>
> If you could please reply to this email address (emergency@ncc.nsw.gov.au) even if nil feedback just to ensure we have captured everyone's responses.
>
> Regards

Responses were received from Police, Fire and Rescue NSW, NSW State Emergency Services (SES), Port Authority, and Hunter Local Land Services with all parties understanding their responsibilities but with no further additions or suggestions.

The SES drew attention to the Flood Plan referencing and requested that the document be amended to replace the reference from *Local Flood Sub Plan* to *NSW State Flood Plan 2018*. This amendment will be incorporated into the final Plan.

The Plan will go to the LEMC in July for formal ratification.

Please contact our Emergency Management Coordinator at emergency@ncc.nsw.gov.au if you have any questions.

Jeremy Bath
LOCAL EMERGENCY MANAGEMENT COMMITTEE CHAIR

DOC20/134735

Chief Executive Officer
City of Newcastle
C/o Philippa Hill
Coastal Management Program Advisor

By email: phill@ncc.nsw.gov.au
cc: stuart.m.young@environment.nsw.gov.au

Dear Philippa

Draft Stockton Coastal Management Program as amended 17 June 2020 (Revision 2)

Thank you for your email, dated 17 June 2020, in which the amended Action Table (Revision 2) for the draft Stockton Coastal Management Program (CMP) was provided for review. As is required under section 15(4)(b) of the *Coastal Management Act 2016* (CM Act), the City of Newcastle is seeking agreement to the actions in the CMP that would be carried out by the Department of Planning, Industry and Environment – Crown Lands (Crown Lands), or that relate to land or assets owned and/or managed by Crown Lands.

The department's review of the CMP has noted there are key issues that have not been addressed in the Stockton CMP, including matters relevant to Crown land in zone 5 of the Stockton Beach study area. In addition, there is a degree of uncertainty surrounding the strategy of offshore mass beach nourishment proposed in the CMP, and the management response that may be required should this strategy fail to realise the outcomes that are envisaged. It will be important that these issues are addressed in the broader Newcastle CMP, to be developed by City of Newcastle in the year ahead.

Notwithstanding these limitations, the City of Newcastle is to be commended on preparing the CMP and developing a strategic response to the challenging coastal management issues at Stockton Beach. Subject to the CMP being amended in accordance with the Action Table (Revision 2), as emailed to the department on 17 June 2020, Crown Lands provides formal agreement to the CMP under section 15(4)(b) of the CM Act. This agreement does not exclude or replace the need for authorities to undertake the various planning, regulatory and approval processes that may be required under the *Crown Land Management Act 2016* as part of implementing the CMP.

The department looks forward to working with the City of Newcastle during the implementation phase of the CMP and the development of the Newcastle CMP. If you have any questions, please do not hesitate to contact Catherine Knight, A/Manager Coastal Management Unit on 0428 967 997.

Yours sincerely,

J Murray

JAMIE MURRAY
A/ EXECUTIVE DIRECTOR GREATER SYDNEY & COMMERCIAL
DEPARTMENT OF PLANNING, INDUSTRY AND ENVIRONMENT – CROWN LANDS

18 June 2020

437 Hunter Street Newcastle NSW 2300
PO Box 2185 Dangar NSW 2309
Tel: 1300 886 235 www.crownland.nsw.gov.au ABN: 72 189 919 072

RELEVANT EXCERPT OF FINAL DRAFT STOCKTON CMP AS SUPPLIED TO DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT - CROWNLAND ON 17 JUNE 2020

Excerpt Table 9 - Management Actions to Address Coastal Hazards

Action #	Approach	Zone	Management Action	Primary Responsibility	Supporting Partners1	Cost Estimate (Funding Source)	Evaluation Method	Timeframe
CH44	Planning	4	Adaptive risk mitigation strategy including design and approval of coastal protection works upon erosion triggers, for the identified risk potential at Griffith Ave and Barrie Cres. See Section 9 Mapping for potential locations for adaptive risk mitigation	CN		$35,000 (CN)	Design and approval of coastal protection works	Short-Medium
CH45	On-ground Works	4	Construction of approved coastal protection works upon reaching threshold, for the identified risk potential at Griffith Ave and Barrie Cres	CN		$100,000 initial budget Final budget variable	Construction of approved coastal protection works	Short-Medium

PORT of NEWCASTLE

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NEWCASTLE, 18 JUNE 2020

JEREMY BATH
Chief Executive Officer
City of Newcastle PO Box 489
NEWCASTLE NSW 2300

Sent via email: mail@ncc.nsw.gov.au

Attention: Philippa Hill

STOCKTON COASTAL MANAGEMENT PROGRAM 2020: IDENTIFIED ACTIONS

Dear Mr Bath

Reference is made to the draft Coastal Management Program 2020 for Stockton Beach and the three identified actions that relate to Port of Newcastle, defined in the table below:

CH13	On-ground works	Port of Newcastle to place suitable sand from maintenance dredging activities from harbour entrance offshore of Stockton Beach in accordance with concurrence issued by Office of Environment and Heritage (to be revised Feb 2022).
CH36	Planning	Undertake annual inspection of the northern breakwater as per the PON lease area and assess potential issues from coastal hazards
CH44	Partnerships	Continue to consult with Port of Newcastle and capital dredging proponents to request excess suitable sand from capital dredging projects is placed offshore of Stockton Beach

In accordance with the requirements of the *Coastal Management Act 2016*, I can confirm that Port of Newcastle are supportive of the three actions identified and will continue to work collaboratively with City of Newcastle on this important matter.

Should you have any questions regarding this letter please contact PON Manager Environment Sustainability and Planning Jackie Spiteri at Jackie.spiteri@portofnewcastle.com.au

Yours sincerely,

Glen Hayward
Executive Manager Marine and Operations

ATTACHMENTS DISTRIBUTED UNDER SEPARATE COVER

CCL 23/06/2020 - ENDORSEMENT OF THE DRAFT STOCKTON COASTAL MANAGEMENT PROGRAM

ITEM-30	**Attachment B:**	Newcastle Coastal Management Program Scoping Study - Stockton CMP Supporting Document B.

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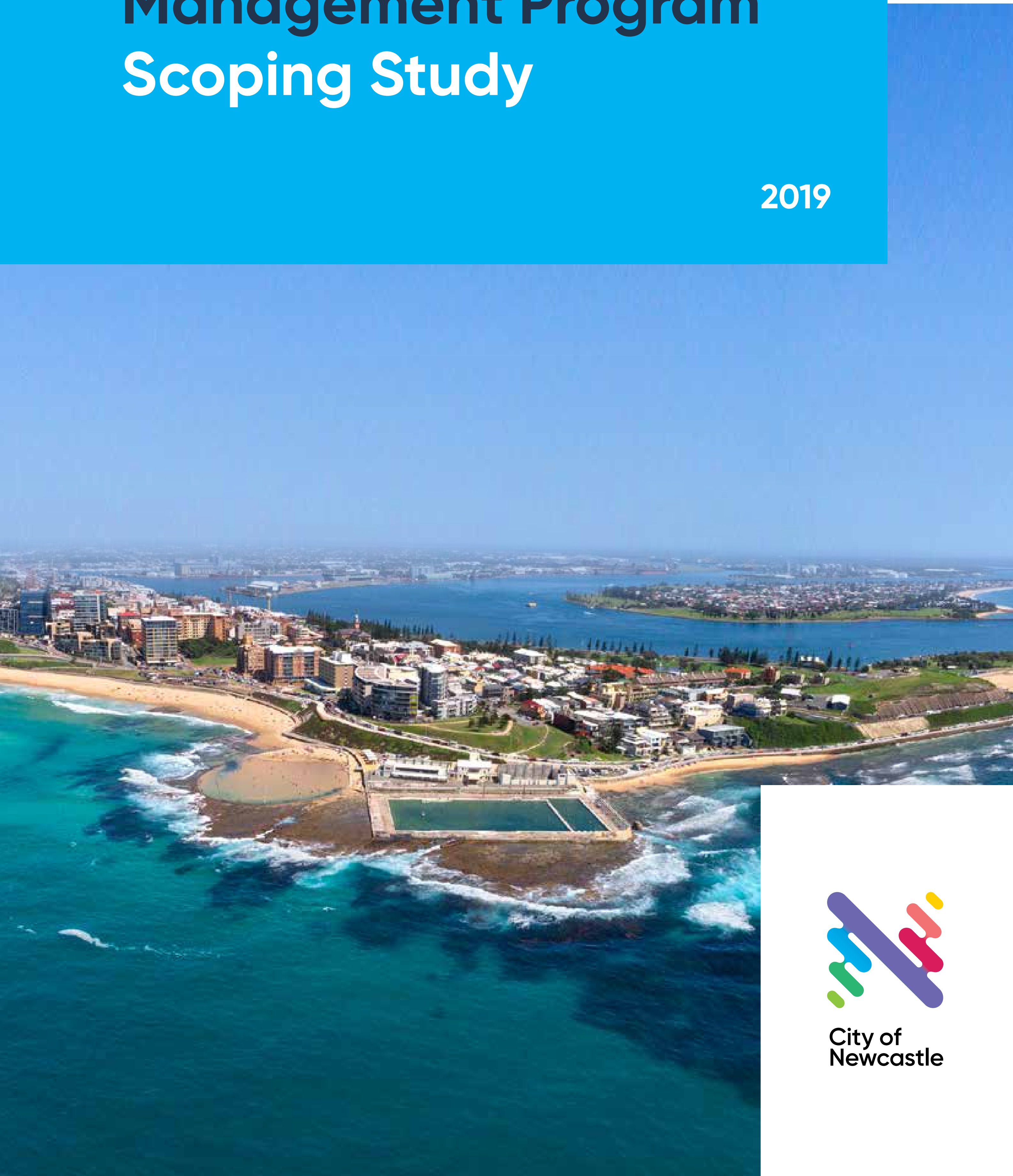
Supporting Documentation B.

Newcastle Coastal Management Program Scoping Study (CN, 2019)

City of Newcastle

Newcastle Coastal Management Program
Scoping Study

2019



City of Newcastle

Contents

Document history

Draft number	Date	Author
1	28/2/19	M.Manning
2	26/7/19	M.Manning
3	10/12/19	M.Manning

Abbreviations

Abbreviation	Full name
AEP	Annual exceedance probability
CMP	Coastal Management Program
CN	City of Newcastle
DCP	Development Control Plan
EEC	Endangered Ecological Community
EPI	Environmental Planning Instruments
HCCDC	Hunter Central Coast Development Corporation
HWC	Hunter Water Corporation
IP&R	Integrated Planning and Reporting
LEP	Local Environment Plan
LGA	Local Government Area
LSPS	Local Strategic Planning Statement
NPWS	National Parks and Wildlife Service
NSW	New South Wales
OEH	Office of Environment and Heritage
PMF	Probable maximum flood
RMS	Roads and Maritime Service
SCA	State Conservation Area
SLR	Sea Level Rise
SEPP	State Environmental Planning Policy

1. Introduction

The coastline of the City of Newcastle is a study in contrasts. From the long sandy embayment of Stockton Bight north of the Hunter River to the high coastal cliffs and headlands dividing pocket beaches to the south, Newcastle's coastline provides a dramatic setting for the expanding metropolitan area of the City of Newcastle. Iconic sites such as Nobbys headland, featuring Nobbys lighthouse at the entrance to the Hunter River, and Merewether Beach, a National Surfing Reserve, are drawcards to explore and play within Newcastle's coastal environment for visitors and locals alike.

The City of Newcastle (CN) is located on the mid-north coast of New South Wales (NSW), approximately 170km north of Sydney. The Hunter River and associated alluvial valley provide the dominant landscape for the second largest population region within NSW (ABS, 2016). CN is the metropolitan centre of the Greater Newcastle region with highly urbanised areas focused around the Hunter River and open coast. Land reclamation has been extensive in the Hunter River lower estuary with the construction of the Port of Newcastle (Institute of Engineers Australia, 1989), which is the largest port on the east coast of Australia and the world's leading coal export port (PoN, 2014).

The sustainable management of Newcastle's coastline is required to ensure the intrinsic environmental, social, economic and recreational qualities of the coast are maintained and enhanced in the present and retained for the use and enjoyment of the community into the future. However, the management of the coastal zone presents various and significant challenges. These challenges include increasing development pressure and use of the coastal zone, increased impacts from urban pollution on coastal and oceanic environments and the effects of a changing climate on both beach areas and adjoining urban areas.

This scoping study forms the first stage of the Coastal Management Program (CMP) process under the NSW Coastal Management Manual (OEH, 2018) and will inform the management of CN's coastal zone.

The purpose of the scoping study is to:

1. provide an overview of the existing knowledge of coastal processes, coastal hazards and the use of the coastal zone within the CN local government area (LGA);
2. provide the strategic context for management of the coastal zone within CN;
3. review the existing management of the coastal area; and
4. identify knowledge gaps within existing studies or management plans and identify the focus of the new CMP.

Section 2 defines the coastal zone scoping study area and provides a description of the beach areas and suburbs surrounding the Hunter River lower estuary that are the subject of the scoping study.

Section 3 outlines the strategic context for management of the coastal zone currently and into the future. Section 3 includes the legislative, planning, environmental, legal, social, cultural and economic context in which coastal management within CN is currently undertaken.

Section 4 outlines the purpose, vision and objectives for the preparation of the CMP.

Section 5 identifies the key management issues within the CN coastal area.

Section 6 identifies the four mapped coastal management areas within the scoping study area and the requirements of *State Environment Planning Policy (Coastal Management) 2018* within the coastal management areas.

Section 7 provides a review of the current coastal management actions within each of the coastal management areas within the scoping study area

Section 8 identifies knowledge gaps within existing information relating to coastal management within the CN LGA.

Section 9 includes a risk assessment in relation to coastal management issues within the CN LGA.

Section 10 includes a preliminary business case for the preparation and certification of the CMP.

Section 11 includes a community and stakeholder engagement strategy to guide the CMP through the process of preparation, evaluation and certification.

2. City of Newcastle coastal zone

2.1 City of Newcastle

City of Newcastle covers a land area of 187km^2 with a population of 154,498 people (2016 ABS Census, enumerated population). The LGA stretches from the coastline of the Pacific Ocean and Tasman Sea through urbanised suburbs to the western suburb of Beresfield, including the Beresfield industrial estate. A primary feature of the LGA is the Hunter River with Newcastle City Centre and the Port of Newcastle located within the lower parts of the estuary.

The LGA is bordered by the LGA's of Port Stephens Council to the north, Maitland City Council to the north-west, Cessnock City Council to the west and Lake Macquarie City Council to the south and south-west (**Figure 1**).

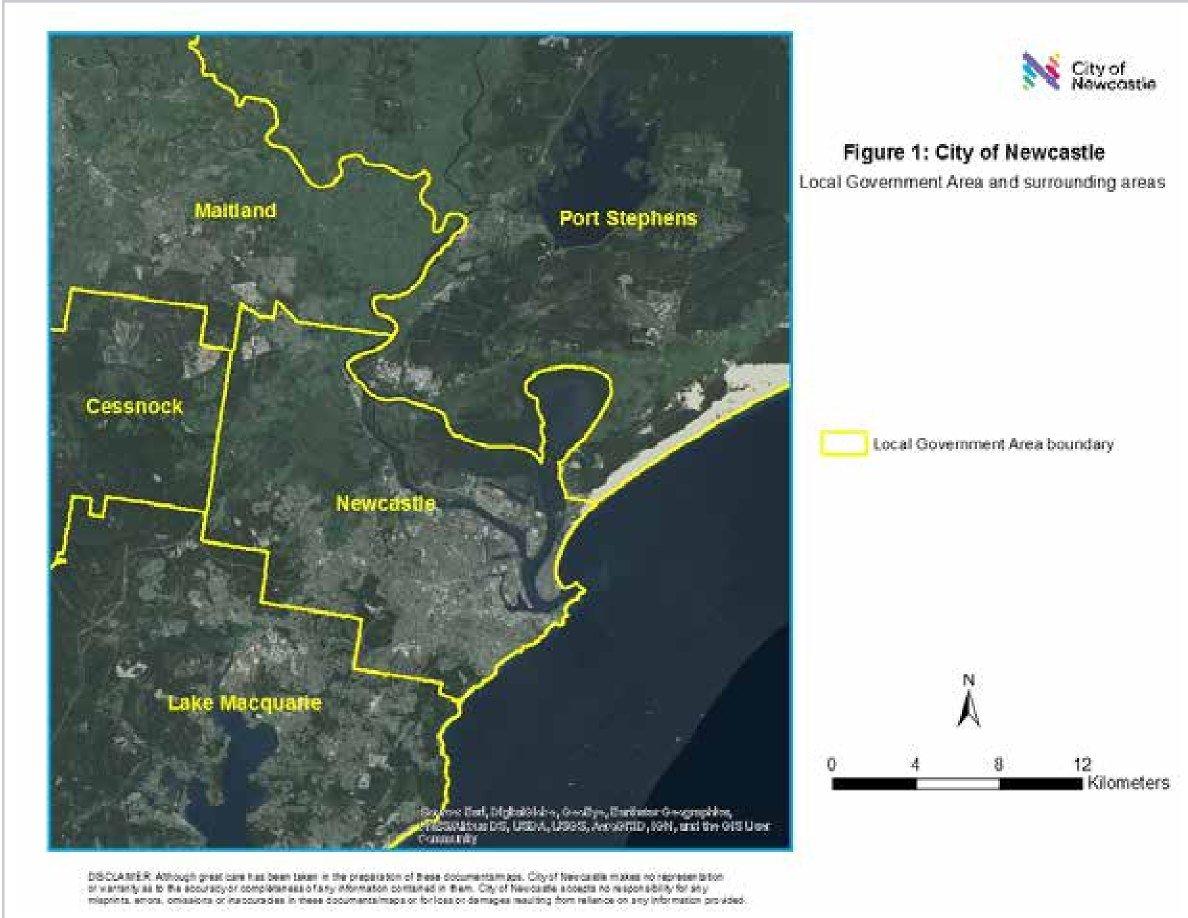


Figure 1: City of Newcastle
Local Government Area and surrounding areas

2.2 Scoping study area

The CMP scoping study includes the coastal area shown in **Figure 2**. The focus of the scoping study area is the coastline and the lower part of the Hunter River estuary, including the Throsby Creek catchment within the coastal zone.

The lower part of the Hunter River estuary within the scoping study area is defined by the bridge structures at Tourle Street, Mayfield North (crossing the south arm of the Hunter River) and Kooragang/Stockton (crossing the north arm of the Hunter River). The lower part of the Hunter River estuary within the scoping study area includes the Throsby Creek catchment, which extends through the suburbs of Islington, Tighes Hill, Maryville, Carrington and Wickham. The scoping study area also comprises part of the water catchment that enters Throsby Creek, primarily constructed stormwater channels that drain urban suburbs including Mayfield, Islington, Hamilton North and Broadmeadow.

The scoping study has been restricted to the lower part of the Hunter River estuary as shown in **Figure 2** to address coastal management issues associated with the urban environment around the Newcastle City Centre, surrounding suburbs and the Port of Newcastle.

Management issues associated with the remainder of the Hunter River catchment will be undertaken in a second CMP in collaboration with Port Stephens Council, Maitland City Council and Dungog Shire Council to ensure a whole of catchment approach is undertaken. The Hunter Estuary Coastal Zone Management Plan was certified under the *Coastal Protection Act 1979* on 26 April 2018. The recent completion and certification of the Hunter Estuary Coastal Zone Management Plan represents an opportunity to expediate the proposed CMP for the Hunter River estuary.

The landward extent of the scoping study area from the open coast and waterways of the Hunter River lower estuary is defined by the boundaries of the coastal environment and coastal use management areas. The mapped coastal management areas were introduced with *State Environmental Planning Policy (SEPP) (Coastal Management) 2018*.

The scoping study area includes the following areas:

- Stockton Beach
- Coastline south of the Hunter River (including parts of Newcastle City Centre, the Hill, Bar Beach, Merewether and Glenrock State Conservation Area)
- Hunter River lower estuary – East of Hannell Street bridge (including parts of Maryville, Carrington, Wickham, Newcastle City Centre, the Port of Newcastle and the western side of Stockton)
- Throsby Creek catchment – West of Hannell Street bridge (including parts of Maryville, Tighes Hill, Islington, Mayfield East, Mayfield, Hamilton North and Broadmeadow).

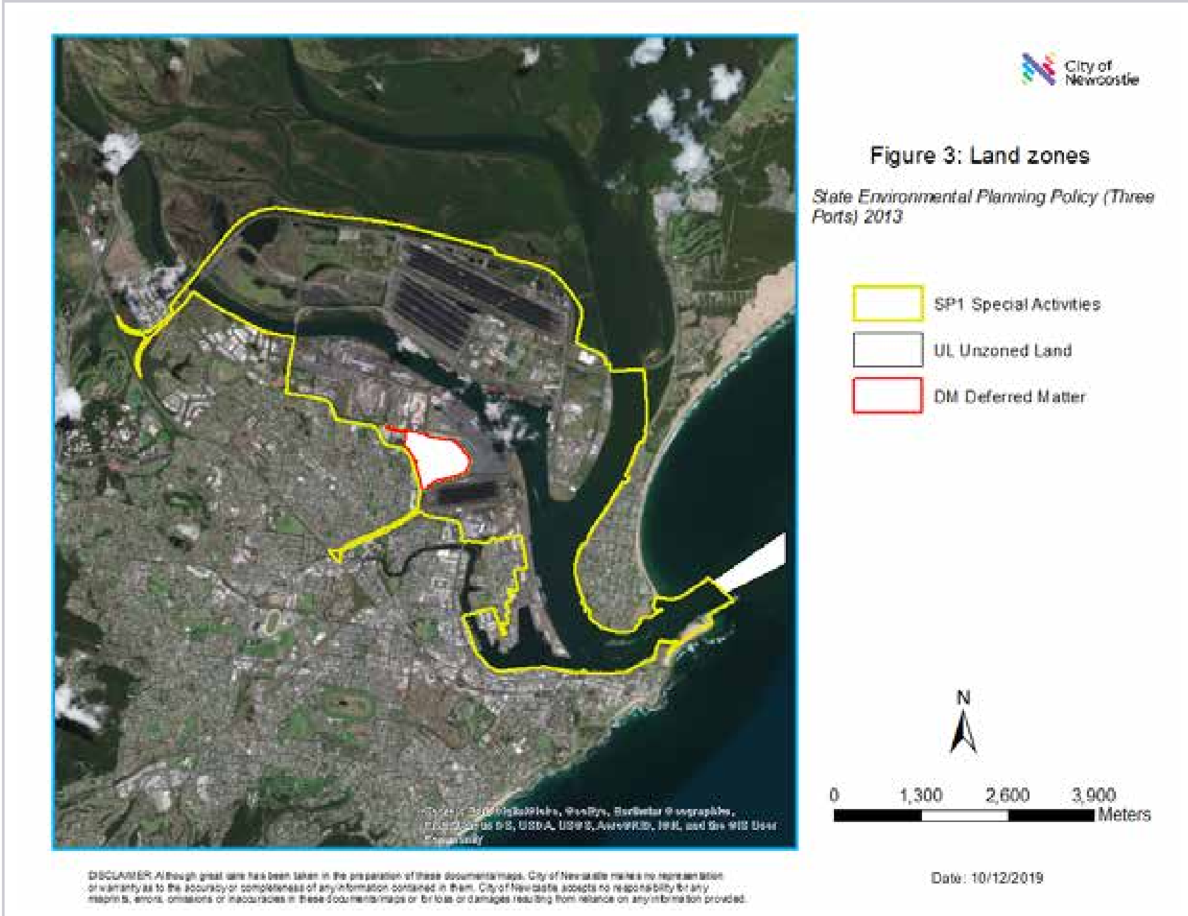
2.3 Port of Newcastle area

The Port of Newcastle is located within the Hunter River lower estuary with the mouth of the river providing entrance to Newcastle harbour.

The Port of Newcastle is located along the highly modified banks of the Hunter River and includes the following areas:

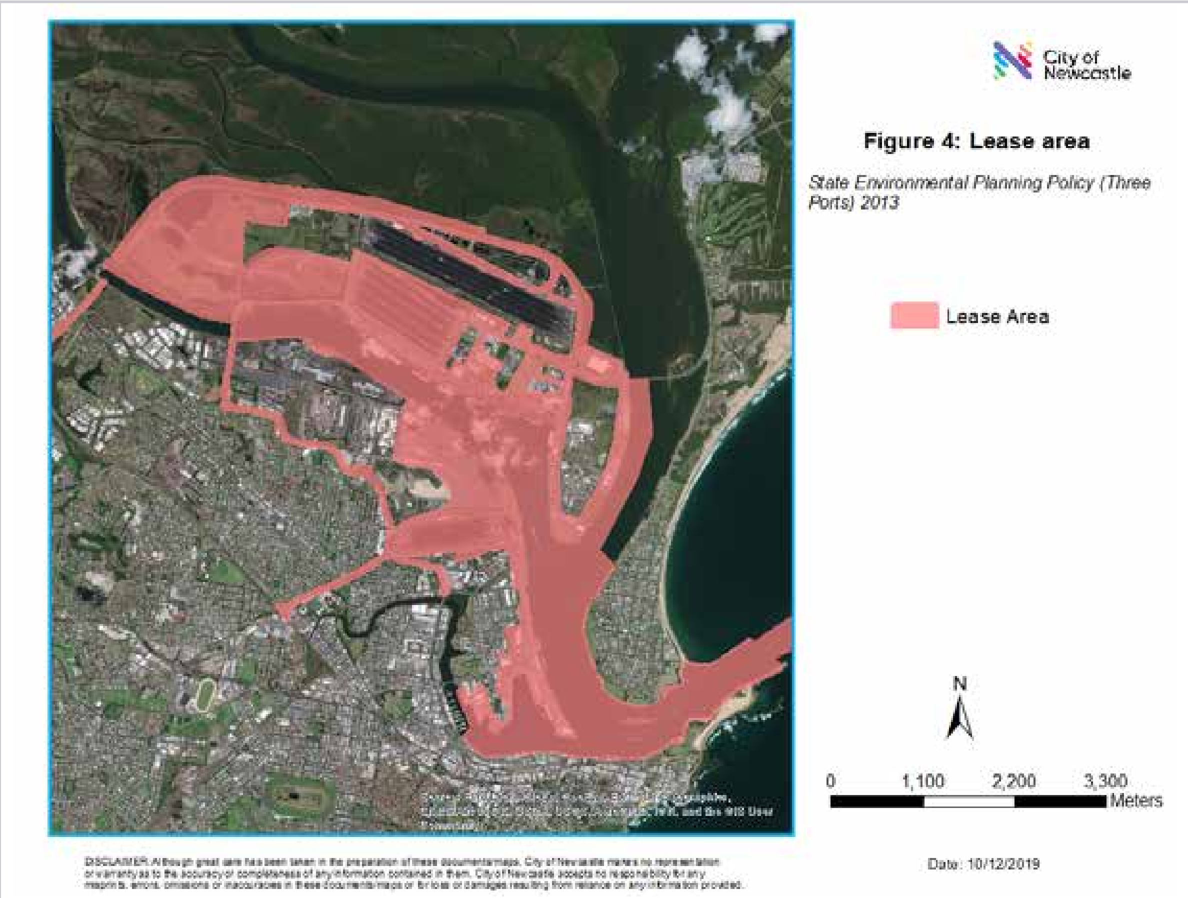
- Kooragang, between the north and south arms of the Hunter River
- Mayfield North on the south bank of the Hunter River south arm
- Eastern and southern parts of Carrington including Dyke Point and the Basin

SEPP (Three Ports) 2013 outlines the zoning boundaries of the Port of Newcastle (**Figure 3**) regarding the application of development provisions within the environmental planning instrument.



The *Coastal Management Act 2016* defines the coastal zone as the area of land within defined coastal management areas. Coastal management areas are mapped in *SEPP (Coastal Management) 2018* and parts of the Port of Newcastle are mapped as coastal management areas. However, sections of the Port of Newcastle are managed under a lease arrangement with the NSW Government, which took effect on 30 May 2014. The Port of Newcastle lease area is defined under *SEPP (Three Ports) 2013* and is shown in **Figure 4**. *Clause 7 of SEPP (Coastal Management) 2018* notes this SEPP, and the requirements of coastal management areas, do not apply within the lease area under *SEPP (Three Ports) 2013*.

While located in the CN coastal zone the Port of Newcastle lease area under *SEPP (Three Ports) 2013* is excluded in the CMP as the mapped coastal management areas do not apply. However, the operation of the Port of Newcastle plays a pivotal role and function within the CN coastal zone and requires consideration in any management of the area. Therefore, Port of Newcastle will be consulted throughout the CMP process to ensure integration of the operation of the port into management of the coastal zone.



2. City of Newcastle coastal zone

2.4 Newcastle coastal zone

The scoping study area, with the exclusion of the Port of Newcastle lease area, accounts for a land area of approximately 20.33km^2 or 15.42% of the LGA area. This coastal area includes a population of 43,797 people (2016 ABS Census, enumerated population) and accounts for 28.35% of the population of the LGA.

The Newcastle coastal zone can be broadly divided into four areas:

- Stockton Beach
- Coastline south of the Hunter River (including parts of Newcastle City Centre, the Hill, Bar Beach, Merewether and Glenrock State Conservation Area)
- Hunter River lower estuary – East of Hannell Street bridge (including parts of Maryville, Carrington, Wickham, Newcastle City Centre, the Port of Newcastle and the western and southern foreshore of Stockton)
- Throsby Creek catchment – West of Hannell Street bridge (including parts of Maryville, Tighes Hill, Islington, Mayfield East, Mayfield, Hamilton North and Broadmeadow).

A description of the four coastal areas is provided below.

2.4.1 Stockton Beach

The residential suburb of Stockton is located on a peninsula at the southern end of the larger embayed section of sandy coast known as Stockton Bight. The northern breakwater of the Hunter River entrance forms the southern end of Stockton Bight which sweeps in a long northeast alignment for 32km to Birubi Point. Stockton Bight extends across the LGA boundaries of CN and Port Stephens Council with the boundary located north of the Stockton Centre at 342 Fullerton Street, Stockton. The southern 4.5km of Stockton Bight is located within the CN LGA.

2.4.1.1 Stockton Beach – northern end

The northern end of Stockton Beach within the CN LGA is a low-density mixture of land uses including a disability services facility (Stockton Centre), former defence services facility (Fort Wallace), former Hunter Water Corporation (HWC) sewerage infrastructure facility, recreation area (Corroba Park) and residential housing (See **Figures 5** and **6**). The northern section of Stockton Beach has a history of erosion events and in January 2018 a storm event resulted in the exposure of a former landfill at the HWC owned site at 310 Fullerton Street. The northern section of Stockton Beach is experiencing ongoing shoreline recession with the highest predicted rates of recession near the HWC owned site at 310 Fullerton Street (DHI, 2006). The rate of shoreline recession decreases further north of this area.

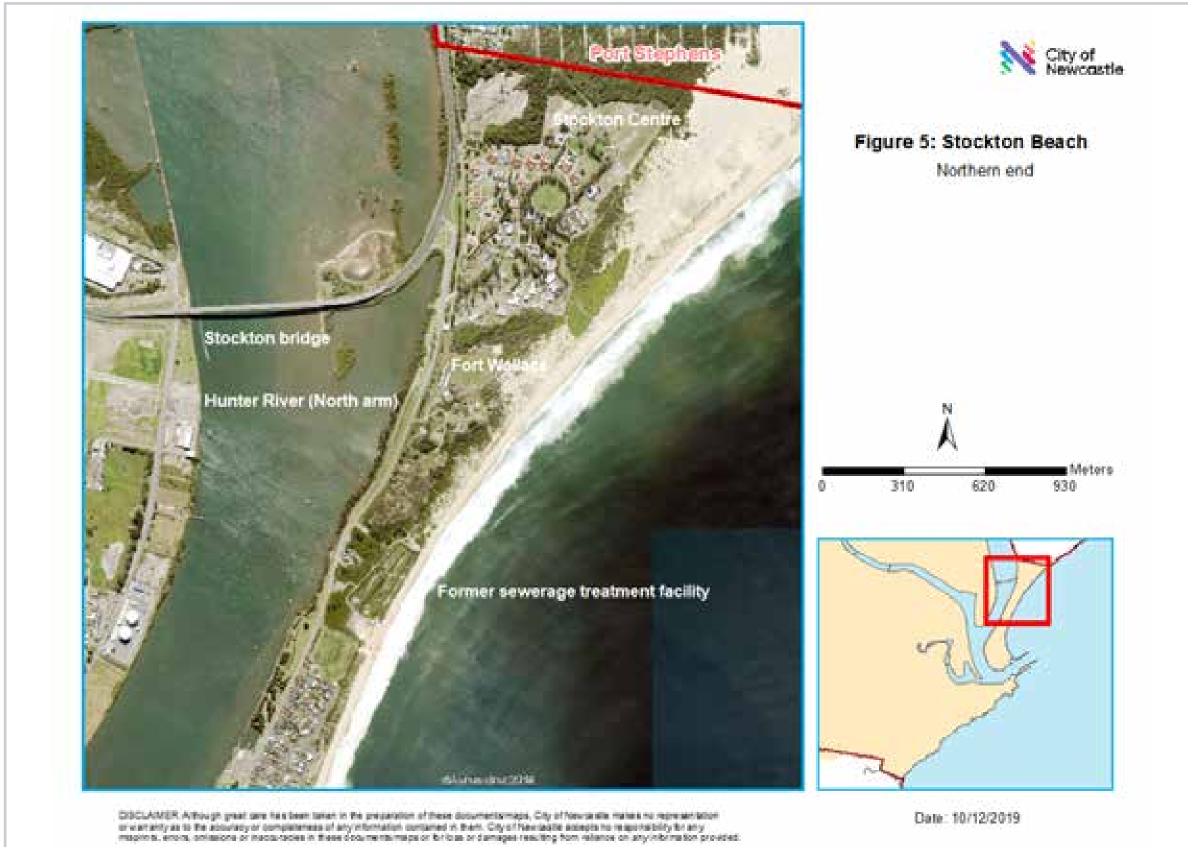


Figure 6. Northern section of Stockton Beach from northern end of Mitchell Street seawall. Former North Stockton Surf Life Saving Club building on back dune area now removed. (Photograph: MManning, CN, 4/1/19).

2.4.1.2 Stockton Beach – central section

The central section of Stockton Beach is dominated by the Mitchell Street seawall, which was constructed between Pembroke Street and Stone Street in 1989. The seawall was constructed to protect residential development and infrastructure west of the beach. The central section of Stockton is primarily residential development with public recreation areas (Dalby Oval) south of the Mitchell Street seawall (See **Figures 7 and 8**).

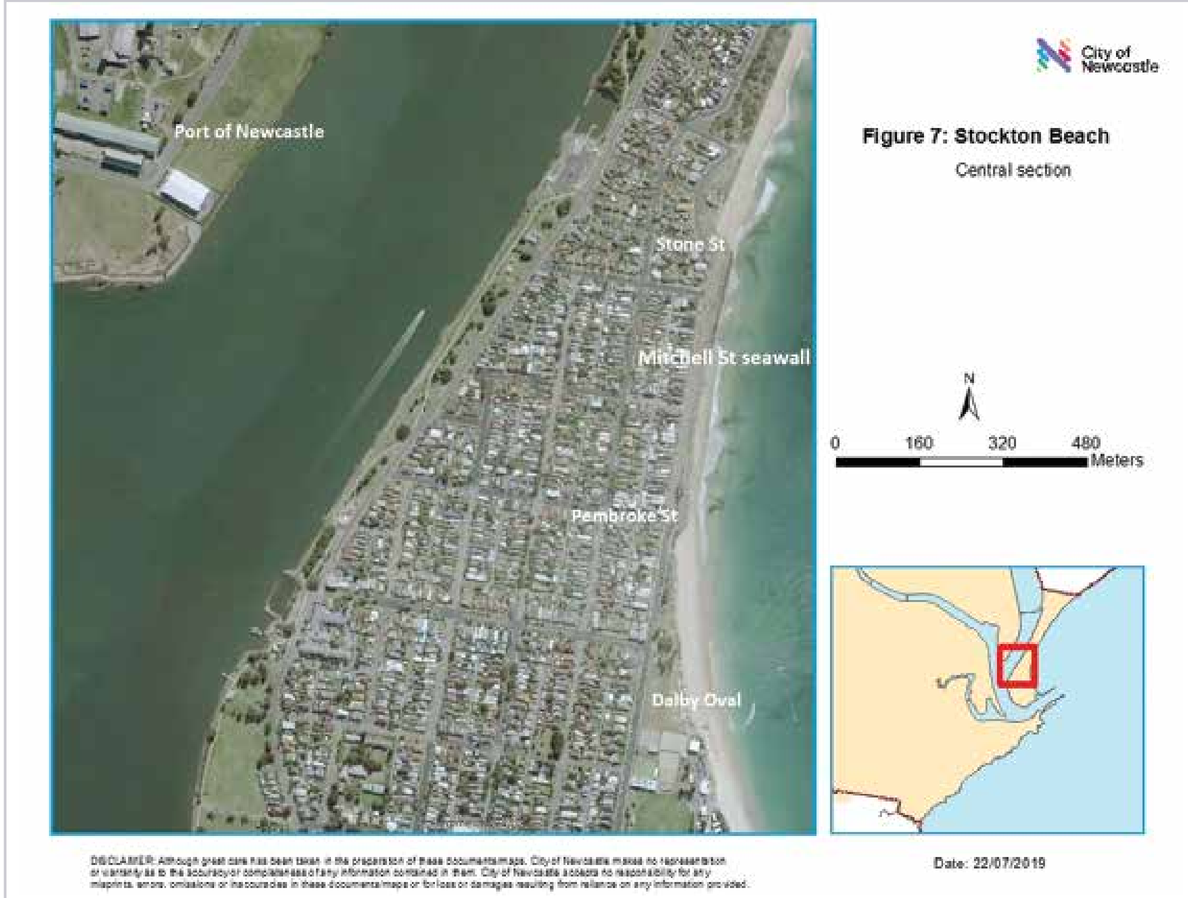


Figure 8. Central section of Stockton Beach with Mitchell Street seawall in midground (Photograph: MManning, CN, 4/1/19)

2.4.1.3 Stockton Beach – southern end

The southern section of Stockton is primarily residential with community facilities along the former hind dune areas of the beach. These community facilities include the Stockton Surf Life Saving Club, Lexie's café, Lynn Oval and the Stockton Beach Holiday Park. A dune system and vegetation were established seaward of the Stockton Beach Holiday Park in the mid-1990's after storm events in 1994 (January and December) and 1995 (March). The northern breakwater of the Hunter River entrance is located to the south of this dune system. Little Beach is located between the northern breakwater of the Hunter River entrance and a smaller rock groyne to the south (See **Figures 9, 10** and **11**).

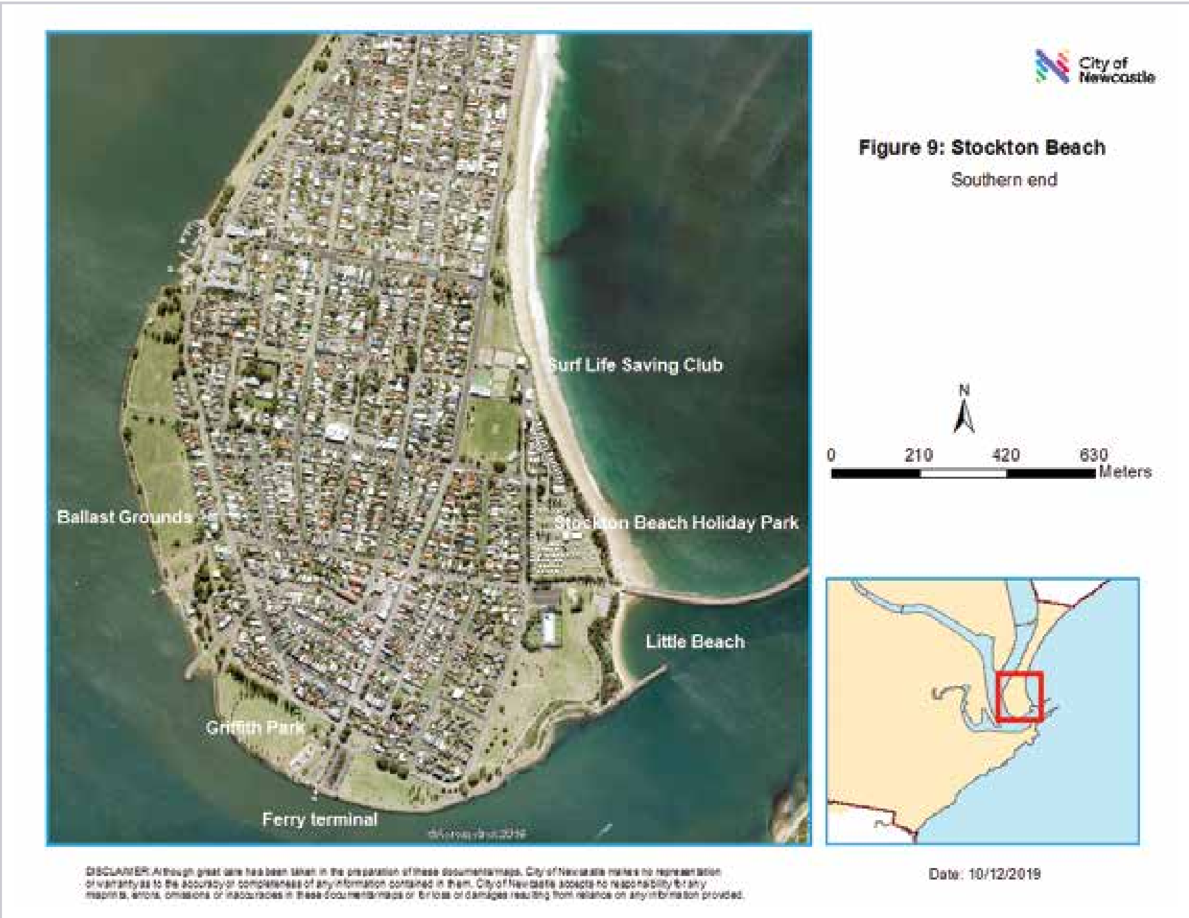


Figure 10. Southern end of Stockton Beach. Stockton Beach Holiday Park is located behind vegetated dune area. (Photograph: MManning, CN, 4/1/19)

Figure 11. Little Beach at Stockton with northern Hunter River entrance breakwater to right (Photograph: MManning, CN, 4/1/19)

2.4.2 Coastline south of the Hunter River

The coastal zone south of the Hunter River is a series of pocket beaches separated by rocky clifflines/headlands. A description of the individual areas, including beaches and headlands from north to south, are provided below.

2.4.2.1 Nobbys Beach

Nobbys Beach extends south from Nobbys headland (Nobbys lighthouse) to Fort Scratchley headland (Signal Hill). The beach has formed adjacent to the southern breakwater at the entrance to the Hunter River. The breakwater was constructed in the mid-1800's and connected the Fort Scratchley headland to Nobbys Island (now Nobbys headland). The construction of the breakwater has interrupted the natural sand movement from the south leading to the formation of Nobbys Beach (See **Figures 12** and **13**).

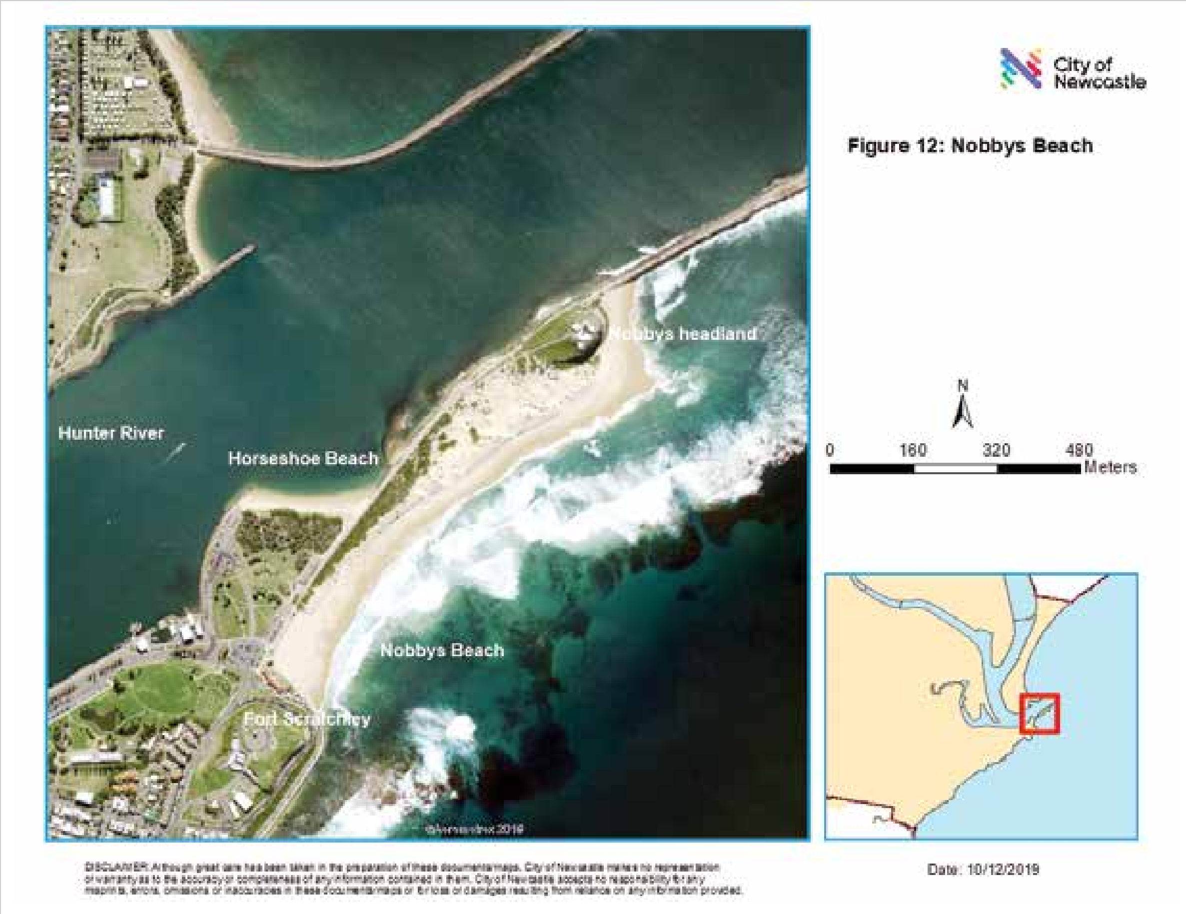


Figure 12: Nobbys Beach

Figure 13. Nobbys Beach looking north (Photograph: MManning, CN, 12/1/19)

A dune system has formed against the breakwater over the underlying bedrock. The dune system broadens out towards Nobbys headland and the beach extends around the base of the headland outcrop. The breakwater extends approximately 500m offshore from Nobbys headland. The southern end of Nobbys Beach has no dune system with seawalls and promenades constructed at the base of Fort Scratchley headland with Nobbys Beach Surf Life Saving Club located behind the constructed seawall and promenade.

At the sheltered side of the breakwater Horseshoe Beach has formed within the mouth of the Hunter River. Horseshoe Beach has formed from sand deposited in southern areas of the river entrance and navigation channel (DHI, 2006). Horseshoe Beach has formed between the breakwater and a rock groyne constructed in the Hunter River.

A significant rock platform outcrop is located to the south of Nobbys Beach (Cowrie Hole) and includes the former Soldier's Baths.

2.4.2.2 Newcastle Beach

Newcastle Beach is a pocket beach between the coastal headlands of Fort Scratchley to the north and Strzelecki headland (including King Edward Park) to the south. Newcastle Ocean Baths and pavilion have been constructed on the rock platform at the northern end of the beach. The Canoe Pool has been constructed to the south of the Newcastle Ocean Baths on the same rock platform.

Newcastle Beach has no dune system with seawalls, pavilions, Newcastle Surf Life Saving Club and a skate park constructed along the former hind dune area of the beach. The southern end of the beach is backed by a steep cliff with the Bathers Way coastal walk located along the promenade below the cliff. (See **Figures 14** and **15**).

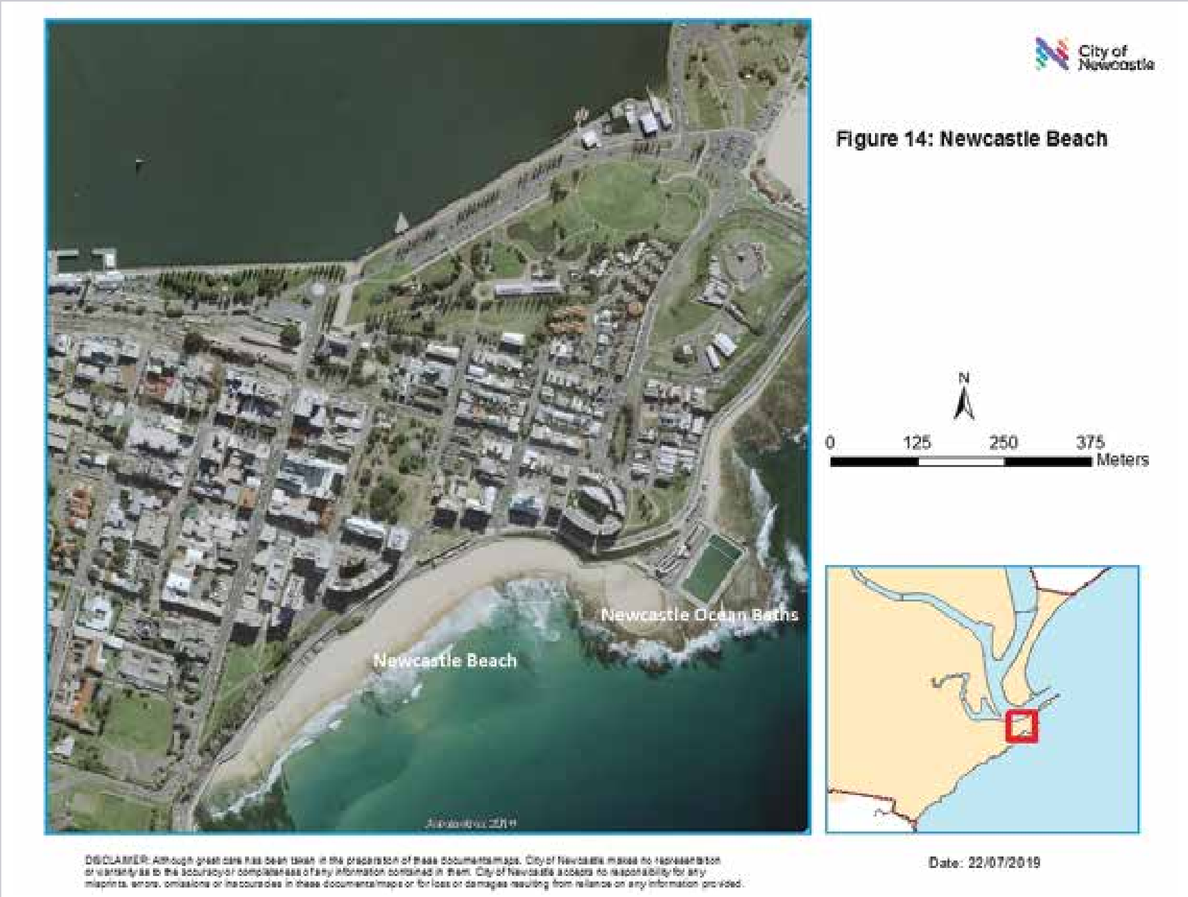


Figure 15. Newcastle Beach (Photograph: MManning, CN, 12/1/19)

2.4.2.3 Strzelecki headland

Strzelecki headland extends from the southern end of Newcastle Beach to the northern end of Bar Beach. The headland is characterised by high cliffs with a rocky platform below. King Edward Park recreation area is located on the northern part of the headland with the historic Shepherds Hill Defence Group military installations at the southern end of the park. King Edward Park contains remnant and actively managed areas of the endangered ecological community (EEC), Themeda grassland on seacliffs and coastal headlands, listed under the *Biodiversity Conservation Act 2016*. A rock platform is located below King Edward Park including the heritage listed Bogey Hole public baths/swimming area (see **Figures 16** and **17**).

The southern end of the headland includes the elevated ANZAC Memorial Walk which contains several lookouts. The elevated walkway crosses coastal heath vegetation including sections of EEC, Themeda grassland on seacliffs and coastal headlands. Fringing sand areas occur at the base of the southern end of the headland (including Susan Gilmore Beach) (**Figure 18**).

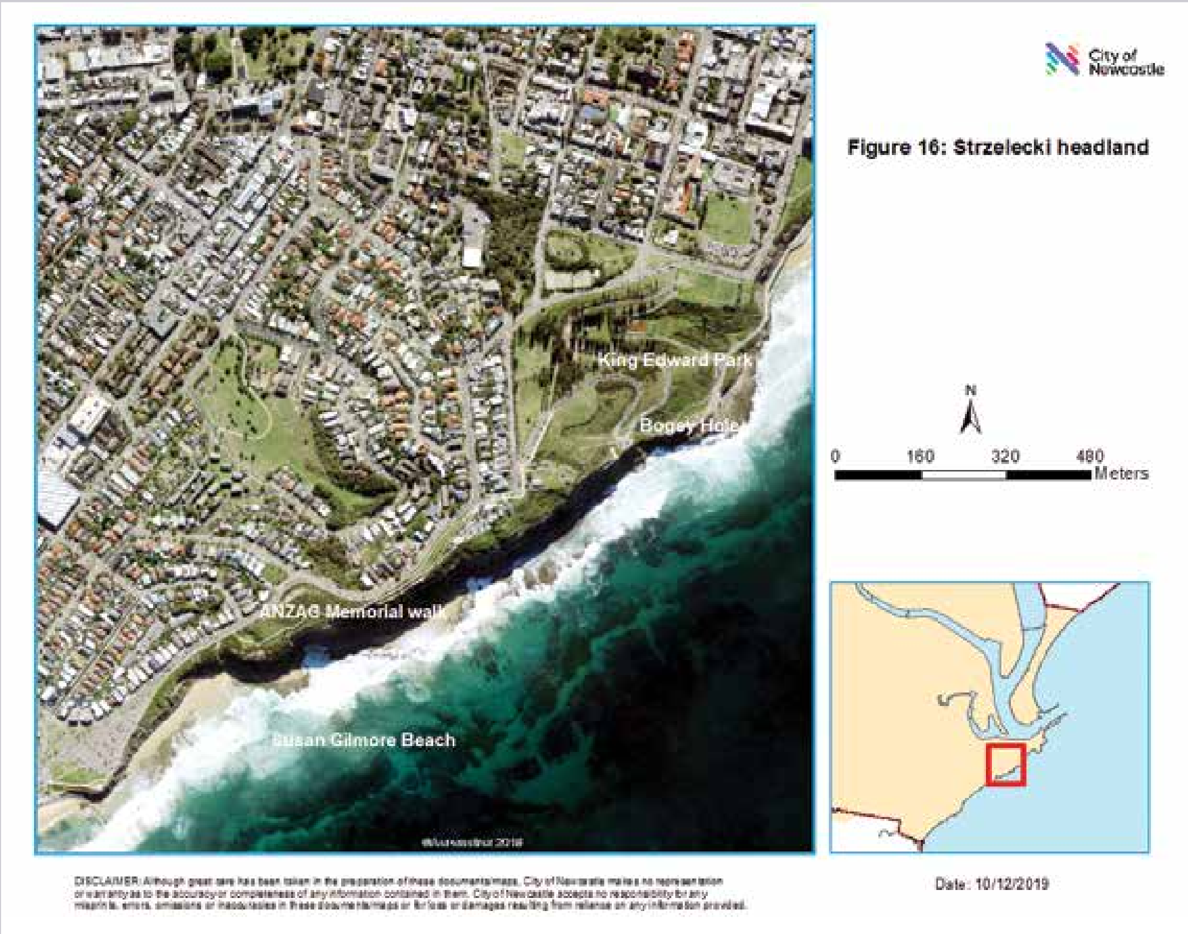


Figure 17. Northern section of Strzelecki headland including King Edward Park (Photograph: MManning, CN, 12/1/19)

Figure 18. Southern section of Strzelecki headland with Susan Gilmore Beach in foreground (Photograph: MManning, CN, 12/1/19)

2.4.2.4 Bar Beach

Bar Beach, Dixon Park and Merewether Beaches form a single beach unit between the rocky headlands of Strzelecki headland in the north and Merewether headland in the south. Bar Beach extends from the southern end of Strzelecki headland, containing Bar Beach carparking area, to the smaller hill and cliff section near Kilgour Avenue. The northern end of Bar Beach contains buildings, including Cooks Hill Surf Life Saving Club and kiosk, above a small seawall and promenade. The southern end of the beach contains a dune system with Bathers Way coastal walk and Memorial Drive elevated above the dune system. Empire Park and Bar Beach Bowling Club are located on the opposite side of Memorial Drive (See **Figures 19** and **20**).

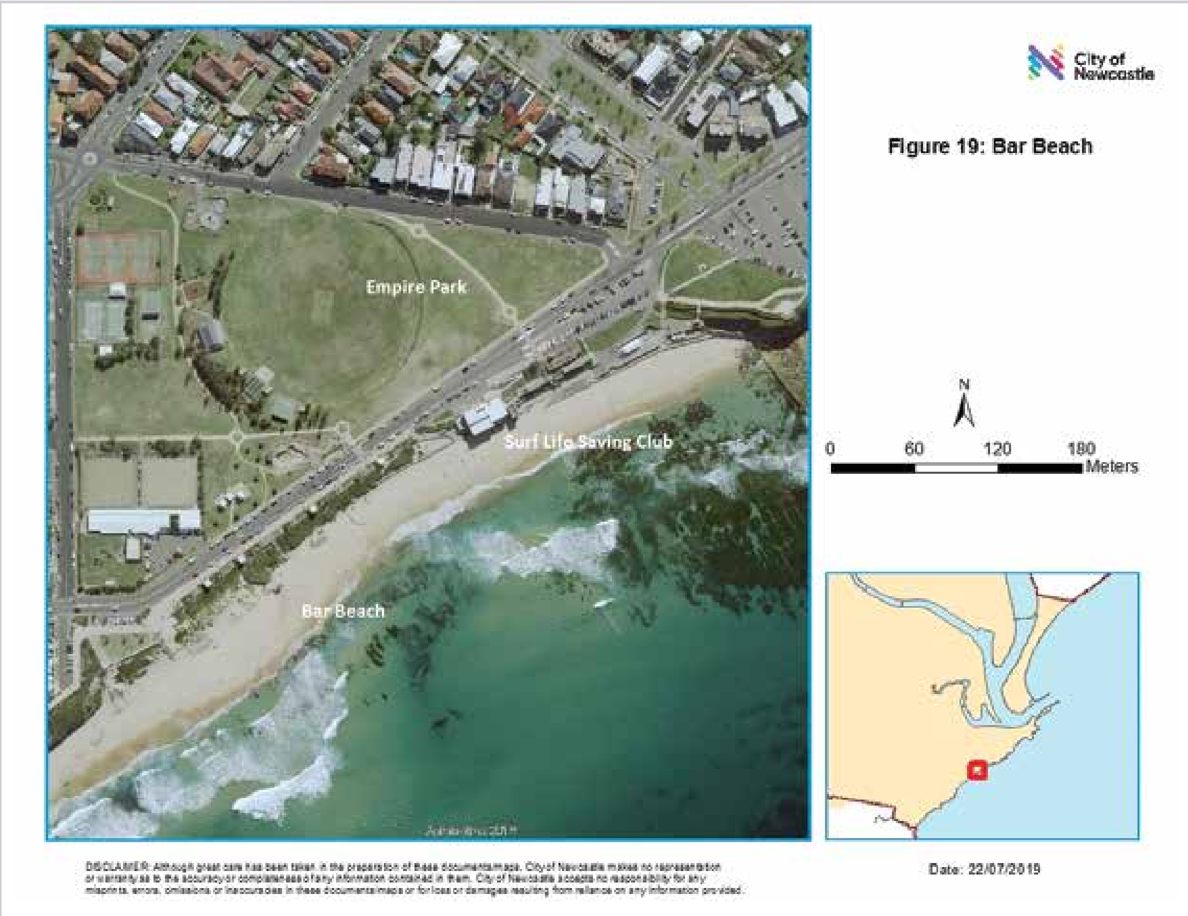


Figure 20. Bar Beach with Strzelecki headland in the background (Photograph: MManning, CN, 12/1/19)

2.4.2.5 Dixon Park Beach

Dixon Park Beach is located between the cliff section at the end of Kilgour Avenue and the intersection of Berner Street and John Parade in the south. The beach is backed by a seawall constructed in 1976 with a dune system established on top of the seawall. The Bathers Way coastal walk continues landward of the seawall with Dixon Park Surf Life Saving Club, a car parking area and a recreation area further landward (See **Figures 21** and **22**).

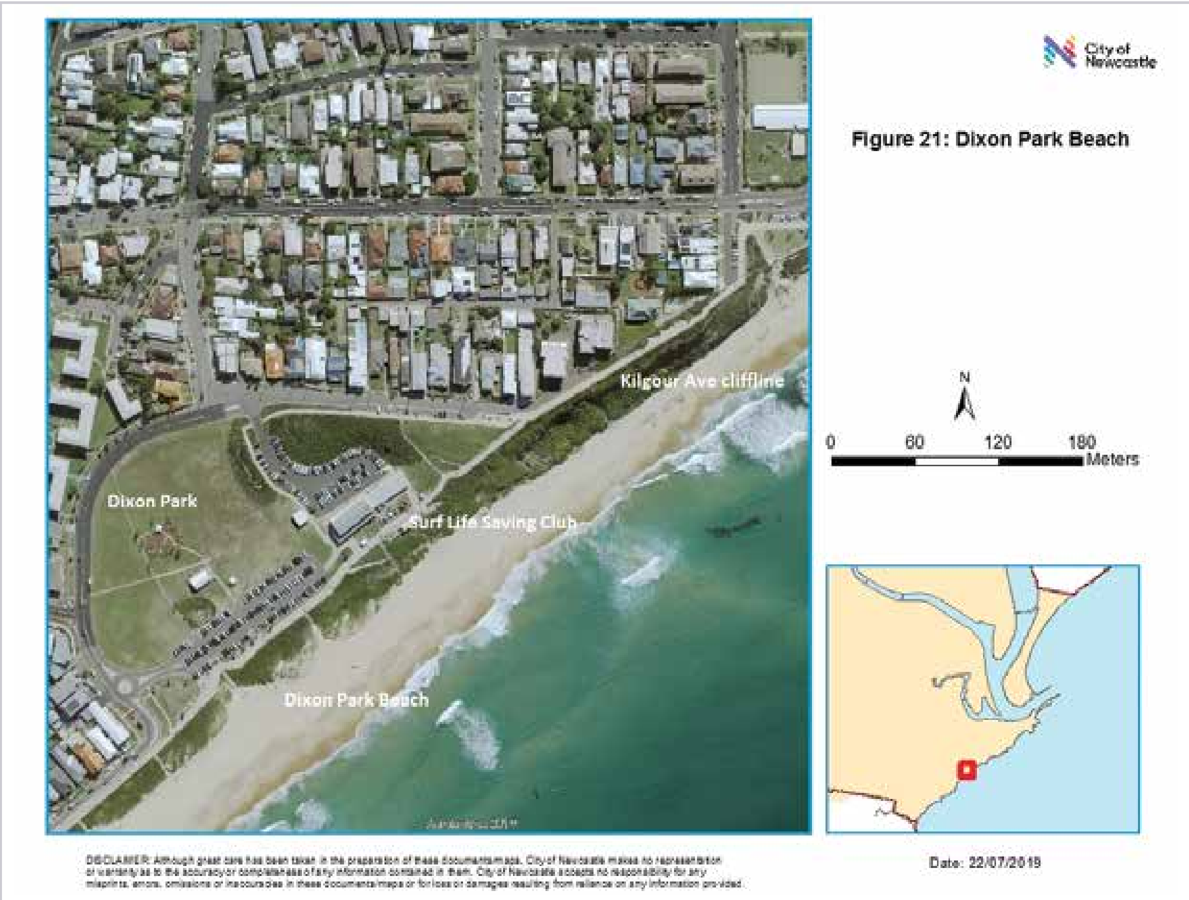


Figure 22. Dixon Park Beach with Strzelecki headland in the background (Photograph: MManning, CN, 12/1/19)

2. City of Newcastle coastal zone

2.4.2.6 Merewether Beach

The northern end of Merewether Beach adjoins Dixon Park Beach and is backed by a seawall with dune vegetation established. The Bathers Way coastal walk and John Parade are located behind the seawall with residential development further landward (See **Figures 23** and **24**).

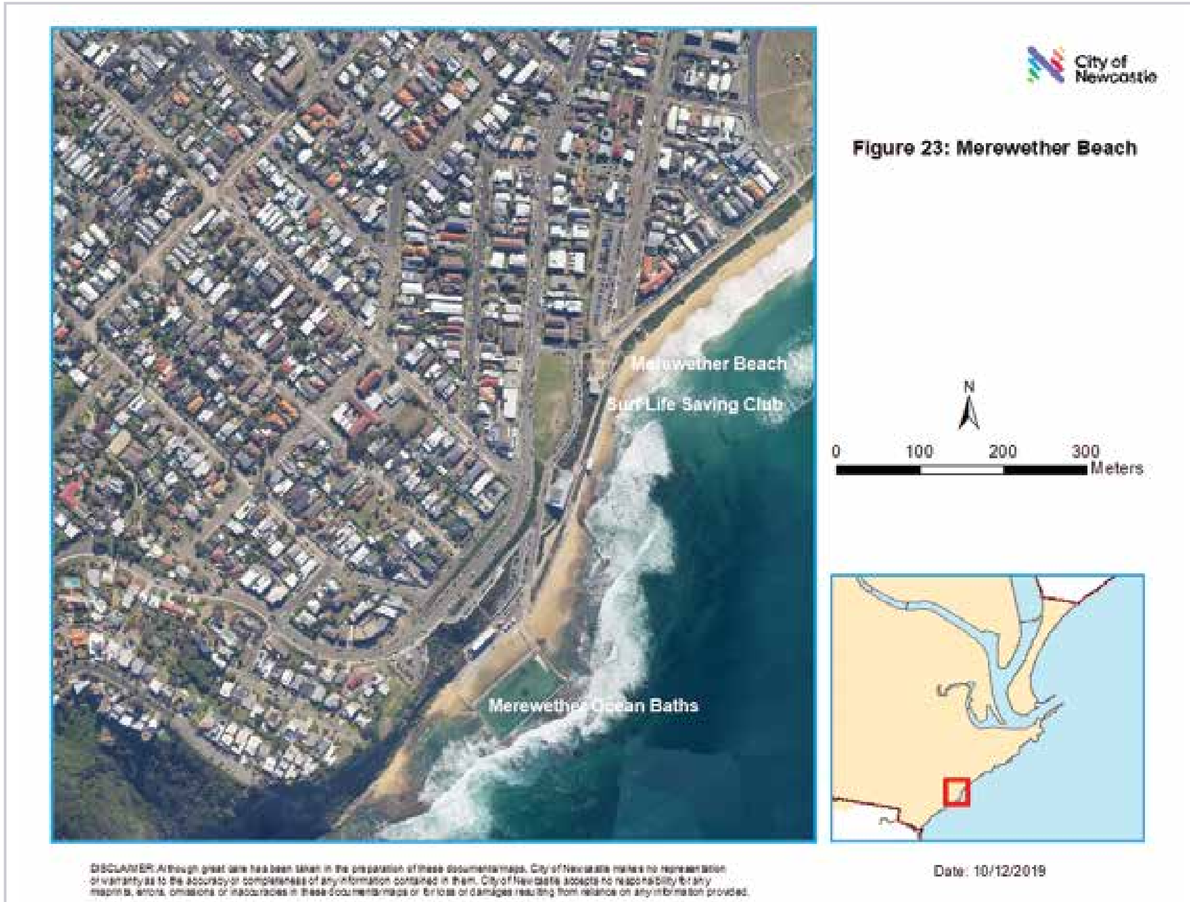


Figure 24. Northern section of Merewether Beach with Dixon Park Beach and Bar Beach further north (Photograph: MManning, CN, 12/1/19).

Figure 25. Merewether Ocean Baths at southern end of Merewether Beach. (Photograph: MManning, CN, 19/1/19).

The central area of Merewether Beach includes constructed promenades with Merewether Surf Life Saving Club and Surf House, a commercial building, located above the promenade.

The southern end of Merewether Beach is primarily bedrock with a substantial rock platform where Merewether Ocean Baths have been constructed. The Ladies Baths area has also been constructed on the rock platform. The southern end of the beach also includes a pavilion building and various carparking areas. (See **Figure 25**).

2.4.2.7 Glenrock State Conservation Area

South of Merewether headland is Glenrock State Conservation Area (SCA). The beach area is known as Burwood Beach and Glenrock Lagoon is the southern extent of the CN LGA (See **Figures 26**, **27** and **28**). Glenrock SCA is primarily undeveloped except for the HWC Wastewater Treatment Plant in the northern section of the reserve. A pipeline extends from the Wastewater Treatment Plant to an offshore discharge point.

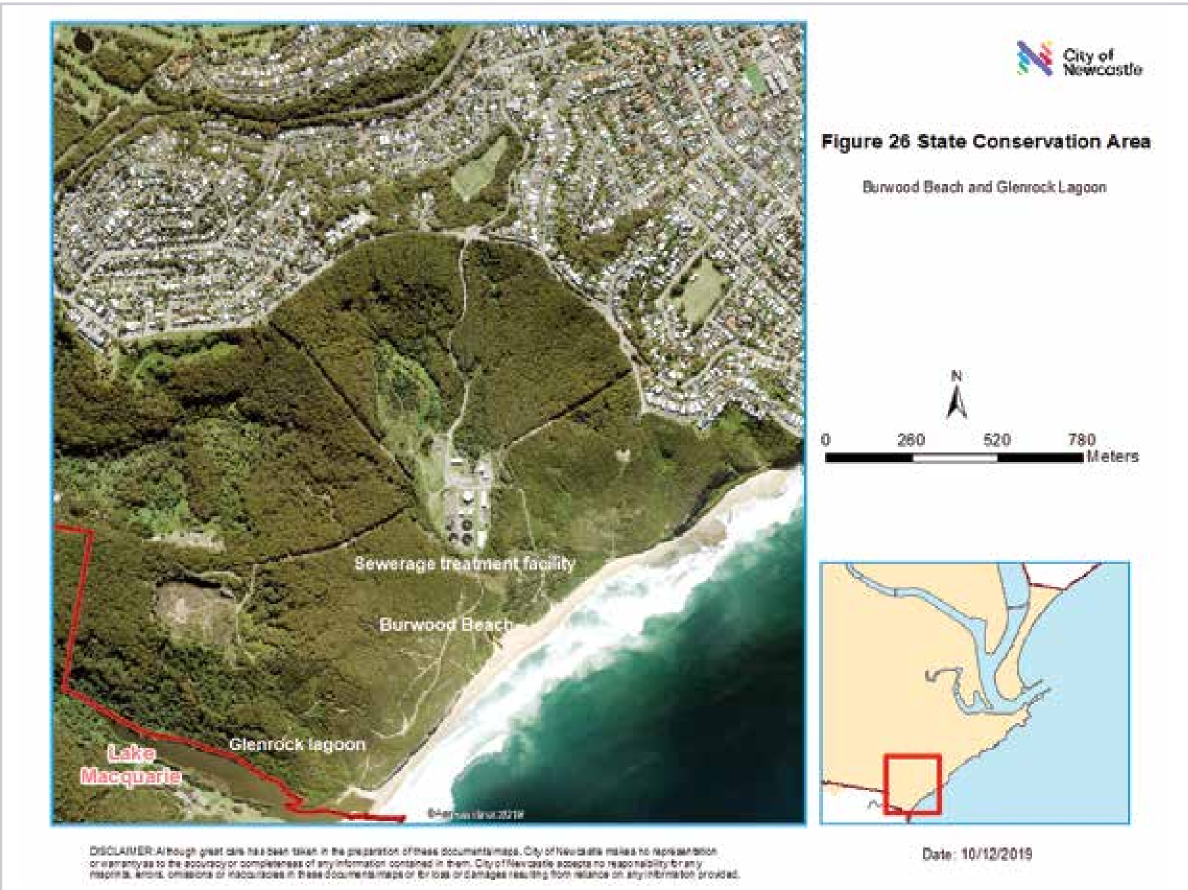


Figure 27. Northern section of Glenrock State Conservation Area (Photograph: MManning, CN, 13/1/19).

Figure 28. Glenrock Lagoon in Glenrock State Conservation Area (Photograph: MManning, CN, 13/1/19).

2.4.3 Hunter River lower estuary – East of Hannell Street bridge

The coastal zone within the lower Hunter River estuary of the scoping study area is an urban environment consisting of a mixture of residential, commercial and industrial land uses. While the Hunter River lower estuary within the scoping study area extends from the Tourle Street bridge and Stockton bridge structures to the mouth of the Hunter River the Port of Newcastle lease area under *SEPP (Three Ports) 2013* has not been included within the area as outlined in **Section 2.3**.

The Hunter River lower estuary – East of Hannell Street bridge is comprised of parts of the Hunter River and Throsby Creek adjoining the suburbs of Newcastle (including Newcastle East and West), Maryville, Wickham and Carrington. The area has been divided into the suburbs surrounding the river and creek and mapped within the coastal management areas under *SEPP (Coastal Management) 2018*.

2.4.3.1 Newcastle City Centre

Newcastle City Centre is the urban centre of CN and is located on the southern bank of the Hunter River lower estuary (**Figure 29**). A significant recreation area (Foreshore Park) is located in the eastern part of the city centre, near Nobbys Beach (**Figure 30**) while the majority of the area contains a high-density combination of commercial and residential buildings. The western part of Newcastle City Centre foreshore has undergone substantial redevelopment by the Hunter & Central Coast Development Corporation (HCCDC) as part of the Honeysuckle development project. Development within this precinct is currently continuing (**Figure 31**).

The banks of the Hunter River lower estuary are rock revetment along the length of the Newcastle City Centre foreshore. These coastal protection structures are in various ownership.

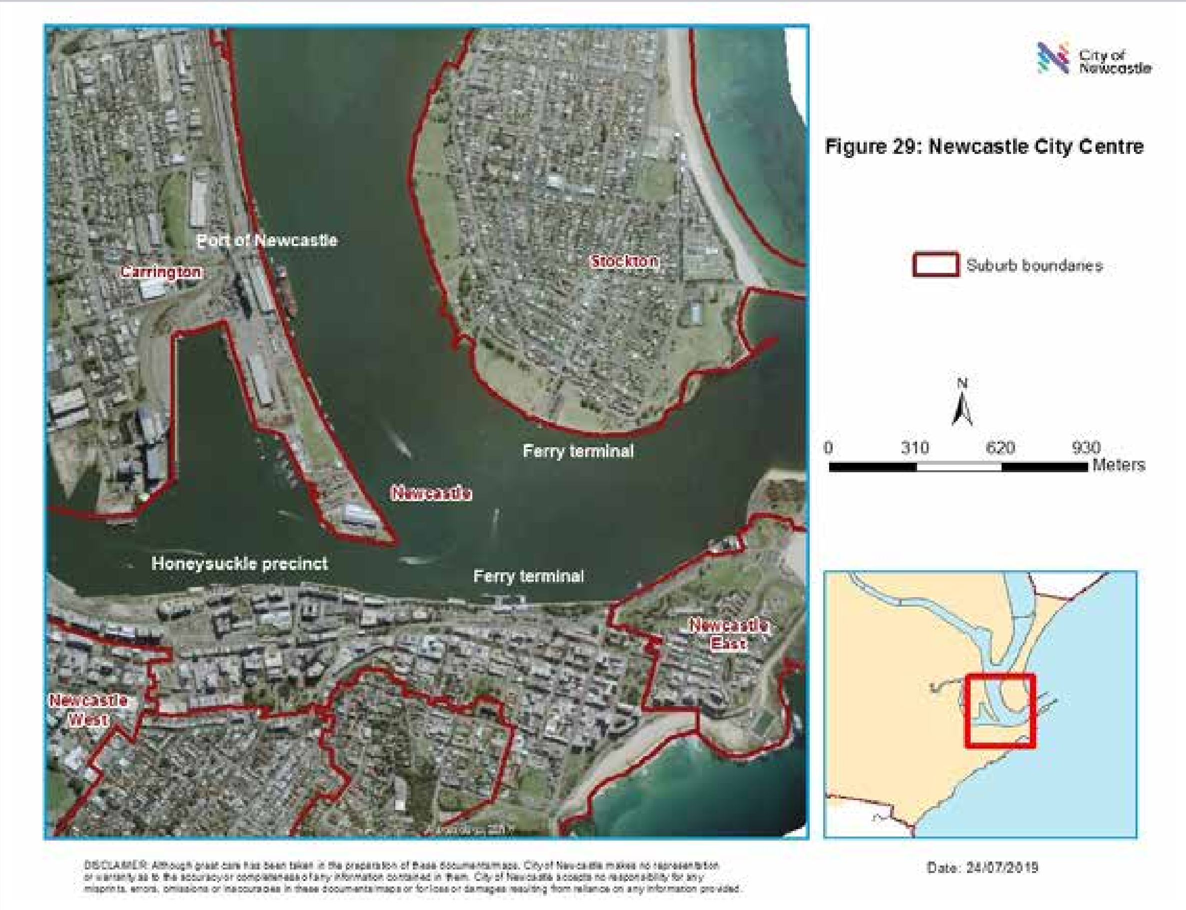


Figure 30. Foreshore Park at eastern end of Newcastle City Centre (Photograph: MManning, CN, 12/1/19).

Figure 31. Newcastle City Centre foreshore at Honeysuckle development precinct at Newcastle West (Photograph: MManning, CN, 12/1/19).

2.4.3.2 Wickham

The suburb of Wickham is located to the west and north-west of the Newcastle City Centre (**Figure 32**). A mix of contrasting larger industrial structures and smaller residential dwellings, Wickham is currently undergoing substantial redevelopment and change through the Wickham Master Plan (CN, 2017). The banks of the Hunter River lower estuary along the Wickham foreshore are rock revetment and include a marina, which was developed under the Honeysuckle development project.

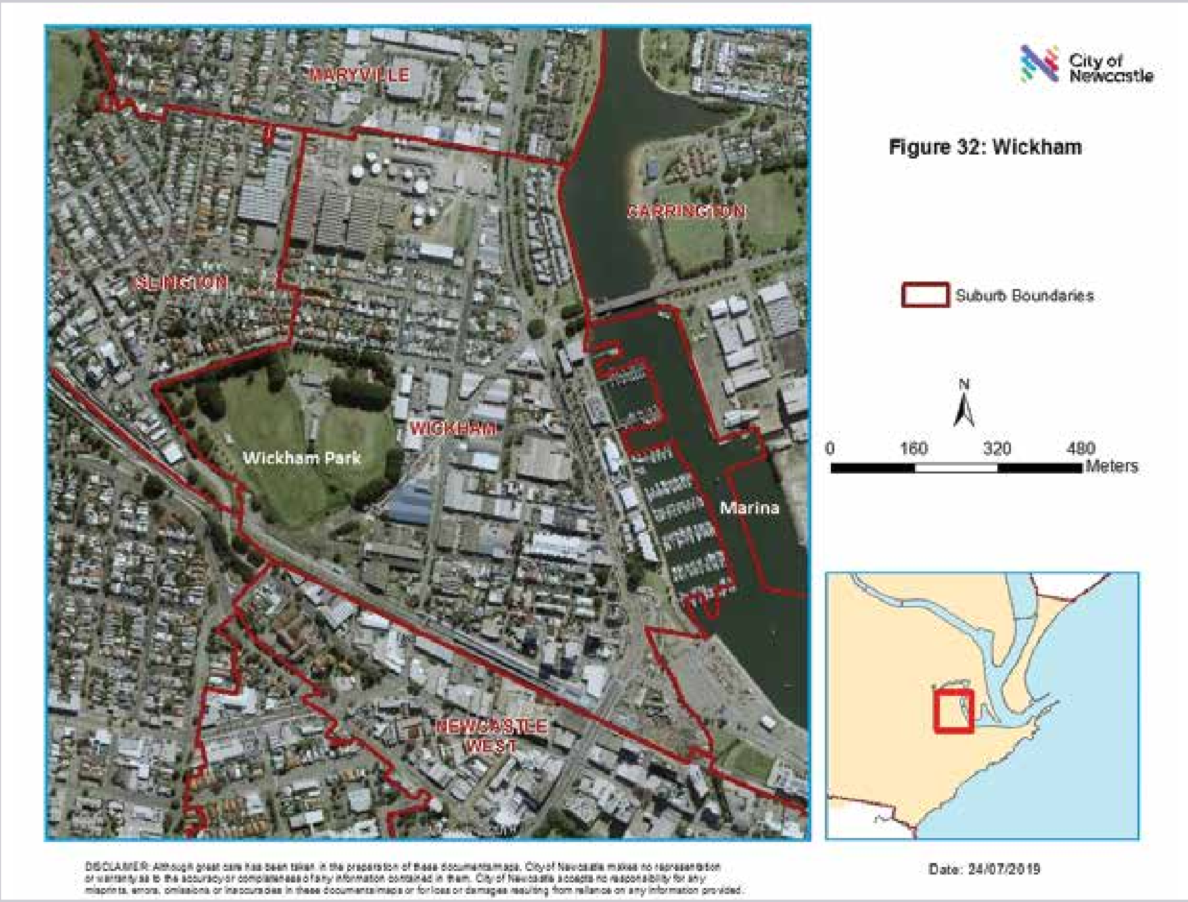


Figure 32: Wickham

2. City of Newcastle coastal zone

2.4.3.3 Maryville

The suburb of Maryville is located north of Wickham and includes large former industrial warehouses, now mainly commercial buildings, with smaller residential dwellings. Maryville has undergone some redevelopment including the Linwood precinct of the Honeysuckle development project. The Linwood precinct includes residential housing and foreshore reserve, including a shared pathway, along the western bank of Throsby Creek (see **Figure 33**). The western bank of Throsby Creek is rock revetment.

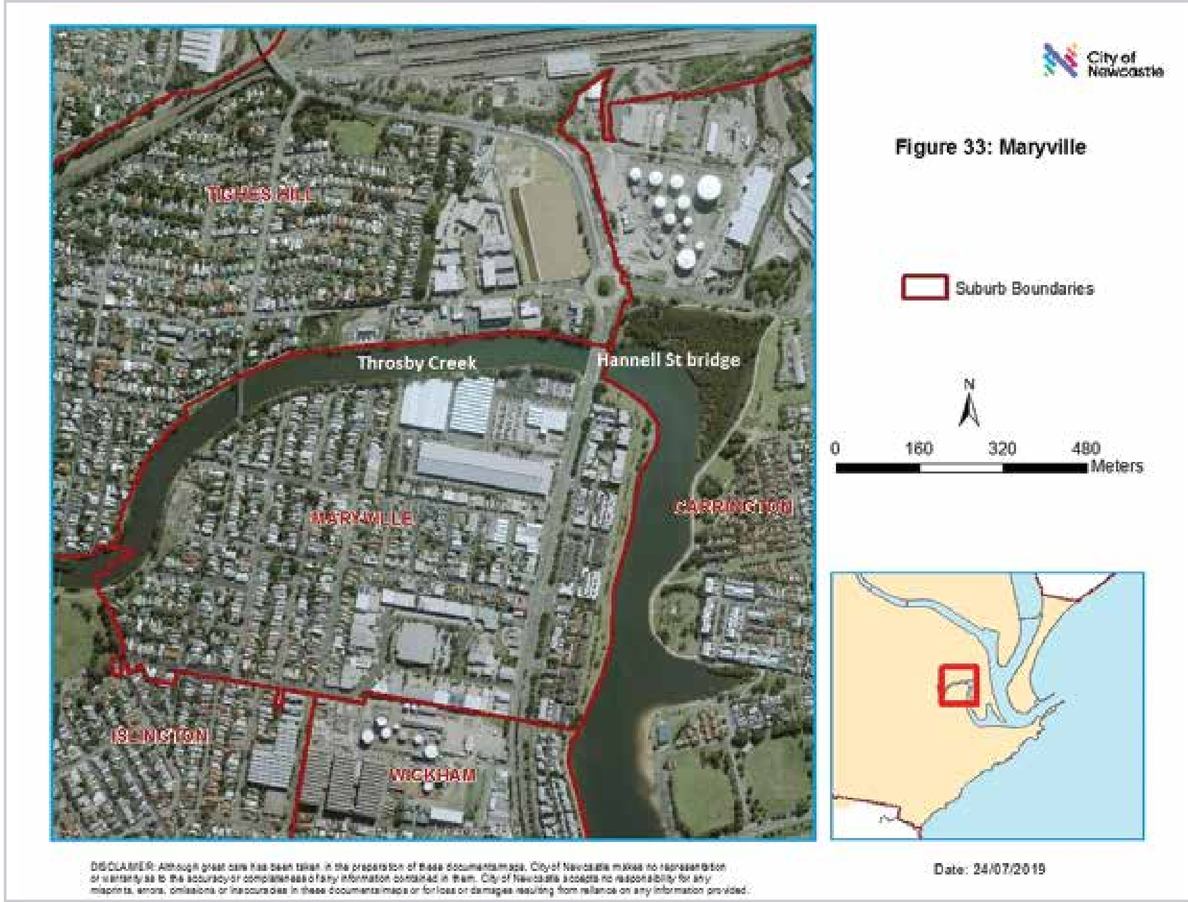


Figure 33: Maryville

2.4.3.4 Carrington

The suburb of Carrington is located on the opposite bank of Throsby Creek to Maryville (See **Figure 34**). The Port of Newcastle occupies the southern and eastern sections of Carrington, including Throsby Basin and Dyke Point. The northern section of the suburb includes various industrial operations and the Port Waratah coal loader facility. The remainder of Carrington, including the section along the eastern bank of Throsby Creek is primarily residential dwellings. The eastern banks of Throsby Creek were redeveloped in the 1990's as part of the Honeysuckle development project and include parklands and a shared pathway. The eastern bank of Throsby Creek is mainly rock revetment apart from Crown Land reserve between Arnold Street to the north and the Carrington boat ramp to the south.

2. City of Newcastle coastal zone

Figure 35. Western foreshore of Stockton with North arm of Hunter River on left. Stockton bridge is located in the background with the Port of Newcastle to west of Hunter River (Photograph: MManning, CN, 21/7/19).

2.4.3.5 Stockton – Western and southern foreshore

The western and southern foreshore of Stockton adjoin the north arm of the Hunter River (See **Figures 5**, **7**, **9**). The banks of the Hunter River at Stockton have been modified by the construction of rock revetment river walls. The northern part of the Hunter River shoreline has been colonised by grey mangrove (Avicennia marina) with other parts of the shoreline are utilised for boating infrastructure. A public recreation area, including a cycleway spans the length of the western foreshore of Stockton (See **Figure 35**).

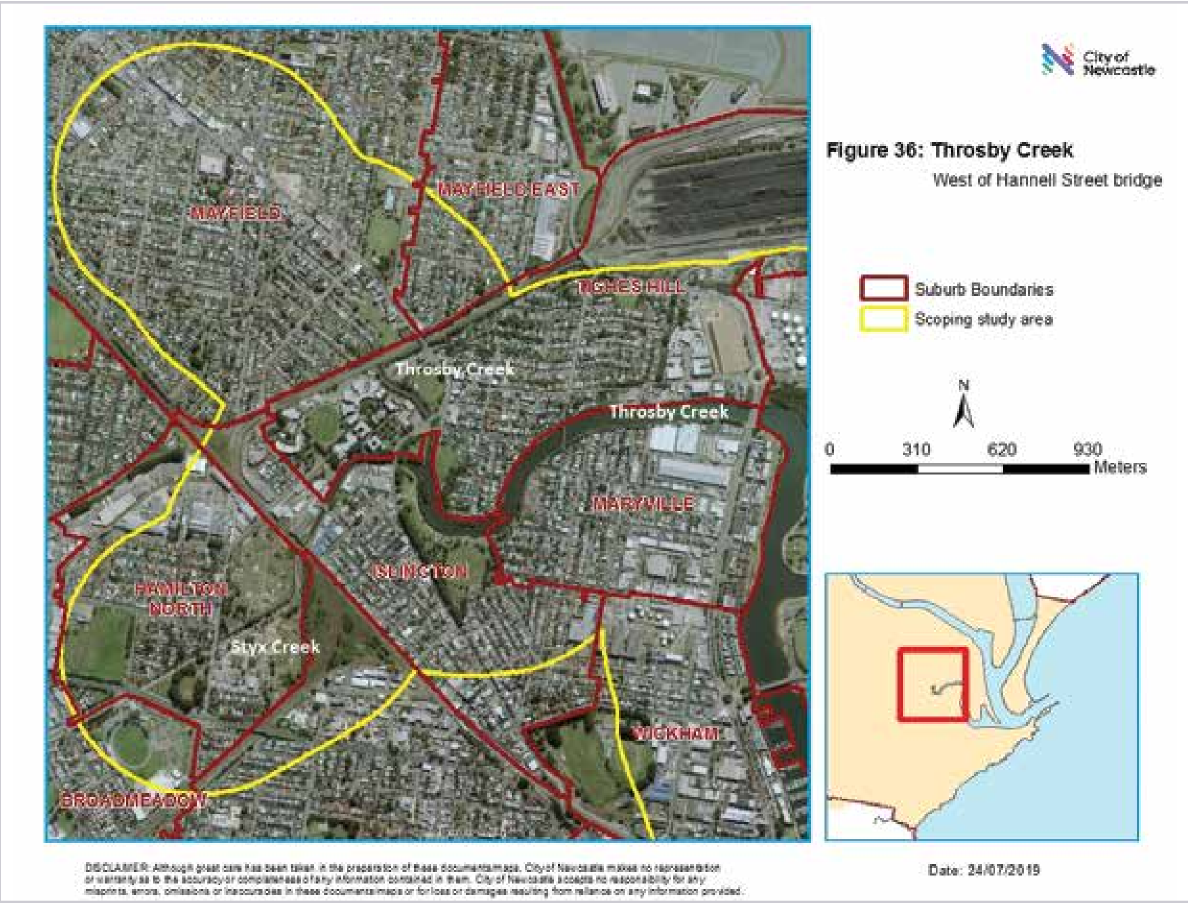
The southern foreshore of Stockton is rock revetment with a public recreation area (Griffith Park). A ferry terminal is located at the southern foreshore area (See **Figure 29**).

2.4.4 Throsby Creek catchment – West of Hannell Street bridge

The Throsby Creek catchment – West of Hannell Street bridge is a highly urbanised area consisting primarily of residential development with interspersed recreational and commercial/industrial areas (See **Figure 36**).

The Throsby Creek catchment within the coastal area can be divided into two distinct areas:

1. The tidal section between Maitland Road at Islington and the Hannell Street bridge at Maryville. This section of the catchment includes the suburb of Tighes Hill on the northern bank and the suburbs of Maryville and Islington on the south bank.
2. Large concrete channels that convey urban stormwater into the tidal section of Throsby Creek at Maitland Road, Islington. Two prominent channels are located in the coastal zone including:
   a) Concrete channel that extends west from Maitland Road through the suburbs of Islington, Hamilton North and Broadmeadow (Styx Creek); and
   b) Concrete channel that extends north/north west from Maitland Road through the suburbs of Mayfield East and Mayfield (Throsby Creek).



2. City of Newcastle coastal zone

Figure 37. Throsby Creek at Islington with Islington Park playground on left midground. (Photograph: MManning, CN, 21/7/19).

2.4.4.1 Islington

The suburb of Islington is located on the southern bank of the tidal section of Throsby Creek with Islington Park a prominent recreational feature (See **Figure 37**). The concrete stormwater channel of Styx Creek enters the tidal section of Throsby Creek from the west at Maitland Road (See **Figure 38**). Islington is predominantly a residential suburb west of Maitland Road, but Styx Creek flows through a commercial/industrial section of the suburb around Hubbard and Chinchen Street. The concrete stormwater channel of Throsby Creek, upstream of Maitland Road, enters the tidal section of Throsby Creek from the north-west at Islington Park (See **Figure 39**).

Figure 38. Styx Creek entering Throsby Creek at Maitland Road, Islington. Styx Creek is a concrete lined stormwater channel. (Photograph: MManning, CN, 21/7/19).

2.4.4.2 Hamilton North

The coastal zone follows Styx Creek to the south -west through the suburb of Hamilton North. Styx Creek is an open concrete channel surrounded by the primarily residential suburb of Hamilton North. A prominent feature in the suburb is the former gasworks facility, currently under remediation, at 1 Chatham Road, Hamilton North (See **Figures 40** and **41**).

Figure 40. Styx Creek (stormwater channel) looking west to Broadmeadow from Chatham Road, Hamilton North. (Photograph: MManning, CN, 21/7/19).

Figure 39. Throsby Creek (stormwater channel) entering tidal section of Throsby Creek near Maitland Road, Islington. (Photograph: MManning, CN, 21/7/19).

Figure 41. Styx Creek (stormwater channel) looking east from Chatham Road, Hamilton North. Forme gasworks remediation site is to right of photograph. (Photograph: MManning, CN, 21/7/19).

2. City of Newcastle coastal zone

2.4.4.3 Broadmeadow

The coastal zone follows Styx Creek to the south-west into the suburb of Broadmeadow. The concrete channel within the coastal zone extends through the suburb with residential properties bordering the channel. Other facilities such as Newcastle Showground (1A Curley Road, Broadmeadow) and sporting fields also border the channel.

2.4.4.4 Tighes Hill

The suburb of Tighes Hill is located on the northern bank of the tidal section of Throsby Creek. Predominantly a residential suburb, Tighes Hill also includes a commercial/industrial estate bordering Throsby Creek at the eastern end of the suburb (along Elizbeth Street and Revelation Close) (see **Figure 42**). An educational facility (Tighes Hill TAFE) is located at the western side of the suburb at Maitland Road.

2.4.4.5 Mayfield East

Mayfield East is located to the north-west of Tighes Hill and to the north of the concrete stormwater channel (Throsby Creek) that extends from Islington Park. Mayfield East is primarily a residential suburb.

2.4.4.6 Mayfield

The concrete channel (Throsby Creek) extends north-west through Mayfield passing through a residential area (see **Figure 43**). A commercial centre along Maitland Road is located north of the stormwater channel.

Figure 42. Throsby Creek tidal section looking east. Tighes Hill commercial buildings at Elizbeth Street in background of photograph (Photograph: MManning, CN, 21/7/19).

Figure 43. Throsby Creek (stormwater channel) looking east from Nile Street, Mayfield. (Photograph: MManning, CN, 21/7/19).

3. Strategic Context

The strategic directions of the NSW State Government are outlined in the Premier's Priorities for New South Wales. An overarching strategy for the management of the NSW coastal zone is not specifically identified within the Premier's Priorities, but the objectives of the recently commenced *Coastal Management Act 2016* identifies the coastal environment is to be appropriately managed and protected in response to various pressures such as development and climate change.

The *Coastal Management Act 2016* provides the statutory framework for coastal zone management in NSW and includes the requirement for the preparation of Coastal Management Programs (CMP).

3.1 Legislative planning

While the *Coastal Management Act 2016* initiates the preparation of a CMP, local councils must also consider legislative planning documents to enable a holistic management approach to the coastal zone. These planning documents are broadly completed under two separate legislative acts:

- *Environmental Planning and Assessment Act 1979*, and
- *Local Government Act 1993.*

3.1.1 Environmental Planning and Assessment Act 1979

Hunter Regional Plan 2036

Strategic planning under the *Environmental Planning and Assessment Act 1979* provides guidance to land use planning priorities regarding environmental, economic and social matters. The Hunter Regional Plan 2036 (DPE, 2016) contains land use priorities for the region, including within the CN LGA and the coastal zone, and provides four key goals:

1. The leading regional economy in Australia;
2. A biodiversity-rich natural environment;
3. Thriving communities; and
4. Greater housing choice and jobs.

The Hunter Regional Plan 2036 (DPE, 2016) incorporates strategic directions for each key goal with actions outlined for each direction. **Appendix A** provides an overview of the relevant goals, directions and actions within the Hunter Regional Plan 2036 (DPE, 2016) that relate to coastal zone management within the CN LGA.

Key elements of the Hunter Regional Plan 2036 (DPE, 2016) in relation to the coastal zone study area are the identification of Newcastle City Centre as a strategic centre within the region and the nomination of the Port of Newcastle as a Global Gateway, a transport or traveller hub. The Hunter Regional Plan 2036 (DPE, 2016) aims to promote the growth of Newcastle City Centre while generating diversification and expansion of the operations of Port of Newcastle. The Hunter Regional Plan 2036 (DPE, 2016) also identifies increasing growth in tourism within the region due to local coastal attractions and highlights the need for community preparedness regarding coastal hazards and climate change impacts.

The Hunter Regional Plan 2036 (DPE, 2016) contains local government narratives and the CN LGA is projected to have a population increase of 33,000 people by 2036 with an additional 16,800 dwellings and 17,964 jobs.

Greater Newcastle Metropolitan Plan 2036

Action 1.1 of the Hunter Regional Plan 2036 (DPE, 2016) required the preparation of a Greater Newcastle Metropolitan Plan, which was completed on the 17 September 2018. The Greater Newcastle Metropolitan Plan 2036 (DPE, 2018) outlines four focused outcomes for the metropolitan area:

1. Create a workforce skilled and ready for the new economy.
2. Enhance environment, amenity and resilience for quality of life.
3. Deliver housing close to jobs and services.
4. Improve connections to jobs, services and recreation.

Each outcome has underpinning strategies and actions and **Appendix B** provides an overview of the relevant outcomes, strategies and actions within the Greater Newcastle Metropolitan Plan 2036 (DPE, 2018) that relate to coastal zone management within the CN LGA.

Key areas of the Greater Newcastle Metropolitan Plan 2036 (DPE, 2036) include revitalisation of the Newcastle City Centre with expanding transformation along waterfront areas, increased expansion and trading capabilities of the Port of Newcastle and improving resilience to natural hazards, such as coastal processes.

The Greater Newcastle Metropolitan Plan 2036 (DPE, 2016) introduces eleven catalyst areas or dedicated zones for increased population, housing and employment growth. The CN LGA includes seven of the catalyst areas within the Greater Newcastle Metropolitan Plan 2036 (DPE, 2018) with two (Newcastle City Centre and Newcastle Port) contained within the scoping study area. These two catalysts areas will result in an additional 8,300 jobs and 4,000 dwellings within the scoping study area and account for 23.8% of the housing growth and 46.2% of the employment growth within the CN LGA, based on the projected growth figures from the Hunter Regional Plan 2036 (DPE, 2016).

Local Planning Strategy

The Local Planning Strategy (NCC, 2015) is a complementary document to the Hunter Regional Plan 2036 (DPE, 2016) and the Greater Newcastle Metropolitan Plan 2036 (DPE, 2018). The Local Planning Strategy (NCC, 2015) provides strategic land use information and direction for future planning within the CN LGA. The strategic direction within the Local Planning Strategy (NCC, 2015) informs amendments to the *Newcastle Local Environment Plan (LEP) 2012*.

The *Environmental Planning and Assessment Act 1979* has recently undergone significant reform and strategic plans, such as the Hunter Regional Plan 2036 (DPE, 2016) and Greater Newcastle Metropolitan Plan 2036 (DPE, 2018), are required to be supported by a Local Strategic Planning Statement (LSPS) by each local council. CN is required to have an LSPS in place by July 2020 under the new reforms. The LSPS may replace the Local Planning Strategy (NCC, 2015).

Environment Planning Instruments

Environmental Planning Instruments (EPI) are used to manage the relationship between development and the environment, reserve land for specific purposes, control specific activities and apply development standards. The principal EPI in the CN LGA is the *Newcastle LEP 2012*. However, site specific EPIs relating to the coastal zone within the scoping study area include:

- *SEPP (Three Ports) 2013* which applies to the mapped lease area (see **Figure 4**) within the Port of Newcastle, and
- *SEPP Infrastructure 2007* facilitates many infrastructure projects within the CN LGA and coastal zone including projects within Newcastle City Centre guided by the Newcastle Urban Renewal Strategy (DPE, 2014).

3.1.2 Local Government Act 1993

The *Local Government Act 1993* grants local councils the power to provide goods, services, facilities and to carry out activities appropriate to the current and future needs of the local community and the wider public. The functions of local councils involve the management of the environment within the LGA, including natural hazards such as coastal processes. These functions are to be performed in a manner that is consistent with the principles of ecologically sustainable development and are outlined in Section 8 of the *Local Government Act 1993*.

Newcastle Community Strategic Plan 2030

Section 402 of the *Local Government Act 1993* requires local councils to develop and adopt a community strategic plan that outlines the main priorities and planning for the LGA for the following ten years. The Newcastle 2030 Community Strategic Plan (NCC, 2018(a)) was adopted by Council on 26 June 2018 and includes seven strategic directions for the future of Newcastle LGA. While all seven strategic directions have relevance to coastal zone management three directions are particularly pertinent and guide CN's coastal planning and management documents.

These three strategic directions from the Newcastle 2030 Community Strategic Plan (NCC, 2018(a)) are:

- protected environment;
- vibrant, safe and active public places; and
- liveable built environment.

Strategic direction: Protected environment

The protected environment strategic direction is supported by the Newcastle Environmental Management Strategy 2013 (NCC, 2013), which outlines three objectives:

1. Greater efficiency in the use of resources.
2. Our unique environment is maintained, enhanced and connected.
3. Environment and climate change risks and impacts are understood and managed.

The Newcastle Environmental Management Strategy 2013 (NCC, 2013) provides strategies to support the objectives outlined above. The Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) has been recently certified by the NSW State Government under the *Coastal Protection Act 1979* and provides a key planning document for management of the coastal zone in the CN LGA.

Strategic direction: Vibrant, safe and active public places

The vibrant, safe and active public places strategic direction is supported by the Parkland and Recreation Strategy (NCC, 2014) which includes four strategic directions:

1. Equitable provision and development of facilities.
2. Efficient management of facilities.
3. Partnership development.
4. Promotion of facilities and opportunities.

The Parkland and Recreation Strategy (NCC, 2014) provides an action plan to deliver each of the four strategic directions. A key planning document for the coastal zone as part of the vibrant, safe and active public places strategic direction is the Newcastle Coastal Revitalisation Strategy Master Plan (Urbis, 2010).

Strategic direction: Liveable built environment

The liveable built environment strategic direction is supported by the Local Planning Strategy (CN, 2015), which in turn informs the *Newcastle LEP 2012* (see **Section 3.2**). Heritage management within the coastal zone is supported by the Heritage Strategy 2013-2017 (CN, 2014).

3.2 Legal

3.2.1 Legislation and policy

The key legislation and policies relevant to the development of a CMP are summarised below.

Coastal Management Act 2016

The *Coastal Management Act 2016* sets out the objectives for coastal zone management in NSW. The objects of the *Coastal Management Act 2016* include:

(a) to protect and enhance natural coastal processes and coastal environmental values including natural character, scenic value, biological diversity and ecosystem integrity and resilience, and
(b) to support the social and cultural values of the coastal zone and maintain public access, amenity, use and safety, and
(c) to acknowledge Aboriginal peoples' spiritual, social, customary and economic use of the coastal zone, and
(d) to recognise the coastal zone as a vital economic zone and to support sustainable coastal economies, and
(e) to facilitate ecologically sustainable development in the coastal zone and promote sustainable land use planning decision-making, and
(f) to mitigate current and future risks from coastal hazards, taking into account the effects of climate change, and
(g) to recognise that the local and regional scale effects of coastal processes, and the inherently ambulatory and dynamic nature of the shoreline, may result in the loss of coastal land to the sea (including estuaries and other arms of the sea), and to manage coastal use and development accordingly, and
(h) to promote integrated and co-ordinated coastal planning, management and reporting, and
(i) to encourage and promote plans and strategies to improve the resilience of coastal assets to the impacts of an uncertain climate future including impacts of extreme storm events, and
(j) to ensure co-ordination of the policies and activities of government and public authorities relating to the coastal zone and to facilitate the proper integration of their management activities, and
(k) to support public participation in coastal management and planning and greater public awareness, education and understanding of coastal processes and management actions, and
(l) to facilitate the identification of land in the coastal zone for acquisition by public or local authorities in order to promote the protection, enhancement, maintenance and restoration of the environment of the coastal zone, and
(m) to support the objects of the *Marine Estate Management Act 2014*.

The *Coastal Management Act 2016* establishes the NSW Coastal Council, provides a framework for the NSW Coastal Management Manual (OEH, 2018) and requires local councils to prepare a CMP in accordance with the manual. The *Coastal Management Act 2016* repealed the *Coastal Protection Act 1979* and requires the transition from the former coastal zone management plans to a CMP.

Local Government Act 1993

Chapter 3 of the *Local Government Act 1993* outlines the principles and functions of local councils. The general principles of local councils include:

(a) Councils should provide strong and effective representation, leadership, planning and decision-making.
(b) Councils should carry out functions in a way that provides the best possible value for residents and ratepayers.
(c) Councils should plan strategically, using the integrated planning and reporting framework, for the provision of effective and efficient services and regulation to meet the diverse needs of the local community.
(d) Councils should apply the integrated planning and reporting framework in carrying out their functions as to achieve desired outcomes and continuous improvements.
(e) Councils should work co-operatively with other councils and the State government to achieve desired outcomes for the local community.
(f) Councils should manage lands and other assets so that current and future local community needs can be met in an affordable way.
(g) Councils should work with others to secure appropriate services for local community needs.
(h) Councils should act fairly, ethically and without bias in the interests of the local community.
(i) Councils should be responsible employers and provide a consultative and supportive working environment for staff.

Chapter 6 of the *Local Government Act 1993* outlines the classification, use and management of public land owned by councils. Plans of management are required for the use and ongoing management of community land, which is categorised into various groups including natural areas, sportsgrounds, parks, cultural significance and general community use.

Environmental Planning and Assessment Act 1979

The *Environmental and Assessment Planning Act 1979* is the key legislative act for planning and land use. The *Environmental Planning and Assessment Act 1979* provides a framework for developing EPIs to regulate competing land uses. Environmental planning instruments are separated into two types:

1. State Environmental Planning Policies.
2. Local Environmental Plans.

The *Environmental Planning and Assessment Act 1979* provides a framework for assessment of development proposals. This framework is outlined in Part 4 of the *Environmental Planning and Assessment Act 1979*, including development that needs consent, development permitted without consent (including exempt development) and complying development.

Part 5 of the *Environmental Planning and Assessment Act 1979* relates to infrastructure development and the activity assessment required for these projects.

State Environmental Planning Policies

Table 1 provides a list of SEPPs that are relevant to coastal zone management in the CN LGA.

Table 1: Relevant State Environmental Planning Policies within the coastal zone.

State Environmental Planning Policy (SEPP)	Aims
SEPP (Coastal Management) 2018	a) Manage development in the coastal zone and protect environmental assets. b) Establish a framework for land use planning in the coastal zone. c) Establish and map 4 coastal management areas.
SEPP (Exempt and Complying Development Codes) 2008	a) Provide codes for exempt and complying development. b) Identify types of development with minimal environmental impact that do not require development consent (exempt development). c) Identify types of complying development that may be carried out with a complying development certificate.
SEPP (Infrastructure) 2008	a) Provide efficiency through consistent planning regime for infrastructure and provision of services. b) Provide flexibility in location of infrastructure and service facilities. c) Efficient development, redevelopment or disposal of surplus government owned land. d) Identify environmental assessment categories for different types of infrastructure and services. e) Identify matters to be considered in the assessment of development adjacent to particular types of infrastructure development. f) Provide consultation for relevant public authorities about certain development during the assessment process or prior to development commencing. g) Provide opportunities for infrastructure to demonstrate good design outcomes.
SEPP (State and Regional Development) 2011	a) Identify State significant development. b) Identify State significant infrastructure and critical significant infrastructure. c) Identify regionally significant development.
SEPP (Three Ports) 2013	a) Provide a consistent planning regime for development and delivery of infrastructure at the Port of Newcastle. b) Allow the efficient development, re-development and protection of land at Port of Newcastle for port purposes. c) Identify certain development in lease area as exempt of complying development. d) Specify matters to be considered in determining whether to grant consent to development adjacent to development for port purposes. e) Identify certain development as State significant development of State significant infrastructure. f) Ensure land around the lease area is maintained for port-related and industrial uses.
SEPP 55 – Remediation of Land	a) Provide a consistent planning approach to the remediation of contaminated land. b) Promote the remediation of contaminated land for the purpose of reducing the risk of harm to human health or any other aspect of the environment.
SEPP (Vegetation in Non-Rural Areas) 2017	a) To protect the biodiversity values of trees and other vegetation in non-rural areas. b) To preserve the amenity of non-rural areas of the State through the preservation of trees and other vegetation.

Local Environmental Plan

The *Newcastle LEP 2012* was gazetted in June 2012. The Newcastle LEP sets out the zones that are applied to land in the CN LGA and the objectives and permitted development within each zone.

Development that requires consent under the *Newcastle LEP 2012* are generally assessed under Part 4 of the *Environmental Planning and Assessment Act 1979*. Development under Part 4 is generally assessed against guidance standards or requirements outlined in development control plans (DCP). CN has adopted the Newcastle DCP 2012 which contains various land use, environmental protection, risk minimisation and locality specific development provisions. **Table 2** provides a list of relevant sections of the Newcastle DCP 2012 that apply to management of the coastal zone.

Table 2: Relevant sections of the Newcastle Development Control Plan 2012 that relate to management of the coastal zone.

Section of Newcastle Development Control Plan (DCP) 2012	Aims and objectives
Section 3.01 Subdivision	a) Requirements in relation to standards for subdivision design and construction. b) Minimise adverse impacts on natural and built environment. c) Ensure subdivision have appropriate levels of amenity, services and access. d) Achieve efficient use of land.
Section 3.02 Single dwellings and Ancillary Development	a) Encourage development that complements and enhances the built environment and existing amenity. b) Ensure efficient use of land for residential purposes. c) Encourage innovation and diversification in site layout and building design. d) Ensure dwellings are generally compatible with the scale and bulk of desired residential character. e) Ensure new development is designed to take advantage of positive attributes of the site. f) Retain existing landscaping where possible.
Section 3.03 Residential Development	a) Efficient use of land for residential purposes. b) Encourage increased residential development in areas in proximity to services and transport. c) Encourage innovation and diversification in the type and size of residential development. d) Ensure development respects the amenity and character of surrounding development. e) Ensure new development is compatible with the scale and desired residential character.
Section 3.09 Tourist and Visitor Accommodation	a) Encourage tourist and visitor accommodation where permissible and ensure that tourist and visitor accommodation have minimal effect on surrounding development and the environment.
Section 3.10 Commercial Uses	a) Enhance the economic viability of commercial centres. b) Encourage commercial development that has a positive contribution to surrounding development. c) Establish the scale, dimensions and form of development appropriate for the context of the area.
Section 3.11 Community Services	a) To maintain the streetscape, amenity and character of areas surrounding community services. b) Ensure community services are accessible, convenient and appropriately located. c) Encourage social connections, community participation and promote health and wellbeing.

Table 2: Relevant sections of the Newcastle Development Control Plan 2012 that relate to management of the coastal zone.

Section of Newcastle Development Control Plan (DCP) 2012	Aims and objectives
Section 3.13 Industrial Development	a) Outline requirements for development within industrial, business development zones. b) Promote the efficient and economic use of the city's industrial resources ensuring that development proposed is appropriate. c) Outline Council's requirements for development on sites that are zoned SP1 under *SEPP (Three Ports) 2013* and are located outside of the lease area.
Section 4.01 Flood Management	a) Guide the development of flood prone land, applying balanced strategies to economically, socially and environmentally manage risk to life and property. b) Set aside appropriate areas to convey and/or store flood waters. c) Ensure development, when considered both individually and as an instance of cumulative development trends, will not cause unreasonable adverse flooding impacts in other locations. d) Implement the principles of the NSW Government Floodplain Development Manual to new development as applicable.
Section 4.02 Bush Fire Protection	a) Ensure the statutory requirements of the *Rural Fire Service Act 1997* are considered in development assessment. b) Ensure risks associated with bush fire are appropriately and effectively managed. c) Ensure bush fire risk is managed in connection with the preservation of the ecological values of the site and adjoining lands.
Section 5.01 Soil Management	a) Prevent export of sediment from sites during construction. b) Prevent litter, sediment, nutrients and soils from entering waterways. c) Minimise potential for landslip on sloping sites.
Section 5.02 Land Contamination	a) Ensure the likelihood of land contamination is considered early in the planning and development process. b) Ensure planning and development decisions consider available information relating to the likelihood of land contamination. c) Ensure development of contaminated land will not result in unacceptable levels of risk to human health or the environment. d) Ensure site investigations and remediation work are carried out in a satisfactory manner.
Section 5.03 Vegetation management	a) To identify declared vegetation under *SEPP (Vegetation in Non-Rural Areas) 2017*. b) To achieve the objectives of the Newcastle Urban Forest Policy for development on private land. c) To ensure existing vegetation on a development site and surrounding sites is considered in the design of the development. d) To ensure that tree canopy cover is considered in the design of development. e) To promote the retention of existing vegetation and provide opportunities for appropriate tree growth. f) To provide guidelines for the management of trees.
Section 5.04 Aboriginal Heritage	a) Provide guidance about appropriate investigations and assessment required to determine the likely impacts of a development on Aboriginal cultural heritage. b) Encourage a precautionary approach to Aboriginal cultural heritage that supports conservation of Aboriginal heritage and places of significance to Aboriginal people.
Section 5.05 Heritage Items	a) Provide controls based on best practice that support adaptation, alteration and modification of structures and buildings that are listed as heritage items. b) Ensure development has a positive effect on the heritage significance of heritage items. c) Support development activity that is commensurate with the heritage significance of heritage items. d) Maximise the adaptive re-use of heritage items.

3. Strategic Context

Table 2: Relevant sections of the Newcastle Development Control Plan 2012 that relate to management of the coastal zone.

Section of Newcastle Development Control Plan (DCP) 2012	Aims and objectives
Section 5.06 Archaeological Management	a) Conserve the archaeological heritage of the City of Newcastle. b) Apply world's best practice to the management of archaeological heritage. c) Provide an integrated statutory process for managing the archaeological sites of the City of Newcastle.
Section 6.01 Newcastle City Centre	a) Implement the Newcastle Urban renewal Strategy. b) Integrate planning for Newcastle East, Honeysuckle and Newcastle West. c) Provide planning and design guidelines based on the characteristic of distinct areas within the city centre.
Section 6.02 Heritage Conservation Areas	a) Provide a framework for conservation of the special qualities of heritage conservation areas. b) To define the importance, in heritage terms, of each heritage conservation area. c) Ensure development within each heritage conservation area is commensurate with heritage significance. d) Ensure all development has a positive effect on the character of heritage conservation areas.
Section 6.03 Wickham	a) Standard and guidance for development as part of the Wickham Master Plan 2017.
Section 7.06 Stormwater	a) Outline CN's requirement for stormwater management for development. b) Adopt a whole of water cycle approach to development. c) Ensure an appropriate quality and quantity of water enters waterways.

Crown Land Management Act 2016

The *Crown Land Management Act 2016* commenced on 1 July 2018. The *Crown Land Management Act 2016* provides for the administration and management of Crown Land Reserves and the proper assessment, development, use and conservation of this land.

Waterbodies such as beaches and foreshores below the mean high-water mark are designated as Crown Land and are managed by the Department of Industry – Lands and Water (Crown Lands). Other Crown Land Reserves in the CN LGA are managed by CN as the reserve trust manager.

However, the reserve trust management arrangement has been reformed with the introduction of the *Crown Lands Management Act 2016* and Crown Land Reserves will be managed by local councils as Crown land managers through plans of management under the *Local Government Act 1993* (see section on *Local Government Act 1993* above). Plans of Management for CN as the Crown land manager are currently being prepared.

3. Strategic Context

Other legislation

Other legislative acts are applicable to management of the coastal zone and can be divided into broad themes. Relevant legislative acts within the development of a CMP are outlined in **Table 3**.

Table 3: Legislative acts applying to the management of the coastal zone.

Theme	Legislation
Biodiversity	*Biodiversity Conservation Act 2016*
	Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)
	Fisheries Management Act 1994
European heritage	*Heritage Act 1977*
Aboriginal heritage	*National Parks and Wildlife Act 1974*
	Native Title Act 1993 (Cwlth)
	Aboriginal Land Rights Act 1983 (Cwlth)
Water management and pollution	*Water Management Act 2000*
	Water Act 1912
	Protection of the Environment Operations Act 1997
Marine estate	*Marine Estate Management Act 2014*
Emergency management	*State Emergency and Rescue Management Act 1989*
Invasive species management	*Biosecurity Act 2015*
Sand sourcing	*Offshore Minerals Act 1999*

3.2.2 Newcastle coastal zone land tenure

Land within the coastal zone of the scoping study area is owned and/or managed by various government and private interests. However, land within the coastal zone along the open coastline and foreshore areas are primarily owned and managed by government departments. **Figures 44** and **45** show the land management tenure within the coastal zone scoping study area.

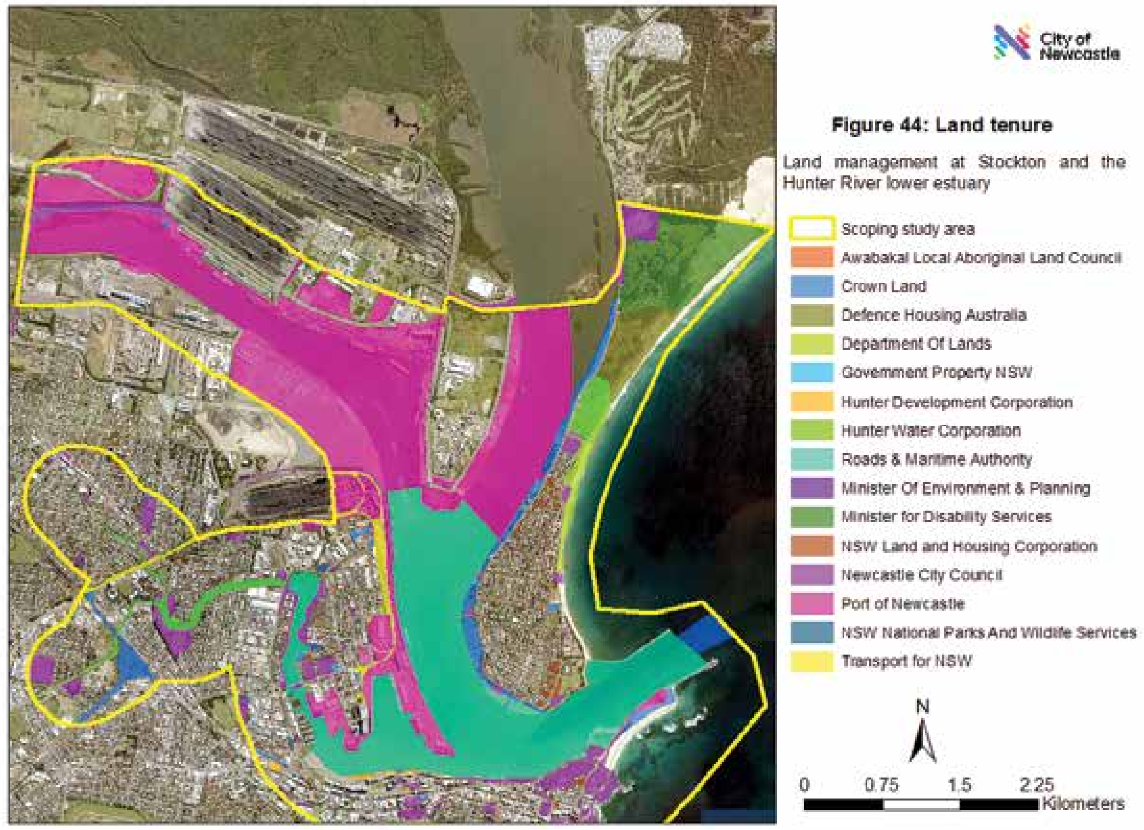


Figure 44: Land tenure

Land management at Stockton and the Hunter River lower estuary

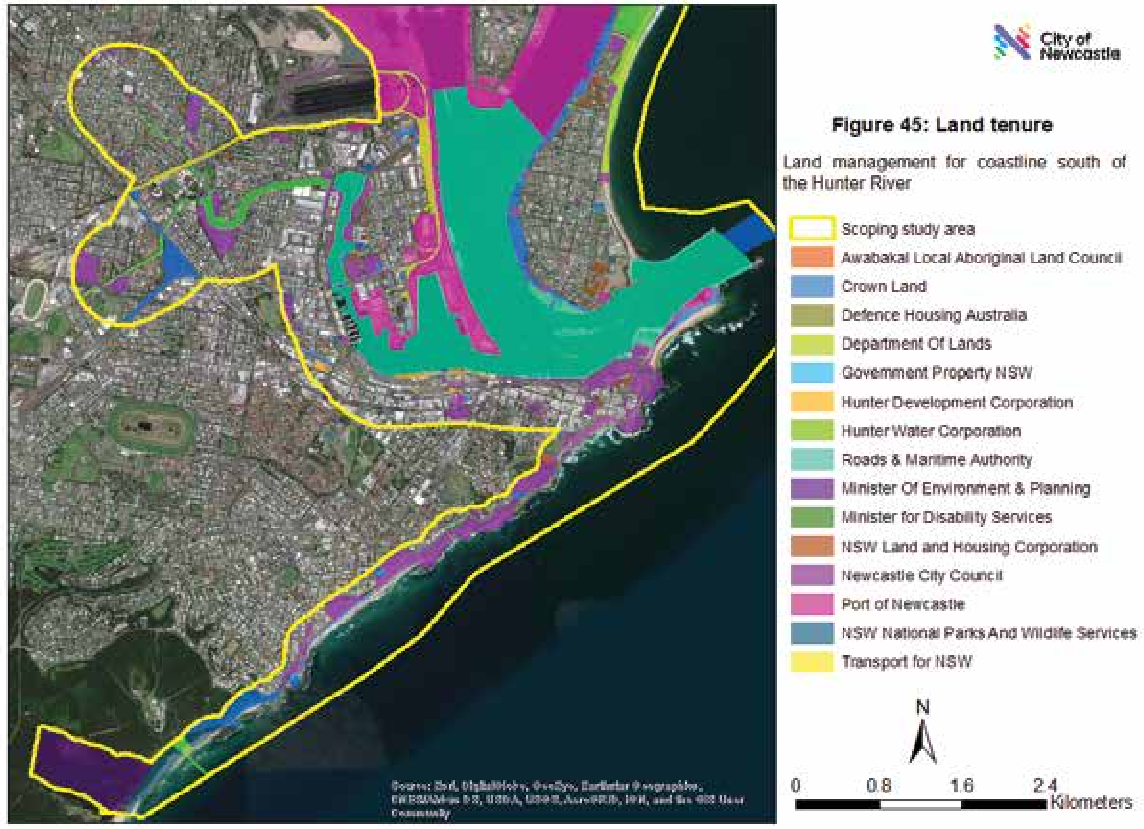


Figure 45: Land tenure

Land management for coastline south of the Hunter River

3.3 Environment

The environment of the scoping study area can be divided into the four areas of the coastal zone as outlined in **Section 2.4**.

3.3.1 Stockton Beach

Stockton Bight is the largest Holocene coastal dune system in NSW (Thom et al, 1992) and extends for a distance of 32km north from the Hunter River to Birubi Point. Schedule 1 of the *Coastal Management Act 2016* identifies coastal sediment compartments, which are not confined to single LGAs.

The coastline of Stockton Bight is in the following coastal sediment compartment:

Stockton Bight: Compartment extends from Birubi Point in the north to Nobbys headland in the south (Coast Adapt Shoreline Explorer, 2018) and includes the LGAs of Port Stephens Council and CN.

The CN LGA occupies only a small proportion of the overall extent of Stockton Bight (approximately 4.5km of the southern tip). This portion of Stockton Bight contains the coastal suburb of Stockton.

The coastal environment has been heavily modified within Stockton by historical activities and construction of infrastructure and dwellings. Dune systems remain along the coastline to the north of the former HWC sewerage treatment plant at 310 Fullerton Street, but are owned by various government departments. These dune systems mainly comprise sand scrub vegetation including Coast Banksia (*Banksia integrifolia*), Coast Tea-tree (*Leptospermum laevigatum*) and Old Man Banksia (*Banksia serrata*) with the shoreline predominantly consisting of Beach Spinifex (*Spinifex sericeus*).

South of the former HWC sewerage treatment plant the coastal vegetation community is highly modified with urban parklands and open spaces dominated by exotic grasses and planted landscape species such as Norfolk Island Pine (*Araucaria heterophylla*). Dune system vegetation has been re-established east of the Stockton Beach Holiday Park and at Pitt Street Reserve at the back beach area of Little Beach. The extent and condition of vegetation within CN owned and managed properties on Stockton Bight are detailed in the City of Newcastle Coasts and Estuary Vegetation Management Plan (Umwelt Pty Ltd, 2014).

3.3.2 Coastline south of the Hunter River

The CN coastline to the south of the Hunter River stretches 6.5km from Nobbys headland and the southern Hunter River breakwall to Glenrock Lagoon in the south. This stretch of coastline is characterised by sandy pocket beaches between rocky headlands and cliffs, with rock frequently exposed in the nearshore zone (BMT WBM, 2014(a)).

The coastline to the south of the Hunter River is in the following coastal sediment compartment:

Newcastle Coast: Compartment extends from Nobbys headland in the north to Norah Head in the south (Coast Adapt Shoreline Explorer, 2018) and includes the LGAs of CN, Lake Macquarie City Council and Central Coast Council.

The coastline to the south of the Hunter River is predominantly residential and contains the coastal suburbs of Newcastle, The Hill, Bar Beach and Merewether. The coastal environment has been heavily modified by historical activities and the construction of infrastructure, including coastal protection works.

Due to the coastline being controlled by outcropping headlands, rock platforms and cliffs the vegetation communities and habitat varies along the coastline extent. **Table 4** provides a general overview of the extent of vegetation and habitat for the coastline south of the Hunter River. Further detail is provided in the City of Newcastle Coasts and Estuary Vegetation Management Plan (Umwelt Pty Ltd, 2014).

Table 4: Vegetation and habitat in coastal zone south of the Hunter River.

Area	Vegetation/habitat description
Nobbys headland	Primarily Bitou Bush (*Chrysanthemoides monilifera*).
Nobbys Beach	Rehabilitated dune system with Coastal Wattle (*Acacia longifolia*), Beach spinifex (*Spinifex sericeus*) and pigface (*Carpobrotus glaucescens*).
Fort Scratchley headland	Primarily Bitou Bush (*Chrysanthemoides monilifera*).
Rock platform between Nobbys and Newcastle Beach	Important roosting site for shorebirds.
Newcastle Beach cliff line	Vegetation dominated by Bitou Bush (*Chrysanthemoides monilifera*).
King Edward Park	Maintained parkland but contains areas of *Biodiversity Conservation Act 2016* listed EEC, Themeda grasslands on seacliffs and coastal headlands.
Strzelecki headland	Large areas of Bitou Bush (*Chrysanthemoides monilifera*) with smaller areas of native coastal shrubland and Themeda grasslands EEC.
Shepherds Hill rock platform	Habitat for invertebrates and migratory birds.
Bar Beach	Rehabilitated dune system with Coastal Wattle (*Acacia longifolia*), Coastal Rosemary (*Westringia fruticosa*) and pigface (*Carpobrotus glaucescens*).
Kilgour cliff line (between Bar Beach and Dixon Park Beach)	Primarily Bitou Bush (*Chrysanthemoides monilifera*).
Dixon Park Beach	Rehabilitated dune system with Coastal Rosemary (*Westringia fruticosa*), pigface (*Carpobrotus glaucescens*) and Beach Spinifex (*Spinifex sericeus*).
Merewether Beach	Rehabilitated dune system with Coastal Wattle (*Acacia longifolia*), Coastal Rosemary (*Westringia fruticosa*) and pigface (*Carpobrotus glaucescens*).
Merewether Beach rock platform	Important roosting site for shorebirds.
Merewether headland	Primarily Bitou Bush (*Chrysanthemoides monilifera*), but some native replanting undertaken.
Lloyd Street Reserve, Merewether	Rehabilitated littoral rainforest area listed under *SEPP (Coastal Management) 2018*.

South of Merewether Beach is Glenrock SCA which is managed by the NSW National Parks and Wildlife Service (NPWS). Glenrock SCA provides a significant area of vegetation and habitat at the southern extent of the CN LGA.

3.3.3 Hunter River lower estuary – East of Hannell Street bridge

The two coastal sediment compartments of the CN coastline converge at the ocean entrance to the Hunter River estuary. The scoping study area includes part of the Hunter River lower estuary, around the Port of Newcastle and Throsby Creek, including the north and south arms of the Hunter River. The diverging arms of the Hunter River estuary are typical of larger NSW estuaries that have evolved through various climatic periods and sea level variations (MHL, 2003). The Hunter River estuary forms part of a mature barrier estuary with high sediment loads that have resulted in a sinuous river channel discharging directly to the ocean (MHL, 2003). However, the development of the Port of Newcastle has highly modified the Hunter River lower estuary. The modifications to the Hunter River estuary are detailed in Kooragang Wetland Rehabilitation Project: History of Changes to estuarine Wetlands of the Lower Hunter River (Williams et al, 2000). The Hunter River estuary is specified in Schedule 1 Part 2 of the *Coastal Management Act 2016* and extends across the LGAs of CN, Port Stephens Council, City of Maitland and Dungog Shire Council.

Newcastle City Centre is located on the south bank of where the estuary meets the ocean. Newcastle City Centre is highly urbanised and connects with the residential/commercial suburbs of Wickham and Maryville, which occupy the western side of Throsby Creek. The residential/industrial suburb of Carrington is placed on the eastern edge of Throsby basin/creek while the Port of Newcastle, including Dyke Point, is located on the eastern side of Carrington with frontage to the Hunter River.

The banks of the south arm of the Hunter River are occupied by the Port of Newcastle, with Kooragang to the north and Mayfield North to the south, while the north arm includes the Port of Newcastle on the western bank (Walsh Island) and the residential suburb of Stockton on the east bank.

Due to the highly urbanised nature of the lower Hunter River estuary minimal vegetation remains. Exceptions are the mangrove forest within Throsby Creek at Carrington, mangrove and saltmarsh habitat along the southern edge of Kooragang (east of Tourle Street bridge) and mangrove forest on the north-western edge of Stockton. Each of these areas is identified as coastal wetland under *SEPP (Coastal Management) 2018*.

3.3.4 Throsby Creek catchment – West of Hannell Street bridge

The Throsby Creek catchment within the coastal zone is highly urbanised. While Throsby Creek between Maitland Road at Islington and the Hannell Street bridge at Maryville contains fringing mangroves the remainder of the catchment is a high-density mixture of residential and commercial properties. Modification of the catchment is highlighted by the concrete channelisation of Styx Creek and Throsby Creek upstream of Maitland Road at Islington.

3.4 Social

3.4.1 Population and dwellings

Existing

The population profile of CN was obtained from the 2016 census data collected by the Australian Bureau of Statistics (ABS, 2018). Additional statistical data and community profiles were obtained from id.the population experts (ID, 2018), which utilise data from the 2016 census.

To enable analysis of the coastal zone in comparison to the CN LGA the coastal zone was defined as the suburbs fringing the open coast, the Hunter River lower estuary and Throsby Creek catchment within the scoping study area.

The coastal zone suburbs included:

Stockton
Newcastle, including Newcastle East and West
The Hill
Bar Beach
Merewether
Carrington
Wickham – Maryville
Islington
Tighes Hill
Mayfield East
Mayfield
Broadmeadow – Hamilton North

Table 5 shows the comparison of the Newcastle coastal zone to the CN LGA. The coastal zone represents 15.42% of the CN LGA land area but contains 28.35% of the LGA population. The coastal zone also contains 31.87% of the LGA total dwellings with a population density of 15.2 persons/hectare compared to an overall population density of 8.69 persons/hectare within the CN LGA.

Table 5: Existing population of Newcastle coastal zone and City of Newcastle (CN) Local Government Area (LGA).

Area	Suburb	Land area (Hectares) [1]	Population [2]	Population density (per hectare) [3]
Newcastle coastal zone	Stockton	360	4179	12.32
	Newcastle (Including Newcastle East and West)	594	4789	7.91
	The Hill	62	1954	36.07
	Bar Beach	48	1147	27.73
	Merewether	622	10426	18.22
	Carrington	217	1866	9.31
	Maryville-Wickham	130	2457	20.19
	Islington	71	1852	28.14
	Tighes Hill	85	1655	21.07
	Mayfield East	56	1518	28.67
	Mayfield	318	9357	31.1
	Broadmeadow–Hamilton North	319	2597	8.65
Newcastle coastal zone Total		2882	43797	15.2
CN LGA Total		18687	154498	8.69
Newcastle coastal zone (% of CN LGA)		15.42	28.35	

[1] Source: ABS 2016 census data
[2] Source: ABS 2016 census enumerated population data
[3] Source: ABS 2016 census data compiled by id.the population experts

3. Strategic Context

Projected population

The Hunter Regional Plan 2036 (DPE, 2016) projects a population increase of 33,300 people within the CN LGA by 2036 within an associated increase in 16,800 dwellings. This population and dwelling projections are based on the common planning assumptions produced by DPE (DPE, 2018). However, the common planning assumptions are limited to LGA level and do not provide population or dwelling growth within the Newcastle coastal zone.

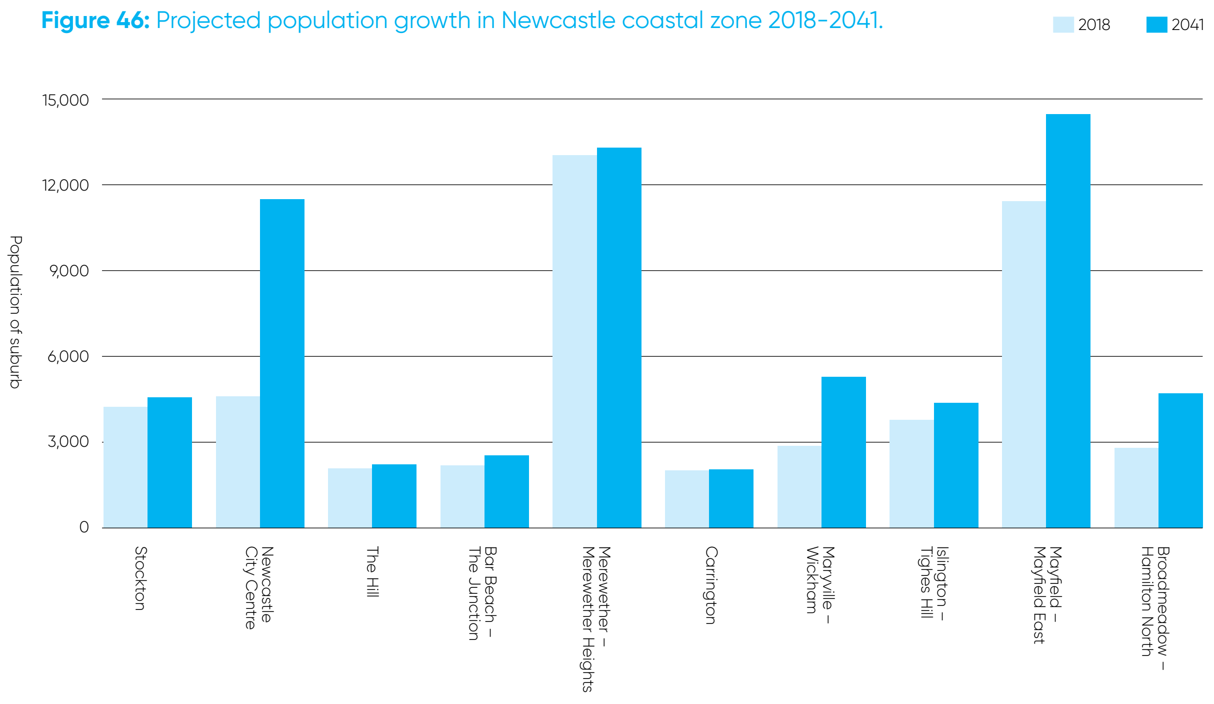
Id. the population experts provide a forecasting model process which projects population and dwelling growth from 2018 to 2041 (ID, 2018). The scoping study has used this forecast model to analyse potential growth within the Newcastle coastal zone and CN LGA. However, the coastal area suburb boundaries differ from the boundaries of the 2016 data above.

The coastal zone included within the 2041 projection model includes:

- Stockton
- Newcastle City Centre, including Newcastle East and West
- The Hill
- Bar Beach - The Junction
- Merewether - Merewether Heights
- Carrington
- Maryville - Wickham
- Islington – Tighes Hill
- Mayfield – Mayfield East
- Broadmeadow – Hamilton North

Figure 46 shows the projected population growth of the Newcastle coastal zone within each coastal suburb in the projection model. The Newcastle coastal zone is projected to increase by 15895 people from 2018-2041 which represents a 32.7% increase in coastal zone population. Projected growth is highest in the Newcastle City Centre (population increase of 6,859 people or population change of 108.7%) and Maryville -Wickham (population increase of 2,422 people or population change of 85.7%). The projected population growth within the Newcastle coastal zone represents 42.51% of the overall projected population growth within the CN LGA and will result in the population of the coastal zone representing 31.92% of the LGA population in 2041.

Figure 46: Projected population growth in Newcastle coastal zone 2018-2041.

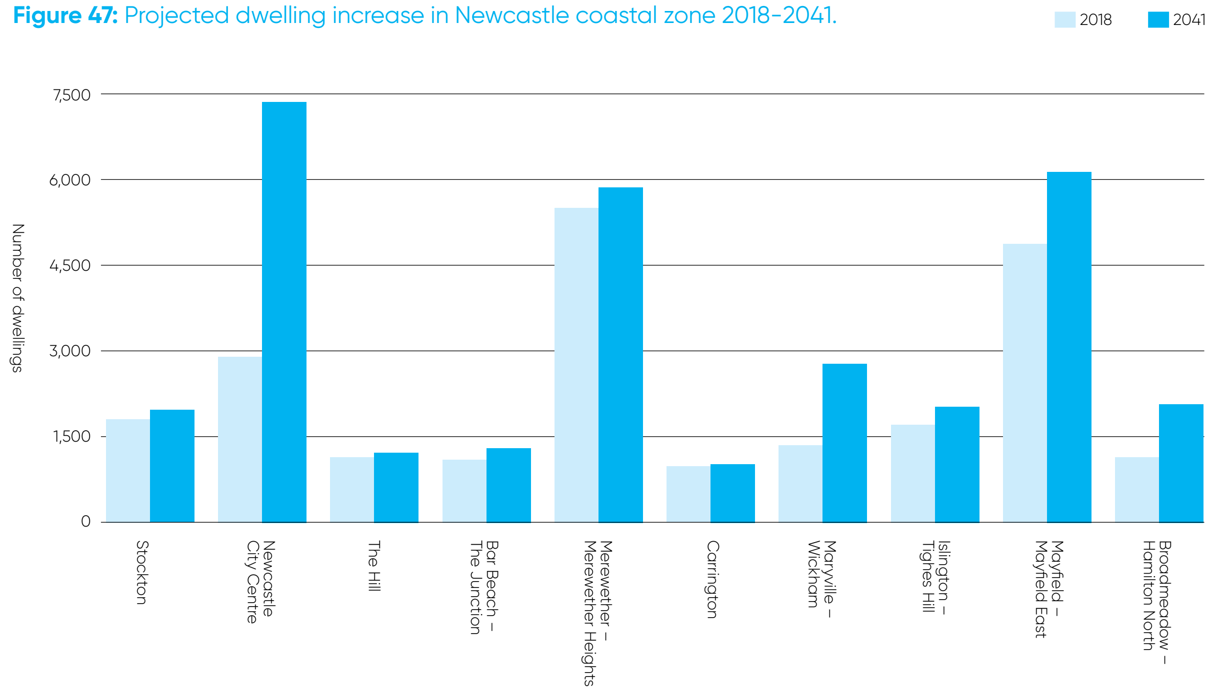


Projected dwellings

The same projection methodology from Id. the population experts used for population growth was utilised to forecast potential dwelling increase in the Newcastle coastal zone.

Figure 47 shows the projected dwelling growth of the Newcastle coastal zone within each coastal suburb. The number of dwellings in the Newcastle coastal zone is projected to increase by 9,267 from 2018-2041 which represents a 41.02% increase. Projected dwelling growth is highest in the Newcastle City Centre (dwelling increase of 4,467 or dwelling change of 153.4%) and Maryville-Wickham (dwelling increase of 1,430 or dwelling change of 105.3%). The three suburb groupings within the Throsby Creek catchment are all projected to increase by approximately 80% from 2018-2041. The projected dwelling growth within the Newcastle coastal zone represents 47.52% of the overall projected growth within the CN LGA and will result in the Newcastle coastal zone containing 35.9% of the dwellings within CN LGA.

Figure 47: Projected dwelling increase in Newcastle coastal zone 2018-2041.



3. Strategic Context

3.5 Cultural context

3.5.1 Ancestry

Analysis of ancestry for the CN LGA and coastal zone has been undertaken with data obtained from the Australian Bureau of Statistics 2016 Census.

Figure 48 shows the greatest nominated ancestries within Newcastle LGA and the Newcastle coastal zone follow a similar distribution with the top five nominated ancestries being:

- English (LGA 30.6%, coastal zone 32.6%),
- Australian (LGA 28.97%, coastal zone 28.25%),
- Irish (LGA 10.05%, coastal zone 11.89%),
- Scottish (LGA 8.7%, coastal zone 9.91%), and
- German (LGA 3.15%, coastal zone 3.61%).

People of Aboriginal or Torres Strait Islander ancestry account for 2.63% of the population of Newcastle LGA and 2.495% of the coastal zone population.

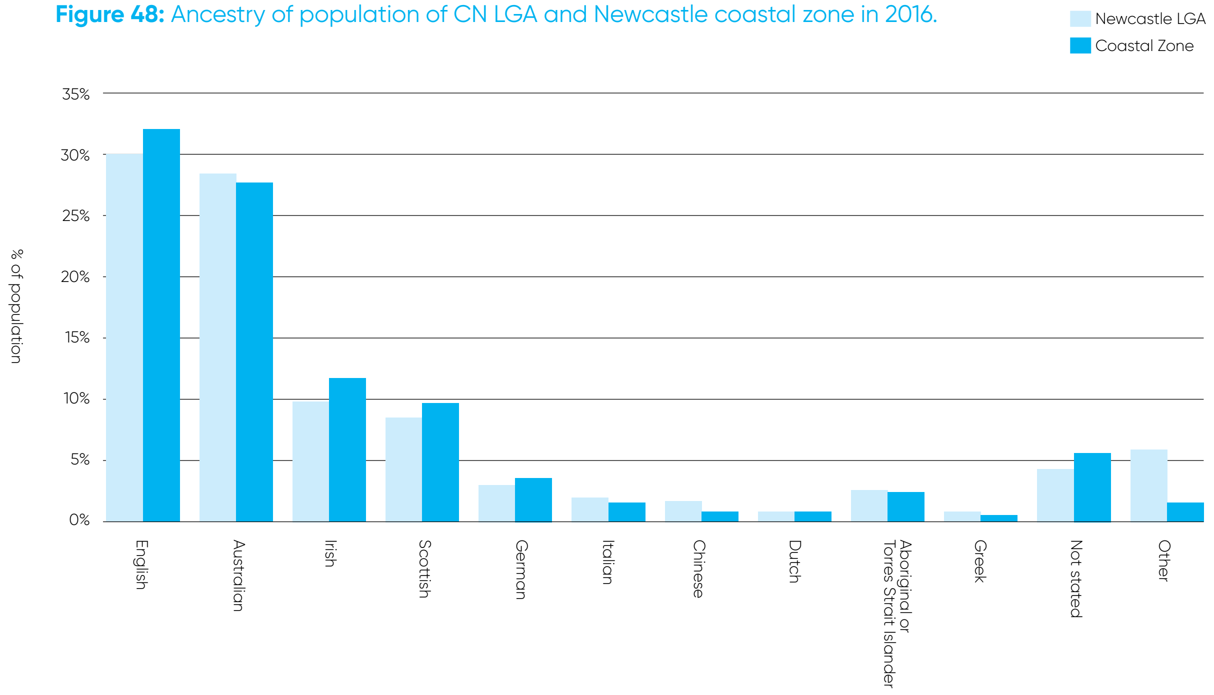


Figure 48: Ancestry of population of CN LGA and Newcastle coastal zone in 2016.

3.5.2 Aboriginal heritage

The Newcastle coastal zone is located within the traditional lands of the Worimi and Awabakal people (AIATSIS, 2018). The Newcastle coastal zone was an extremely rich resource zone and provided a variety of seasonal food resources (HLA-Envirosciences Pty Ltd, 1995). The coastal zone provided food resources such as fish and many types of shellfish including pippis, mussels and oysters, while many flora species were also valued as food sources (AMBS, 2005).

The Aboriginal Heritage Study of Newcastle Local Government Area (AMBS, 2005) confirmed the Newcastle coastal zone has a high to moderate archaeological sensitivity and significance to the Worimi and Awabakal people. A search of the Office of Environment and Heritage's (OEH) Aboriginal Heritage Information Management System (AHIMS) on 19 October 2018 revealed 117 Aboriginal sites are recorded within or near the Newcastle coastal zone (See **Appendix C**).

Features of the coastal landscape and estuary form an integral part of the life of the traditional owners and were identified by name. **Table 6** provides a list of Aboriginal names for different features within the coastal zone.

Nobbys headland also holds a significant dreaming story for the Awabakal people. The headland is the home of a kangaroo who had transgressed Wallaby clan law. The kangaroo was chased to the headland, once an island, and hid. The kangaroo remains hidden in the headland and at times trembles and shakes in frustration at his confinement and the perpetual fear of being caught by the Wallaby clan (Albrecht, 2000).

Aboriginal people's connections to the coastal area are long-standing and involve a complex interaction of spiritual links, customary obligations to care for Country and the sustainable use of resources (Sue Feary, 2015). Sea Countries of NSW: A benefits and threats analysis of Aboriginal people's connections with the marine estate (Sue Feary, 2015) outlines historical and contemporary benefits derived from the coastal area from various Aboriginal communities in NSW. The CMP will endeavour to explore these benefits and opportunities further through consultation with local aboriginal groups through the CMP process.

There are currently no Native Title claims under the *Native Title Act 1993* (Cwlth) within the scoping study area. However, within the scoping study area there are fifty-one Aboriginal land claims under the *Aboriginal Land Rights Act 1983* (NSW). These Aboriginal land claims include significant portions of terrestrial Crown Land at Stockton and Carrington and aquatic areas including the seabed off Stockton Beach and the north and south arms of the Hunter River.

Table 6: Aboriginal names for features within the Newcastle coastal zone.

Aboriginal name	Feature
Tahlbihn Point	Entrance to the Hunter River - south
Burrabihngarn	Entrance to the Hunter River - north, Pirate Point at Stockton
Muloobinbah	Newcastle harbour
Coquun	Hunter River
Corrumbah	Bullock Island (modern day Carrington)

Source: Albrecht (2000)

3.5.3 European heritage

Drawn to the abundant natural resources along the coast and estuary, including coal and timber, Newcastle was first established by Europeans as a convict settlement in 1801. The settlement was abandoned in 1802, but a second convict settlement commenced in 1804 around the mouth of the Hunter River estuary. The Newcastle City Wide Heritage Study (Suters Architects, 1997) provides a comprehensive history of Newcastle including heritage themes and identified places of heritage significance.

To determine the presence of places of historical significance within the scoping study area the current mapped coastal environment and coastal use management areas from *SEPP (Coastal Management) 2018* were utilised as the landward boundary.

174 items of historical significance were identified within the scoping study area. 33 items listed on the State Heritage Register under the *Heritage Act 1977* and 141 items from Schedule 5 of the *Newcastle Local Environment Plan 2012* were identified in the scoping study area (**Appendix D**).

No areas within the scoping study area were identified on the Federal Government's National Heritage List, but two locations (Nobbys Lighthouse and Fort Wallace, Stockton) are identified as Commonwealth Heritage Places.

3.6 Economic

3.6.1 Median household income

The measurement of income provides a potential indicator of wealth within communities. Median household income data from the 2016 census (ABS, 2016) has been utilised to analyse the distribution of wealth within the CN LGA and Newcastle coastal zone.

Figure 49 shows the median household income within the CN LGA is $1,366/week while the coastal zone has a median household income of $1,426/week. Additional analysis of the distribution of wealth within the coastal zone has been undertaken utilising data for the individual suburbs within the coastal zone.

Figure 50 shows five of the seven suburbs within the coastal zone exceed the CN LGA average median weekly household income with Merewether ($1,841/week) and Newcastle, including Newcastle East and West, ($1,713/week) being the highest earning suburbs. Mayfield ($1,171/week), Stockton ($1,226/week), Mayfield East $1,273/week), Islington ($1,313/week), Broadmeadow-Hamilton North ($1,326/week) are below the CN LGA average with Tighes Hill ($1,354/week) and Carrington ($1,359/week) slightly below the LGA average of $1,366/week.

Figure 49: Median weekly household income in City of Newcastle LGA and coastal zone 2016.

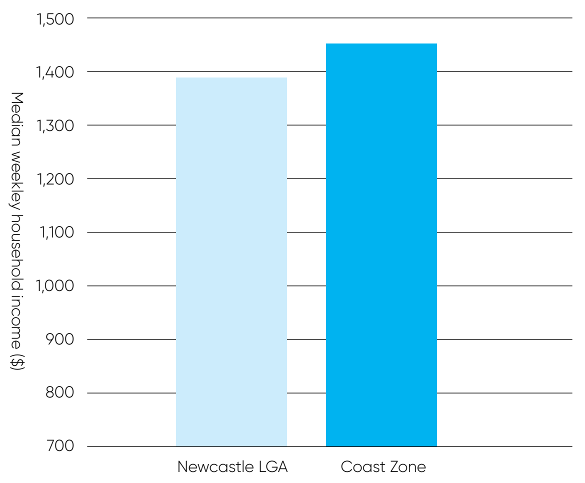
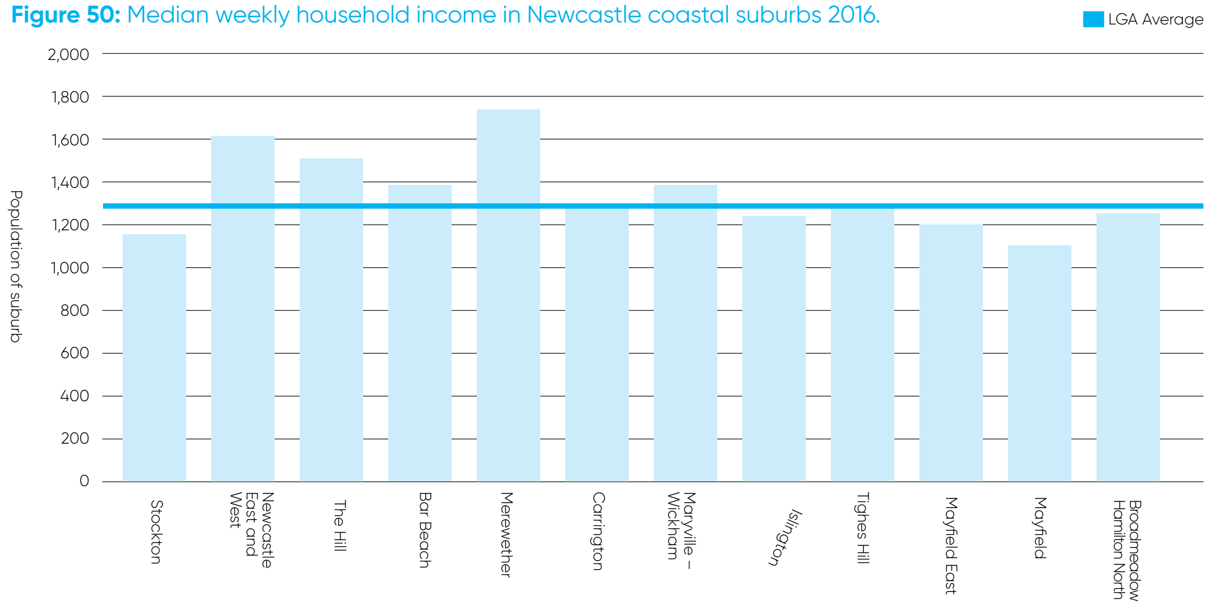


Figure 50: Median weekly household income in Newcastle coastal suburbs 2016.



3.6.2 Housing tenure

A second indicator of potential wealth within communities is the type of housing tenure and/or ownership of dwellings. Housing tenure data was obtained from the 2016 census data (ABS, 2016).

Table 7 shows dwellings within the Newcastle coastal zone have a smaller percentage of ownership occupation (dwelling owned) compared to the CN LGA ownership occupation of dwellings while a smaller percentage of dwellings in the coastal zone are mortgage indebted. However, the coastal zone has a higher percentage of rented dwellings than the CN LGA average.

Table 7: City of Newcastle (CN) Local Government Area (LGA) and coastal zone housing tenure 2016.

Tenure	CN LGA	LGA %	Coastal zone	Coastal zone %
Dwelling owned	18058	26.2	4948	23.4
Dwelling mortgage	18853	27.3	5312	25.1
Dwelling rented	21254	31.2	7420	35.1
Other dwelling tenure	3886	5.6	993	4.7
Unknown tenure	6699	9.7	2475	11.7
Total dwellings	**69020**		**21148**	

Figure 51: Housing tenure within Newcastle coastal zone suburbs in 2016.

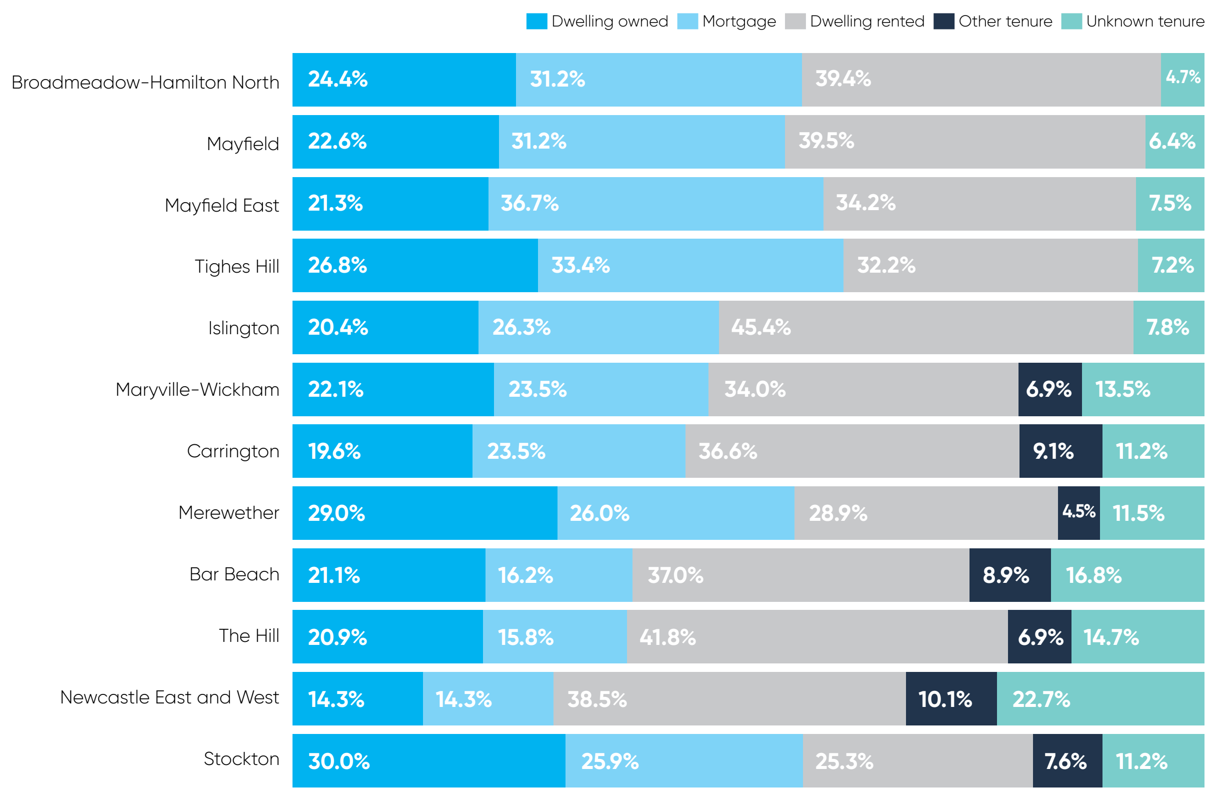


Figure 51 shows dwelling ownership is highest in Stockton (30%) and Merewether (29%). Mortgage of property is greatest in Mayfield East (36.7%), Tighes Hill (33.4%), Mayfield (31.2%) and Broadmeadow-Hamilton North (31.2%). The highest percentage of dwellings rented are in Islington (45.4%) The Hill (41.8%), Mayfield (39.4%), Broadmeadow-Hamilton North (39.4%) and Newcastle East and West (38.5%).

3.6.3 Employment sector

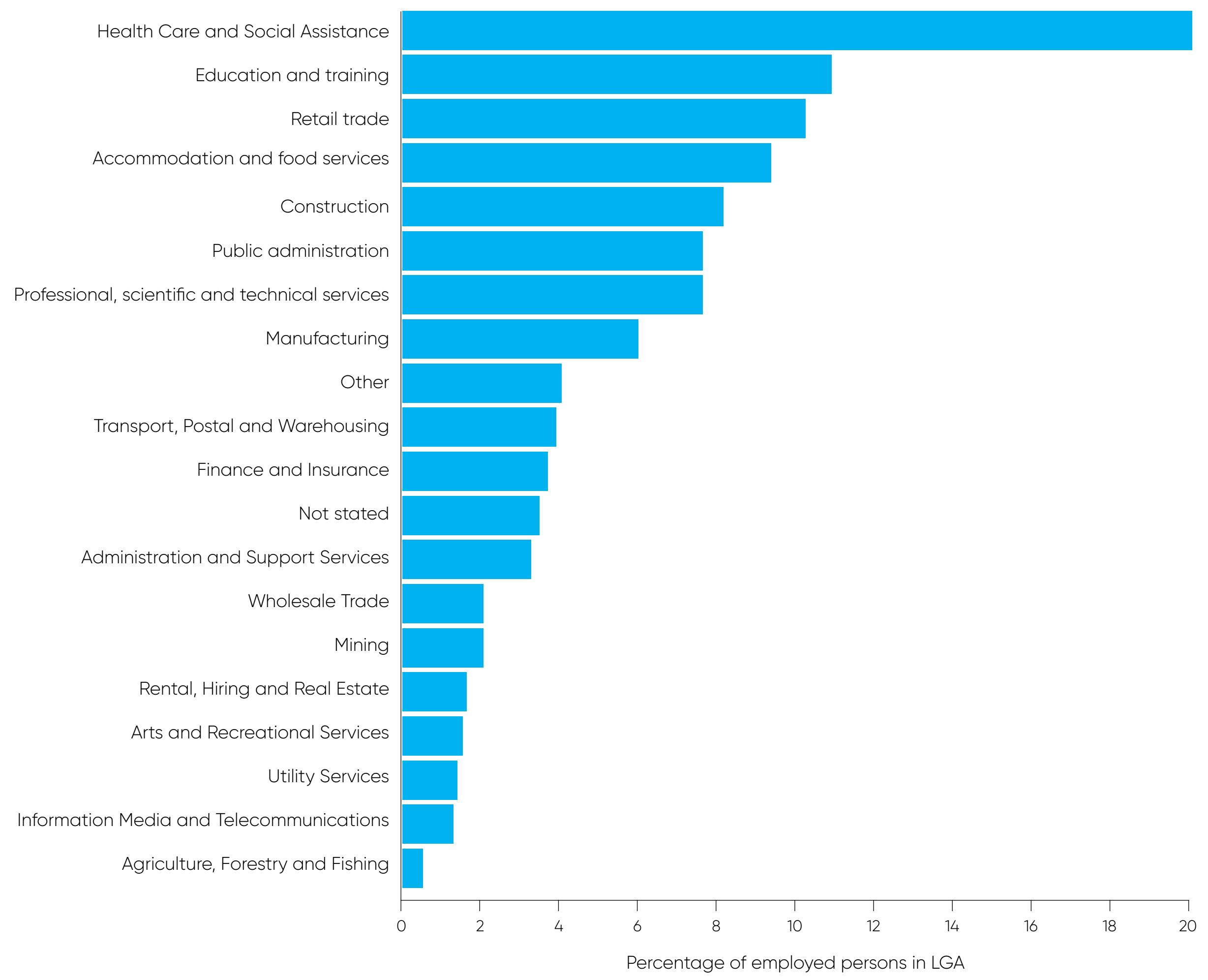
The CN LGA included 73,042 employed persons in 2016. **Figure 52** shows the employment sector with the highest number of employees was health care and social assistance (18.4%), education and training (10%) and retail trade (9.4%). While industry sectors such as manufacturing and mining are reliant on the coastal zone through the Port of Newcastle for export and importation, primary industries that are dependent on the coastal zone, such as fishing, account for 0.5% (670 jobs) of the CN LGA employee population. The CN LGA is primarily a medical, education and service sector and coast-dependant industries form a smaller part of the CN LGA workforce.

3.6.4 Tourism

In 2017, 3.85 million people visited the CN LGA with 67% of visitors being domestic day trips (TRA, 2018). Tourism visitation contributed $867 million to the local economy during 2017 (TRA, 2018). Visitors to the CN LGA have identified coastal areas of interest such as Nobbys Beach, Queens Wharf, Nobbys breakwall, Fort Scratchley, Nobbys lighthouse and Newcastle Beach amongst the top attractions within the LGA (TRA, 2013). Visitors also identified their highest satisfaction with Newcastle natural attractions.

An estimated 5,031 jobs are supported by tourism in the Newcastle LGA (Remplan, 2018). Statistics regarding seasonality of tourism are not currently available, but the cruise ship market is growing within the CN LGA. In 2015/16, 10 cruise ships berthed at the Port of Newcastle carrying 16,296 passengers (NCC, 2016). Events within the CN LGA, such as the V8 Supercars event, also result in varying tourism numbers throughout the year.

Figure 52: Employment sectors in the City of Newcastle Local Government Area



3. Strategic Context

3.7 Previous coastal management plans

After the construction of the Mitchell Street seawall at Stockton in 1989 by the NSW Public Works Department the management documentation for the coastline of Newcastle has consisted of the following:

- Stockton Beach Remedial Action Plan Study Report (WBM Oceanics Australia,1996);
- Newcastle Coastline Management Plan (Umwelt (Australia) Pty Ltd, 2003); and
- Newcastle Coastal Zone Management Plan 2018 (NCC, 2018(b)).

Management of the lower Hunter River estuary is undertaken in accordance with the following documents:

- Hunter Estuary Coastal Zone Management Plan (BMT WBM, 2017(a)); and
- Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012).

4. Purpose, vision and objectives

4.1 Purpose

The purpose of the Newcastle CMP is to provide an integrated long-term strategy for the sustainable use, management and conservation of Newcastle's coastal zone. The Newcastle CMP will aim to protect and enhance the coastal zone while balancing the diversity of needs of the community.

4.2 Vision

Our coastal environment is protected, enhanced and resilient while maintaining the recreational amenity and sense of identity the coast provides to the community. Through sustainable and integrated management, the coastal zone will provide a liveable and distinct urbanism that strengthens community connections and wellbeing. Management will be responsive and adaptable to current and future coastal hazard risks, including climate change, to ensure the continued community use and enjoyment of our unique coastal area.

4.3 Objectives

The objectives of the Newcastle CMP are to:

- Protect and enhance the environmental qualities and amenity of the coastal zone;
- Facilitate sustainable management and development of the coastal zone and support recreational opportunities, including involving the community in an active lifestyle;
- Identify adaptable management measures to address risks from coastal hazards into the future, including in response to the effects of climate change;
- Provide for equity in access to the coastal zone and facilities;
- Provide vibrant and active places within the coastal zone that strengthen social connections and maintain Newcastle's sense of identity as a coastal city;
- Retain and protect cultural items and areas to continue connection to the land and identification of the city's history;
- Integration of CN's coastal management with internal policies and procedures to enable co-ordinated operations in the coastal zone;
- Integration of CN's coastal management with other stakeholders to achieve consistent and quality management of the Newcastle coastal zone for the benefit of the community;
- Enable the community to engage, learn and participate in the management of the Newcastle coastal zone; and
- Identify and implement terrestrial or land-based management actions to support protection of the estuarine and marine environment.

5. Coastal management issues

5.1 Management issues identification

The identification of management issues within the coastal zone can be determined by the impact a management issue poses to community benefit. Community benefit is considered as anything that contributes to the wellbeing of the community (BMT WBM, 2017). Community benefits can be separated into three categories:

1. Environmental.
2. Economic.
3. Social and cultural.

Coastal management issues and the potential impacts the management issue poses to community benefit are outlined below.

5.2 Coastal hazards

The *Coastal Management Act 2016* defines coastal hazards as the following:

a) beach erosion;
b) shoreline recession;
c) coastal lake or watercourse entrance stability;
d) coastal inundation;
e) coastal cliff or slope instability;
f) tidal inundation; and
g) erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters.

The Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)) has undertaken a comprehensive assessment of coastal hazards along the Newcastle coastline from the northern border of the CN LGA at Stockton to Merewether in the south. The primary coastal hazards impacting upon the CN coastal zone are summarised below.

5.2.1 Beach erosion

Beach erosion can be defined as the offshore movement of sand from the sub-aerial beach during a storm event (OEH, 2013). Storm events generate transport of sand:

- Offshore, with sand eroded from the beach face and transported to the seabed to form a sand bar roughly parallel to the shoreline; and
- Alongshore, either upcoast or downcoast depending on wave direction.

Erosion on the beach face may result in potential threats to areas behind the back beach, including infrastructure and other assets.

5.2.2 Shoreline recession

Shoreline recession is defined as the landward movement of the shoreline over time due to a net loss of sediment (OEH, 2013). Shoreline recession is frequently associated with a longshore sediment transport differential, where the supply of sediment into the system is less than the sediment losses from the system.

Beaches experiencing long-term shoreline recession are characterised by a prominent back beach escarpment which moves landward over time following storm events. Longshore sand losses create an overall net depletion of the active beach profile, initially in the surfzone, and subsequently redistributed across the entire active beach profile. Shoreline recession poses a risk to beach amenity and constructed assets as the beach profile moves landward.

Beach erosion and shoreline recession modelling

Analysis and modelling of beach erosion and shoreline recession of the Newcastle coastline has been undertaken in multiple studies. Erosion hazard zones were mapped for the Newcastle coastline in the Newcastle Coastline Hazard Definition Study (WBM Oceanics, 1998). These erosion hazard zones were mapped on an immediate and fifty-year temporal scale.

Further erosion and shoreline recession hazard line mapping was conducted for Stockton Beach within the Stockton Beach Coastal Processes Study Stage 1 - Sediment and Transport Analysis and Description of Ongoing Processes (DHI, 2006). The beach erosion and shoreline hazard lines were modelled for the short (immediate), medium (20 years) and long-term (50 years) time periods. These beach erosion and shoreline recession hazard lines were remodelled to account for potential impacts from climate change and sea level rise in the Stockton Beach Coastal Processes Study - Addendum (DHI, 2011). The hazard lines were modelled with a sea level rise benchmark of 0.4m by 2050 and 0.9m by 2100, above the 1990 mean sea level, in accordance with the, now repealed, NSW Sea Level Rise Policy Statement (DECCW, 2009). While repealed, these adopted sea level rise benchmarks are widely accepted by competent scientific opinion.

Beach erosion and shoreline recession hazard lines were completed in the Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)). The Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)) adopted the previous hazard line methodology from the Stockton Beach Coastal Processes Study Stage 1 - Sediment and Transport Analysis and Description of Ongoing Processes (DHI, 2006) and Stockton Beach Coastal Processes Study - Addendum (DHI, 2011) for Stockton Beach. New modelling was undertaken to define hazard lines for the coastline south of the Hunter River. However, due to uncertainties when modelling areas that are potentially impacted by coastal hazards the Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)) adopted risk probability areas. The areas represent different probabilities/likelihood that the coastal hazard will occur and range from almost certain to rare (See **Table 8**). The risk probability hazard lines were modelled across three timeframes (immediate, 2050 and 2100).

Table 8: Risk probability areas for beach erosion and shoreline recession.

Probability	Description
Almost certain	There is a high possibility the event will occur as there is a history of frequent occurrence.
Likely	It is likely the event will occur as there is a history of casual occurrence.
Unlikely	There is a low possibility that the event will occur, however, there is a history of infrequent or isolated occurrence.
Rare	It is highly unlikely that the event will occur, except in extreme/ exceptional circumstances, which has not been recorded historically.

Source: BMT WBM (2014)(a) p40

Community benefit impact

The impacts to community benefit from beach erosion and shoreline recession are outlined in **Table 9.**

Table 9: Impacts to community benefit from beach erosion and shoreline recession

Community benefit	Impact from beach erosion/shoreline recession
Environmental	• Loss of habitat. • Loss of species from local area.
Economic	• Impact on tourism. • Impact on coast dependant businesses eg. surf schools. • Impact on buildings eg. structural damage etc, and cost of replacement/repair. • Impact on property or land values.
Social and cultural	• Loss of assets, infrastructure, private property. • Loss or disruption of services. • Impact on beach amenity. • Impact on recreational opportunities eg. surfing, surf lifesaving. • Impact on access to beach. • Loss of Aboriginal heritage items/sites. • Impact on heritage listed items.

5.2.3 Coastal entrance instability

Coastal entrance instability refers to the tendency of entrances to estuaries and coastal lakes to migrate along the shoreline, close, reopen or form new entrances in response to wave and current action and/or freshwater flows ((OEH, 2013). The CN LGA contains three entrances to the open coast with the stability of these entrances detailed in the Newcastle Coastline Hazard Definition Study (WBM Oceanics, 1998) and Section 3.6.3 of the Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)).

The three coastal entrances are detailed below.

1. Glenrock Lagoon within the Glenrock SCA. Glenrock Lagoon is predominantly closed as wave and longshore transport processes prevail compared to the small catchment input from Flaggy Creek. During periods of heavy rainfall, the lagoon entrance scours to allow discharge of water. The lagoon entrance may stay open for a period of time and migrate northwards until coastal processes allow for closure of the entrance. Review of aerial photography in the Newcastle Coastline Hazard Definition Study (WBM Oceanics, 1998) reveals northern migration of the entrance over a relatively short distance.
2. Murdering Gully within Glenrock SCA. Similar to Glenrock Lagoon the entrance opens intermittently until coastal processes once gain close the entrance. Review of aerial photography in the Newcastle Coastline Hazard Definition Study (WBM Oceanics, 1998) reveals northern migration of the entrance over a relatively short distance.
3. The Hunter River entrance has been trained to provide navigational access to the Port of Newcastle. The breakwaters at the Hunter River entrance have required periodic maintenance, but the entrance has been reasonably stable (Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)).

Community benefit impact

The impacts to community benefit from coastal entrance instability are outlined in **Table 10**.

Table 10: Impacts to community benefit from coastal entrance instability

Community benefit	Impact from coastal entrance instability
Environmental	• Loss of habitat or migration of habitat. • Loss of species from local area.
Economic	• Impact on operation of Port of Newcastle. • Impact on dune or beach revegetation projects.
Social and cultural	• Impact on beach amenity. • Restriction/change to use of beach area. • Impact to access to beach or surf zone. • Loss of Aboriginal heritage items/sites. • Impact on heritage listed items.

5.2.4 Coastal inundation

Coastal inundation is the storm-related flooding of coastal lands by ocean waters due to elevated water levels (storm surge) and wave run-up (OEH, 2013). Coastal inundation is characterised by two processes:

A 'quasi-static' component, which includes the effects of elevated water levels due to astronomical tide, inverted barometric setup, wind setup (storm surge) and wave setup; and

A 'dynamic' component, which includes the effects of wave run-up and wave overtopping caused by the direct impact of waves on coastal dunes, cliffs and structures.

The Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)) has undertaken modelling of coastal inundation for the Newcastle open coastline. The approach to calculation of coastal inundation is summarised in **Table 11** and risk probability areas were defined as per **Table 8**.

Table 11: Approach for calculation of coastal inundation for Newcastle coastline.

Probability	Immediate	2050	2100
Almost certain	1 in 20-year storm surge and wave set up.	As per immediate	As per immediate
Likely	NM1	NM[1]	NM[1]
Unlikely	1 in 100-year storm surge and wave set up AND wave run up and overtopping[2].	1 in 100-year storm surge and wave set up + 0.4m SLR and change in storm surge AND indicative areas of potential overtopping[2] including 0.4m SLR.	1 in 100-year storm surge and wave set up + 0.9m SLR and change in storm surge AND indicative areas of potential overtopping[2] including 0.9m SLR.
Rare	1 in 100-year storm surge and wave set up + extreme climatic conditions (eg. Tropical cyclone, 1 in 1000 year east coast low).	Worse case of either: • 1 in 100-year storm surge and wave set up + Extreme climatic conditions + 0.4m SLR and climate change conditions[3], OR • 1 in 100-year storm surge and wave set up + 0.7m SLR and climate change impacts.	Worse case of either: • 1 in 100-year storm surge and wave set up + Extreme climatic conditions + 0.9m SLR and climate change impact[3], OR • 1 in 100-year storm surge and wave set up + 1.4m SLR and climate change impacts

Source: BMT WBM (2014)(a) p61

1. NM= not mapped.
2. Only applies at open coast barriers. Wave run up and overtopping are calculated using 1 in 100-year storm surge + 1 in 100-year 6 hour duration.
3. Includes increase in set up levels associated with 5% and 10% increase in storm wave heights by 2050 and 2100 respectively.

Modelling of coastal inundation of the Hunter River lower estuary, including the Throsby Creek catchment, was undertaken in the Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012). While the assessment was conducted as a flood study the flooding mechanisms were conducted independently of one another allowing for potential flooding from coastal inundation to be analysed. The Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012) modelled potential coastal inundation for the immediate planning horizon for a 10% AEP ocean level. The adopted frequent flood level for the Hunter River lower estuary, within Newcastle Harbour, was RL 1.35m AHD. Infrequent (1% AEP) and extreme ocean flood events (PMF) were modelled with a peak Newcastle Harbour ocean level of RL 1.4 AHD. The 1% AEP and PMF scenarios were modelled with a 0.9m allowance for sea level rise and represent future planning horizons with adjustment for potential climate change impacts.

The modelled results from the Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012) showed low-lying areas such as Carrington and Maryville would be subject to increased coastal inundation into the future. The Strategic Position for the Management of the Low Lying Areas in Newcastle (BMT WBM, 2015) has undertaken further coastal inundation modelling of the low-lying parts of the coastal zone and included 1% and PMF scenarios for the immediate planning horizon. The Strategic Position for the Management of the Low Lying Areas in Newcastle (BMT WBM, 2015) has also undertaken more detailed modelling for future planning horizons, 2050 with 0.4m sea level rise and 2100 with 0.9m sea level rise, for 1%AEP and PMF events for the low-lying areas of the coastal zone.

Community benefit impact

The impacts to community benefit from coastal inundation are outlined in **Table 12**.

Table 12: Impacts to community benefit from coastal inundation

Community benefit	Impact from coastal inundation
Environmental	• Loss of habitat. • Change to habitat and floristic composition.
Economic	• Impact on tourism. • Impact on coast dependant businesses eg. surf schools. • Impact on buildings eg. structural damage, etc.
Social and cultural	• Loss of assets, infrastructure, private property. • Impact on beach amenity. • Loss or disruption of services. • Impact on recreational opportunities eg. surfing, surf lifesaving. • Impact to access to beach or surf zone. • Loss or disturbance of Aboriginal heritage items/sites. • Impact on heritage listed items.

5.2.5 Coastal cliff or slope instability

Assessment of cliff or slope instability geotechnical hazards along the Newcastle coastline from Nobbys headland to Glenrock SCA was undertaken in the Newcastle Coastline Hazard Definition Study (WBM Oceanics, 1998).

A further geotechnical assessment of coastal cliff and slope instability was undertaken in the Geotechnical Assessment of Newcastle Coastal Cliffs/Slopes (RCA Australia, 2013). The Geotechnical Assessment of Newcastle Coastal Cliffs/Slopes (RCA Australia, 2013) addressed specific geotechnical hazards along the coastline and undertook assessment in accordance with projected sea level rise outlined in the NSW Sea Level Rise Policy Statement (DECCW, 2009). Likely changes to current cliff/slope recession rates as a consequence of projected sea level rise were included in the Geotechnical Assessment of Newcastle Coastal Cliffs/Slopes (RCA Australia, 2013).

The Geotechnical Assessment of Newcastle Coastal Cliffs/Slopes (RCA Australia, 2013) performed a risk assessment posed by the identified geotechnical hazards for people, property, services, facilities, access, transport services and the environment. The identified hazards were ranked in order of risk and mitigation priority. Qualitative assessment of stability and suitability for development was conducted and risk mitigation and maintenance options for identified hazards provided.

Community benefit impact

The impacts to community benefit from coastal cliff or slope instability are outlined in **Table 13**.

Table 13: Impacts to community benefit from coastal cliff or slope instability

Community benefit	Impact from coastal cliff or slope instability
Environmental	• Loss or damage to habitat.
Economic	• Impact on buildings eg. structural damage, etc. • Impact on infrastructure. • Decrease in land value.
Social and cultural	• Loss or damage to assets, infrastructure, private property. • Loss or disruption of services. • Injury or loss of life. • Impact on aboriginal items/places of significance. • Impact on heritage listed items.

5.2.6 Tidal inundation

Tidal inundation is defined as the inundation of land by tidal action under average meteorological conditions and under any combination of astronomical conditions (OEH, 2013). The Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012) identified tidal inundation, during king tides, impacted low-lying drainage systems and suburbs around the lower Hunter River estuary. However, in addition to normal astronomical tides, low air pressure causes ocean levels to increase (inverse barometric set-up), while strong onshore winds can 'pile-up' water against the coast or estuary resulting in additional inundation.

The Strategic Position for the Management of the Low-Lying Areas in Newcastle: Scoping Study (BMT WBM, 2015) has modelled tidal inundation extents within the low-lying suburbs surrounding the Port of Newcastle and Throsby Creek. Modelling has been conducted under existing tidal conditions and under projected sea level rise rates in accordance with the NSW Sea Level Rise Policy Statement (DECCW, 2009). Tidal inundation extents were modelled with a projected sea level rise of 0.4m by 2050 and 0.9m by 2100.

Community benefit impact

The impacts to community benefit from tidal inundation are outlined in **Table 14**.

Table 14: Impacts to community benefit from tidal inundation.

Community benefit	Impact from tidal inundation
Environmental	• Loss of habitat. • Change to habitat and floristic composition.
Economic	• Impact on tourism. • Impact on coast dependant businesses. • Impact on buildings eg. structural damage or flooding, etc. • Impact on infrastructure.
Social and cultural	• Loss of assets, infrastructure, private property. • Impact on foreshore amenity such as parklands. • Loss or disruption of services. • Impact on recreational opportunities. • Impact on access to waterway. • Loss or disturbance of Aboriginal heritage items/sites. • Impact on heritage listed items.

5.3 Stormwater erosion

The contribution of stormwater outlets to overall erosion volumes on the beach during storm events is minor compared with natural coastal processes. However, stormwater discharge onto the beach can result in impacts such as:

- Localised erosion around outlets, which can result in steep, unstable eroded banks along the stormwater flow path; and
- Increased access of large waves to the beach profile.

Stormwater discharge directly onto the beach can result in high velocity flows following significant rainfall events. Stormwater discharge can also have poor water quality due to runoff from urban catchments. The Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)) identified ten stormwater discharge points directly onto the beach or into the ocean in the coastal zone.

Community benefit impact

The impacts to community benefit from stormwater erosion are outlined in **Table 15**.

Table 15: Impacts to community benefit from stormwater erosion.

Community benefit	Impact from stormwater erosion
Environmental	• Damage to dune systems.
Economic	• Impact on coast dependant businesses eg. surf schools. • Replacement of dune systems or upgrade to stormwater discharge outlet.
Social and cultural	• Impact on beach amenity. • Impact on recreational opportunities. • Impact to beach access. • Loss or disturbance of Aboriginal heritage items/sites. • Impact on heritage listed items.

5.4 Sand drift

Windborne sediment transport can result in sand drift from the beach profile to surrounding areas. All sandy beaches have a certain amount of sand drift, but sand drift can become a management issue where coastal development is being impacted by windborne sediment or significant volumes of sediment are being lost from the active beach system. Dune systems act as repositories to supply sand to the active beach during erosion periods, but if sand is lost landward through windborne transport the volume of sand available during erosion events is reduced resulting in greater potential erosion extent.

Sand drift can impact coastal development through:

- Burial of infrastructure and blockage of gutters and stormwater drains;
- Burial of property and private infrastructure and abrasion of buildings, vehicles etc; and
- Burial of terrestrial ecosystems.

Dune vegetation performs an important role in reducing sand drift by trapping windblown sand and retaining sand within the dune system and the active beach system. Sand drift can be initiated by dune degeneration and can lead to sand blowouts, which concentrate wind velocities and accelerate sand drift. A common cause of dune degeneration is uncontrolled pedestrian and vehicle traffic.

Community benefit impact

The threats to community benefit from sand drift are outlined in **Table 16**.

Table 16: Impacts to community benefit from sand drift.

Community benefit	Impact from sand drift
Environmental	• Damage to dune systems. • Loss of habitat.
Economic	• Impact on buildings and infrastructure. • Impact to private property.
Social and cultural	• Impact on beach amenity. • Disruption to beach access arrangements. • Exposure of Aboriginal heritage items/sites. • Impact on heritage listed items.

5.5 Urban stormwater discharge and water pollution

A water quality monitoring program was undertaken by the Office of Environment and Heritage (OEH) from August 2014-March 2015 in the Hunter River estuary (Swanson, Potts and Scanes, 2017). The water quality monitoring program identified concentrations of ammonia, nitrates and phosphate were elevated within the estuary. Ammonia levels were highest in the South Arm of the Hunter River suggesting industry may be a primary source of ammonia. Concentrations of nitrates and phosphates increased with distance upstream suggesting agricultural land use in the upper catchment is a primary source. However, nutrients were lower than pre-2000 levels (Swanson, Potts and Scanes, 2017(b)).

The water quality monitoring program identified chlorophyll in the lower Hunter River estuary was low despite the persistently high concentrations of dissolved nutrients. Swanson, Potts and Scanes (2017) identified the low level of chlorophyll may be a result of multiple stressors within the estuary, including high concentrations of nutrients, heavy metals and turbidity.

In 2015, OEH implemented a stormwater quality monitoring program, which targeted storm runoff from industrial sites and urban areas in the lower Hunter River estuary (Swanson, Potts and Scanes, 2017(c)). High concentrations of ammonia, nitrate and phosphates were measured in stormwater discharge, particularly around Kooragang. Moderate concentrations of nitrates and ammonia were also measured in Throsby Creek.

The stormwater quality monitoring program also identified high concentrations of dissolved zinc and manganese after rainfall in the south arm of the Hunter River, around the Port of Newcastle and in Throsby Creek. High concentrations of dissolved copper were widespread in the lower estuary and may be a result of anti-fouling coatings applied to ship hulls. Moderate levels of arsenic were measured at multiple stormwater discharge sites and may be a by-product from industrial sources or leached from contaminated fill material. Polyaromatic hydrocarbons (PAH) were identified in low concentrations in Throsby Creek with vehicle use in the urban area identified as a potential source.

Faecal bacteria and Escherichia coli (E.coli) were sampled in the lower Hunter River estuary. Throsby Creek contained the highest number of faecal bacteria after rainfall events. This is typical of urban waterways after rainfall due to stormwater overflows in the sewerage network, broken pipes and aging infrastructure. Water samples collected from the south arm of the Hunter River also had high numbers of faecal bacteria. This may be due to discharge of sewage treatment plants. High levels of faecal bacteria were also identified in the north arm of the Hunter River.

The Beachwatch water quality program is undertaken at eight sites along the open coast of the CN LGA by Hunter Water Corporation. The Beachwatch programs monitors microbial levels (Enterococci) in ocean waters. **Table 17** provides an overview of the sampling sites, bacteria analysis and sampling frequency.

Weekly star ratings for water quality are reported on the HWC and OEH websites. The Beachwatch State of the Beaches 2017-2018 – Hunter Region (OEH, 2018(b)) notes all sampling sites within the CN LGA are rated as good or very good under the Beach Suitability Grade Matrix for the 2017-2018 period. These grades have continued since the 2014-2015 period indicating microbial water quality levels at beaches in the CN LGA are relatively low and meet the requirements of the 'Guidelines for managing risks in recreational water' (NHMRC, 2008).

Table 17: Beachwatch water quality program within the City of Newcastle.

Beachwatch sample location	Analyte	Frequency of sampling
South Stockton Beach	Enterococci	Weekly, year round
Nobbys Beach	Enterococci	Weekly, year round
Newcastle Beach	Enterococci	Weekly, year round
Bar Beach	Enterococci	Weekly, year round
Merewether Beach	Enterococci	Weekly, year round
Glenrock State Conservation Reserve (Burwood Beach North)	Enterococci	Weekly, year round
Glenrock State Conservation Reserve (Burwood Beach South)	Enterococci	Weekly, year round
Glenrock State Conservation Reserve (Glenrock Lagoon Beach)	Enterococci	Weekly, year round

Community benefit impact

The threats to community benefit from urban stormwater discharge and water pollution are outlined in **Table 18**.

Table 18: Impacts to community benefit from urban stormwater discharge and water pollution.

Community benefit	Impact from urban stormwater discharge and water pollution
Environmental	• Impacts on trophic levels and habitat. • Impacts to aquatic species eg. microplastics.
Economic	• Impact on fishing industry. • Impact on tourism, coast-dependant businesses.
Social and cultural	• Impact on recreational opportunities eg. fishing. • Impact on swimming areas, surf areas. • Beach amenity.

5.6 Climate change

The potential impacts of climate change within the Hunter Region have been outlined as part of the Hunter Central Coast Regional Environmental Management Strategy (HCCREMS, 2010).

Potential impacts on the coastal zone include:

- coastal inundation associated with sea level rise and storm surges;
- extreme rainfall, flooding and storms;
- changes to fire weather conditions;
- changes to average rainfall; and
- changes to average and extreme temperatures.

The Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014) includes modelling of potential coastal hazards along the open coast in response to projected climate change levels. However, climate change impacts are not restricted to coastal hazards alone and climate change poses a significant threat to the overall management of the coastal zone.

Community benefit impact

The threats to community benefit from climate change are outlined in **Table 19**.

Table 19: Impacts to community benefit from climate change

Community benefit	Impact from climate change
Environmental	• Loss of habitat. • Change to habitat and floristic composition. • Loss of species.
Economic	• Impact on infrastructure, industries. • Impact on private properties.
Social and cultural	• Impact on beach amenity. • Impacts on use of coastal zone. • Loss of Aboriginal heritage items/sites. • Impact on heritage listed items.

5.7 Urban development

The Newcastle coastal zone is projected to increase in population by 10,368 people in the period 2018-2041 (**Figure 35**) with an associated increase in 6,733 dwellings (**Figure 36**). The Greater Newcastle Metropolitan Plan 2036 (DPE, 2018) also projects an additional 8,300 jobs within the Newcastle coastal zone by 2036. The CN coastal zone is currently highly urbanised, but increased demand for residential and employment land will place additional pressure on the coastal zone.

Increased population growth, both within the coastal zone and the wider region, will place increased demands on the beach environment and coastal facilities for recreational and leisure purposes (see increased community use).

Community benefit impact

The impact to community benefit from urban development in the coastal zone are outlined in **Table 20**.

Table 20: Impacts to community benefit from increasing urban development

Community benefit	Impact from urban development
Environmental	• Water pollution from urban stormwater. • Impact on terrestrial habitat from development including foreshore development.
Economic	• Increased money spent in local economy from construction. • Increased employment opportunities.
Social and cultural	• Change in coastal communities eg. higher density urban environment. • Disturbance to Aboriginal heritage items. • Increased use of European heritage items eg. Newcastle Ocean Baths. • Redevelopment or loss of European heritage items.

5.8 Increased community use

Increased population growth, both within the coastal zone and the wider region, and increased visitation to the coastal zone eg. from tourism, has the potential to result in impacts such as overcrowding of beaches and congestion within the coastal zone. Congestion of the local road network and carparking facilities during summer months is currently evident for some beaches south of the Hunter River eg. Newcastle, Bar Beach and Merewether.

Community benefit impact

The impact to community benefit from increased community use of the coastal zone are outlined in **Table 21**.

Table 21: Impacts to community benefit from increased community use of the coastal zone.

Community benefit	Impacts from increased use of the coastal zone
Environmental	• Damage to habitat.
Economic	• Increased money spent in local economy. • Increased employment opportunities. • Increased tourism. • Parking revenue.
Social and cultural	• Overcrowding of beach areas. • Congestion on road network/ parking facilities. • Increased use of facilities eg. ocean baths and associated amenities. • Disturbance to Aboriginal heritage items. • Increased use of European heritage items eg. Newcastle Ocean Baths.

5.9 Boating

In July 2009, 229,000 boating vessels were registered in NSW with 97% listed as recreational vessels (NSW Maritime, 2010). The Hunter Inland Region recorded the highest number of boat ownership in NSW with 53,705 vessels or 24% of the overall state boat ownership. NSW Maritime forecasted boat ownership in the Hunter Inland Region to reach 92,140, or a 58% increase, by 2026.

Specific boat ownership statistics could not be obtained for the Newcastle coastal zone but based on the forecasted boat ownership trend the recreational use of the coastal zone is likely to increase. Three public boat ramps are located within the scoping study area at:

1. Carrington: North of Cowper Street bridge. Ramp to Throsby Creek.
2. Stockton: 197 Fullerton Street. Ramp to Hunter River.
3. Stockton: 71 Clyde Street. Ramp to Hunter River.

The Newcastle Cruising Yacht Club 180 berth floating marina is in Throsby Creek at Wickham while the Commercial Fisherman's Co-operative is located further north at 97B Hannell Street, Wickham with mooring for commercial fishing vessels.

The increasing recreational boating use of the coastal zone presents potential management issues for the coastal zone including aquatic species catch management and water pollution from vessels.

Community benefit impact

The impact to community benefit from boating activities are outlined in **Table 22**.

Table 22: Impacts to community benefit from increased boating in the coastal zone.

Community benefit	Impacts from increased boating
Environmental	• Water pollution (antifouling chemicals, spills, debris). • Disturbance to wildlife. • Reduction in fish species or aquatic organisms from increased fishing activity. • Spread of exotic species.
Economic	• Management of fish, aquatic species for commercial fishing operations.
Social and cultural	• Increased use of coastal zone by increasing number of recreational boat users. • Congestion at boat ramps, availability of boat ramps.

5.10 Port operations

A key goal of the Hunter Regional Plan 2036 (DPE, 2016) is to be the leading regional economy in Australia. A key strategic direction for this goal is the diversification and expansion of the operation of the Port of Newcastle. The operation of the Port of Newcastle, both current and future, represents a significant economic driver for the local, NSW and Australian economy as the port handles over $15 billion in trade annually (Port of Newcastle, 2014).

The proposed expansion of the operations of the Port of Newcastle present potential management issues for the coastal zone. Potential management issues associated with the expanding operations of the port include ongoing dredging of the harbour, increased shipping numbers and intensified development of port-side land.

Community benefit impact

The impact to community benefit from coastal inundation are outlined in **Table 23**.

Table 23: Impacts to community benefit from operations at Port of Newcastle.

Community benefit	Impacts from operation of Port of Newcastle
Environmental	• Water pollution (antifouling chemicals, spills, sediment, debris). • Changes to riverbed/aquatic habitat from dredging activities. • Changes to tidal flow and pattern. • Loss of terrestrial habitat from port development. • Disturbance to wildlife. • Introduction of exotic species.
Economic	• Increased trade through port.
Social and cultural	• Increased employment opportunities. • Disturbance of aboriginal heritage items.

5.11 Impacts to rock platforms

The Newcastle coastal zone has nine rock platforms along the southern part of the CN coastline. These platforms can be divided into three distinct areas, Nobbys; Newcastle-Susan Gilmore; Merewether-Burwood. These rock platforms provide habitat for a high diversity of plants and animals (Gladstone and Herbert, 2006). The rock platforms are also easily accessible by people and provide opportunities for recreation and education.

Community benefit impact

The impact to community benefit from rock platforms in the coastal zone are outlined in **Table 24**.

Table 24: Impacts to community benefit of rock platforms.

Community benefit	Impacts to rock platforms
Environmental	• Damage to habitat. • Disturbance of wildlife. • Change to platform habitat from climate change eg. sea level rise.
Economic	• Damage to facilities currently built on rock platform.
Social and cultural	• Impacts from recreation activities eg. fishing, access to surfing areas. • Loss of recreation area.

5.12 Invasive species

The environment of the CN coastal zone has been highly modified by urban development. However, areas of the coastal zone comprise sand scrub, spinifex and coastal heathland vegetation communities. These communities are threatened by invasive species such as Bitou Bush (*Chrysanthemoides monilifera*), which was first recorded in Australia in the Stockton area (NPWS, 2006).

Community benefit impact

The impact to community benefit from invasive species in the coastal area are outlined in **Table 25**.

Table 25: Impacts to community benefit from invasive species

Community benefit	Impact from invasive species
Environmental	• Loss of habitat. • Change in floristic composition of habitat. • Loss of native species.
Economic	• Increased costs for maintenance of environment areas including bush regeneration activities.
Social and cultural	• Disturbance of aboriginal heritage items.

6. Coastal management areas

SEPP (Coastal Management) 2018 defined and mapped four coastal management areas within the coastal zone. The following section identifies the four coastal management areas within the scoping study area.

6.1 Littoral rainforest

The scoping study area has one land parcel mapped as littoral rainforest under *SEPP (Coastal Management) 2018*. This land parcel is 5000m^2 in size and is located at 66 Hickson Street, Merewether (Lot 21 DP 774388) (**Figure 53**). The land parcel is owned and managed by CN and bush regeneration works are being undertaken within the parcel to enhance and re-establish the floristic composition of the littoral rainforest. This is being undertaken in accordance with a vegetation management plan for the site (Coast Ecology, 2017).

The area at Hickson Street, Merewether is the first littoral rainforest mapped in the CN LGA as no previous areas were included in *SEPP 26 - Littoral Rainforests*. However, the littoral rainforest vegetation community is known to occur in Glenrock SCA to the south of the land parcel (NPWS, 2010).

The CMP will include this area of littoral rainforest and the boundary of the mapped area will not change as the area is surrounded by residential housing. The land area is being appropriately managed and ongoing/future management actions for the littoral rainforest will be included in the CMP.

Figure 53: Littoral rainforest
Hickson Street, Merewether

6.2 Coastal wetlands

Three areas mapped as coastal wetland under *SEPP (Coastal Management) 2018* are located within the scoping study area. Clause 10 of *SEPP (Coastal Management) 2018* relates to development in mapped coastal wetlands and littoral rainforest (see **Section 6.1**) and includes:

(1) The following may be carried out on land identified as "coastal wetlands" or "littoral rainforest" on the Coastal Wetlands and Littoral Rainforests Area Map only with development consent:

(a) the clearing of native vegetation within the meaning of Part 5A of the *Local Land Services Act 2013*,

(b) the harm of marine vegetation within the meaning of Division 4 of Part 7 of the *Fisheries Management Act 1994*,

(c) the carrying out of any of the following:

(i) earthworks (including the depositing of material on land),

(ii) constructing a levee,

(iii) draining the land,

(iv) environmental protection works,

d) any other development.

Note.

Clause 17 provides that, for the avoidance of doubt, nothing in this Part:

(a) permits the carrying out of development that is prohibited development under another environmental planning instrument, or

(b) permits the carrying out of development without development consent where another environmental planning instrument provides that the development may be carried out only with development consent.

(2) Development for which consent is required by subclause (1), other than development for the purpose of environmental protection works, is declared to be designated development for the purposes of the Act.

(3) Despite subclause (1), development for the purpose of environmental protection works on land identified as "coastal wetlands" or "littoral rainforest" on the Coastal Wetlands and Littoral Rainforests Area Map may be carried out by or on behalf of a public authority without development consent if the development is identified in:

(a) the relevant certified coastal management program, or

(b) a plan of management prepared and adopted under Division 2 of Part 2 of Chapter 6 of the *Local Government Act 1993*, or

(c) a plan of management approved and in force under Division 6 of Part 5 of the *Crown Lands Act 1989*.

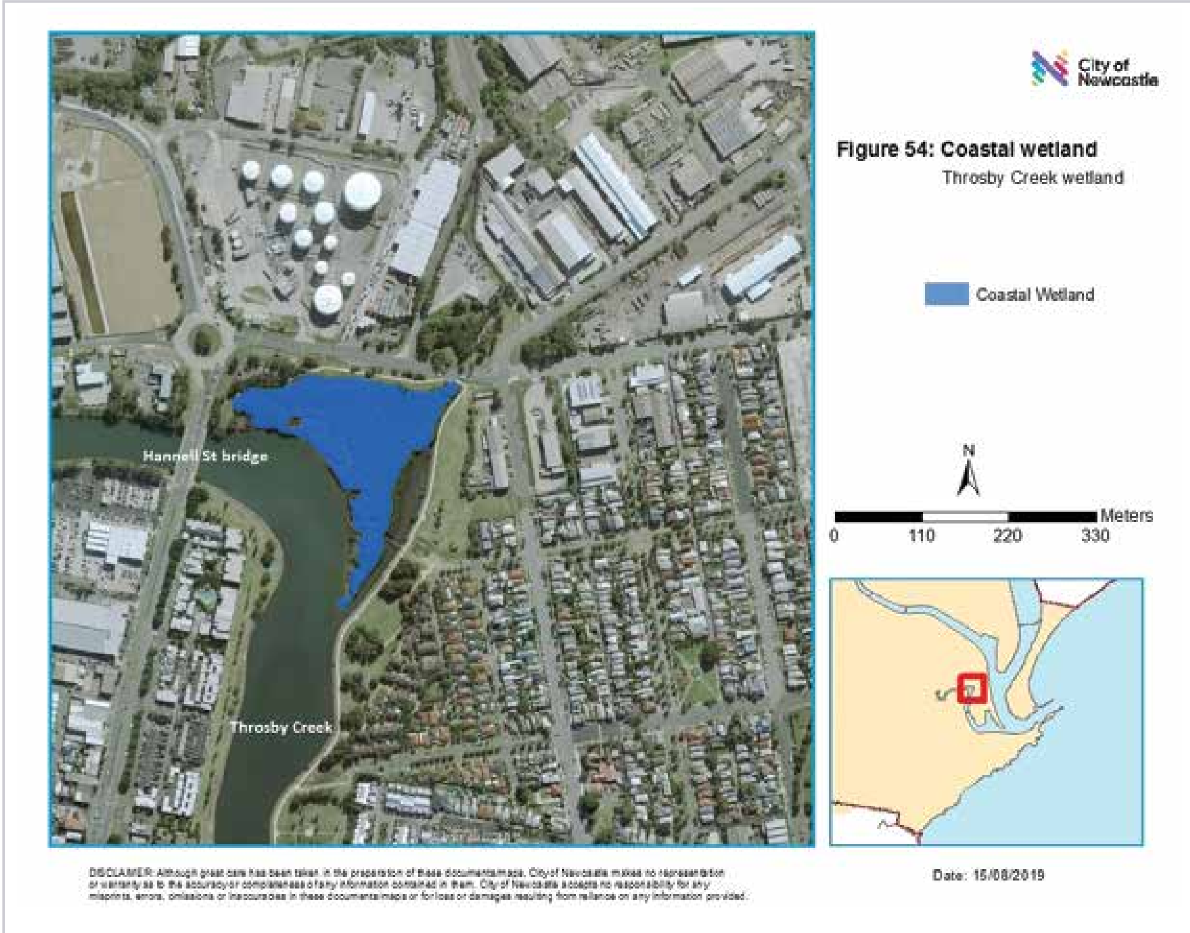
(4) A consent authority must not grant consent for development referred to in subclause (1) unless the consent authority is satisfied that sufficient measures have been, or will be, taken to protect, and where possible enhance, the biophysical, hydrological and ecological integrity of the coastal wetland or littoral rainforest.

(5) Nothing in this clause requires consent for the damage or removal of a priority weed within the meaning of clause 32 of Schedule 7 to the *Biosecurity Act 2015*.

(6) This clause does not apply to the carrying out of development on land reserved under the *National Parks and Wildlife Act 1974* if the proposed development is consistent with a plan of management prepared under that Act for the land concerned.

6.2.1 Throsby Creek wetland

Mangrove forest in Throsby Creek at Carrington, east of the Hannell Street bridge (**Figure 54**). The mangrove forest provides habitat for a flying-fox camp (DEE, 2018) including migrating or transient Grey-headed Flying-fox (*Pteropus poliocephalus*) and Black Flying-fox (*Pteropus alecto*). The Grey-headed Flying-fox is listed as vulnerable under the *NSW Biodiversity Conservation Act 2016* and the federal *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth). The coastal wetland is also considered key fish habitat under the *Fisheries Management Act 1994*. The mapped coastal wetland is located on land owned by the Roads and Maritime Services (RMS). RMS will be consulted through the CMP process regarding the management of this coastal wetland.



6.2.2 Kooragang wetland – East of Tourle Street bridge

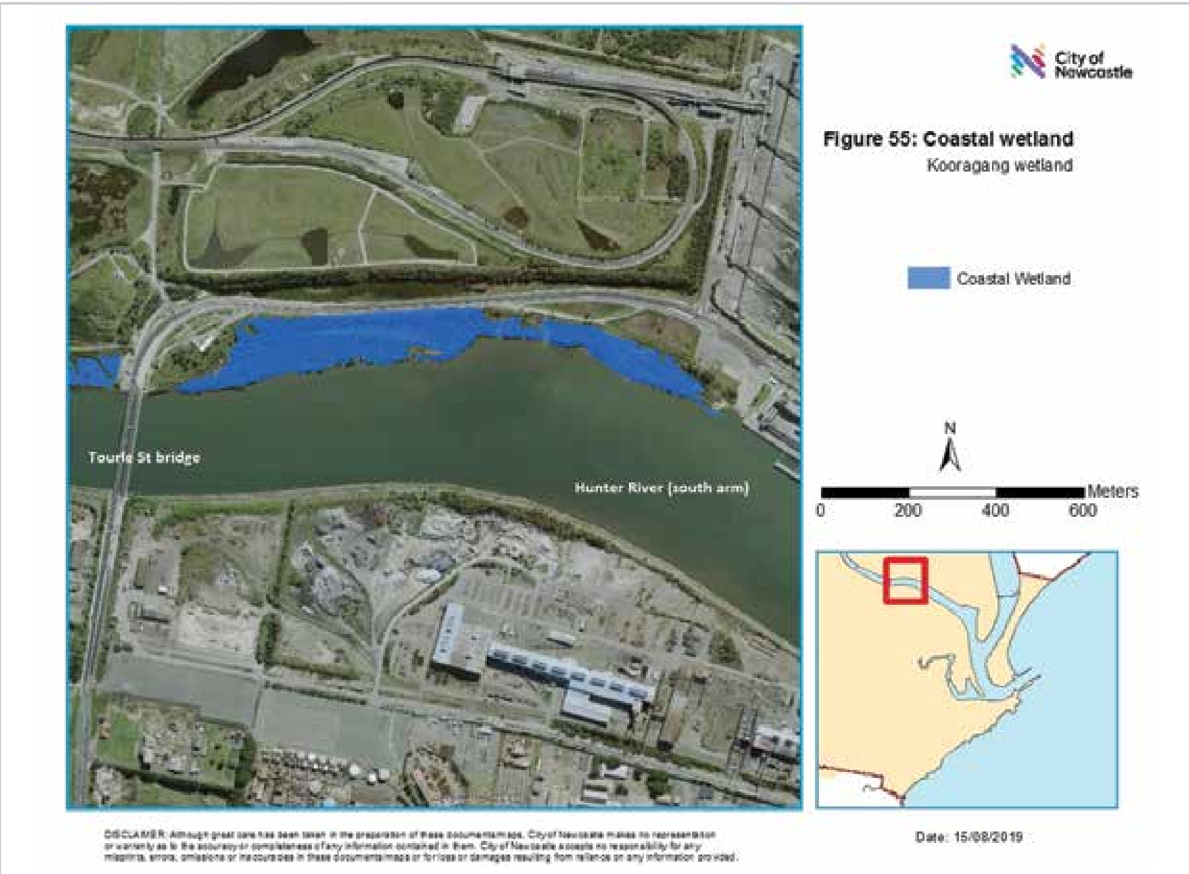
Area on the northern bank of the south arm of the Hunter River at Kooragang, east of Tourle Street bridge (**Figure 55**). The mapped coastal wetland consists of the following vegetation communities (Parsons Brinckerhoff, 2014):

- Coastal freshwater wetland (EEC under the *Biodiversity Conservation Act 2016*);
- Mangrove Forest; and
- Coastal saltmarsh (EEC under the Biodiversity *Conservation Act 2016* and vulnerable community under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)).

The mapped coastal wetland provides habitat for the following threatened species:

- Green and Golden Bell Frog (*Litoria aurea*) (Endangered under the *Biodiversity Conservation Act 2016* and vulnerable species under *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth));
- Little Bentwing-Bat (*Miniopterus australis*) (Vulnerable species under the *Biodiversity Conservation Act 2016*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (Vulnerable species under the *Biodiversity Conservation Act 2016*);
- Southern Myotis (*Myotis maropus*) (Vulnerable species under the *Biodiversity Conservation Act 2016*); and
- White-fronted Chat (*Epthianura albifrons*) (Vulnerable species under the *Biodiversity Conservation Act 2016*).

This coastal wetland is located within the lease area of *SEPP (Three Ports) 2013* and under Clause 7 of *SEPP (Coastal Management) 2018* the coastal management area does not apply. The area is owned by RMS and leased to the Port of Newcastle. CN will consult with both RMS and Port of Newcastle regarding the management of this coastal wetland as part of the CMP process.



6.2.3 Stockton sandspit and Stockton foreshore wetland

Coastal wetland at Stockton Sandspit (base of Stockton Bridge) and edge of western Stockton shoreline on north arm of Hunter River (**Figure 56**). The Stockton Sandspit is an artificially created landscape from the construction of Stockton Bridge, but comprises open saltmarsh and is significant habitat for threatened and migratory birds (NPWS, 2015). The Stockton Sandpit also forms part of the Hunter Estuary Wetlands Ramsar site and is protected under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth). The Stockton Sandspit is managed by the NSW NPWS under a Plan of Management (NPWS, 2015).

The remainder of the mapped coastal wetland is located on the western edge of Stockton foreshore on the North Arm of the Hunter River. This part of the coastal wetland is mainly estuarine mangrove forest and is managed by CN.

The CMP process will address potential impacts to this wetland area in consultation with NPWS, but the boundary of the coastal wetland is not proposed to be changed as part of the CMP process.

6.3 Coastal vulnerability area

Coastal vulnerability areas were not mapped with the introduction of *SEPP (Coastal Management) 2018*. However, Clause 12 of *SEPP (Coastal Management) 2018* outlines development controls for areas mapped as coastal vulnerability areas and include:

(1) Development consent must not be granted to development on land that is within the area identified as "coastal vulnerability area" on the Coastal Vulnerability Area Map unless the consent authority is satisfied that:

(a) if the proposed development comprises the erection of a building or works—the building or works are engineered to withstand current and projected coastal hazards for the design life of the building or works, and

(b) the proposed development:

(i) is not likely to alter coastal processes to the detriment of the natural environment or other land, and

(ii) is not likely to reduce the public amenity, access to and use of any beach, foreshore, rock platform or headland adjacent to the proposed development, and

(iii) incorporates appropriate measures to manage risk to life and public safety from coastal hazards, and

(c) measures are in place to ensure that there are appropriate responses to, and management of, anticipated coastal processes and current and future coastal hazards.

6. Coastal management areas

Assessment of coastal hazards for the open coastline was completed in the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014) with coastal hazard lines/areas defined for beach erosion/shoreline recession and coastal inundation. The Geotechnical Assessment of Newcastle Coastal Cliffs/Slopes (RCA Australia, 2013) also defined areas of geotechnical hazards regarding coastal cliff and slope instability.

Assessment of coastal and tidal inundation and the impacts of sea level rise for low-lying areas, including impacts on flooding, on the scoping study area was completed in the Strategic Position for the Management of the Low-Lying Areas in Newcastle Report (BMT WBM, 2015).

These reports will be used to inform the potential assessment, or additional studies required, for mapping of the coastal vulnerability area.

6.4 Coastal environment area

The coastal environment area is mapped as a defined distance of 500m landward from the edge of the ocean shoreline and around the waters of the Hunter River estuary, including the Throsby Creek catchment, within the scoping study area. The coastal environment area extends outside of the scoping study area into other parts of the CN LGA and adjoining LGAs. The coastline south of the Hunter River, from the southern end of Newcastle Beach to the southern extent of the CN LGA, is a defined distance of 250m from the edge of the ocean shoreline.

The coastal environment area also includes the marine environment seaward of the shoreline and the waterways of the Hunter River and Throsby Creek (**Figure 57**).

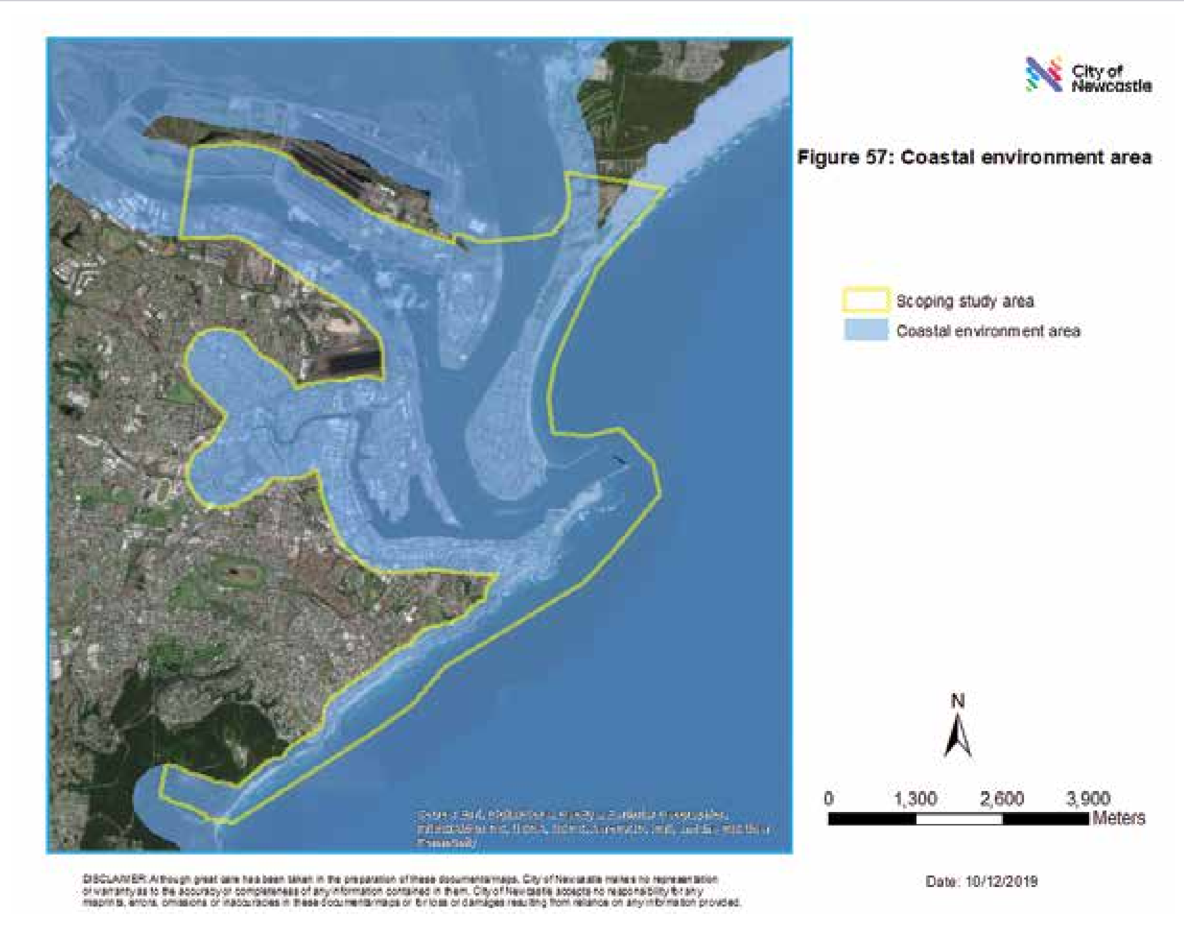


Figure 57: Coastal environment area

6.5 Coastal use area

The coastal use area is mapped as a defined distance of 250m landward from the edge of the ocean shoreline and around the waters of the Hunter River estuary within the scoping study area. The coastal use extends outside of the scoping study area. The coastline south of the Hunter River, from the southern end of Newcastle Beach to the southern extent of the CN LGA, is a defined distance of 500m from the edge of the ocean shoreline. This 500m distance also occurs from the edge of the ocean shoreline along Stockton Beach (**Figure 58**).

Overlap of the coastal environment and coastal use management areas occur throughout most of the scoping study area. Development controls for these two coastal management areas are hierarchical with the development controls for coastal environment area prevailing over the coastal use area.

Clause 13 of *SEPP (Coastal Management) 2018* outlines development controls for the coastal environment area as:

(1) Development consent must not be granted to development on land that is within the coastal environment area unless the consent authority has considered whether the proposed development is likely to cause an adverse impact on the following:

(a) the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment,

(b) coastal environmental values and natural coastal processes,

(c) the water quality of the marine estate (within the meaning of the *Marine Estate Management Act 2014*), in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes identified in Schedule 1,

(d) marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms,

(e) existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability,

(f) Aboriginal cultural heritage, practices and places,

(g) the use of the surf zone.

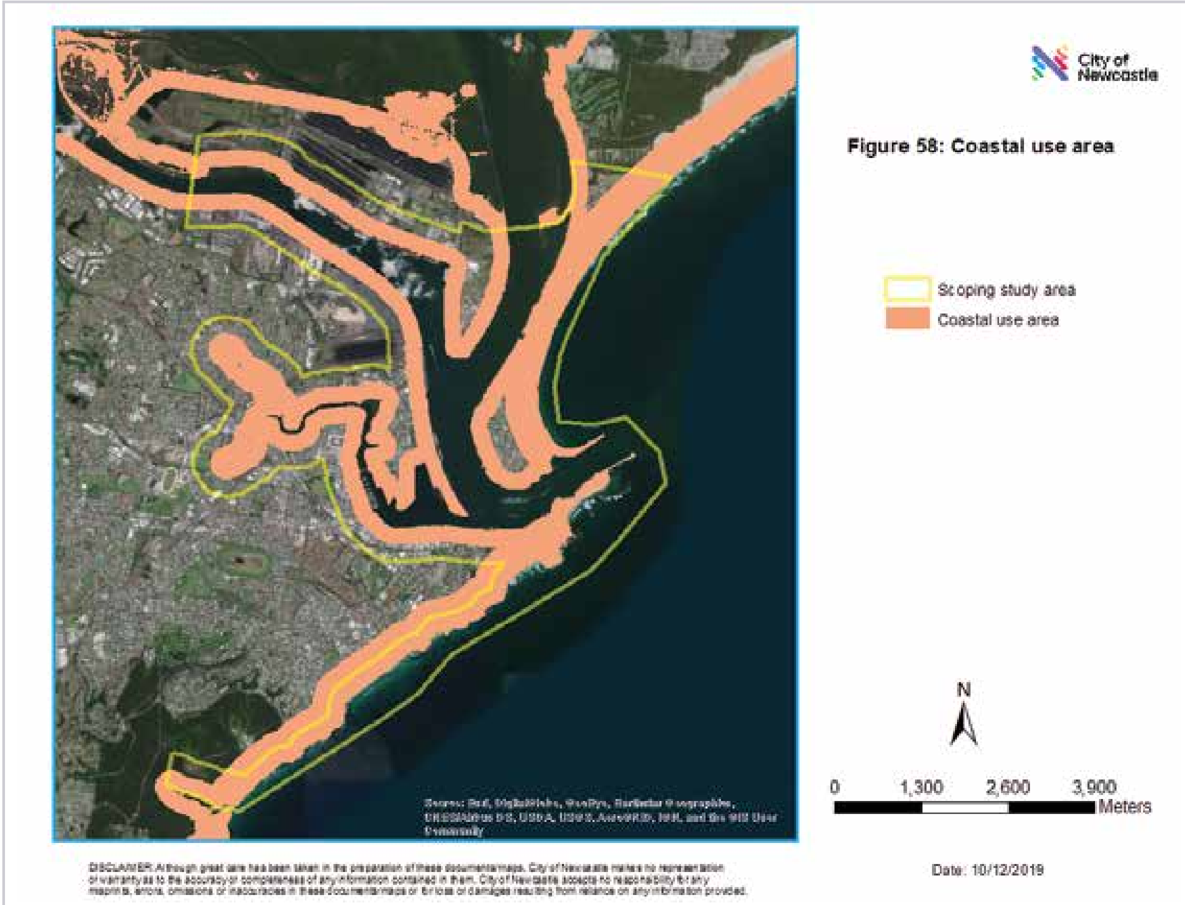


Figure 58: Coastal use area

(2) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

(a) the development is designed, sited and will be managed to avoid an adverse impact referred to in subclause (1), or

(b) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or

(c) if that impact cannot be minimised—the development will be managed to mitigate that impact.

Clause 14 of *SEPP (Coastal Management) 2018* outlines the development controls for the coastal use area as:

(1) Development consent must not be granted to development on land that is within the coastal use area unless the consent authority:

(a) has considered whether the proposed development is likely to cause an adverse impact on the following:

(i) existing, safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability,

(ii) overshadowing, wind funnelling and the loss of views from public places to foreshores,

(iii) the visual amenity and scenic qualities of the coast, including coastal headlands,

(iv) Aboriginal cultural heritage, practices and places,

(v) cultural and built environment heritage, and

(b) is satisfied that:

(i) the development is designed, sited and will be managed to avoid an adverse impact referred to in paragraph (a), or

(ii) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or

(iii) if that impact cannot be minimised—the development will be managed to mitigate that impact, and

(c) has taken into account the surrounding coastal and built environment, and the bulk, scale and size of the proposed development.

There is significant overlap of the development controls for the coastal environment and coastal use management areas. The development controls are broad and wide ranging and many controls relate to other legislative instruments referred to under the *Environmental Planning and Assessment Act 1979* or development assessment is controlled by the requirements of other legislative acts or the Newcastle DCP 2012. While the development controls are hierarchical the two coastal management areas could generate confusion and CN may potentially seek alterations to rationalise the mapped areas. The requirements and mapping of the coastal environment and coastal use areas will be discussed with the appropriate State Government departments responsible for the environment planning instrument.

7. Review of current coastal arrangements

Coastal zone management has been undertaken since the mid-2000's through the previously adopted Newcastle Coastline Management Plan (Umwelt, 2003). The Newcastle Coastal Zone Management Plan 2018 (NCC, 2018(b)) was certified under the *Coastal Protection Act 1979* in August 2018 and evaluation of management actions from this plan are restricted due to the limited timeframe for implementation.

7.1 Littoral rainforest

The area of littoral rainforest at Hickson Street, Merewether is undergoing a bush regeneration program in accordance with a Vegetation Management Plan (Coast Ecology, 2017). The area was degraded and the re-establishment of the littoral rainforest vegetation community has been successful with the parcel being mapped in *SEPP (Coastal Management) 2018*.

The current management of the area has been successful and continued bush regeneration activities will be undertaken to ensure resilience of this vegetation community at the site. Due to the area being surrounded by urban development, potential management issues into the future include edge effects, control of invasive species including Bitou Bush (*Chrysanthemoides monilifera*), waste dumping and urban stormwater discharge through the area. The area is constrained by surrounding urban development but the primary constraint to ongoing re-establishment and management is financial resources.

Other vegetated land parcels close to the area of littoral rainforest at Merewether may contain littoral rainforest but require further investigation to establish the existing vegetation community and potential for re-establishment and/or management as littoral rainforest.

7.2 Coastal wetlands

7.2.1 Throsby creek wetland

The mangrove forest at Throsby Creek is currently managed by RMS. CN provides public access to the coastal wetland via a boardwalk through the mangrove forest which was undertaken as part of the Honeysuckle redevelopment project in the early 1990s. Study of herbivory and insect damage to the leaves of the mangrove as an indicator of mangrove health was conducted in 2015 (Swanson, Potts and Scanes, 2017(d)). Analysis of the mangrove leaves revealed considerable amounts of dead tissue and leaf health was poor. However, the mangrove forest provides substantial habitat for endemic species, including roosting habitat for threatened flying-fox species.

Management practices of the RMS within the coastal wetland are currently unknown, but CN provides public access to the wetland which requires asset management.

Management issues for this coastal wetland include:

- impacts on mangrove health from water quality in Throsby Creek due to urban stormwater discharge;
- impacts on mangrove health from sediment contamination and potential dredging of Throsby Creek;
- impacts on mangrove health from air emissions from surrounding industries and operation of the Port of Newcastle;
- inundation from sea level rise and impacts on mangrove mortality rate. Mangrove forest migration is constrained by urban development; and
- inundation impacts and hydrological changes from the implementation of the Strategic Position for the Management of Low-Lying Areas of Newcastle (NCC, 2017).

7.2.2 Kooragang wetland – East of Tourle Street bridge

The mangrove forest and saltmarsh community are currently owned by RMS and forms part of the lease area under *SEPP (Three Ports) 2013*. Study of herbivory and insect damage to the leaves of the mangroves in the coastal wetland revealed considerable amounts of dead tissue and mangrove leaves were covered in a layer of fine black particles (Swanson, Potts and Scanes, 2017(d)). Overall, the leaves of the mangroves were considered to be in poor condition. However, the area does contain listed EECs under the *Biodiversity Conservation Act 2016* and *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) as outlined in **Section 6.2.2**. Management issues and threats to the coastal wetland include:

- impacts on coastal wetland from water quality in south arm of Hunter River, including urban and industrial stormwater and sewerage discharge;
- impacts from sediment contamination;
- impacts on mangrove health from air emissions from surrounding industries and operation of the Port of Newcastle;
- inundation from sea level rise and change in vegetation communities and habitat;
- lack of wetland retreat area due to surrounding development;
- development and expansion of the Port of Newcastle and application of *SEPP (Three Ports) 2013*.
- edge effects from urban development including invasive species; and
- waste dumping.

7.2.3 Stockton sandspit and Stockton foreshore wetland

The area mapped as coastal wetland at the Stockton sand spit is managed as below:

- area north of Stockton Bridge in the Hunter River is managed by NPWS. The area is managed through the Hunter Wetlands National Park Draft Plan of Management (NPWS, 2015) and includes active removal of mangroves to facilitate maintenance of saltmarsh areas for migratory bird habitat; and
- area south of Stockton Bridge is managed by CN. The area has been rehabilitated with native vegetation and is managed through the Coasts and Estuary Vegetation Management Plan (Umwelt, 2014).

The area mapped as coastal wetland along the Stockton foreshore is primarily mangrove forest and managed by CN. The mangrove forest is in good condition and is managed through the Coasts and Estuary Vegetation Management Plan (Umwelt, 2014). Management issues for the coastal wetland include:

- impacts on coastal wetland from water quality in north arm of Hunter River including urban and industrial stormwater and sewerage discharge,
- impacts from sediment contamination,
- impacts on mangrove health from air emissions from surrounding industries and operations of the Port of Newcastle,
- inundation from sea level rise and change in vegetation communities and habitat,
- invasive species, and
- waste dumping.

The management of CN's coastal wetland areas are undertaken through the Coasts and Estuary Vegetation Management Plan (Umwelt, 2014). The primary constraint to ongoing management of CN's coastal wetland is the availability of financial resources to maintain the vegetation community.

7.3 Coastal vulnerability area

7.3.1 Interaction of environmental planning instruments

EPIs have the potential to change the planning pathway for development within the coastal zone, particularly on public land. Clause 8 of *SEPP (Infrastructure) 2007* aims to facilitate the effective delivery of infrastructure across NSW by public authorities on public and community land. This delivery is facilitated by many infrastructure activities being considered development permitted without consent and assessed under Part 5 of the *Environmental Planning and Assessment Act 1979*. However, the requirements of the coastal vulnerability area under Clause 12 of *SEPP (Coastal Management) 2018* are only considered for development with consent under Part 4 of the *Environmental Planning and Assessment Act 1979*. Therefore, most infrastructure projects, or at least those considered as development permitted without consent, will not be required to consider the requirements of the mapped coastal vulnerability area.

The relationship between *SEPP (Infrastructure) 2007* and *SEPP (Coastal Management) 2018* is contained within Clause 8 of *SEPP (Infrastructure) 2007* below:

(1) Except as provided by subclause (2), if there is an inconsistency between this Policy and any other environmental planning instrument, whether made before or after the commencement of this Policy, this Policy prevails to the extent of the inconsistency.

Note.

Subclause (1) does not prevent a local environmental plan from making provision about development of a kind specified in Part 3 in a particular zone if the provisions of this Policy dealing with development of that kind do not apply in that zone.

(2) Except as provided by subclauses (3) and (4), if there is an inconsistency between a provision of this Policy and any of the following provisions of another environmental planning instrument, the provision of the other instrument prevails to the extent of the inconsistency:

(a) clauses 10, 11 and 19 of State *Environmental Planning Policy (Coastal Management) 2018*,

(b) all of the provisions of *State Environmental Planning Policy (State Significant Precincts) 2005*.

(3) Clause 48B of this Policy prevails over clauses 10 and 11 of *State Environmental Planning Policy (Coastal Management) 2018* to the extent of any inconsistency.

(4) A provision of this Policy that permits development for the purpose of emergency works or routine maintenance works to be carried out without consent, or that provides that development for that purpose is exempt development, prevails over clauses 10 and 11 of *State Environmental Planning Policy (Coastal Management) 2018* to the extent of any inconsistency, but only if any adverse effect on the land concerned is restricted to the minimum possible to allow the works to be carried out.

(5) For the avoidance of doubt, development to which subclause (3) or (4) applies is not declared designated development for the purposes of the Act.

As shown by Clause 8 of *SEPP (Infrastructure) 2007* the requirements of coastal vulnerability areas under Clause 12 of *SEPP (Coastal Management) 2018* are excluded and leads to the question of whether public land is required to be mapped as a coastal vulnerability area.

Development permitted without consent is required to consider factors outlined in Clause 228 of the *Environmental Planning and Assessment Regulation 2000*. These factors include:

(a) any environmental impact on a community,

(b) any transformation of a locality,

(c) any environmental impact on the ecosystems of the locality,

(d) any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality,

(e) any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations,

(f) any impact on the habitat of protected animals (within the meaning of the *Biodiversity Conservation Act 2016*),

(g) any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air,

(h) any long-term effects on the environment,

(i) any degradation of the quality of the environment,

(j) any risk to the safety of the environment,

(k) any reduction in the range of beneficial uses of the environment,

(l) any pollution of the environment,

(m) any environmental problems associated with the disposal of waste,

(n) any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply,

(o) any cumulative environmental effect with other existing or likely future activities,

(p) any impact on coastal processes and coastal hazards, including those under projected climate change conditions.

While assessment factors include impacts on coastal processes and coastal hazards this does not enact the requirements of the coastal vulnerability area. Therefore, while CN and public authorities are required to consider coastal processes based on available information as part of infrastructure projects that are considered development permitted without consent, the requirements of the coastal vulnerability are not required to be considered.

Due to time and financial implications involved in preparing a planning proposal for addition of areas to the coastal vulnerability map CN notes that public land will not be considered for addition to the coastal vulnerability areas at this stage.

7.3.2 Coastal vulnerability area methodology

Coastal vulnerability areas were not mapped with the introduction of *SEPP (Coastal Management) 2018*. CN has previously carried out assessment of coastal hazards for the open coastline in the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)) with the methodology for assessment outlined in Section 3 of the report. To meet the management objectives of the coastal vulnerability management area, as outlined in Section 7(2) of the *Coastal Management Act 2016*, a risk framework was applied to CN's open coastline area. The methodology for application of the risk framework is outlined in the Newcastle Coastal Zone Management Study ((BMWT WBM, 2014(b)).

Further assessment of coastal inundation was undertaken for areas within the Hunter River lower estuary, including the Throsby Creek catchment within the coastal zone, in the Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012). Additional assessment of coastal inundation, including tidal inundation was undertaken in the Strategic Position for the Management of the Low-Lying Areas in Newcastle: Scoping Study (BMT WBM, 2015).

A summary of the vulnerability and potential management risk for each area of the Newcastle coastline is provided below. However, CN notes the implementation of future management strategies, which are intended to be investigated and further developed through the CMP process, may alter the risk profile for parts of the coastal zone and influence the potential inclusion of these areas on the coastal vulnerability map in the future.

7.3.2.1 Stockton Beach

Beach erosion and shoreline recession

The complex modelling of coastal processes at Stockton Beach have been investigated in the Stockton Beach Coastal Processes Study (DHI, 2006) and Stockton Beach Coastal Processes Study Addendum (DHI, 2011). The Stockton Beach Coastal Processes Study (DHI, 2006) indicated that Stockton Beach is experiencing ongoing shoreline recession due to interruption of littoral drift into the sediment compartment from the south by the construction of the Hunter River breakwaters. Modelling showed ongoing shoreline recession is expected to continue across all planning horizons (2050, 2100) without management measures being undertaken. Figures in **Appendix E** are from the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)), but replicate the modelling from the Stockton Beach Coastal Processes Study (DHI, 2006) and Stockton Beach Coastal Processes Study Addendum (DHI, 2011) for beach erosion and shoreline recession.

Erosion events and associated shoreline recession have contributed to community infrastructure, including the former North Stockton Life Saving Club (currently operating as a childcare centre), and current Stockton Surf Life Saving Club, being at high risk of structural damage. A storm erosion event in January 2018 also resulted in exposure of a former landfill site at HWC owned land at 310 Fullerton Street.

Management of beach erosion and shoreline recession in the short-medium term have been outlined in the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018(b)). Management actions include removal of the former North Stockton Life Saving Club and temporary coastal protection works for the former landfill area, which has been recently completed. While the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018(b)) provides short-medium term direction for management of Stockton Beach further evaluation of long-term management measures is required to address beach erosion and shoreline recession.

Management of Stockton Beach prior to the certification of the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018(b)) was undertaken in a reactive manner with previous works including construction of temporary sandbag walls near the Stockton Surf Life Saving Club and dune reconstruction (WBM Oceanics, 1996) and construction of a seawall seaward of the Stockton Surf Life Saving Club in 2017. Management of Stockton Beach has been challenging in response to storm erosion events and the community has expressed dissatisfaction with current beach access arrangements and state of the beach for community use (CN, 2018).

Suitable dredged material from the Hunter River has been placed off Stockton Beach by the Port of Newcastle since 2009 under a concurrence issued by OEH. The dredged material has contributed to replacement of sediment within the sediment budget for the coastal compartment. However, evaluation of the contribution of the dredged material in addressing coastal hazards on Stockton Beach has not been undertaken and results/effectiveness of the sediment placement is currently unknown.

Due to risks from beach erosion and shoreline recession the potential for Stockton Beach to be included as a coastal vulnerability area under *SEPP (Coastal Management) 2018* requires further investigation.

7.3.2.2 Coastline south of the Hunter River

Nobbys Beach

Beach erosion and shoreline recession

Nobbys Beach has formed from the accretion of littoral drift sediment from the south against the southern Hunter River breakwater. While long term accretion has been evident at Nobbys Beach in the past the rate of accretion has appeared to slow and is expected to stabilise in the future without sea level rise. However, with the application of sea level rise modelling predicts sediment transport to Nobbys Beach will reduce resulting in recession at the southern end of the beach by 2100. Figures in **Appendix E** for Nobbys Beach for beach erosion and shoreline recession are from the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)).

Management of beach erosion and shoreline recession is currently managed through the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018(b)) with the focus on dune restoration works in accordance with the Coasts and Estuary Vegetation Management Plan (Umwelt, 2014). The management of Horseshoe Beach is currently unknown, but the land is owned by RMS.

Coastal inundation

Nobbys Beach is backed by vertical seawalls and promenades, including the Bathers Way coastal walk, that are exposed at the southern end of the beach. The seawall at Shortland Esplanade overtops frequently at high tides at present impacting on the roadway. The frequency and volume of overtopping is expected to increase in the future with projected sea level rise (see Figures in **Appendix F**). The management of the seawalls and roadway is managed through an asset management framework, CN's Asset Management Strategy 2018-2027 (CN, 2018) and service asset plans.

Cliff and slope instability

The Geotechnical Assessment of Newcastle Cliffs and Slopes (RCA, 2013) assessed the risk to property (breakwater and lighthouse) and people from geo-hazards at Nobbys Headland. Nobbys Headland is managed by the Port of Newcastle and the current management arrangements for cliff and slope instability hazards are unknown.

Assessment of inclusion in coastal vulnerability area

While Nobbys Beach is subject to coastal hazards the projected hazards are limited to public land. Therefore, a planning proposal for inclusion in the coastal vulnerability area will not be undertaken as part of the CMP at this stage as outlined in **Section 7.3.1**. CN may potentially consider further assessment after completion of the CMP for inclusion of Nobbys Beach in the coastal vulnerability area.

Newcastle Beach

Beach erosion and shoreline recession

Historical photographs from 1974 show storm events can remove all sand from Newcastle Beach exposing underlying bedrock. Similar extents of erosion can be expected to recur in the future. Newcastle Beach is backed by seawalls along its extent and sections of the beach may comprise exposed bedrock or exposed seawalls by as early as 2050. The exposure of the bedrock and/or seawall will have potential impacts on beach amenity as the beach will have limited sand width. Figures in **Appendix E** for Newcastle Beach for beach erosion and shoreline recession are from the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)).

Newcastle Beach is considered a high risk for beach erosion in the immediate planning horizon. The risk of beach erosion increases to extreme in future planning horizons (2050, 2100) as a result of sea level rise (BMWT WBM, 2014(b)). Buildings at the back beach area, such as Newcastle Surf Lifesaving Club, are considered a high immediate risk from beach erosion.

The sandy beach area of Newcastle Beach does not contain a dune system and the only maintenance activity undertaken is sand grooming for cleanliness. The seawalls and promenades are managed through CN's Asset Management Strategy 2018-2027 (CN, 2018) and service asset plans.

Coastal inundation

The lower promenades along the entire Newcastle Beach overtop at present. Overtopping would be expected to affect the surf club and kiosk during modelled storm events. The frequency of overtopping is expected to increase in the future with sea level rise (BMWT WBM, 2014(a)).

Newcastle Baths and the adjacent rock platform, including the Canoe Pool, would be engulfed by ocean water during a severe storm in the immediate and future planning horizons (Figures in **Appendix F** are from the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)). Shortland Esplanade to the north of the Newcastle Ocean Baths also overtops currently during storm events. Due to sea level rise, the frequency of overtopping of Newcastle Baths and Shortland Esplanade is expected to increase. Works for the Bathers Way coastal walk were completed along Shortland Esplanade as part of the Bathers Way Public Domain Plan (NCC, 2012), but consideration of coastal inundation was limited. Further investigation of management of coastal inundation within this area is required if impacts increase in the future.

Cliff and slope instability

The Geotechnical Assessment of Newcastle Cliffs and Slopes (RCA, 2013) assessed the risk to property and people from geo-hazards at Fort Scratchley headland, above Shortland Esplanade, and the cliff line at the southern end of Newcastle Beach, above the Bathers Way coastal walk. These areas are currently managed by CN through CN's Asset Management Strategy 2018-2027 (CN, 2018) and service asset plans to reduce risk to property and life.

Assessment of inclusion in coastal vulnerability area

While Newcastle Beach is subject to storm erosion events the beach profile appears to be naturally oscillating while infrastructure at the rear of the beach is protected by seawall structures. Newcastle Ocean Baths are constructed on a natural rock platform and are already subject to coastal inundation impacts that require management.

While Newcastle Beach is subject to coastal hazards the projected hazards are limited to public land. Therefore, a planning proposal for inclusion in the coastal vulnerability area will not be undertaken as part of the CMP at this stage as outlined in **Section 7.3.1**. CN may potentially consider further assessment after completion of the CMP for inclusion of Newcastle Beach in the coastal vulnerability area.

Strzelecki headland

Cliff and slope instability

The Geotechnical Assessment of Newcastle Cliffs and Slopes (RCA, 2013) assessed the risk to property and people from geo-hazards at Strzelecki headland. Geotechnical hazards were identified with the cliff line above the Bogey Hole identified as a potential risk. The headland is currently managed by CN through CN's Asset Management Strategy 2018-2027 (CN, 2018) and service asset plans to reduce risk to property and life. Management of the headland includes cliff grooming and removal of rock while ongoing monitoring is undertaken through new available technology such as drone surveying.

Assessment of inclusion in coastal vulnerability area

Geohazards at Strzelecki headland are currently managed by CN. The Bogey Hole and associated rock platform are already subject to coastal inundation impacts that require management. These coastal hazards are limited to public land and a planning proposal for inclusion in the coastal vulnerability area will not be undertaken as part of the CMP at this stage as outlined in **Section 7.3.1**. CN may potentially consider further assessment after completion of the CMP for inclusion of parts of Strzelecki headland in the coastal vulnerability area.

Bar Beach

Beach erosion and shoreline recession

Beach erosion and shoreline recession at the southern end of Bar Beach is constrained by the coastal cliff below Ocean Street and Kilgour Avenue. The middle section of Bar Beach comprises dunal sands while the northern end is developed with a low promenade providing some protection to a group of buildings, including Cooks Hill Surf Life Saving Club, located on the back beach area.

Bar Beach is subject to erosion events where sand is stripped from the beach profile, as demonstrated in a 1974 storm event. These events are expected to be more frequent into the future with rising sea levels. The middle section of Bar Beach is more susceptible to erosion events as it is not backed by a coastal protection structure (See Figures in **Appendix E** from the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)).

Bar Beach is considered a high risk in the immediate planning horizon due to potential erosion of sediment from the beach profile and loss of beach amenity. This risk profile progresses to extreme risk in the future with sea level rise (BMWT WBM, 2014(b)). Buildings at the northern end of Bar Beach are considered a high immediate risk while Bathers Way and Memorial Drive are considered a medium risk into the future from shoreline recession in the middle section of Bar Beach.

Coastal inundation

The lower promenade at the northern end of Bar Beach experiences overtopping at present and this is likely to become more frequent in the future with sea level rise (See Figures in **Appendix F** from the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)). This is considered low risk at present, but as frequency and volume of overtopping increases in the future the level of risk increases to high.

Assessment of inclusion in coastal vulnerability area

While Bar Beach is subject to storm erosion events the beach profile appears to be naturally oscillating. Infrastructure at the northern end of the beach may be subject to beach erosion and coastal inundation while the southern end of the beach may be impacted by beach erosion. While the beach is currently stable impacts from coastal hazards may increase into the future.

Further investigation into impacts from coastal hazards on Bar Beach is required before progressing to a planning proposal for inclusion in the coastal vulnerability area under *SEPP (Coastal Management) 2018*. A planning proposal for inclusion in the coastal vulnerability area will not be undertaken as part of the CMP at this stage as outlined in **Section 7.3.1**. CN may potentially consider further assessment after completion of the CMP for inclusion of Bar Beach in the coastal vulnerability area.

Dixon Park Beach

Beach erosion and shoreline recession

Beach erosion and shoreline recession at Dixon Park Beach is constrained by bedrock control and the construction of a rock seawall at the rear of the beach. Similar to Bar Beach, Dixon Park Beach is subject to storm events where complete removal of sediment from the beach profile occurs exposing bedrock and/or the rock seawall. This is likely to occur more frequently as sea levels rise and wave action occurs at a higher position on the beach. The exposure of the seawall will have potential impacts on beach amenity as the beach will have limited sand width at the base of the exposed seawall (See Figures in **Appendix E** from the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)).

Utilising a risk framework methodology Dixon Park Beach is considered a high-risk area in the immediate planning horizon due to potential erosion of sediment from the beach profile and loss of beach amenity. This risk profile progresses to extreme risk in the future with sea level rise (BMWT WBM, 2014(b)).

Coastal inundation

The beach access at the southern end of Dixon Park Beach may experience some wave overtopping during storm events (See Figures in **Appendix F** from the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)). However, this is considered a low risk in the immediate and future planning horizons.

Assessment of inclusion in coastal vulnerability area

While Dixon Park Beach is subject to storm erosion events the beach profile appears to be naturally oscillating while infrastructure at the rear of the beach is protected by seawall structures. The projected coastal hazards are limited to public land and a planning proposal for inclusion in the coastal vulnerability area will not be undertaken as part of the CMP at this stage as outlined in **Section 7.3.1**. CN may potentially consider further assessment after completion of the CMP for inclusion of Dixon Park Beach in the coastal vulnerability area.

Merewether

Beach erosion and shoreline recession

Historical photographs of erosion during storm events in the 1970s provide guidance to the potential impacts from storms on Merewether Beach. The beach is virtually devoid of sand with bedrock exposed. The position of the beach profile is naturally oscillating, but similar extents of erosion to the 1970s storm event are expected to reoccur in the future.

Beach erosion and shoreline recession at Merewether Beach is limited by bedrock control and seawalls from Merewether Baths promenade to the corner of John Parade and Berner Street. At this location it can be expected that complete removal of sediment from the beach profile will occur more frequently as sea levels rise and wave action occurs at a higher position on the beach. Sections of the beach may be commonly exposed bedrock or rock seawall by 2050 with increasing exposure to 2100. The exposure of the seawall will have potential impacts on beach amenity as the beach will have limited sand width at the base of the exposed seawall (See Figures in **Appendix E** from the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)).

Utilising the risk framework in the Newcastle Coastal Zone Management Study ((BMWT WBM, 2014(b)) Merewether Beach is considered a high risk area in the immediate planning horizon due to potential erosion of sediment from the beach profile and loss of beach amenity. Infrastructure at the rear of Merewether Beach is protected by existing seawall structures, which will require periodic maintenance to ensure structural integrity. The seawalls and promenades are managed through CN's Asset Management Strategy 2018-2027 (CN, 2018) and service asset plans.

Coastal inundation

The lower promenades near Merewether Baths currently experience wave overtopping. Wave overtopping is likely to become more frequent and at greater volumes in the future with sea level rise. The back beach area behind Merewether Beach is elevated and is unlikely to be impacted by coastal inundation in the present or future (See Figures in **Appendix F** from the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)).

Merewether Baths would be fully engulfed by ocean water during a severe storm at the present time. Wave overtopping of this structure is expected to be more frequent with sea level rise and will impact on the community's use of this facility.

Merewether Beach is considered a low risk for coastal inundation, but Merewether Baths and the accessways to the baths along the lower promenades are considered a high risk from coastal inundation due to the high public use of these areas (BMWT WBM, 2014(b)).

Cliff and slope instability

The Geotechnical Assessment of Newcastle Cliffs and Slopes (RCA, 2013) assessed the risk to property and people from geo-hazards at Merewether headland. This headland is currently managed by CN through CN's Asset Management Strategy 2018-2027 (CN, 2018) and service asset plans to reduce risk to property and life. However, the headland does present a potential geotechnical hazard and risk is likely to increase into the future.

Assessment of inclusion in coastal vulnerability area

While Merewether Beach is subject to storm erosion events the beach profile appears to be naturally oscillating while infrastructure at the rear of the beach is protected by seawall structures. Merewether Ocean Baths are constructed on a natural rock platform and are already subject to coastal inundation impacts that require management.

While Merewether Beach is subject to coastal hazards the projected hazards are limited to public land. Therefore, a planning proposal for inclusion in the coastal vulnerability area will not be undertaken as part of the CMP at this stage as outlined in **Section 7.3.1**. CN may potentially consider further assessment after completion of the CMP for inclusion of Merewether Beach in the coastal vulnerability area.

7.3.2.3 Hunter River lower estuary – East of Hannell Street bridge

Hunter River Lower estuary coastal vulnerability methodology

The Hunter River lower estuary within the scoping study area is located on the Hunter River floodplain. CN has previously undertaken a comprehensive review of potential risk from flooding within the Hunter River lower estuary in the Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012). The Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012) was conducted through the floodplain risk management program but identified coastal hazards (coastal and tidal inundation) as contributing to flooding risks. Additional study was conducted in the Strategic Position for the Management of the Low Lying Areas in Newcastle (BMT WBM, 2015) for coastal and tidal inundation and identified tidal inundation impacts in low-lying areas such as Wickham, Maryville, Islington, Tighes Hill and Carrington (See **Appendix G** and **H**).

The Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012) modelled the impacts from the interaction of catchment and oceanic waters but overtopping of existing coastal protection structures were not included within the study. However, the Seawall Central and Western Foreshore Promenade Repair and Remediation Strategy (Patterson Britton, 2003) notes overtopping of seawalls near Queens Wharf is likely in significant events. Technical specifications for coastal protection work at Carrington (Coffey Partners, 1996) also note that structures are designed for 1 in 50 year events only.

A previous working party was formed in the early 2000's to investigate the ownership and maintenance of the coastal protection structures within the Hunter River lower estuary. However, the working group did not progress the investigation and the current effectiveness of the coastal protection structures are not known.

A summary of the vulnerability and potential management risk for each suburb in the Hunter River lower estuary within the scoping study area is provided below. However, CN notes the implementation of future management strategies, included those outlined in the Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017), will be further developed through the CMP process and may alter the risk profile for parts of the coastal zone in the Lower Hunter estuary and influence the potential inclusion of areas on the coastal vulnerability map in the future.

Newcastle City Centre

Coastal inundation

The Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012) has modelled ocean flood depths (coastal inundation) for 10%AEP, 1%AEP events and PMF events (1%AEP and PMF modelling undertaken with projected 0.9m sea level rise to account for probability of event). The area subject to coastal inundation within these scenarios is Horseshoe Beach at the eastern end of the Newcastle City Centre. The majority of Newcastle City Centre is protected by riverwalls along the southern edge of the bank of the Hunter River.

The modelling undertaken in the Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012) for coastal inundation assumed the flooding mechanism was independent of flooding mechanisms from the Hunter River and local catchment flooding. These mechanisms all contribute to flooding risks and potential inundation may be greater than the modelled outcomes.

Assessment of inclusion in coastal vulnerability area

The majority of Newcastle City Centre is protected from coastal inundation by estuary protection structures. However, the effectiveness and ongoing serviceability of these structures requires further investigation. The investigation of these structures will inform any potential inclusion of parts of Newcastle City Centre being included in a planning proposal for the costal vulnerability area. However, flooding risks will continue to be managed through development controls outlined through the Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012) and continued investigation of flooding potential.

While Horseshoe Beach is subject to coastal inundation the projected hazard is limited to public land. Therefore, a planning proposal for inclusion in the coastal vulnerability area will not be undertaken as part of the CMP at this stage as outlined in **Section 7.3.1**. CN may potentially consider further assessment after completion of the CMP for inclusion of Horseshoe Beach in the coastal vulnerability area.

Wickham

Coastal inundation

Given the low lying topography of the suburb there is potential for extensive coastal inundation of Wickham in the immediate planning horizon (See **Appendix G**). Potential impacts and extent of coastal inundation will increase with sea level rise. Coastal inundation will have potential significant impacts on public infrastructure, such as roads and stormwater, and private property including both commercial and residential properties.

Tidal inundation

The Strategic Position for the Management of the Low Lying Areas in Newcastle (BMT WBM, 2015) shows existing tidal inundation is limited to stormwater infrastructure and roadways within Wickham in the immediate timeframe. However, tidal inundation will significantly increase with sea level rise and will inundate a large part of the suburb by 2100 (See **Appendix H**).

Assessment of inclusion in coastal vulnerability area

Due to the risk to residential and commercial properties along with public infrastructure the potential for Wickham to be included as a coastal vulnerability area under *SEPP (Coastal Management) 2018* requires further investigation. This investigation will coincide with continuing studies under the flood risk management program outlined in the Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017).

Maryville

Coastal inundation

Maryville is subject to coastal inundation to a greater extent than Wickham in the immediate planning horizon (See **Appendix G**). Potential impacts and extent of coastal inundation will increase with sea level rise (See **Appendix G)**. Coastal inundation will have potential significant impacts on public infrastructure and a large number of private commercial and residential properties.

Tidal inundation

The Strategic Position for the Management of the Low Lying Areas in Newcastle (BMT WBM, 2015) shows existing tidal inundation is limited to stormwater infrastructure and roadways within Maryville in the immediate timeframe. However, tidal inundation will significantly increase with sea level rise and will inundate a large part of the suburb by 2100 (See **Appendix H**).

Assessment of inclusion in coastal vulnerability area

Due to the potential risk to residential and commercial properties along with public infrastructure the potential for Maryville to be included as a coastal vulnerability area under *SEPP (Coastal Management) 2018* requires further investigation. This investigation will coincide with continuing studies under the flood risk management program outlined in the Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017).

Carrington

Coastal inundation

Coastal inundation is primarily limited to the stormwater and road network during a 1%AEP event, but extends throughout the majority of the suburb. Coastal inundation is more extensive during a PMF event (See **Appendix G**) including areas within the SEPP (Three Ports) lease area. Potential impacts increase significantly with sea level rise (See **Appendix G**) and engulf a large portion of the residential suburb, including parts of the *SEPP (Three Ports)* lease area.

Tidal inundation

The Strategic Position for the Management of the Low Lying Areas in Newcastle (BMT WBM, 2015) shows existing tidal inundation is limited to stormwater infrastructure and roadways within western part of Carrington in the immediate timeframe. However, tidal inundation will significantly increase with sea level rise and will inundate a large part of the suburb by 2100 (See **Appendix H**).

Assessment of inclusion in coastal vulnerability area

Due to the potential risk to residential and commercial properties along with public infrastructure the potential for Carrington to be included as a coastal vulnerability area under *SEPP (Coastal Management) 2018* requires further investigation. This investigation will coincide with continuing studies under the flood risk management program outlined in the Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017). However, areas contained within the *SEPP (Three Ports)* lease area will be excluded as *SEPP (Coastal Management) 2018* does not apply within this area.

Stockton – Western and southern foreshore

Coastal inundation

The Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012) has modelled ocean flood depths (coastal inundation) for 10%AEP, 1%AEP events and PMF events (1%AEP and PMF modelling undertaken with projected 0.9m sea level rise to account for probability of event). The area subject to coastal inundation within these scenarios is the south-western part of the Stockton peninsula. This area is protected by a riverwall along the bank of the Hunter River.

The modelling undertaken in the Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012) for coastal inundation assumed the flooding mechanism was independent of flooding mechanisms from the Hunter River and local catchment flooding. These mechanisms all contribute to flooding risks and potential inundation may be greater than the modelled outcomes.

Assessment of inclusion in coastal vulnerability area

The majority of Stockton on the Hunter River estuary is protected from coastal inundation by estuary protection structures. However, the effectiveness and ongoing serviceability of these structures requires further investigation. The investigation of these structures will inform any potential inclusion of parts of Newcastle City Centre being included in a planning proposal for the coastal vulnerability area.

7.3.2.4 Throsby Creek catchment – West of Hannell Street bridge

Islington

Coastal inundation

Islington Park is subject to a minor level of coastal inundation in the immediate planning horizon due to proximity to Throsby Creek and low lying topography (See **Appendix G**). However, coastal inundation is predicted to extend further then the boundaries of Islington Park and to nearby residential properties due to sea level rise.

Tidal inundation

Tidal inundation does not have significant impact on the suburb or Islington Park in the immediate planning horizon. However, tidal inundation will increase with sea level rise and will potentially impact Islington Park and surrounding residential properties (See **Appendix H**).

Assessment of inclusion in coastal vulnerability area

Due to the potential risk to residential properties along with a public recreation area the potential for Islington to be included as a coastal vulnerability area under *SEPP (Coastal Management) 2018* requires further investigation. This investigation will coincide with continuing studies under the flood risk management program outlined in the Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017).

Hamilton North and Broadmeadow

Coastal inundation

Coastal inundation is primarily confined to the large concrete stormwater channel (Styx Creek) that traverses Hamilton North and Broadmeadow in the immediate planning horizon. While the coastal inundation extent will increase slightly with sea level rise the impacts will be mainly confined to Styx Creek (See **Appendix G**).

Tidal inundation

Tidal inundation will remain confined to the Styx Creek stormwater channel during all planning horizons (See **Appendix H**).

Assessment of inclusion in coastal vulnerability area

While Styx Creek is subject to coastal hazards the projected hazards are limited to the concrete stormwater channel. CN will not be seeking a planning proposal for inclusion in the coastal vulnerability area as part of the CMP process.

Mayfield East and Mayfield

Coastal inundation

Coastal inundation is primarily confined to the large concrete stormwater channel (Throsby Creek) that traverses Mayfield East and Mayfield in the immediate planning horizon. While the coastal inundation extent will increase slightly with sea level rise the impacts will be mainly confined to Throsby Creek (See **Appendix G**).

Tidal inundation

Tidal inundation will remain confined to the Throsby Creek stormwater channel during all planning horizons (See **Appendix H**).

Assessment of inclusion in coastal vulnerability area

While Throsby Creek is subject to coastal hazards the projected hazards are limited to the concrete stormwater channel. CN will not be seeking a planning proposal for inclusion in the coastal vulnerability area as part of the CMP process.

Tighes Hill

Coastal inundation

Coastal inundation is limited to the stormwater and road network during a 1%AEP event at the industrial/commercial estate at the eastern end of the suburb. Coastal inundation is more extensive during a PMF event (See **Appendix G**). Potential impacts increase with sea level rise but remain limited to the commercial/industrial area in the eastern part of the suburb (See **Appendix G**).

Tidal inundation

Tidal inundation is limited in the immediate planning horizon (See **Appendix H**). However, tidal inundation will increase with sea level rise, but will remain confined to the industrial/commercial estate at the eastern end of the suburb.

Assessment of inclusion in coastal vulnerability area

Due to the potential risk to commercial/industrial properties along with public infrastructure the potential for Tighes Hill to be included as a coastal vulnerability area under *SEPP (Coastal Management) 2018* requires further investigation. This investigation will coincide with continuing studies under the flood risk management program outlined in the Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017).

7.4 Coastal environment area

The coastal environment area within the scoping study area is highly urbanised. However, smaller areas of the coastal zone contain environment features that are applicable to the coastal environment area.

7.4.1 Stockton Beach

The northern end of Stockton Beach within the scoping study area includes dune systems stretching from the northern boundary of the CN LGA to Corroba Park. The dune system mainly comprises sand scrub vegetation including Coast Banksia (*Banksia integrifolia*), Coast Tea-tree (*Leptospermum laevigatum*) and Old Man Banksia (*Banksia serrata*). The dune system is owned by various government agencies, including Family and Community Services (Stockton Centre), Defence Housing Australia (Fort Wallace) and HWC (former sewerage treatment facility at 310 Fullerton Street). The management of these dune systems is varied between the landowners, but invasive species such as Bitou Bush (*Chrysanthemoides monilifera*) remain a management issue. Urban development of the area is also a management issue with additional residential development currently proposed for the Fort Wallace site. Assessment of this proposal is currently being undertaken through a rezoning application under the *Environmental Planning and Assessment Act 1979.*

A dune system is located seaward of Corroba Park and extends to Griffith Avenue to the south. The dune system is managed by CN in accordance with Coasts and Estuary Vegetation Management Plan (Umwelt, 2014). The dune system is maintained by a local Landcare group and has resulted in a re-established sand scrub vegetation community and high quality habitat for local species. However, beach erosion has been an ongoing management issue for this dune system with ongoing loss of habitat due to shoreline recession. Overtopping of the dune system has also occurred resulting in plant die-off in the back dune area due to saltwater intrusion on the dune system.

While Stockton Beach stretches to the south no further coastal environment features are present until the dune system seaward of Stockton Holiday Park. This dune system was re-established in the mid 1990s after storm events in 1994 and 1995. The dune system is managed by CN in accordance with the Coasts and Estuary Vegetation Management Plan (Umwelt, 2014). While well vegetated, the dune system is exposed to erosion events and impacted by unauthorised access points.

Dune vegetation has been re-established at the rear of Little Beach with additional coastal planting within Pitt Street Reserve as part of the Newcastle Coastal Revitalisation Strategy (Urbis, 2010). The dune vegetation has remained well established and requires minor maintenance by CN.

7.4.2 Coastline south of the Hunter River

Nobbys Beach

A significant dune system is located within the back beach area of Nobbys Beach. Dune vegetation restoration activity has been conducted in the dune system to establish habitat and resilience within the beach environment. Sections of the dune system are well established, but other sections near the Nobbys headland are less well vegetated and experience blow-outs and sand drift issues.

A dune system has also formed at Horseshoe Beach within the Hunter River estuary, at the back of the breakwater. The establishment of the dune system was undertaken as part of previous coastal planning for the area. The land is owned by RMS, but management of vegetation has been previously undertaken by CN. However, ongoing management of the dune system remains a management issue.

Newcastle Beach

The coastal environment area within the Newcastle Beach precinct includes one coastal feature:

1. Rock platform around Newcastle Baths between Nobbys Beach and Newcastle Beach. The area is not actively managed, but usage by the public is high. Evidence of algae (*Enteromorpha intestinalis, Ulva lactuca*) and cunjevoi (*Pyura stolonifera*) use by recreational fishers at this rock platform has been previously documented ((Gladstone and Herbert, 2006). This rock platform also provides a significant roosting site for Little Tern (*Sternula albifrons*) and Sooty oystercatcher (*Haematopus fuliginosus*) which are both listed under the *Biodiversity Conservation Act 2016*. Management actions for the rock platform have been included in the Newcastle Coastal Zone Management Plan 2018 (2018(b)) and may be added to the future CMP.

Strzelecki headland

The coastal environment area within the Strzelecki headland precinct contains seven coastal features:

1. The northern end of King Edward Park contains vegetation that is comprised mainly of exotic species, including Bitou Bush (*Chrysanthemoides monilifera*) and Pampas Grass (*Cortaderia selloana*). However, remnant patches of Kangaroo grass (*Themeda australis*) are in this area and comprise an EEC, Themeda grasslands on seacliffs and coastal headlands, under the *Biodiversity Conservation Act 2016*. While the EEC is present management is required to ensure the vegetation community remains sustainable.
2. The central section of King Edward Park, part of the headland overlooking the Bogey Hole, features regenerating coastal heathland, including coastal rosemary (*Westringia fruticosa*) and coast banksia (*Banksia integrifolia*), and Themeda grassland EEC. Exclusion of mowing of the recreational areas has aided in the management and regeneration of the EEC.
3. Rock platform near Bogey Hole. The area is not actively managed, but public use is low.
4. Southern end of King Edward Park is native coastal heathland with exotics such as Bitou Bush (*Chrysanthemoides monilifera*). Remnant Themeda grassland EEC is also present. Exclusion of mowing of the recreational areas has aided in the management and regeneration of the EEC.
5. Area around Shepherds Hill military installation and Strzelecki Lookout (entrance to ANZAC memorial walkway). Area is mainly native coastal heathland with the cliff edge and face dominated by Bitou Bush (Chrysanthemoides monilifera). Remnant Themeda grassland EEC is also present and managed in accordance with the Coasts and Estuary Vegetation Management Plan (Umwelt, 2014).
6. Rock platforms below Strzelecki headland. Areas are not actively managed, but public use is very low due to accessibility.
7. Area below ANZAC memorial walkway. Area is mainly native coastal heathland with remnant Themeda grassland EEC also present. The EEC is managed in accordance with the Coasts and Estuary Vegetation Management Plan (Umwelt, 2014).

Bar Beach

The coastal environment area within the Bar Beach precinct contains two coastal features:

1. Dune system at the southern end of the beach comprises spiny headed mat rush (*Lomandra longifolia*), coastal rosemary (*Westringia fruticosa*) and beach spinifiex (*Spinifex sericeus*). Regeneration activities have been previously undertaken as part of the Bathers Way Public Domain Plan (NCC, 2012). However, the success of vegetation activities has been varied with the dune system experiencing vegetation loss and sand blowouts from stormwater runoff and informal pedestrian access.
2. Rock platform north of Bar Beach and below Bar Beach carpark. The area is not actively managed but has previously exhibited signs of disturbance from trampling and marine species collection (Gladstone and Herbert, 2006). Signage has been erected to inform users of the site regarding potential impacts on species utilising the rock platform.

Dixon Park Beach

The coastal environment area within the Dixon Park Beach precinct contains one coastal feature:

1. Regenerating dune vegetation on seawall at the southern end of the beach. Vegetation comprises primarily pigface (*Carpobrotus glaucescens*) and beach spinifiex (*Spinifex sericeus*) with the invasive exotic pennywort (*Hydrocotyle boanariensis*). The southern end of the dune system is being managed through the Coasts and Estuary Vegetation Management Plan (Umwelt, 2014). The northern end of the dune system and cliff vegetation at the northern end of the beach is primarily non-native including Bitou Bush (*Chrysanthemoides monilifera*).

Merewether Beach

The coastal environment area within Merewether Beach precinct contains two coastal features:

1. Revegetated coastal heath community on seawall between Berner Street and Watkins Street. Dune includes coastal wattle (*Acacia longifolia*), spiny headed mat rush (*Lomandra longifolia*) and pigface (*Carpobrotus glaucescens*). The dune has been successfully revegetated and is maintained in accordance with the Coasts and Estuary Vegetation Management Plan (Umwelt, 2014) with work completed by a local landcare group. This restoration has been successful in providing habitat and dune stability.
2. Merewether rock platform at southern end of Merewether Beach. Important foraging area for Sooty oystercatchers (*Haematopus fuliginosus*), listed as vulnerable under the *Biodiversity Conservation Act 2016*. The area is not actively managed, but has previously exhibited signs of disturbance from trampling and marine species collection (Gladstone and Herbert, 2006)

Glenrock State Conservation Area

The coastal environment area within the Glenrock State Conservation Area comprises a significant area of native vegetation with twelve different vegetation communities identified (NPWS, 2010). The area is managed by NPWS under the Glenrock State Conservation Area Plan of Management (NPWS, 2010).

7.4.3 Hunter River lower estuary – East of Hannell Street bridge

The coastal environment area within the Hunter River lower estuary within the scoping study area is highly urbanised. The urban area is a high-density mixture of residential and commercial/industrial development with the Port of Newcastle a dominant feature within the Hunter River lower estuary. The operations of the Port of Newcastle, including dredging of the Hunter River, has significantly altered both the terrestrial and aquatic habitat within the Hunter Rive lower estuary. However, patches of mangrove forest, including the coastal wetland areas outlined in **Section 6.2**, remain on the fringes of the Hunter River lower estuary.

The Hunter River lower estuary is impacted by water pollution, from both upstream land uses and the surrounding urban environment within the scoping study area. Water quality is also impacted by contamination from historical industrial operations such as BHP which operated along the south arm of the Hunter River. Concentrations of nutrients within the Hunter River lower estuary are relatively high, but are lower than pre-2000s levels (Swanson, Potts and Scanes, 2017(b)). While measures have been implemented through development controls and regulation, including regulation of environment pollution licences within the Port of Newcastle area under the Protection of the *Environment Operations Act 1997*, water pollution remains a threat to the Hunter River lower estuary. A further issue is no consistent water quality monitoring program has been implemented within the estuary to evaluate any improvement within the estuary.

7.4.4 Throsby Creek catchment – West of Hannell Street bridge

The coastal environment area within the Throsby Creek catchment is highly urbanised with primarily residential development. Throsby creek downstream of Maitland Road at Islington provides a key environmental feature of the area with mangroves fringing parts of the shoreline. However, Throsby Creek is a depositional environment and urban sediment from the upstream catchment accumulates in this part of the creek (NCC, 2004). This sediment accumulation resulted in Throsby Creek being dredged in 1992 and 1997 (BMT WBM, 2017 (c)). However, this section of Throsby Creek continues to accumulate sediment from upstream resulting in odours being emitted during low tides and impacting on the amenity of the area for residents.

Throsby Creek, including the stormwater channels of Styx Creek and Throsby Creek (Mayfield), is owned and managed by HWC. Stormwater treatment devices including trash racks, sediment traps and CDS units have been installed by HWC upstream to assist in managing sediment and water quality in the catchment. CN has undertaken bush regeneration works in the vegetated reaches of the upper Throsby Creek catchment (outside of the defined coastal zone), to reduce sediment entry into the catchment.

The Throsby Creek Catchment Agencies Plan 2019-2024 (Throsby Creek Government Agencies Committee, 2019) outlines objectives for the multi-stakeholder committee to address water quality and sediment issues within the Throsby Creek catchment. The actions from the Throsby Creek Catchment Agencies Plan 2019-2024 (Throsby Creek Government Agencies Committee, 2019) will be reviewed and considered for incorporation into the CMP.

7. Review of current coastal arrangements

7.5 Coastal use area

7.5.1 Stockton

The framework for management of public land within the coastal use area in Stockton is outlined in the Newcastle Coastal Revitalisation Strategy Masterplan (Urbis, 2010). The Newcastle Coastal Revitalisation Strategy Masterplan (Urbis, 2010) outlines planning and design concepts to encourage greater access for residents and visitors and provide a higher standard of liveability, safety and vibrancy along the coastline.

The South Stockton Reserves Public Domain Plan (Irwin Landscape Architecture et al, 2012) provides further detail regarding community amenity and access to the coastal zone. The management of public land is also supported by the existing Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) and Newcastle Coastal Plan of Management 2015 (NCC, 2015).

Table 26 outlines broad coastal community facilities within the coastal use area of Stockton.

Table 26: Coastal community facilities within Stockton coastal use management area.

Coastal community asset/facility	Description	Current management	Evaluation/community view
Beach access	Twenty-six existing beach access points.	• Newcastle Coastal Zone Management Plan 2018. • Asset Management Strategy 2018 – 2027.	• Many beach access points impacted by beach erosion. • Low community satisfaction with beach access (CN, 2018).
Boat ramps	Two ramps on Hunter River side of Stockton.	• Asset Management Strategy 2018-2027. • CN Service Asset Plans.	• Northern boat ramp facility recently reconstructed by CN. • Southern boat ramp facility currently being renewed by RMS.
Beach and foreshore carparks	• Small beach carpark at end of Griffith Avenue. • Small carpark at memorial off Mitchell Street. • Beach carpark south of Stockton Surf Lifesaving Club. • Lexie's café carpark. • Little Beach carpark. • Stockton ferry terminal carpark. • North Stockton boat ramp carpark.	• Asset Management Strategy 2018-2027. • CN Service Asset Plans.	• Griffith Avenue carpark impacted by beach erosion and has periods of closure for repairs. • Stockton ferry terminal carpark can become overcrowded during weekdays.
Riverwalls, seawalls and breakwater Rare	• Riverwalls from Stockton Bridge along Hunter River to small training wall at Little Beach. • Mitchell Street seawall. • Northern Hunter River breakwall.	• Asset Management Strategy 2018-2027. • CN Service Asset Plans. • Newcastle Coastal Zone Management Plan 2018.	• Riverwalls are part of asset management program by CN. • Mitchell Street seawall maintenance in Newcastle CZMP 2018. • Breakwater maintenance by Port of Newcastle and management action in Newcastle CZMP 2018.

Coastal community asset/facility	Description	Current management	Evaluation/community view
Promenade	• Northern Hunter River breakwall.	• Management by Port of Newcastle.	• Breakwater maintenance by Port of Newcastle and management action in Newcastle CZMP 2018.
Foreshore reserves	• Reserves on western and southern sides of Stockton (Ballast Grounds). • Pitt Street Reserve	• Parkland and Recreation Strategy.	• Cycleway has been constructed along foreshore area. • Northern end of reserve subject to tidal inundation due to riverwall construction.
Shared pathways/ cycleway	• Shared pathway from Stockton Bridge to Punt Road.	• Asset Management Strategy 2018-2027. • CN Service Asset Plans.	• Shared pathway constructed by CN
Playgrounds	• Corroba Park. • Playground east of Stockton Bowling Club. • Pitt Street Reserve. • Reserve near Hunter Street.	• Asset Management Strategy 2018-2027. • CN Service Asset Plans.	• Community generally satisfied with playground areas (CN, 2018).
Surf zone	• Surf zone off Stockton Beach.		
Surf club	• Stockton Surf Lifesaving Club.	• Asset Management Strategy 2018-2027. • CN Service Asset Plans.	• Stockton Surf Lifesaving Club at risk from beach erosion resulting in construction of seawall in 2017. • Building requires inspections for ongoing maintenance requirements.
Sportsgrounds	• Corroba Park. • Dalby Oval.	• Parkland and Recreation Strategy. • Asset Management Strategy 2018-2027. • CN Service Asset Plans.	• Dalby Oval at risk from beach erosion. • Concern from community regarding ongoing use of Dalby Oval from sports.
Tennis courts	• Stockton Tennis Club.	• Parkland and Recreation Strategy • Asset Management Strategy 2018-2027 • CN Service Asset Plans	
Bowling club	• Stockton Bowling Club.	• Lease from Crown lands.	
Childcare centre	• Childcare operation in former North Stockton Surf Lifesaving Club at Barrie Crescent Reserve.	• Asset Management Strategy 2018-2027. • Newcastle Coastal Zone Management Plan 2018.	• Building will be demolished at end of lease agreement in 2020.

7.5.2 Coastline south of the Hunter River

The framework for management of public land within the coastal use area for the coastline south of the Hunter River is outlined in the Newcastle Coastal Revitalisation Strategy Masterplan (Urbis, 2010). The Bathers Way Public Domain Plan (NCC, 2012) provides further detail regarding design of public facilities for coastal amenity and access arrangements. The management of public land is also supported by the existing Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) and Newcastle Coastal Plan of Management 2015 (NCC, 2015). The coastal use area has been divided into beach areas.

Nobbys Beach

Table 27: Coastal community facilities at Nobbys Beach.

Coastal community asset/facility	Description	Current management	Evaluation/community view
Beach access	• Beach access via the southern end of the beach.	• Newcastle Coastal Zone Management Plan 2018. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Beach access maintained in good condition and rated by community has having best access in CN LGA (CN, 2018).
Beach carparks	• Two carparks off Pasha Way. • Carpark at Horseshoe Beach road. • Carparking on Wharf Road and Shortland Esplanade.	• Bathers Way Public Domain Plan. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Carparks are time restricted and time limits enforced. • Use of carparks is high and limited spaces at times.
Nobbys Headland	• Headland and lighthouse.	• Management by Port of Newcastle.	
Surf club	• Nobbys Beach Surf Lifesaving Club.	• Asset Management Strategy 2018-2027. • CN Service Asset Plans.	• Recently upgraded by CN.
Fort Scratchley	• Heritage listed former military facility.	• Asset Management Strategy 2018-2027. • CN Service Asset Plans.	• Facility managed by Fort Scratchley Historical Society. Funding to ensure heritage item is appropriately maintained has been a management issue.

Newcastle Beach

Table 28: Coastal community facilities at Newcastle Beach.

Coastal community asset/facility	Description	Current management	Evaluation/community view
Beach access	• Beach access via promenade around beach.	• Newcastle Coastal Zone Management Plan 2018. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Beach access maintained in good condition and rated as satisfactory by community (CN, 2018).
Beach carparks	• Carpark at Newcastle Ocean Baths. • Parking on Shortland Esplanade.	• Bathers Way Public Domain Plan. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Carparks are time restricted and time limits enforced. • Use of carparks is high and limited spaces at times.
Promenade	• Bathers Way coastal walk from Newcastle Ocean Baths to King Edward Park.	• Bathers Way Public Domain Plan. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Coastal walk recently completed in area and high community use as recreation facility. Community satisfaction with facility (CN, 2018).
Newcastle Ocean Baths	• Ocean Baths swimming facility and amenities building.	• Bathers Way Public Domain Plan. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Community satisfaction with cleanliness of facility (CN, 2018). Upgrade to amenities required. • Management issues with maintenance of heritage fabric of the item.
Canoe pool	• Recreation/swimming area on southern end of rock platform.	• Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	
Surf club	• Newcastle Surf Lifesaving Club.	• Bathers Way Public Domain Plan. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Surf club part of potential upgrade planning.
Recreation facility	• Skate park at southern end of beach promenade	• Bathers Way Public Domain Plan • Asset Management Strategy 2018 - 2027 • CN Service Asset Plans	• Skate park is scheduled for upgrade

Strzelecki headland

Table 29: Coastal community facilities at Strzelecki headland.

Coastal community asset/facility	Description	Current management	Evaluation/community view
Access	• Stairway to Bogie Hole swimming area.	• Managed by Crown Lands.	
Carparking	• Roadway in King Edward Park • Carpark at southern end of King Edward Park. • ANZAC memorial walk carpark • Bar Beach carpark (southern end of headland).	• Bathers Way Public Domain Plan. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Carparks are time restricted and time limits enforced. • Use of carparks is high and limited spaces at times.
Pathway	• Bathers Way coastal walk. • ANZAC memorial elevated walkway.	• Bathers Way Public Domain Plan. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• High use of walkway as recreational facility ((CN, 2018).
Park	• King Edward Park.	• Parkland and Recreation Strategy. • Asset Management Strategy 2018-2027. • CN Service Asset Plans.	• Management of park as a heritage item requires further planning and investigation.

Bar Beach

Table 30: Coastal community facilities at Bar Beach.

Coastal community asset/facility	Description	Current management	Evaluation/community view
Beach access	• Access via promenade at northern end of beach. • Two stairway access points on southern end of beach.	• Newcastle Coastal Zone Management Plan 2018. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	Beach access maintained in good condition and rated by community has having second best access in CN LGA (CN, 2018).
Beach carparks	• Carpark near northern end of beach. • Street parking along Memorial Drive. • Carpark at Kilgour Avenue.	• Bathers Way Public Domain Plan. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Carparks are time restricted and time limits enforced. • Use of carparks is high and limited spaces at times.
Promenade	• Promenade on northern end of beach near surf club and kiosk. • Bathers way coastal walk from Strzelecki headland to Dixon Park Beach.	• Asset Management Strategy 2018 – 2027. • CN Service Asset Plans. • Bathers Way Public Domain Plan.	• High use of Bathers Way as recreational facility ((CN, 2018).
Surf club	• Cooks Hill Surf Lifesaving Club.	• Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Surf lifesaving club recently upgraded. Upgrade was inconsistent with coastal hazard risks.
Sportsgrounds	• Empire Park.	• Parkland and Recreation Strategy. • Asset Management Strategy 2018-2027. • CN Service Asset Plans.	
Bowling club	• Bar Beach bowling club.	• Lease from Crown lands.	

Dixon Park Beach

Table 31: Coastal community facilities at Dixon Park Beach.

Coastal community asset/facility	Description	Current management	Evaluation/community view
Beach access	• Stair access from Dixon Park Surf Lifesaving Club. • Two stair access points from Bathers Way coastal walk.	• Asset Management Strategy 2018-2027. • CN Service Asset Plans. • Bathers Way Public Domain Plan.	• Accessways recently upgraded as part of Bathers Way capital works.
Beach carparks	• Carpark at Dixon park Surf Lifesaving Club. • Carpark south of Dixon park Surf Lifesaving Club.	• Asset Management Strategy 2018-2027. • CN Service Asset Plans.	• Substantive parking areas and congestion minimal.
Promenade	• Bathers Way coastal walk from Bar Beach to Merewether Beach.	• Bathers Way Public Domain Plan. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• High use of Bathers Way as recreational facility ((CN, 2018).
Surf club	• Dixon Park Surf Lifesaving Club.	• Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	
Playgrounds	• Dixon park playground	• Parkland and Recreation Strategy. • Asset Management Strategy 2018-2027.	

Merewether Beach

Table 32: Coastal community facilities at Merewether Beach.

Coastal community asset/facility	Description	Current management	Evaluation/community view
Beach access	• Two stair access points from John Parade. • Access from promenade at southern end of beach. • Disabled access from Merewether Ocean Baths amenities building to baths.	• Bathers Way Public Domain Plan. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Access rated as third lowest in satisfaction from community survey (CN, 2018).
Beach carparks	• Carpark at Watkins Street. • Carparking along Henderson Parade. • Two small carparks on access road to Merewether Ocean Baths.	• Bathers Way Public Domain Plan. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Carparks are time restricted and time limits enforced. • Use of carparks is high and limited spaces at times.
Promenade	• Bathers Way coastal walk from Dixon Park to Merewether Beach. • Promenade from Merewether Surf Life Saving Club to Merewether Ocean Baths.	• Bathers Way Public Domain Plan. • Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• High use of Bathers Way as recreational facility ((CN, 2018).
Merewether Ocean Baths	• Ocean Baths swimming facility and amenities building.	• Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Community satisfaction with cleanliness of facility (CN, 2018).
Merewether Surf House	• Restaurant and function centre.	• Lease arrangement.	

7. Review of current coastal arrangements

7.5.3 Hunter River lower estuary – East of Hannell Street bridge

The coastal use management area in the Hunter River lower estuary is highly urbanised. **Table 33** provides a consolidated list of community facilities within the coastal use area of the Hunter River lower estuary within the scoping study area.

Table 33: Coastal community facilities at Hunter River lower estuary.

Coastal community asset/facility	Suburb	Description	Current management	Evaluation/ community view
Boat ramp	Carrington	Boat ramp north of Cowper Street bridge.	• Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	• Patronage of boat ramp is high.
Carparks	Newcastle City Centre	Horseshoe Beach carpark. Foreshore Park carpark. Queens Wharf carpark. Honeysuckle carpark.	• Asset Management Strategy 2018 – 2027. • CN Service Asset Plans. • Honeysuckle carpark owned by HCCDC.	• Patronage at carparks is high and time restricted.
	Carrington	Boat ramp carpark.	• Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	
Promenade	Newcastle City Centre	• Walkway from Nobbys Beach to Wickham.	• Walkway from Nobbys Beach to Lynch's building (292 Wharf Road) managed by CN. • Walkway from Lynch's building to Wickham owned and managed by HDC.	• High use of walkway as recreational facility ((CN, 2018).
	Wickham, Maryville	• Walkway from Wickham to Hannell Street bridge, Maryille.	• Walkway from Wickham to Cowper Street bridge owned and managed by HDC. • Walkway from Cowper Street bridge to Hannell Street bridge owned and managed by CN.	
	Carrington	• Walkway along Throsby Creek foreshore.	• Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	
Foreshore reserves	Newcastle City Centre	• Foreshore Park.	• Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	
		• Worth Place Park.	• Owned by HDC.	
	Carrington	• Maryville Foreshore Reserve. • Carrington Foreshore reserve.	• Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	
Wharf	Newcastle City Centre	• Ferry terminal at Queens Wharf.	• Managed by RMS.	
Marina	Wickham	• Newcastle Yacht Club.	• Private marinas.	
		• Commercial Fisherman's Co-operative.	• Private commercial marina.	

7.5.4 Throsby Creek catchment – west of Hannell Street bridge

The coastal use management area in the Throsby Creek catchment is highly urbanised. **Table 34** provides a consolidated list of community facilities within the coastal use area of the Throsby Creek catchment within the scoping study area.

While management arrangements are currently in place for various facilities in the coastal use management area CN will continue to monitor any issues that may arise. Issues will be monitored, and funding apportioned through the Integrated Planning and Reporting framework under the *Local Government Act 1993* and through the future CMP. Further evaluation of assets and use of areas is required through a socio-economic analysis to gain a detailed understanding of the community use of the coastal zone.

Table 34: Coastal community facilities in Throsby Creek catchment.

Coastal community asset/facility	Suburb	Description	Current management	Evaluation/ community view
Promenade	Maryville, Islington	Cycleway from Hannell Street bridge to Maitland Road (southern bank of Throsby Creek)	• Asset Management Strategy 2018 – 2027. • CN Service Asset Plans.	
Recreation facility	Islington	Islington Park including dog off lease area	• Parkland and Recreation Strategy. • Asset Management Strategy 2018-2027. • CN Service Asset Plans.	Park has high community use.

8. Knowledge gaps

Gaps in knowledge for each of the coastal management areas from *SEPP (Coastal Management) 2018* are outlined in **Table 35**.

Table 35: Coastal Management Program knowledge gaps

Coastal management area	Knowledge gap
Littoral rainforest	Additional areas in the CN LGA that might be considered littoral rainforest and potential planning proposal for inclusion in *SEPP (Coastal Management) 2018.*
Coastal vulnerability area	Sediment transport patterns within Stockton Bight including bathymetric survey to determine change to subaqueous profile. Sediment budget from Stockton Beach Coastal Processes Study Stage 1 - Sediment and Transport Analysis and Description of On-going Processes (DHI, 2006) is confined to small portion of Stockton Bight only.
	Potential sand sourcing for sand replenishment within Stockton Bight sediment compartment.
	Changes to coastal hazard lines in Stockton in response to coastal protection works constructed since previous modelling undertaken in Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)).
	Information to investigate planning proposal for inclusion of Stockton Beach and other potential locations subject to coastal hazards in coastal vulnerability area under *SEPP (Coastal Management) 2018.*
	Current asset management and climate change adaptation of seawalls/ riverwalls within the lower Hunter River estuary.
Coastal environment area	Consolidated water quality data in Hunter River lower estuary to inform ongoing water quality monitoring program.
Coastal use area	Socio economic analysis of the use of the coastal zone.

9. Risk assessment

9.1 Risk management framework

A risk-based management framework is a robust methodology for dealing with outcomes that are uncertain, have limited data, or for impacts with uncertain timeframes. This methodology is particularly applicable to coastal management issues, including coastal hazards, and the impacts of climate change where there is uncertainty regarding when and if impacts will occur.

The objectives of the *Coastal Management Act 2016* and the NSW Coastal Management Manual include the application of risk-based management of coastal issues, including coastal hazards. The risk management framework for the first-pass assessment is adapted from the Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000: 2009) (See **Figure 59**).

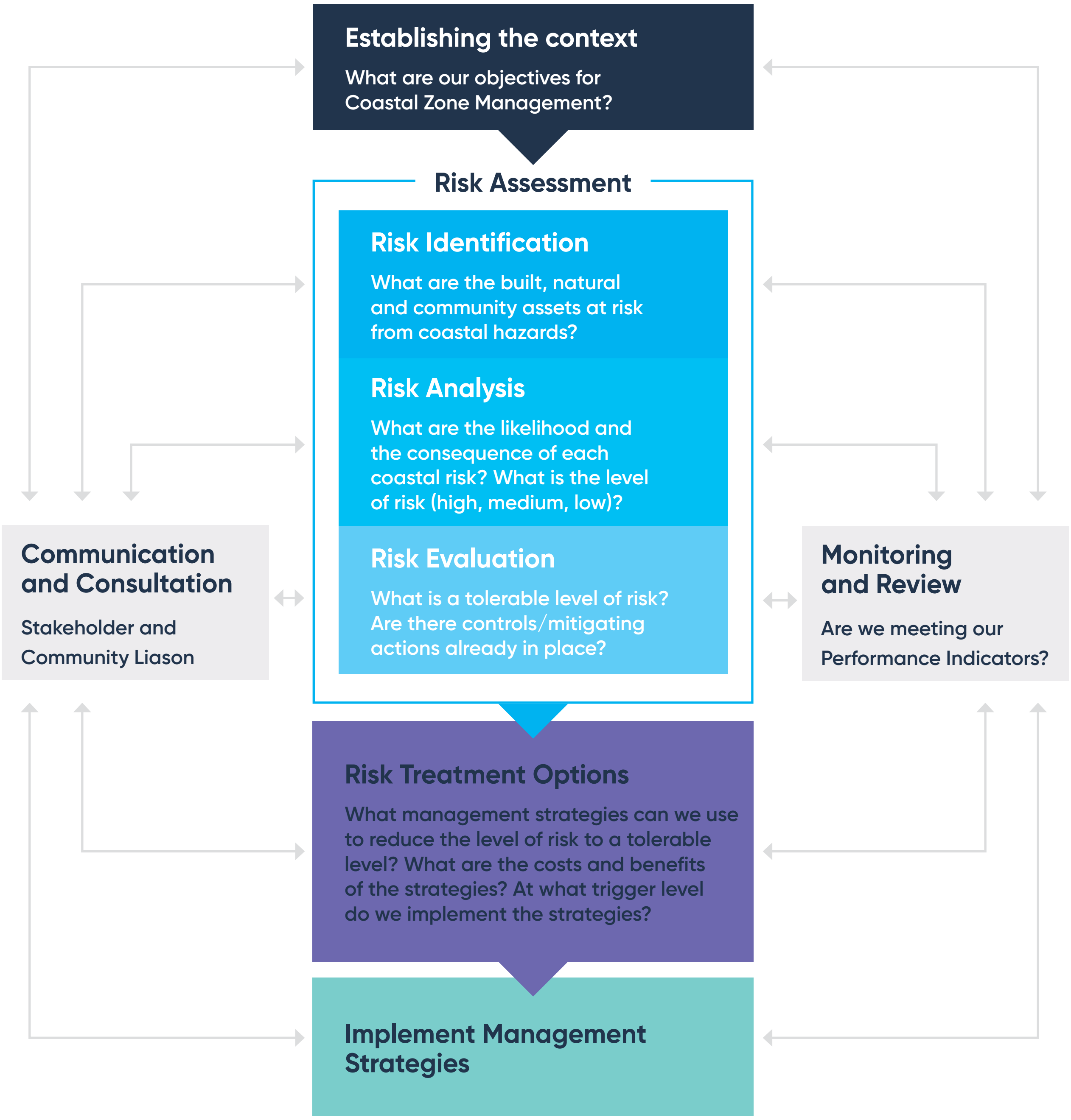


Figure 59: Risk management framework adapted to coastal zone management (BMT WBM, 2014(b) p36).

The elements of the risk management framework are described below:

Establish the context: The *Coastal Management Act 2016* and NSW Coastal Management Manual provide the objectives and context for management of coastal issues, including coastal hazards. The purpose of management of various coastal issues are outlined in Section 4.1.

Risk identification: Risk identification, including coastal hazards, has been previously outlined in the Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)). Additional threats that impact on the coastal zone, including impacts on environmental, social and economic wellbeing, are outlined in Section 5.

Risk analysis: Involves the consideration of likelihood and consequence of the identified risks, to determine the overall level of risk.

Risk evaluation: Risk evaluation was previously completed in the Newcastle Coastal Zone Management Study (BMT WBM, 2014(b)) in consultation with CN internal stakeholders and other stakeholders.

Risk treatment: Treatment is directly related to reducing or eliminating intolerable risks. Tolerable risks can be treated through monitoring programs while management options can be designed to reduce the likelihood or risk or reduce the consequence of the risk.

Implement management strategies: the CMP will detail how recommended management options will be implemented and funded. Ongoing monitoring

9.2 Risk analysis

9.2.1 Likelihood

The Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000: 2009) notes risk assessment involves the consideration of causes and risk to achieving objectives of the person/organisation undertaking the assessment. In this case, the objectives of the *Coastal Management Act 2016* are to be taken into account, particularly coastal environmental values.

A scale of 'likelihood' or probability of occurrence of threats impacting on environmental wellbeing was derived from the Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000: 2009) and the companion document HB 436: 2004 Risk Management Guidelines Companion. The risk likelihood for environment risks are detailed in **Table 36**.

9.2.2 Timeframe

The Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)) provided risk assessment timeframes of immediate (2013), 2050 and 2100 in accordance with the previous Guidelines for Preparing Coastal Zone Management Plans (OEH, 2013). The risk assessment will maintain these planning timeframes with immediate updated to 2018. However, the NSW Coastal Management Manual requires planning to be undertaken at immediate, 20, 50, 100 years and beyond. Existing information and coastal hazard mapping are limited to the immediate, 2050, 2100 timeframes, but additional planning timeframes could be included as part of future studies.

Table 36: Risk probability and likelihood.

Probability	Likelihood of impact
Almost certain	Large certainty (>90%) this will occur within short-term (1-5 years) or by future planning timeframe. History of frequent occurrence of threat.
Likely	Expected to occur (50-90%) this will occur within short-term (1-5 years) or by future planning timeframe. History of casual occurrence.
Possible	Some clear evidence to suggest threat is possible (30-50%) within short-term (1-5 years) or by future planning timeframe. History of infrequent occurrence.
Unlikely	Low possibility that threat will occur (5-30%) within short-term (1-5 years) or by future planning timeframe. History of isolated occurrence.
Rare	Very low possibility that threat will occur (<5%) within short-term (1-5 years) or by future planning timeframe. History of occurrence in extreme/ exceptional circumstances only.

9.2.3 Consequence

Environment

A consequence scale was developed for risk to environment wellbeing. To remain consistent with terminology in the Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000: 2009) 'catastrophic', 'major', 'moderate', 'minor' and 'insignificant' was adopted for the consequence scale. The consequence scale for environment risks are detailed in **Table 37**.

Economic

A consequence scale was developed for risk to economic well-being. To remain consistent with terminology in the Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000: 2009) 'catastrophic', 'major', 'moderate', 'minor' and 'insignificant' was adopted for the consequence scale. The consequence scale for economic risks are detailed in **Table 38**.

Table 37: Risk consequence scale for environmental impacts.

Consequence	Consequence of impact
Catastrophic	Widespread or permanent impact (eg. Habitat destruction, loss of species) or loss of environmental amenity. Irrecoverable environmental damage or permanent change to environmental processes.
Major	Widespread or semi-permanent impact, severe loss of environmental amenity, continuing environmental damage or ongoing change to environmental processes.
Moderate	Significant environmental damage or loss of habitat. Damage may be reversed with intensive efforts or works.
Minor	Environmental damage that may be reversed or ecological processes maintained.
Insignificant	Minimal short-term impact (similar to natural variations), with recovery occurring.

Table 38: Risk consequence scale for economic impacts.

Consequence	Consequence of impact
Catastrophic	Significant ongoing negative impacts or permanent impact on local community, damage to property, infrastructure or local economy >$5,000,000.
Major	Substantial ongoing negative impacts on local community, damage to property, infrastructure or local economy >$500,000 to $5,000,000.
Moderate	Ongoing negative impacts on local community, damage to property, infrastructure or local economy >$200,000 to $500,000.
Minor	Minor negative or temporary impact on local community, damage to property, infrastructure or local economy > $50,000 to $200,000.
Insignificant	Small negative impact on local community, damage to property, infrastructure or local economy <$50,000.

Social and cultural

A consequence scale was developed for risk to social and cultural wellbeing. To remain consistent with terminology in the Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000: 2009) 'catastrophic', 'major', 'moderate', 'minor' and 'insignificant' was adopted for the consequence scale. The consequence scale for social and cultural risks are detailed in **Table 39**.

9.3 Level of risk

Risk is defined as likelihood x consequence. A risk matrix defining the level of risk from the combinations of likelihood and consequence was developed for impacts on the environment (See **Table 40**).

Table 39: Risk consequence scale for social and cultural impacts.

Consequence	Consequence of impact
Catastrophic	Significant ongoing or permanent negative impacts on local community, widespread permanent impact to community services, destruction of cultural or heritage items (non-reversible)
Major	Ongoing negative impacts on local community, major disruption to community services (over 50% of community), complete disturbance or structural impacts on cultural or heritage items
Moderate	Minor ongoing negative or major short-term impact on local community, disruption to community services (up to 50% of community), disturbance or moderate impacts on cultural or heritage items
Minor	Minor negative or temporary (reversible) impact on local community, disruption to community services (up to 15% of community), minor disturbance or impact on cultural or heritage items
Insignificant	Small negative impact on local community, minimal disruption to community services, minimal disturbance or impact on cultural or heritage items

Table 40: Risk assessment matrix.

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Minimal	Low	Moderate	High	High
Likely	Minimal	Low	Moderate	High	High
Possible	Minimal	Minimal	Low	Moderate	High
Unlikely	Minimal	Minimal	Minimal	Low	Moderate
Rare	Minimal	Minimal	Minimal	Minimal	Low

Overall risk

In deriving the overall risk from threats on each of the community wellbeing factors the following simple rules were applied.

Risk to benefit factor from multiple threats (columns)

- All threats were considered to be of equal value.
- If a threat was considered high risk to a benefit, the overall risk to the community benefit factor was rated as a high risk to that factor.
- If a benefit has at least two moderate risk threats, but no threat was high risk it was rated as a moderate risk to the benefit overall.
- If a benefit had at least two low or moderate risk threats and had no high risk threats or one moderate risk threat, only the overall risk to that factor was low.
- A benefit that had no more than one low risk threat was rated as a minimal threat overall.

Risk to multiple benefit factors from a single threat (rows)

- All benefit factors were considered to be of equal value.
- If a threat posed a high risk to a single benefit, the threat was rated overall as a high risk.
- If a threat posed a moderate risk to at least two benefits, but it was not a high risk to any benefit, it was rated as a moderate risk overall.
- If a threat posed a low or moderate risk to at least two benefits, but it was not a high risk to any benefit or a moderate risk to one benefit only, it was rated as a low risk overall.
- A threat that was no more than a low risk to one benefit was rated as a minimal threat overall.

9.4 Risk assessment

The evaluation of cumulative risks to assets in each area are detailed in **Tables 41-57**. The evaluation was conducted with reference to the previous risk assessment undertaken in the Newcastle Coastal Zone Management Study (BMT WBM, 2014(b)) and current assessment by CN staff.

The risk assessment was adapted from the Threat and Risk Assessment Framework for the NSW Marine Estate (MEMA, 2015) that was applied in the NSW Marine Estate threat and Risk Assessment Report (BMT WBM, 2017(b)). The risk assessment considered priority threats from the NSW Marine Estate Threat and Risk Assessment Report (BMT WBM, 2017(b)) and the coastal management issues outlined in Section 5 as part of the overall assessment.

9. Risk assessment

9.4.1 Risk assessment: Stockton Beach – Northern end

Table 41 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located at the northern end of Stockton Beach. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 1**.

Table 41: Cumulative risk assessment for Stockton Beach – northern end.

Cumulative risk level from threats to asset

Asset	Environment: Immediate (2018)	Environment: 2050	Environment: 2100	Economic: Immediate (2018)	Economic: 2050	Economic: 2100	Social and cultural: Immediate (2018)	Social and cultural: 2050	Social and cultural: 2100	Notes
Stockton Centre (342 Fullerton St)	Low	Moderate	High	Low	Low	High	Low	High	High	Notes: While not at immediate risk beach erosion and shoreline recession will continue and pose high risk to property into future. Proposed North Stockton and Fern Bay Land Use Strategy requires development to be landward of 2100 unlikely erosion hazard line.
Fort Wallace (338 Fullerton St)	Low	High	High	Low	Low	High	Low	High	High	Notes: While not at immediate risk beach erosion and shoreline recession will continue and pose high risk to property into future. Proposed North Stockton and Fern Bay Land Use Strategy requires development to be landward of 2100 unlikely erosion hazard line.
Former Hunter Water sewerage treatment facility (310 Fullerton St)	Low	Moderate	High	High	High	High	Low	High	High	Notes: High risk to immediate planning horizon due to impact of beach erosion and shoreline recession on former landfill material remaining at the site. Proposed North Stockton and Fern Bay Land Use Strategy requires development to be landward of 2100 unlikely erosion hazard line.
Dune system between northern end of Corroba Oval and Griffith Ave	Moderate	High	High	Low	High	High	Moderate	High	High	Notes: Moderate risk from beach erosion in immediate planning horizon, but risk will increase with loss of dune system and potential increase in coastal inundation.
Corroba Park (2 Meredith St)	Minimal	Minimal	High	Minimal	High	High	Minimal	High	High	Notes: Risks minimal in immediate planning horizon due to dune system above. However, loss of dune system will result in high risk to park due to remaining landfill material.
Road network between Meredith St and Griffith Ave (Eames Ave, Meredith St, Beeston Rd, Griffiths Ave)	Minimal	Minimal	Minimal	Minimal	High	High	Minimal	High	High	Notes: Risk minimal in immediate planning horizon due to dune system above. However, loss of dune system will result in increased impacts for road infrastructure.

Table 41: Cumulative risk assessment for Stockton Beach – northern end.

Cumulative risk level from threats to asset

Asset	Environment: Immediate (2018)	Environment: 2050	Environment: 2100	Economic: Immediate (2018)	Economic: 2050	Economic: 2100	Social and cultural: Immediate (2018)	Social and cultural: 2050	Social and cultural: 2100	Notes
Residential dwellings between Meredith St and Griffith Ave	Minimal	Minimal	Minimal	Minimal	High	High	Minimal	High	High	Notes: Risk minimal in immediate planning horizon, but risk to properties will increase with loss of dune system above.
Barrie Street Reserve	Low	High	High	Low	High	High	Minimal	Low	High	Notes: Risk to reserve is low in immediate planning horizon as minimal infrastructure in reserve with exception of former North Stockton Surf Life Saving Club below. Risk will increase rapidly due to ongoing beach erosion and shoreline recession.
Former North Stockton Surf Life Saving Club (operating as childcare centre)	Minimal	High	High	Low	High	High	High	High	High	Notes: Risk to building is high due to beach erosion. Building will be demolished in 2020 in accordance with Newcastle Coastal Zone Management Plan 2018. If not demolished, risk will increase into future.
Road network between Griffith Avenue and Stone Street (Griffith Ave, Booth St, Stone St, Dunbar St)	Minimal	Minimal	High	Low	High	High	Low	High	High	Road network between Griffith Avenue and Stone Street (Griffith Ave, Booth St, Stone St, Dunbar St).
Residential dwellings between Griffith Ave and Stone St	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Moderate	High	Notes: Risk minimal in immediate planning horizon, but risk to properties will increase with loss of Barrie Street Reserve to shoreline recession.

Risk overview: Stockton Beach – Northern end

The coastal management issue with the highest risk for Stockton Beach – northern end is coastal erosion and subsequent shoreline recession. While coastal erosion represents a high risk in the immediate planning horizon for properties such as the former North Stockton Surf Life Saving Club, Barrie Crescent Reserve and the former Hunter Water sewerage treatment plant (310 Fullerton Street) ongoing erosion will increase potential properties at risk into the future (See **Appendix E**).

Invasive plant species such as Bitou Bush (*Chrysanthemoides monilifera*) are rated as a moderate risk to the coastal management area in the northern properties such as the Stockton Centre (342 Fullerton Street), Fort Wallace (338 Fullerton Street) and the former Hunter Water sewerage treatment facility (310 Fullerton Street). While this is rated as a moderate risk further action can be included in the future CMP, but ongoing action can be undertaken under the *Biosecurity Act 2015*.

9.4.2 Risk assessment: Stockton Beach – Central section

Table 42 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located at the central section of Stockton Beach. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 2**.

Table 42: Cumulative risk assessment for Stockton Beach – Central section.

Cumulative risk level from threats to asset

Asset	Environment: Immediate (2018)	Environment: 2050	Environment: 2100	Economic: Immediate (2018)	Economic: 2050	Economic: 2100	Social and cultural: Immediate (2018)	Social and cultural: 2050	Social and cultural: 2100	Notes
Mitchell St seawall	Low	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low	Notes: Risk from coastal erosion and inundation, but main risk is maintenance cost of structure. Maintenance cost reflected in Newcastle Coastal Zone Management Plan 2018.
Dune system between Mitchell St seawall and Memorial Reserve	Moderate	High	High	Low	Moderate	High	Low	Moderate	High	Notes: High risk from beach erosion.
Mitchell St roadway between Pembroke St and Hereford St	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Notes: High risk from beach erosion and shoreline recession in future if dune system lost. Minimal and low risk rating based on assumed serviceability and effectiveness of Mitchell Street seawall.
Residential dwellings between Pembroke St and Hereford St	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Low	High	Notes: Increasing risk to properties in future if dune system lost to beach erosion.
Memorial Reserve (21 Pitt St)	Minimal	Minimal	Low	Minimal	Low	High	Minimal	Low	High	Notes: Low risk at present, but increasing risk from beach erosion and shoreline recession.
Dalby Oval	Minimal	Minimal	Minimal	Minimal	Low	High	Low	Moderate	High	Notes: Low risk at present, but increasing risk from beach erosion and shoreline recession.

Risk overview: Stockton Beach – Central section

The central section of Stockton Beach is dominated by the Mitchell Street seawall protection structure. While affording protection for a section of Mitchell Street and adjoining residential properties the coastal protection structure has resulted in increasing risk of beach erosion at the terminal ends. This is highlighted by the moderate and increasing risk of beach erosion at the dune system between Mitchell Street seawall and Memorial Reserve. The risk of beach erosion is also shown by the high risk ratings at Memorial Reserve and Dalby Oval.

9. Risk assessment

9.4.3 Risk assessment: Stockton Beach – Southern end

Table 43 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located at the southern end of Stockton Beach. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 3**.

Table 43: Cumulative risk assessment for Stockton Beach – Southern end.

Table 43: Cumulative risk assessment for Stockton Beach – Southern end.

Cumulative risk level from threats to asset

	Environment			Economic			Social and cultural			
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Notes
Stockton Surf Life Saving Club seawall	Moderate	Moderate	Moderate	Low	Low	Low	Minimal	Minimal	Low	Notes: Main risk is from economic maintenance of seawall. May increase erosion on beachfront in future.
Stockton Surf Life Saving Club	Minimal	Minimal	Moderate	Minimal	Low	Low	Low	Low	Low	Notes: Construction of seawall has changed potential risk compared to previous reports.
Stockton Bowling Club and tennis club	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Notes: Potential risks from beach erosion, but loss of dune system at Dalby Oval will increase risk.
Surf Life Saving Club carpark	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal	Notes: Construction of seawall has changed potential risk compared to previous reports.
Surf Life Saving Club pavilion	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low	Notes: Construction of seawall has changed potential risk compared to previous reports.
Lexie's café	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low	Notes: Risk from coastal inundation and overtopping. Risk in maintenance of building.
Dune system seaward of Stockton caravan park	Moderate	Moderate	High	Low	Low	High	Low	Low	High	Notes: Moderate to high risk from beach erosion, shoreline recession and overtopping of dune system.
Stockton caravan park	Minimal	Low	High	Low	Low	High	Minimal	Moderate	High	Notes: Risk will increase with loss of dune system. Potential inundation overtopping will increase.
King St roadway near breakwall	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Minimal	Moderate	Notes: Potential inundation overtopping will increase in future planning horizons.
Stockton breakwall	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Minimal	Low	Notes: Overtopping of structure. Maintenance undertaken by Port of Newcastle
Pitt St Reserve carpark near Stockton breakwall	Minimal	Minimal	High	Low	Moderate	High	Minimal	Low	High	Notes: Risk will increase with erosion of dune system below.
Little Beach dune system	Low	Low	High	Low	Low	Moderate	Low	Moderate	High	Notes: Risk from beach erosion and coastal inundation due to predicted sea level rise.

Risk overview: Stockton Beach – Southern end

Beach erosion is considered the highest risk to the southern end of Stockton Beach. The increasing risks from beach erosion is shown by the high environmental and economic risks to the dune system seaward of the Stockton Beach Holiday Park into the future. Beach erosion also contributes to the high risk for the Stockton Beach Holiday Park as loss of the dune system will increase economic costs for the caravan park. Beach erosion is also a risk for the Little Beach area with high potential for impacts on the beach and associated dune system. The increased risk of the Little Beach dune system will also result in increased risk of coastal inundation of public assets such as the Pitt Street Reserve parking area.

The risk profile is minimal or low for properties landward of the recently constructed seawall at the Stockton Surf Life Saving Club. While risk has been minimised the risk of the structure contributing to additional erosion and/or loss of beach amenity requires further investigation.

9.4.4 Risk assessment: Nobbys Beach

Table 44 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located at Nobbys Beach. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are outlined in **Appendix I 4**.

Table 44: Cumulative risk assessment for Nobbys Beach.

Cumulative risk level from threats to asset

Asset	Environment: Immediate (2018)	Environment: 2050	Environment: 2100	Economic: Immediate (2018)	Economic: 2050	Economic: 2100	Social and cultural: Immediate (2018)	Social and cultural: 2050	Social and cultural: 2100	Notes
Hunter River southern breakwall	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low	Notes: Increased risk from overtopping of seawall will result in increased maintenance costs. Maintenance by Port of Newcastle.
Nobbys Beach dune system	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Notes: Minimal risk to dune system with ongoing maintenance.
Nobbys Road	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Notes: Increasing risk due to beach erosion and shoreline recession, but low overall.
Nobbys Beach Surf Life Saving Club and facilities (35 Nobbys Road)	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Low	Notes: Increasing risk as modelled beach erosion focused around southern end of beach. Small seawall provides some protection, but cost of seawall maintenance will increase.
Shortland Esplanade and Bathers Way walkway (between Nobbys Rd and Newcastle Ocean Baths)	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Minimal	High	Notes: Increasing risk from coastal inundation due to sea level rise. Economic risk will increase due to maintenance/retrofit of area.
Nobbys Road and Fort Drive	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Notes: Risk from cliff instability will increase, but currently managed through maintenance program.
Fort Scratchley (31 Nobbys Rd)	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Notes: Risk from cliff instability, but currently managed.

Table 44: Cumulative risk assessment for Nobbys Beach.

Cumulative risk level from threats to asset

Asset	Environment: Immediate (2018)	Environment: 2050	Environment: 2100	Economic: Immediate (2018)	Economic: 2050	Economic: 2100	Social and cultural: Immediate (2018)	Social and cultural: 2050	Social and cultural: 2100	Notes
Residential dwellings (1-17 Shortland Esplanade)	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Low	Moderate	Moderate	Notes: Increased risk from coastal inundation due to sea level rise
Residential dwellings (Fort Dr, Beach St, Murray Ave) Residential dwellings (1-17 Shortland Esplanade)	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Notes: Some risk from cliff instability
Rock platform between Nobbys Beach and Newcastle Ocean Baths (incl Cowrie Hole)	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Notes: Platform already has periods of coastal inundation.
Nobbys Beach	Minimal	Low	Moderate	Low	Moderate	High	Low	Low	High	Notes: Increasing risk from beach erosion and coastal inundation. High social value placed on use of beach area.
Horseshoe Beach	Minimal	Low	Moderate	Minimal	Minimal	Low	Low	Low	Low	Notes: Risk from coastal inundation due to sea level rise.
Nobbys headland and lighthouse	Minimal	Minimal	Minimal	Minimal	Low	Low	Moderate	Moderate	Moderate	Notes: Risk from cliff instability identified, but management unknown. Risk to cultural heritage.

Risk overview: Nobbys Beach

Beach erosion at Nobbys Beach and coastal inundation along Shortland Esplanade, including the Bathers Way coastal walkway, are considered the highest risks for the Nobbys Beach area. Beach erosion at Nobbys Beach is reasonably well understood through the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)) and is unlikely to have significant amenity impacts in the next twenty years. Nobbys Beach is currently managed under the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) and further study is not required at this stage. Management actions from the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) may be included in the future CMP.

Coastal inundation at Shortland Esplanade is reasonably understood and managed through the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018). Emergency actions for Shortland Esplanade are also detailed in the coastal erosion emergency action subplan contained with the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) and CN internal procedures.

9.4.5 Risk assessment: Newcastle Beach

Table 45 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located at Newcastle Beach. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 5**.

Table 45: Cumulative risk assessment for Newcastle Beach.

Cumulative risk level from threats to asset

Asset	Environment Immediate (2018)	Environment 2050	Environment 2100	Economic Immediate (2018)	Economic 2050	Economic 2100	Social and cultural Immediate (2018)	Social and cultural 2050	Social and cultural 2100	Notes
Newcastle Ocean Baths	Minimal	Minimal	Minimal	Low	Moderate	High	Low	Moderate	High	Notes: High risk of coastal inundation with predicted sea level rise. Increasing economic cost of maintaining heritage asset.
Newcastle Ocean Baths carpark	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Notes: Risk from coastal inundation
Newcastle Ocean Baths rock platform	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Notes: Coastal inundation will impact on habitat of roosting shorebirds into the future. Reduction of habitat due to sea level rise.
Canoe Pool	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Notes: Some risk from coastal inundation will result in loss of community asset.
Newcastle Beach	Moderate	Moderate	Moderate	Minimal	Moderate	Moderate	Low	Moderate	High	Notes: Risk from beach erosion and loss of amenity. Increasing risk due to changing climatic conditions. High social risk from loss of beach asset.
Newcastle Surf Life Saving Club Newcastle Beach	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Moderate	Moderate	Notes: Risk from beach erosion, but current protection from seawall. Economic risk increases into future for maintenance of seawall and building.

Table 45: Cumulative risk assessment for Newcastle Beach.

Cumulative risk level from threats to asset

Asset	Environment Immediate (2018)	Environment 2050	Environment 2100	Economic Immediate (2018)	Economic 2050	Economic 2100	Social and cultural Immediate (2018)	Social and cultural 2050	Social and cultural 2100	Notes
Bathers Way promenade (between Newcastle Ocean Baths and King Edward Park)	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Low	Low	Low	Notes: Current protection by seawall.
Newcastle south skate park and amenities	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Low	Notes: Current protection by seawall. Some overtopping predicted.
Shortland Esplanade (between Newcastle Ocean Baths and Watt St)	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Moderate	Notes: Increased social risk from increasing use/overcrowding.
Slope below Shortland Esplanade	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	
Coastal cliff line (southern end of beach)	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Low	Notes: Risk from cliff instability, but currently managed.

Risk overview: Newcastle Beach

Beach erosion at Newcastle Beach and coastal inundation of Newcastle Ocean Baths are considered the highest risks for the Newcastle Beach area. Beach erosion at Newcastle Beach is reasonably well understood through the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)). Beach erosion also contributes to potential risks for assets to the rear of the beach, such as the Newcastle Surf Life Saving Club, and maintenance of the existing seawall structure will be required in the future. Newcastle Beach is currently managed under the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) and further study is not required at this stage. Management actions from the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) may be included in the future CMP.

Coastal inundation of the Newcastle Ocean Baths facility has been a management issue for a significant period and risks are reasonably understood and managed through the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018). The economic risk for Newcastle Ocean Baths is associated with ongoing maintenance of the heritage listed item and management of coastal inundation impacts.

9.4.6 Risk assessment: Strzelecki headland

Table 46 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located at Strzelecki headland. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 6**.

Table 46: Cumulative risk assessment for Strzelecki headland.

Cumulative risk level from threats to asset

Asset	Environment Immediate (2018)	Environment 2050	Environment 2100	Economic Immediate (2018)	Economic 2050	Economic 2100	Social and cultural Immediate (2018)	Social and cultural 2050	Social and cultural 2100	Notes
King Edward Park	Low	Low	Low	Low	Low	Moderate	Minimal	Minimal	Low	Notes: Increasing risk from increased community use of park, risk to habitat/EEC.
Coastal cliff line (King Edward Park to Susan Gilmore Beach)	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Notes: Minimal use of cliff line/area below cliff line.
Rock platform below King Edward Park (including Bogie Hole)	Low	Low	Low	Minimal	Moderate	Moderate	Low	Low	Moderate	Notes: Increasing risk from maintaining access to Bogey Hole. Access may become more dangerous over time.
Rock platform below Memorial Drive	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Notes: Low use area.
ANZAC Memorial walkway	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	
Shepherds Hill military installation (heritage site)	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Notes: Some risk from cliff instability

Table 46: Cumulative risk assessment for Strzelecki headland.

Cumulative risk level from threats to asset

Asset	Environment Immediate (2018)	Environment 2050	Environment 2100	Economic Immediate (2018)	Economic 2050	Economic 2100	Social and cultural Immediate (2018)	Social and cultural 2050	Social and cultural 2100	Notes
Memorial walkway carpark	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Notes: Increasing social risk from increasing use of carpark area.
Residential properties at Nesca Pde and Fenton Av	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Notes: Cliff instability area, but low risk.
Memorial Drive	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Notes: Cliff instability area, but low risk.
Susan Gilmore Beach	Low	Low	Moderate	Minimal	Minimal	Minimal	Minimal	Low	Low	Notes: Risk from beach erosion increasing, but low level community use of beach.
Coastal heathland vegetation (including Themeda grasslands)	Minimal	Low	Low	Low	Low	Low	Minimal	Minimal	Low	Notes: Risk from increased use of area by community.

Risk overview: Strzelecki headland

No coastal management issues were rated as high for the Strzelecki headland area. Moderate risks were identified for the following parts of Strzelecki headland:

Increasing economic risk for King Edward Park due to invasive species and maintenance of the Themeda grasslands EEC. These issues are managed through the *Biosecurity Act 2015*, plan of management under the *Local Government Act 1993* and the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018). These risks are currently managed and will be included in the future CMP.

Coastal inundation of the rock platform and Bogey Hole swimming area. There is increasing risk to the public swimming area and management will need to be discussed with the Crown Lands department as the land owner.

Beach erosion at Susan Gilmore Beach. This area is managed under the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) and further study is not required at this stage. Management actions from the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) may be included in the future CMP.

9.4.7 Risk assessment: Bar Beach

Table 47 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located at Bar Beach. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 7**.

Table 47: Cumulative risk assessment for Bar Beach.

Cumulative risk level from threats to asset

Asset	Environment Immediate (2018)	Environment 2050	Environment 2100	Economic Immediate (2018)	Economic 2050	Economic 2100	Social and cultural Immediate (2018)	Social and cultural 2050	Social and cultural 2100
Bar Beach carpark (north end of beach)	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low
Coastal cliff line below Bar Beach carpark	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Minimal	Minimal
Rock platform between Susan Gilmore and Bar Beach	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low
Bar Beach	Low	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	High
Cooks Hill Surf Life Saving Club and facilities	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Minimal	Minimal
Bathers Way viewing platform	Minimal	Low	Moderate	Minimal	Moderate	Moderate	Minimal	Minimal	Minimal

Notes (Bar Beach carpark (north end of beach)): Some risk from cliff instability and increased community use of facility.

Notes (Coastal cliff line below Bar Beach carpark): Cliff instability risk, but currently managed.

Notes (Rock platform between Susan Gilmore and Bar Beach): Increasing risk from coastal inundation and habitat modification. Coastal inundation may impact community use of Susan Gilmore beach.

Notes (Bar Beach): Moderate risk from beach erosion and reduced amenity of beach area. Risk to beach increases over time.

Notes (Cooks Hill Surf Life Saving Club and facilities): Increased risk from beach erosion and coastal inundation/overtopping. Economic risk from maintenance of seawall and facilities.

Notes (Bathers Way viewing platform): Risk from cliff instability.

Table 47: Cumulative risk assessment for Bar Beach.

Cumulative risk level from threats to asset

Asset	Environment Immediate (2018)	Environment 2050	Environment 2100	Economic Immediate (2018)	Economic 2050	Economic 2100	Social and cultural Immediate (2018)	Social and cultural 2050	Social and cultural 2100
Bar Beach kiosk and public promenade	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Minimal	Minimal
Bar Beach dune system (southern end of beach)	Low	Moderate	High	Low	Moderate	High	Minimal	Low	Low
Bathers Way coastal walk (between Memorial Dr and Kilgour Ave)	Minimal	Minimal	Minimal	Minimal	Minimal	High	Minimal	Low	High
Memorial Drive	Minimal	Minimal	Minimal	Minimal	Minimal	High	Minimal	Minimal	High
Coastal cliff line below Kilgour Ave	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Moderate

Notes (Bar Beach kiosk and public promenade): Increased risk from beach erosion and coastal inundation/overtopping.

Notes (Bar Beach dune system (southern end of beach)): Risk from beach erosion and shoreline recession. Dune restoration to be undertaken in near future.

Notes (Bathers Way coastal walk (between Memorial Dr and Kilgour Ave)): Increased risk from beach erosion due to loss of dune system above.

Notes (Memorial Drive): Increased risk from beach erosion due to loss of dune system above.

Notes (Coastal cliff line below Kilgour Ave): Risk from cliff instability, but currently managed. Increased risk due to access to bottom of cliff by public.

Risk overview: Bar Beach

Beach erosion at Bar Beach and coastal inundation of facilities at the northern end of the beach, including Cooks Hill Surf Life Saving Club are considered the highest risks for the Bar Beach area. Beach erosion at Bar Beach is reasonably well understood through the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)). Beach erosion also contributes to potential risks for assets landward of the beach, particularly assets at the southern end of the beach such as the Bathers Way coastal walk which are not protected by seawall structures, and maintenance of the existing seawall at the northern end of the beach requires maintenance. Bar Beach is currently managed under the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) and further study is not required at this stage. Management actions from the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) may be included in the future CMP.

Coastal inundation of facilities at the northern end of Bar Beach is an existing risk and risk will increase with sea level rise. The risk from coastal inundation is reasonably understood and managed through the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018).

9.4.8 Risk assessment: Dixon Park Beach

Table 48 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located at Dixon Park Beach. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 8**.

Table 48: Cumulative risk assessment for Dixon Park Beach.

Cumulative risk level from threats to asset

	Environment			Economic			Social and cultural			
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Notes
Dixon Park Beach	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	High	Notes: Moderate/high risk from beach erosion and reduced amenity of beach area.
Dixon Park dune system (between Berner St and Ocean St	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Moderate	Notes: Beach erosion will increase with sea level rise. Impacts on dune system and beach access.
Bathers Way coastal walk (between Berner St and Kilgour Ave)	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	Notes: Some risk from increased community use, but low risk overall.
Dixon Park carpark	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Low	Moderate	Notes: Increased risk from coastal inundation in southern end due to predicted sea level rise.
Dixon Park Beach seawall	Low	Low	Low	Low	Low	Moderate	Minimal	Low	Low	Notes: Risk from beach erosion and exposure of seawall. Seawall requires monitoring.

Risk overview: Dixon Park Beach

Beach erosion at Dixon Park is considered the highest risk for the area. Beach erosion is reasonably well understood through the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)). Facilities landward of the beach are currently protected by an existing seawall, but the economic risk from maintenance of the seawall requires consideration in future planning horizons. Dixon Park Beach is currently managed under the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) and further study is not required at this stage. Management actions from the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) may be included in the future CMP.

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9.4.9 Risk assessment: Merewether Beach

Table 49 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located at Beach. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 9**.

Table 49: Cumulative risk assessment for Merewether Beach.

Cumulative risk level from threats to asset

	Environment			Economic			Social and cultural			
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Notes
Merewether Beach	Low	Moderate	Moderate	Low	Moderate	High	Low	Moderate	High	Notes: Social impact on loss of beach significant. Erosion and inundation likely to increase due to changing climatic conditions.
Merewether Beach seawall	Low	Low	Low	Low	Low	High	Minimal	Low	Low	Notes: Risk from beach erosion and exposure of seawall. Seawall requires monitoring.
Merewether Beach dune system (between Berner St and Watkins St)	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Notes: Risk from beach erosion and coastal inundation. Seawall below dunes.
Bathers Way coastal walk (between Berner St and Watkins St)	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	Notes: Some risk from increased community use, but low risk overall.
Merewether Surf Life Saving Club (1 John Parade)	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal	Notes: Some risk from beach erosion but protected by seawall.
Surf House (5 Henderson Parade)	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low	Notes: Some risk from beach erosion but protected by seawall.
Henderson Parade roadway	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Notes: Some risk from beach erosion but protected by seawall.
Merewether Ocean Baths	Minimal	Minimal	Minimal	Low	Low	High	Low	Low	High	Notes: Increased risk from coastal inundation with predicted sea level rise. Increased cost for maintenance of heritage item.

Table 49: Cumulative risk assessment for Merewether Beach.

Cumulative risk level from threats to asset

Asset	Environment			Economic			Social and cultural			Notes
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	
Merewether Ocean baths rock platform	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Notes: Potential loss of habitat from sea level rise.
Merewether Ocean Baths amenities building	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Low	Low	Notes: Some risk from coastal inundation
Merewether Ocean Baths carparking areas:	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	
Frederick Street	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	
Residential properties at Robinson St, Lloyd St and Hickson St	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate	Notes: Increased risk from cliff instability. Economic risk from loss of property etc.
Promenade between Watkins St and Merewether Ocean Baths	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low	Notes: Some risk from beach erosion and coastal inundation. Currently protected by small seawall.
Coastal cliff below Lloyd St and Hickson St	Minimal	Minimal	Low	Low	Moderate	Moderate	Low	Moderate	Moderate	Notes: Cliff instability risk likely to increase with sea level rise impacts on base of cliff.

Risk overview: Merewether Beach

Beach erosion at Merewether Beach and coastal inundation of Merewether Baths are considered the highest risks for the Merewether area. Beach erosion at Merewether Beach is reasonably well understood through the Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a)). Facilities landward of the beach are currently protected by a variety of different types of seawall, but the economic risk from maintenance of the seawalls requires consideration in future planning horizons. Newcastle Beach is currently managed under the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) and further study is not required at this stage. Management actions from the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) may be included in the future CMP.

Coastal inundation of the Merewether Baths facility has been a management issue for a significant period of time and risk are reasonably understood and managed through the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018). The economic risk for Merewether Baths is associated with ongoing maintenance of the heritage listed item and management of coastal inundation impacts.

A moderate risk in future planning horizons is cliff instability for private residential properties at Merewether headland. Cliff instability is currently managed in the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018) and review of the Geotechnical Assessment of Newcastle Cliffs and Slopes (RCA, 2013) is required in the future. The review of the Geotechnical Assessment of Newcastle Cliffs and Slopes will be completed as an action for the future CMP.

9. Risk assessment

9.4.10 Risk assessment: Glenrock State Conservation Area

Table 50 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located at Glenrock State Conservation Area. Individual risk assessments for each property or asset outlining individual risk from each coastal management issue are in **Appendix I 10**.

Table 50: Cumulative risk assessment for Glenrock State Conservation Area.

Cumulative risk level from threats to asset

Asset	Environment			Economic			Social and cultural			Notes
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	
Rock platform between Merewether Beach and Burwood Beach	Low	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Notes: Potential loss of habitat due to predicted sea level rise. Coastal inundation may also impact access to platform.
Northern end of SCA (including beach and forest area)	Low	Moderate	Moderate	Low	Low	Low	Low	Moderate	Moderate	Notes: Increased risk from cliff instability and beach erosion.
Hunter Water sewerage outfall pipeline	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Notes: Economic and social impact risk from disruption of pipeline from coastal hazards.
Burwood Beach dune system	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	
Burwood beach	Low	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Notes: Low risk due to low use of beach.
Glenrock lagoon	Low	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Notes: Low risk from entrance instability.
Murdering Gully (riparian entrance to beach)	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low	Notes: Low risk from entrance instability.
Remains of Glenrock railway (Local heritage item)	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Moderate	Notes: Low risk of damage to heritage listed item from beach erosion.

Risk overview: Glenrock State Conservation Area

Moderate risks to the dune system of Burwood Beach from beach erosion have been identified in the risk assessment. The natural assets of Glenrock State Conservation Area are managed by NPWS and risk management of these assets needs to be determined with the land manager. Engagement with NPWS will be undertaken as part of the CMP process. Management of HWC built assets in response to coastal hazards will be discussed with HWC during the CMP process.

9.4.11 Risk assessment: Newcastle City Centre

Table 51 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located in Newcastle City Centre. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 11**.

Table 51: Cumulative risk assessment for Newcastle City Centre.

Cumulative risk level from threats to asset

Asset	Environment			Economic			Social and cultural			Notes
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	
Horseshoe Beach carpark	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Low	Notes: Some economic risk from coastal inundation.
Horseshoe Beach riverwall/ training wall	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low	Notes: Increasing economic risk from coastal inundation and associated maintenance cost. Maintained by Port of Newcastle.
Stony Point rock platform (western side of Nobbys breakwater)	Low	Low	Moderate	Minimal	Minimal	Minimal	Minimal	Low	Low	Notes: Increasing environmental risk due to disturbance of shorebird roosting habitat. Disturbance from inundation and increasing use of area by community and companion animals.
Department of Defence building (40 Wharf Road, Newcastle East)	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Notes: Increasing economic risk from coastal inundation but remains low priority.
RMS buildings, boat marina	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Notes: Increasing economic risk from coastal inundation but remains low priority.
River wall (between RMS Building and Queens Wharf)	Minimal	Minimal	Minimal	Minimal	High	High	Minimal	Low	Low	Notes: Increasing economic risk due to rising sea levels and coastal inundation. Maintenance cost will continue to increase unless maintenance undertaken.
Walkway promenade (between RMS buildings and Queens Wharf)	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Notes: Risk assessment based on ongoing serviceability of river wall.
Wharf Road, Newcastle East	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Notes: Risk assessment based on ongoing serviceability of river wall.
Queens Wharf buildings (150 Wharf Road, Newcastle)	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Low	Moderate	Notes: Economic and social risk will be based on maintenance of river wall at wharf site. Increasing risk to buildings from coastal inundation.
Queens Wharf outdoor area (170 Wharf Road, Newcastle)	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High	Notes: Increasing risk from coastal inundation. Social risk high due to disruption to area from coastal hazard.
Queens Wharf ferry terminal	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High	Notes: Increasing risk from coastal inundation. Social risk high due to disruption to ferry service from coastal hazard.
Scratchleys building (200 Wharf Road, Newcastle)	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High	Notes: Increasing risk from coastal inundation. Impact to building and area based on serviceability of river wall.
Walkway promenade (between Queens Wharf and 292 Wharf Road)	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Notes: Risk assessment based on ongoing serviceability of river wall.
River wall (between Queens Wharf and 292 Wharf Road)	Minimal	Minimal	Minimal	Minimal	Moderate	High	Minimal	Low	Low	Notes: Increasing economic risk due to rising sea levels and coastal inundation. Maintenance cost will continue to increase unless maintenance undertaken.
River wall and promenade (9 Honeysuckle Dr, Newcastle)	Minimal	Minimal	Minimal	Low	Moderate	High	Minimal	Moderate	Moderate	Notes: Increasing economic risk due to rising sea levels and coastal inundation. Maintenance cost will continue to increase unless maintenance undertaken. Disruption to use of promenade due to coastal inundation. Area currently owned by HDC.

Table 51: Cumulative risk assessment for Newcastle City Centre.

Cumulative risk level from threats to asset

Asset	Environment – Immediate (2018)	Environment – 2050	Environment – 2100	Economic – Immediate (2018)	Economic – 2050	Economic – 2100	Social and cultural – Immediate (2018)	Social and cultural – 2050	Social and cultural – 2100
Wharf (9 Honeysuckle Drive, Newcastle)	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Minimal	Low
Lee Wharf building (3C Honeysuckle Drive, Newcastle)	Minimal	Minimal	Minimal	Low	High	High	Low	Low	Low
Honeysuckle Hotel (13 Honeysuckle Drive, Newcastle)	Minimal	Minimal	Minimal	Low	High	High	Low	Low	Low
Worth Place park (16 Worth Place, Newcastle)	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low

Notes (Wharf): Risk assessment based on ongoing serviceability of river wall.

Notes (Lee Wharf building): Increasing risk from coastal inundation. Impact to building and area based on serviceability of river wall. Building owned by HDC.

Notes (Honeysuckle Hotel): Increasing risk from coastal inundation. Impact to building and area based on serviceability of river wall.

Notes (Worth Place park): Area owned and managed by HDC.

Risk overview: Newcastle City Centre

Coastal inundation is considered the highest risk management issue for the Newcastle City Centre, particularly for property and assets located along the Hunter River including Queens Wharf. Coastal inundation has been assessed for the Newcastle City Centre through the Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012). While risk have been highlighted for various assets the bank of the Hunter River has been modified by river wall protection structures. The economic risk for maintenance of these structures is considered high, but the responsibility and ownership of these structures is varied. Management of these structures requires further investigation prior to further studies.

9.4.12 Risk assessment: Wickham

Table 52 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located in Wickham. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 12**.

Table 52: Cumulative risk assessment for Wickham.

Cumulative risk level from threats to asset

Asset	Environment – Immediate (2018)	Environment – 2050	Environment – 2100	Economic – Immediate (2018)	Economic – 2050	Economic – 2100	Social and cultural – Immediate (2018)	Social and cultural – 2050	Social and cultural – 2100
Park (79 Hannell St, Wickham)	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Newcastle Yacht Club marina (87B Hannell St, Wickham)	Low	Low	Low	Low	Moderate	Moderate	Low	Low	Low
Commercial Fisherman's Cooperative	Low	Low	Low	Low	Moderate	Moderate	Low	Low	Low
River wall and walkway (between Cowper Street bridge and 50 Honeysuckle Drive)	Minimal	Minimal	Minimal	Low	Moderate	High	Low	Low	Low
Wickham - Commercial and residential properties	Minimal	Minimal	Minimal	Low	High	High	Low	High	High
Wickham - Roads and infrastructure	Minimal	Minimal	Minimal	Low	High	High	Low	High	High

Notes (Park): Park protected by existing river wall.

Notes (Newcastle Yacht Club marina): Increasing economic risk due to coastal inundation. Cost of maintenance of marina berths will increase in future planning horizons.

Notes (Commercial Fisherman's Cooperative): Increasing economic risk due to coastal inundation. Cost of maintenance of marina berths will increase in future planning horizons.

Notes (River wall and walkway): Economic risk will increase due to maintenance cost for river wall.

Notes (Wickham - Commercial and residential properties): Significant risk from both coastal and tidal inundation (See **Appendix G and H**). Increasing economic and social risk due to number of properties potentially impacted.

Notes (Wickham - Roads and infrastructure): Significant risk from both coastal and tidal inundation (See **Appendix G and H**). Increasing economic and social risk due to infrastructure potentially impacted.

Risk overview: Wickham

Coastal and tidal inundation are considered the highest risks for the suburb of Wickham. Coastal and tidal inundation are reasonably well understood through the Strategic Position for the Management of the Low Lying Areas in Newcastle (BMT WBM, 2015) that was undertaken through the flood grants program. The results of this study have informed the Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017) which outlines a protection plan for the suburb from inundation. The Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017) outlines trigger points for additional investigations and the results of these investigations will inform the CMP process and potential future actions in the CMP.

The banks of the Hunter River lower estuary have been modified by the construction of river walls. The economic risk for maintenance of these structures is considered high, but the responsibility and ownership of these structures is varied. Management of these structures requires further investigation prior to further studies.

9.4.13 Risk assessment: Maryville

Table 53 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located in Maryville. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 13**.

Table 53: Cumulative risk assessment for Maryville.

Cumulative risk level from threats to asset

Asset	Environment: Immediate (2018)	Environment: 2050	Environment: 2100	Economic: Immediate (2018)	Economic: 2050	Economic: 2100	Social and cultural: Immediate (2018)	Social and cultural: 2050	Social and cultural: 2100
Hannell Street Reserve (259 Hannell St, Maryville)	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low
Riverwall - Hannell Street Reserve	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low
Cycleway and riverwall (between Islington Park and Hannell Street bridge)	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low
Maryville - commercial and residential properties	Minimal	Minimal	Minimal	Low	High	High	Low	High	High
Maryville - roads and infrastructure	Minimal	Minimal	Minimal	Low	High	High	Low	High	High

Notes (Hannell Street Reserve): Increasing economic risk due to coastal inundation. Potential impacts to cycleway.

Notes (Riverwall - Hannell Street Reserve): Increasing economic risk due to maintenance of river wall. Maintenance of river wall will impact Hannell Street Reserve.

Notes (Cycleway and riverwall): Impacts to cycleway will be dependent on maintenance of river wall. Maintenance undertaken by HWC in recent times.

Notes (Maryville - commercial and residential properties): Significant risk from both coastal and tidal inundation (See **Appendix G and H)**. Increasing economic and social risk due to number of properties potentially impacted.

Notes (Maryville - roads and infrastructure): Significant risk from both coastal and tidal inundation (See **Appendix G and H**). Increasing economic and social risk due to infrastructure potentially impacted.

Risk overview: Maryville

Coastal and tidal inundation are considered the highest risks for the suburb of Maryville. Coastal and tidal inundation are reasonably well understood through the Strategic Position for the Management of the Low Lying Areas in Newcastle (BMT WBM, 2015) that was undertaken through the flood grants program. The results of this study have informed the Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017) which outlines a protection plan for the suburb from inundation. The Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017) outlines trigger points for additional investigations and the results of these investigations will inform the CMP process and potential future actions in the CMP.

The banks of the Hunter River lower estuary have been modified by the construction of river walls. The economic risk for maintenance of these structures is considered high, but the responsibility and ownership of these structures is varied. Management of these structures requires further investigation prior to further studies.

The highest risk within Maryville is coastal and tidal inundation of the suburb. The Strategic Position for the Management of low Lying Areas of Newcastle (NCC, 2017) outlines protection of the suburb from coastal and tidal inundation will be undertaken based on certain trigger points. Additional investigation of the trigger points is currently been undertaken and results of these investigations will inform the CMP process.

9.4.14 Risk assessment: Carrington

Table 54 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located in Carrington. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 14**.

Table 54: Cumulative risk assessment for Carrington.

Cumulative risk level from threats to asset

Asset	Environment: Immediate (2018)	Environment: 2050	Environment: 2100	Economic: Immediate (2018)	Economic: 2050	Economic: 2100	Social and cultural: Immediate (2018)	Social and cultural: 2050	Social and cultural: 2100
Mangrove forest and boardwalk (Throsby creek)	Minimal	Low	Low	Minimal	Low	Low	Minimal	Minimal	Minimal
Carrington foreshore reserve	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal
Carrington foreshore reserve river wall	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Minimal	Low
Rowing club building (34 Tully Street, Carrington)	Minimal	Minimal	Minimal	Low	High	High	Low	Moderate	Moderate
Pat Jordan Oval (1 Cowper Street, Carrington)	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate
Boat ramp (271 Hannell Street, Carrington)	Minimal	Minimal	Low	Minimal	Minimal	Low	Low	Low	Low
Carrington – commercial and residential properties	Minimal	Minimal	Minimal	Low	High	High	Low	High	High

Notes (Mangrove forest and boardwalk): Increasing environment risk due to habitat modification from changing climate. Economic risk due to maintenance of boardwalk.

Notes (Carrington foreshore reserve): Foreshore reserve currently protected by river wall. Most of reserve has been elevated above flooding levels.

Notes (Carrington foreshore reserve river wall): Increasing economic risk due to maintenance of river wall.

Notes (Rowing club building): Increasing risk from coastal and tidal inundation. Building does not have river wall. Building owned by Crown Lands.

Notes (Pat Jordan Oval): Increasing risk from coastal and tidal inundation.

Notes (Carrington – commercial and residential properties): Significant risk from both coastal and tidal inundation (See **Appendix G and H**). Increasing economic and social risk due to number of properties potentially impacted, including Port of Newcastle facilities.

Table 54: Cumulative risk assessment for Carrington.

Cumulative risk level from threats to asset

Asset	Environment			Economic			Social and cultural			Notes
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	
Carrington – Roads and infrastructure	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Notes: Significant risk from both coastal and tidal inundation (See **Appendix G and H**). Increasing economic and social risk due to infrastructure potentially impacted, including Port of Newcastle facilities.
Throsby Creek (from Hannell Street bridge to Hunter River)	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate	Notes: Increasing risk from urban water pollution and increasing development. Risk to environment, amenity and community use of Throsby Creek.

Risk overview: Carrington

Coastal and tidal inundation are considered the highest risks for the suburb of Carrington. Coastal and tidal inundation are reasonably well understood through the Strategic Position for the Management of the Low Lying Areas in Newcastle (BMT WBM, 2015) that was undertaken through the flood grants program. The results of this study have informed the Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017) which outlines a protection plan for the suburb from inundation. The Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017) outlines trigger points for additional investigations and the results of these investigations will inform the CMP process and potential future actions in the CMP.

The banks of the Hunter River lower estuary have been modified by the construction of river walls. The economic risk for maintenance of these structures is considered high, but the responsibility and ownership of these structures is varied. Management of these structures requires further investigation prior to further studies.

Water pollution within Throsby creek is considered a moderate environment and social risk. While management measures have been implemented to improve water quality within the catchment a monitoring system for evaluation has not been co-ordinated. Therefore, a water quality monitoring system is required to be investigated to evaluate existing and historical trends and to allow for management actions to be appropriately assessed.

9.4.15 Risk assessment: Stockton – Western and southern foreshore

Table 55 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located along the western and southern foreshore of Stockton. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 15**.

Table 55: Cumulative risk assessment for Stockton – Western and southern foreshore.

Cumulative risk level from threats to asset

Asset	Environment			Economic			Social and cultural			Notes
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	
Mangrove forest (197 Fullerton Street, Stockton)	Low	Low	Low	Minimal	Low	Low	Minimal	Minimal	Minimal	Notes: Environmental risk from water pollution from upstream catchment.
Crown reserve (197 Fullerton Street – between Stockton bridge and Hereford Street)	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Notes: Risk assessment based on river wall remaining serviceable.
Crown Reserve river wall	Minimal	Minimal	Minimal	Low	Moderate	High	Minimal	Low	Low	Notes: Facility recently upgraded by RMS.
North Stockton boat ramp and carpark	Minimal	Minimal	Low	Low	Low	Low	Minimal	Low	Low	Notes: Facility recently upgraded by RMS.
Stockton boat ramp and carpark (97 Fullerton Street, Stockton)	Minimal	Minimal	Low	Low	Low	Low	Minimal	Low	Low	Notes: Facility recently upgraded by RMS
Ballast grounds (71 Clyde Street, Stockton)	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Notes: Risk assessment based on river wall remaining serviceable.

Table 55: Cumulative risk assessment for Stockton – Western and southern foreshore.

Cumulative risk level from threats to asset

Asset	Environment Immediate (2018)	Environment 2050	Environment 2100	Economic Immediate (2018)	Economic 2050	Economic 2100	Social and cultural Immediate (2018)	Social and cultural 2050	Social and cultural 2100
Crown land building (2 Foreshores, Stockton)	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low
Griffith Park and carpark	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate
Ferry terminal	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High

Notes (Crown land building): Risk assessment based on river wall remaining serviceable.

Notes (Griffith Park and carpark): Increasing economic and social risk from coastal inundation.

Notes (Ferry terminal): Increasing economic and social risk from coastal inundation. Social risk increased due to disruption to ferry service.

Risk overview: Stockton – Western and southern foreshore

Coastal inundation is considered the highest risk management issue for the Stockton foreshore, particularly property and assets located along the south-western end of the peninsula including Griffith Park. Coastal inundation has been assessed through the Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012). While risk have been highlighted for various assets the bank of the Hunter River has been modified by river wall protection structures. The economic risk for maintenance of these structures is considered high, but the responsibility and ownership of these structures is varied. Management of these structures requires further investigation prior to further studies

It must be noted that some assets at risk are located within the lease area under *SEPP (Three Ports) 2013* and are excluded from the coastal zone. The inclusion of these areas as part of the CMP requires clarification.

9.4.16 Risk assessment: Hunter River lower estuary

Table 56 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for the Hunter River lower estuary within the scoping study area. The individual risk assessment for the Hunter River lower estuary is in **Appendix I 16**.

Table 56: Cumulative risk assessment for Hunter River lower estuary.

Cumulative risk level from threats to asset

Asset	Environment Immediate (2018)	Environment 2050	Environment 2100	Economic Immediate (2018)	Economic 2050	Economic 2100	Social and cultural Immediate (2018)	Social and cultural 2050	Social and cultural 2100
Hunter River	Moderate	High	High	Low	Low	Low	Low	Moderate	Moderate

Notes: High environmental risk from water pollution due to operation of surrounding industry and from upstream catchment.

Risk overview: Hunter River lower estuary

The high risk management issue for the Hunter River lower estuary is the environmental impact from urban stormwater discharge and water pollution on the estuary itself. Management issues that contribute to this risk include increasing urban development and the ongoing operations of the Port of Newcastle. The management of water pollution within the Hunter River lower estuary requires further investigation and analysis of the historical pollution impacts needs consideration, including previous water quality monitoring, prior to establishing a framework for the ongoing management of the system.

9.4.17 Risk assessment: Throsby Creek catchment – West of Hannell Street bridge

Table 57 outlines the cumulative risk assessment for coastal management issues (outlined in **Section 5**) for properties and assets located in the Throsby Creek catchment – west of Hannell Street bridge. Individual risk assessments for each property or asset outlining the individual risk from each coastal management issue are in **Appendix I 17**.

Table 57: Cumulative risk assessment for Throsby Creek catchment – west of Hannell Street bridge.

Cumulative risk level from threats to asset

Asset	Environment: Immediate (2018)	Environment: 2050	Environment: 2100	Economic: Immediate (2018)	Economic: 2050	Economic: 2100	Social and cultural: Immediate (2018)	Social and cultural: 2050	Social and cultural: 2100	Notes
Islington Park (151A Maitland Road, Islington)	Minimal	Minimal	Minimal	Low	Moderate	High	Low	Moderate	Moderate	Notes: Increasing economic risk from coastal and tidal inundation. Social risk increasing due to disruption/loss of Islington Park.
Styx Creek stormwater channel	Low	Low	Low	Low	Moderate	Moderate	Low	Low	Low	Notes: Economic risk due to maintenance of stormwater channel.
Throsby Creek stormwater channel	Low	Low	Low	Low	Moderate	Moderate	Low	Low	Low	Notes: Economic risk due to maintenance of stormwater channel.
Throsby Creek (Maitland Road to Hannell Street bridge)	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate	Notes: Environmental risk due to water pollution and increasing urbanisation of catchment.
Islington - Residential properties	Minimal	Minimal	Low	Minimal	Moderate	High	Minimal	Moderate	High	Notes: Significant risk from both coastal and tidal inundation (See **Appendix G and H**). Increasing economic and social risk due to number of properties potentially impacted.

9. Risk assessment

Table 57: Cumulative risk assessment for Throsby Creek catchment – west of Hannell Street bridge.

Cumulative risk level from threats to asset

Asset	Environment: Immediate (2018)	Environment: 2050	Environment: 2100	Economic: Immediate (2018)	Economic: 2050	Economic: 2100	Social and cultural: Immediate (2018)	Social and cultural: 2050	Social and cultural: 2100	Notes
Commercial properties (Elizbeth Street and Revelation Close, Tighes Hill)	Minimal	Minimal	Minimal	Low	High	High	Low	Low	Moderate	Notes: Significant risk from both coastal and tidal inundation (See **Appendix G and H**). Increasing economic and social risk due to number of properties potentially impacted.
River wall (Northern side of Throsby Creek, Tighes Hill)	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	

Risk overview: Throsby Creek catchment – West of Hannell Street bridge

Coastal and tidal inundation are considered the highest risks for the Throsby Creek catchment. Coastal and tidal inundation are reasonably well understood through the Strategic Position for the Management of the Low Lying Areas in Newcastle (BMT WBM, 2015) that was undertaken through the flood grants program. This study highlighted the potential risks of coastal and tidal inundation on the recreation area at Islington Park, residential properties at Islington and the commercial/industrial estate at Elizabeth Street and revelation Close, Tighes Hill.

The results of this study have informed the Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017) which outlines a protection plan for the suburb from inundation. The Strategic Position for the Management of Low Lying Areas of Newcastle (NCC, 2017) outlines trigger points for additional investigations and the results of these investigations will inform the CMP process and potential future actions in the CMP.

Water pollution within Throsby Creek is considered a moderate environment and social risk. While management measures have been implemented to improve water quality within the catchment a monitoring system for evaluation has not been co-ordinated. Therefore, a water quality monitoring system is required to be investigated to evaluate existing and historical trends and to allow for management actions to be appropriately assessed.

10. Preliminary business case

This section includes a preliminary business case for the completion of a CMP for the scoping study area within the CN LGA outlined in **Section 2.2**.

10.1 Project name and description

Coastal management program for the Newcastle coastline and Hunter River lower estuary.

10.2 Project definition

The purpose of the Newcastle CMP is to provide an integrated long-term strategy for the sustainable use, management and conservation of Newcastle's coastal area. The Newcastle CMP aims to protect and enhance the coastal area while balancing the diversity of needs of the community.

10.3 Need for coastal management program

The Newcastle coastal zone is subject to impacts from coastal hazards such as beach erosion, shoreline recession, coastal and tidal inundation and coastal cliff or slope instability. These coastal hazards pose a threat to community and private assets presently and into the future. Coastal hazards also pose a risk to the ongoing use of coastal areas and facilities by the community. These impacts are particularly highlighted in the coastal suburb of Stockton where beach erosion and shoreline recession pose a high risk to community assets and the amenity and use by the community of Stockton Beach.

The *Coastal Management Act 2016* commenced on the 3 April 2018 and outlines objectives for the integrated management of the coastal zone in accordance with the principles of ecologically sustainable development for the social, cultural and economic wellbeing of the community. The *Coastal Management Act 2016* requires Councils with land within the coastal zone to undertake a Coastal Management program (CMP) to set a long-term strategy for the co-ordinated management of community use and development within the coastal zone.

The CMP will build upon CN's current coastal management practices outlined in the Newcastle Coastal Zone Management Plan 2018. However, the management measures within the Newcastle Coastal Zone Management Plan 2018 for the coastal area of Stockton are limited to short – medium actions and do not address ongoing coastal hazards such as beach erosion and shoreline recession. Beach erosion and shoreline recession has been identified as a significant environmental, economic and social threat to the local community and further investigation and evaluation of management options to address coastal hazards is required.

Potential risks from not undertaking a CMP include:

- A long-term strategy for management of coastal hazards will not be defined in CN's planning documents and areas vulnerable to coastal hazards, particularly the coastal suburb of Stockton, will be subject to continued threat and impacts from coastal processes without management, or piece meal management.
- Potential legal liability for impacts from coastal hazards. The CMP is required to be undertaken in accordance with the NSW Coastal Management Manual to ensure good faith provisions of the *Local Government Act 1993* are met and allow exemption from liability in regard to coastal hazards.
- Inappropriate development within the coastal zone may result in future risks or impacts.
- The lack of representation or confusion regarding management of coastal hazards in development planning instruments, eg. Local Environment Plan or planning documents such as Development Control Plan, and Council internal policy/planning documentation will continue potentially resulting in poor planning outcomes.
- The Newcastle Coastal Zone Management Plan 2018 ceases to have effect at the end of 31 December 2021 (Schedule 3 of the *Coastal Management Act 2016*) and is required to be replaced by a CMP. If a CMP is not prepared CN may be in breach of a Ministerial direction under Section 9.1 of the *Environmental Planning and Assessment Act 1979*.
- Under Section 20 of the *Coastal Management Act 2016* the Minister can direct CN to prepare a CMP. This may be issued if a CMP is not prepared by 31 December 2021. Alternatively, the Minister may prepare a CMP on the Council's behalf if a CMP is not prepared or is unsatisfactory for certification.
- Access to funding under OEH's Coastal and Estuary Grants Program will cease after 31 December 2021. This will reduce CN's capacity to undertake management of coastal hazards and the coastal zone.
- Limit CN's capacity to apply for future funding opportunities under other grant programs.
- Frustration within the community will continue as a long-term strategy for management of coastal hazards will remain unknown. Frustration will increase as impacts from coastal hazards will continue without management.
- Continuation of ad hoc, reactionary or temporary coastal protection works.

Potential opportunities for completion of the CMP include:

- Continuation of management actions from the Newcastle Coastal Zone Management Plan 2018 (NCC, 2018(i)).
- Funding opportunities to undertake management within the coastal zone through State Government funding streams such as the Coast and Estuary Grants Program.
- Integration of coastal management actions into CN's operational plans and practices.
- Assessing risks to CN's assets and facilities from coastal processes and intensified use of recreational facilities and areas.
- Maintaining coastal environmental areas.
- Maintaining and restoring cultural and built heritage areas and assets.

10.4 Project objectives

The objectives for the CMP include:

- Protect and enhance the environmental qualities and amenity of the coastal area.
- Facilitate sustainable management and development of the coastal area and support recreational opportunities, including the community leading an active lifestyle.
- Identify adaptable management measures to address risks from coastal hazards into the future, including in response to the effects of climate change.
- Provide for equity in access to the coastal area and coastal facilities.
- Provide vibrant and active places within the coastal area that strengthen social connections and maintain Newcastle's sense of identity as a coastal city.
- Retain and protect cultural items and areas to continue connection to the land and identification of the history of the city's development.
- Integration of CN's coastal policy with internal policies and procedures to enable co-ordinated management of operations in the coastal area.
- Integration of CN's coastal management with other stakeholders to achieve consistent and quality management of the Newcastle coastal area for the benefit of the community.
- Enable the community to engage, learn and participate in the management of the Newcastle coastal area.
- Identify and implement terrestrial or land-based management actions to support protection of the estuarine and marine environment.

10.5 Strategic Context

The management of the coastal zone at the State Government level is derived from the objectives of the *Coastal Management Act 2016*. While the *Coastal Management Act 2016* provides the framework for the preparation of a CMP the management of the coastal zone encompasses the objectives of various other State legislative acts including:

- *Environmental Planning and Assessment Act 1979*
- *Local Government Act 199*
- *Crown lands Management Act 2016*
- *Marine Estate Management Act 2014*
- *Biodiversity Conservation Act 2016*
- *Fisheries Management Act 1994*
- *National Parks and Wildlife Act 1974*
- *Heritage Act 1977*
- *Water Management Act 2000*
- *Biosecurity Act 2015*
- *Protection of the Environment Operations Act 1997*
- *State Emergency and Rescue Management Act 1989.*

The CMP also accounts for the objectives of the Federal Government's *Environment Protection and Biodiversity Conservation Act 1999*.

The CMP also aligns with the State Government outcomes and management actions outlined in:

- Hunter Regional Plan 2036
- Greater Newcastle Metropolitan Plan
- Lower Hunter Regional Conservation Plan
- Marine Estate Management Strategy 2018-2028.

Integrated Planning and Reporting (IP&R) provides local government a framework for establishing community priorities and to link these community needs to operational functions of CN. The Newcastle 2030 Community Strategic Plan (NCC, 2018(a)) sets the long term vision of the community with core strategic documents providing the basis for the long term vision.

Three key strategic directions from the Newcastle 2030 Community Strategic Plan (NCC, 2018(a)) the CMP will address are:

- protected environment;
- vibrant, safe and active public places; and
- liveable built environment.

Strategic direction: Protected environment

The protected environment strategic direction is supported by the Newcastle Environmental Management Strategy 2013 (NCC, 2013), which outlines three objectives:

1. Greater efficiency in the use of resources.
2. Our unique environment is maintained, enhanced and connected.
3. Environment and climate change risks and impacts are understood and managed.

Strategic direction: Vibrant, safe and active public places

The vibrant, safe and active public places strategic direction is supported by the Parkland and Recreation Strategy (NCC, 2014) which includes four strategic directions:

1. Equitable provision and development of facilities.
2. Efficient management of facilities.
3. Partnership development.
4. Promotion of facilities and opportunities.

The Parkland and Recreation Strategy (NCC, 2014) provides an action plan to deliver each of the four strategic directions. A key planning document for the coastal zone as part of the vibrant, safe and active public places strategic direction is the Newcastle Coastal Revitalisation Strategy Master Plan (Urbis, 2010).

Strategic direction: Liveable built environment

The liveable built environment strategic direction is supported by the Local Planning Strategy (NCC, 2015), which in turn informs the Newcastle Local Environment Plan 2012 (an EPI under the *Environmental Planning and Assessment Act 1979*). Heritage management within the coastal zone is supported by the Heritage Strategy 2013-2017 (NCC, 2014).

10.6 Consistency with Delivery Program and Operational Plan

Integrated Planning & Reporting requires the preparation of a Delivery Program that sets out a four-year plan to achieve the objectives of the Newcastle 2030 Community Strategic Plan (NCC, 2018(a)) and supporting strategies such as the Newcastle Environmental Management Strategy 2013 (NCC, 2013). The CMP will form a sub-plan to the Newcastle Environmental Management Strategy 2013 (NCC, 2013) with its management actions included in CN's Delivery Program (CN's Our Budget document which contains CN's four-year Delivery Program and annual Operational Plan).

The proposed timeline for the completion of the CMP will coincide with the midpoint of the Delivery Program (2018-2022). However, the proposed completion date will also coincide shortly after the election of a new Council. Therefore, a review of the Delivery Program may potentially be undertaken by the newly elected Council.

Based on the proposed timeline the integration of the CMP would commence with the adoption of the 2021/22 annual Operational Plan.

10.7 Community views

The Newcastle Coastal Zone Management Plan 2018 was publicly exhibited in June-July 2018. Public submissions mainly related to addressing coastal hazards, particularly at Stockton Beach, as management actions were restricted to short-medium term actions. The community seeks a long-term management option for addressing beach erosion and shoreline recession at Stockton Beach. The CMP will evaluate long-term management options for coastal hazards to address community concerns.

10.8 Cost estimate

CN has received Coastal and Estuary Grant Program funding for $147,500 for the preparation of the CMP. CN will provide matching funding to the preparation of the CMP as per the funding agreement with a total estimated cost through this funding being $295,000.

Complementary studies will be conducted as part of Stage 2 of the CMP and will cost approximately $50,000. This will be funded by CN with other stakeholder partners.

This will result in a total project cost for the CMP of $345,000.

10.9 Ongoing costs

The CMP will result in management actions being identified for the coastal zone. CN has included budget for management of the coastal zone within its delivery plan, but ongoing costs because of the CMP are currently unknown and will be dependent on the outcomes of additional investigations and agreed management options, primarily for Stockton Beach.

10.10 Governance

CN is the lead organisation for the development of the CMP as outlined in the *Coastal Management Act 2016.* CN will coordinate with other stakeholders and public authorities through the following governance framework for management of preparation of the CMP:

- CN internal steering group including relevant representatives from various sections of CN involved in coastal management;
- Newcastle Coastal Planning Working Group including external stakeholders and members of the public. The Newcastle Coastal Planning Working Group includes members from:
  - a) Port of Newcastle,
  - b) Roads and Maritime Services,
  - c) Hunter Water Corporation,
  - d) Office of Environment and Heritage,
  - e) National Parks and Wildlife Service,
  - f) Worimi Local Aboriginal Land Council,
  - g) Awabakal Local Aboriginal Land Council,
  - h) Department of Industry – Land and Water (Crown Lands), and
  - i) Local community

Other stakeholders may also be invited to attend the working group and could include Lake Macquarie City Council, Port Stephens Council, Department of Planning and Environment, Department of Primary Industries (Fisheries) and Hunter Central Coast Development Corporation.

10.11 Forward program

The forward program for the CMP is outlined in **Table 58**.

Table 58: Forward Program for completion of Coastal Management Program.

Stage	Task/study needed	Funding options	Cost	Timeframe
2	1. Study of sediment transport patterns within Stockton Bight including bathymetric survey to determine change to subaqueous profile. 2. Study to determine potential sand sourcing for sand replenishment within Stockton Bight sediment compartment. 3. Changes to coastal hazard lines in Stockton in response to coastal protection works constructed since previous modelling undertaken in Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)). Includes probabilistic assessment of risks for Stockton coastal area. 4. Socioeconomic study into value of coastal use area.	OEH Coast and Estuary Grants Program/CN (1:1)	$150,000	March 2020
2A Complementary works through other programs	1. Investigation of additional areas in CN LGA that might be considered littoral rainforest. 2. Analysis of water quality data in lower Hunter estuary (historical trends analysis) to inform ongoing water quality monitoring program. 3. Review of current asset management and climate change adaptation of seawalls/riverwalls within the Hunter River lower estuary. To be reviewed as part of floodplain risk management program.	1. CN 2. CN/HWC/RMS/Port of Newcastle. 3. CN/OEH Floodplain management grants/HCCDC/RMS/Port of Newcastle.	$50,000	Complete by March 2020
3	1. Identify and evaluate potential management options including a) Feasibility (technical feasibility, effectiveness, reliability, planning and legal constraints, environmental impacts, sustainability) b) Viability (economic considerations, cost benefit analysis, distributional analysis, potential funding models) c) Acceptability (Community and stakeholder acceptability, equity and fairness, public benefit, community resilience) 2. Development of Business Plan for CMP implementation. 3. Undertake consultation with stakeholders regarding management options and potential actions for inclusion in CMP.	OEH Coast and Estuary Grants Program/CN (1:1).	$120,000	Complete by July 2020
4	• Prepare draft CMP document. • Undertaken consultation with stakeholders. • Finalise draft CMP. • Exhibit draft for nominated period. • Assess public exhibition and stakeholder comments. • Gain final stakeholder agreement. • Finalise CMP for adoption by Council. • Submit to State Government.	OEH Coast and Estuary Grants Program/CN (1:1)	$25,000	Complete by October 2020
5	Implement CMP, monitor and evaluate.	Ongoing	-	-

11. Stakeholder and community engagement strategy

Effective engagement and communication are important aspects of the CMP. Engagement of both stakeholders and members of the community will be undertaken through the stages of the CMP process in accordance with CN's Community Engagement Policy (CN, 2018(c)).

The Community Engagement Policy (CN, 2018(c)) recognises and abides by the best practice principles developed by the International Association for Public Participation (IAP2). IAP2 promotes the values of involving the public in the government decision making process. CN has adopted the IAP2 Public Participation Spectrum (**Table 59**) as a core tool to help identify and select the appropriate level of public participation, select methods of engagement, and identify how the public will be involved in the process.

Table 59: International Association for Public Participation (IAP2) spectrum.

Increasing impact on the decsion

	Inform	Consult	Involve	Collaborate	Empower
Public participation goal	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions	To obtain public feedback on analysis, alternatives and/or decisions	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of public.
Promise to the Public	We will keep you informed.	We will keep you informed, listen to and acknowledge concern and aspirations, and provide feedback on how the public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

A stakeholder engagement strategy will be prepared for the CMP process with specific levels of engagement and proposed methodologies prepared for each stage of the CMP. The stakeholder engagement strategy will guide implementation of engagement activities in response to the results of the detailed studies undertaken in Stage 2 of the CMP process and the evaluation of management options undertaken in Stage 3. The stakeholder engagement strategy will outline the messaging for each stage of the CMP process and distribute communication methods in a timely and transparent manner. The stakeholder engagement strategy will undertake stakeholder mapping, which will define communities, as individuals or groups of individuals, organisations or government departments with an interest or knowledge input into the CMP process. CN will implement a variety of consultation activities, ranging from workshops, surveys, online engagement, information sessions and mechanisms for stakeholder engagement to ensure the widest possible reach throughout the CMP process.

The stakeholder engagement strategy will include the following:

- Stakeholder mapping, including government (Local, State and Federal) and community stakeholders such as interested businesses, Local Aboriginal Land Councils and special interest groups.
- Assigning a level of engagement on IAP2 scale for each engagement action for stakeholders.
- Engagement aim of each stage and key messaging for each stage.
- Evaluation methods for level of engagement with engagement reports to be undertaken at the end of each stage of the CMP process.
- Aims of each stage and key messages to be delivered to stakeholders. Messaging for results of Stage 2 studies and Stage 3 evaluation of management options will be included.
- Timing and identification of communication tool for each engagement activity.
- If planning proposals are undertaken to amend maps in *SEPP (Coastal Management) 2018* additional engagement activities, including those specified by the planning proposal process, will be undertaken with appropriate stakeholders and interest groups.

CN will raise awareness of the CMP process and encourage participation through a number of platforms, both internally within CN and to external stakeholders and the community. These platforms include:

- Media activity including media releases and other communications
- Iterative key messaging across Stage 2 and Stage 3 of the CMP process. Continued messaging will be undertaken during Stage 5 implementation activities of the CMP.
- Use of CN website as platform for information and progress of CMP process.
- Release of information at CN facilities, such as libraries, and capture of feedback including translated content.
- Digital and social media for both information and engagement activities.
- Use of CN community newsletter and monthly e-newsletter being utilised as key channels for broad-based communications
- Advertising in local print media.
- Development of Frequently Asked Questions (FAQs).
- Potential use of video to create engaging and accessible messaging for distribution across digital platforms and social media.
- Distributing and discussing information through CN committees
- Providing regular internal updates to staff through a range of channels.

Table 60 describes the indicative engagement activities that will be undertaken during the stages of the CMP process but is not an exhaustive list of engagement activities during the CMP process.

11. Stakeholder and community engagement strategy

Table 60: Indicative engagement activities for each stage of the Coastal Management Program process.

Stage	Engagement activity
1	Establishment and meetings of the Newcastle Coastal Planning Working Group.
	Meetings with the Stockton Community Liaison Group.
	Broad communication strategy through social and traditional media channels.
2	Continued meetings with Newcastle Coastal Planning Working Group.
	Meetings with the Stockton Community Liaison Group.
	Community information sessions with identified stakeholder and interest groups.
3	Continued meetings with Newcastle Coastal Planning Working Group
	Meetings with the Stockton Community Liaison Group
	Community information sessions with identified stakeholder and interest groups.
4	Public exhibition of CMP
	Broad communication strategy through social and traditional media channels regarding adoption and certification.
5	Communication as required or key interest issues.

Ongoing monitoring and review of CN's engagement methods and activities is recognised as an important evaluation method in our approach to community engagement for continuous improvement. Measurements of success for the CMP engagement approach include:

- Did stakeholders and community have appropriate input into the CMP and its outcomes
- Where adequate opportunities provided for feedback into the CMP process.

Evaluation of the CMP process will be outlined in a final engagement evaluation report after the completion of the CMP.

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Appendices

Appendix A: Goals, directions and actions from Hunter Regional Plan 2036 in relation to coastal management in City of Newcastle Local Government Area

Goal	Direction	Action
1. The leading regional economy in Australia	1. Grow Greater Newcastle as Australia's next metropolitan city.	1.1 Prepare a Greater Newcastle Metropolitan Plan.
	2. Enhance connections to the Asia-Pacific through global gateways (Port of Newcastle).	2.1 Promote diversification of operations at the Port of Newcastle and enhanced connectivity to the Asia-Pacific.
		2.2 Develop and review strategies and precinct plans for global gateways and surrounding lands to support their growth, diversification and sustainability.
		2.3 Prepare local plans that adequately respond to air, noise and other issues relevant to the gateways and protect their ongoing operations and expansion.
	3. Revitalise Newcastle City Centre.	3.1 Promote the growth and renewal of Newcastle City Centre through local strategies and controls.
		3.4 Focus investment in developing infrastructure.
	4. Enhance inter-regional linkages to support economic growth.	4.1 Enhance inter--regional transport connections to support economic growth.
		4.4 Promote freight facilities that leverage the Port of Newcastle and its associated freight transport network.
		4.5 Plan for multimodal freight facilities that support economic development of the region and respond to the location of the proposed Freight Rail Bypass.
	9. Grow tourism in the region.	9.1 Enable investment in infrastructure to expand the tourism industry, including connections to tourism gateways and attractions.
		9.2 Encourage tourism development in natural areas that support conservation outcomes.
2. A biodiversity-rich natural environment	14. Protect and connect natural areas.	14.1 Identify terrestrial and aquatic biodiversity values and protect areas of high environmental value to sustain the lifestyle, economic success and environmental health of the region.
		14.2 Identify and strengthen biodiversity corridors as places for priority biodiversity offsets.
		14.4 Protect biodiversity by maintaining and where possible, enhancing the existing protection of high environmental value areas.
		14.5 Secure the long term protection of regionally significant biodiversity corridors.
	15. Sustain water quality and security.	15.4 Implement catchment-based for the ongoing sustainable management and health of estuaries.
		15.5 Apply the neutral or beneficial water quality objectives to land use planning in surface and groundwater drinking water catchment areas to minimise the effects of development on waterways, including watercourses, wetlands, groundwater dependant ecosystems, riparian lands, estuaries, lakes, beaches and marine waters.

Appendix A: Goals, directions and actions from Hunter Regional Plan 2036 in relation to coastal management in City of Newcastle Local Government Area

Goal	Direction	Action
2. A biodiversity-rich natural environment	15. Sustain water quality and security.	15.6 Reduce the risk of introduction or spread of aquatic pests and diseases from new development that may affect fisheries and aquaculture industry practices.
		15.7 Incorporate water-sensitive design into development that is likely to have an adverse impact on coastal water catchments, water quality and flows.
	16. Increase resilience to hazards and climate change.	16.1 Manage the risks of climate change and improve the region's resilience to flooding, sea level rise, bushfire, mine subsidence and land contamination.
		16.2 Review and consistently update floodplain risk and coastal zone management plans, particularly where urban growth is being investigated.
		16.3 Incorporate new knowledge on regional climate projections and related cumulative impacts in local plans for new urban development.
3. Thriving communities	18. Enhance access to recreational facilities and connect open spaces.	18.1 Facilitate more recreational walking ad cycling paths and expanded inter-regional and intra-regional walking and cycling links, including the NSW Coastal Cycleway.
		18.2 Deliver connected biodiversity-rich corridors and open space areas for community enjoyment.
		18.3 Enhance public access to natural areas, including coastal and lake foreshores.
		18.4 Assist councils to develop open space and recreation strategies that identify a range of accessible open space and recreation opportunities; integrate open space, active transport and recreation networks; and improve public foreshore access.
		18.5 Implement actions and invest in boating infrastructure priorities identified in regional boating plans to improve boating safety, boat storage and waterway access.
	19. Identify and protect the region's heritage.	19.1 Consult with the local Aboriginal communities to identify and protect heritage values and minimise the impact of urban growth and development, and to recognise their contribution to the character and landscape of the region.
		19.2 Assist the preparation of appropriate heritage studies to inform the development of strategic plans, including regional Aboriginal cultural heritage studies.
	20. Revitalise existing communities.	20.1 Accelerate urban revitalisation by directing social infrastructure where there is growth.
		20.2 Undertake planning and place-making for main streets and centres.
		20.3 Enhance the amenity and attractiveness of existing places.
4. Greater housing choices and jobs	21. Create a compact settlement.	21.1 Promote development that respects the landscape attributes and character of the metropolitan areas, towns and villages.

Appendix A

Appendix A: Goals, directions and actions from Hunter Regional Plan 2036 in relation to coastal management in City of Newcastle Local Government Area

Goal	Direction	Action
4. Greater housing choices and jobs	21. Create a compact settlement.	21.5 Promote small-scale renewal in existing urban areas, in consultation with the community and industry to ensure that this occurs in the right locations.
		21.6 Provide greater housing choice by delivering housing, lot types and sizes, including small-lot housing in infill and greenfield locations.
		21.7 Promote new housing opportunities in urban areas to maximise the use of existing infrastructure.
	23. Grow centres and renewal corridors (Newcastle City Centre).	23.1 Concentrate growth in strategic centres, local centres and urban renewal corridors to support economic and population growth and mix of uses.

Appendix B

Appendix B: Outcomes, strategies and actions from the Greater Newcastle Metropolitan Plan 2036 in relation to coastal management in the City of Newcastle Local Government Area.

Goal	Direction	Action
1. Create a workforce skilled and ready for the new economy	1. Reinforce the revitalisation of Newcastle city centre and expand transformation along the waterside	1.1 Hunter Development Corporation, through the Revitalising Newcastle Program, will: • transform sites for public open space, new shops and residential opportunities and connecting the city to the waterfront; and • activate the waterfront by improving pedestrian, cyclist and public transport safety, amenity, access and connectivity to the waterfront.
	3. Increase domestic and global trade capabilities at Newcastle Port	3.1 The Department of Planning and Environment, working with the Port of Newcastle, will facilitate the diversification of activities at Newcastle Port to adapt to changing global demand for trade and tourism through the Three Ports State Environmental Planning Policy.
		3.2 The Port of Newcastle will: • work with the Hunter Development Corporation to build capacity of the Newcastle Cruise Terminal as a home port; and • work with Transport NSW to provide public transport connections between Newcastle Port and Newcastle City Centre to service visitors and workers of the Newcastle Cruise Terminal.
2. Enhance environment, amenity and resilience for quality of life	10. Create better buildings and great places	10.1 Greater Newcastle Councils will: • enhance the design quality of the built environment by implementing the Design objectives for NSW in local plans and developing local character statements for centres a urban renewal corridors undergoing renewal and revitalisation; and • promote innovative approaches to the creative re-use of heritage places, ensuring good urban design preserves and renews historic buildings and places.
	11. Create more great public spaces where people come together	11.1 Greater Newcastle councils with support from the Department of Planning and Environment, will: • Provide public lookout places that maintain views to iconic buildings and vistas; • Protect and enhance waterfront parkland areas; and • Identify, protect and celebrate Aboriginal cultural heritage, historic heritage and maritime heritage.
	12. Enhance the Blue and Green Grid and the urban tree canopy	12.1 Greater Newcastle councils with support from the Department of Planning and Environment, will: • Improve access to open space, recreation areas and waterways so that 90% of houses are within a 10-minute walk of open space; • Enhance Greater Newcastle's Blue and Green Grid by implementing the Green Infrastructure Outcomes of the Greener Places policy to integrate water sensitive urban design principles in local plans; and • Enhance nature-based tourism through protection and promotion of natural assets such as Lake Macquarie and the Hexham Wetlands.
		12.2 Greater Newcastle councils will identify local blue and green corridors and continue rehabilitation of waterways.

Appendix B: Outcomes, strategies and actions from the Greater Newcastle Metropolitan Plan 2036 in relation to coastal management in the City of Newcastle Local Government Area.

Goal	Direction	Action
2. Enhance environment, amenity and resilience for quality of life	14. Improve resilience to natural hazards	14.1 Greater Newcastle councils will apply the following principles to land use planning and development assessment decisions: • Employ risk-responsive land use controls so that new development does not occur in high risk areas; • Ensure coastal dependant development mitigates natural hazards and incorporates resilience measures that have triple bottom line benefits; • Prevent intensive urban development in Blue and Green Grid; and • Ensure the planning for urban development adjoining or interfacing with the Blue and Green Grid addresses the impact of extreme events.
		14.2 The Department of Planning and Environment will work with Grater Newcastle councils to plan for a changing climate by: • Ensuring major redevelopments include a natural hazard risk assessment that incorporates climate change parameters and mitigation/adaptation measures • Ensuring planning for road upgrades of critical linkages considers sea level rise and flooding • Developing a methodology to incorporate evacuation considerations into strategic, precinct and site based planning.

Appendix C: Aboriginal Heritage Information Management System search in Newcastle coastal zone.

Office of Environment & Heritage

AHIMS Web Services (AWS)
Search Result

Purchase Order/Reference : 1

Client Service ID : 377509

Mark Manning

Date: 19 October 2018

282 King Street
Newcastle New South Wales 2300

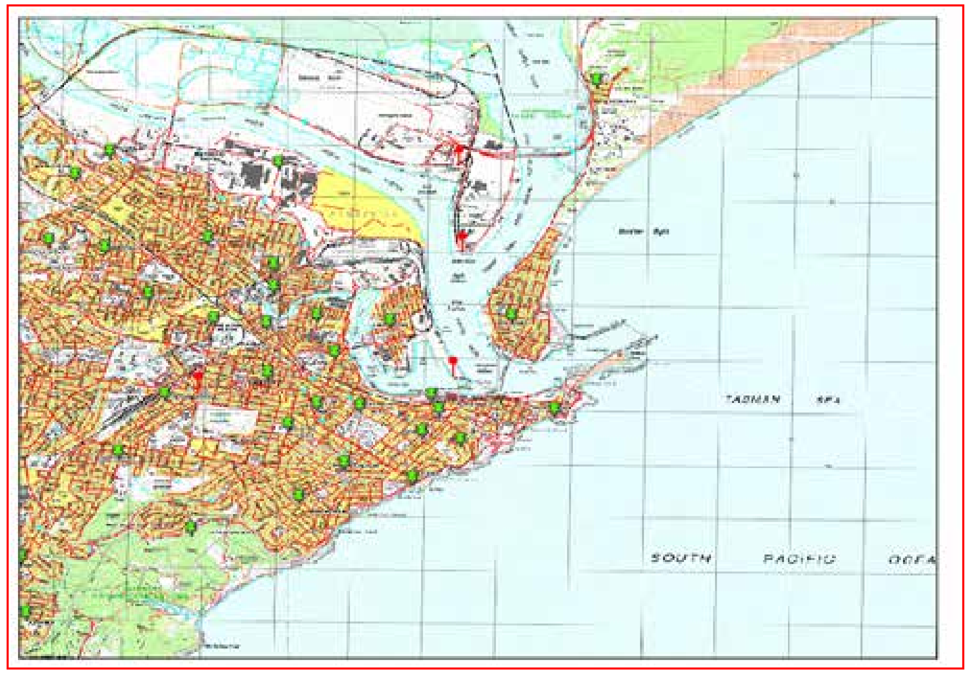
Attention: Mark Manning

Email: mmanning@ncc.nsw.gov.au

Dear Sir or Madam:

AHIMS Web Service search for the following area at Lat, Long From : -32.9575, 151.7117 - Lat, Long To : -32.8742, 151.8439 with a Buffer of 50 meters, conducted by Mark Manning on 19 October 2018.

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

117	Aboriginal sites are recorded in or near the above location.
0	Aboriginal places have been declared in or near the above location. *

Appendix D: Heritage items listed within the Newcastle coastal zone.

Suburb	Item number	Item name	Address	Significance
Stockton	694	Stockton cemetery	344 Fullerton Street	Local (Schedule 5 of LEP)
	532	Stockton Centre	342 Fullerton Street	Local (Schedule 5 of LEP)
	531	Boatrowers Hotel	130A Fullerton Street	Local (Schedule 5 of LEP)
	A12	Wreck of Adolphe	Off breakwater	Local (Schedule 5 of LEP)
	536	General Washington Hotel	1 Mitchell Street	Local (Schedule 5 of LEP)
	538	Beach cafe	115 Mitchell Street	Local (Schedule 5 of LEP)
	522	Stockton Public School	10 Clyde Street	Local (Schedule 5 of LEP)
	535	Former St Pauls Rectory	32 Maitland Street	Local (Schedule 5 of LEP)
	540	John Slade Memorial Pavilion	124 Mitchell Street	Local (Schedule 5 of LEP)
	545	Residence	1 Queen Street	Local (Schedule 5 of LEP)
	A10	Prawners Slipway	Fullerton Street	Local (Schedule 5 of LEP)
	526	St Peter in Chains Hall	1-5 Dunbar Street	Local (Schedule 5 of LEP)
	A15	Boat Harbour (Place)	Hunter Street	Local (Schedule 5 of LEP)
	523	Mine Disaster Memorial	Corner Clyde and Mitchell Streets	Local (Schedule 5 of LEP)
	529	The Laurels (Residence)	48 Fullerton Street	Local (Schedule 5 of LEP)
	A13	The Ballast Ground (Place)	Fullerton Street and Wharf Crescent	Local (Schedule 5 of LEP)
	539	Residence	121-123 Mitchell Street	Local (Schedule 5 of LEP)
	541	Former Sister Brown's Residence	139 Mitchell Street	Local (Schedule 5 of LEP)
	521	St Pauls Anglican Church Group	10 Clyde Street	Local (Schedule 5 of LEP)
	530	Former Callan Residence	118 Fullerton Street	Local (Schedule 5 of LEP)
	533	Stockton Fire Station	36 Hereford Street	Local (Schedule 5 of LEP)
	543	War memorial	226 Mitchell Street	Local (Schedule 5 of LEP)
	542	Ocean View Flats	179 Mitchell Street	Local (Schedule 5 of LEP)
	A11	Former Locomotive Ash Pit	71 Clyde Street	Local (Schedule 5 of LEP)
	527	St Peters in Chains Presbytery	7 Dunbar Street	Local (Schedule 5 of LEP)
	537	Former Savoy Picture Theatre	68 Mitchell Street	Local (Schedule 5 of LEP)
	534	St Giles Presbyterian Church	91 Hereford Street	Local (Schedule 5 of LEP)
	544	Former Police Station/ Residence	1A Newcastle Street	Local (Schedule 5 of LEP)
	695	Gladstone Hotel	36 Mitchell Street	Local (Schedule 5 of LEP)
	524	Former Sister Ogden's Hospital	29 Crown Street	Local (Schedule 5 of LEP)
	525	Stockton Horse Trough	Douglas Street	Local (Schedule 5 of LEP)
Newcastle East	492	Former Earp Gillam Bond Store	16 Telford Street	State Significance
	481	Nobbys Beach Pavilion	35 Nobbys Road	State Significance
	484	Column from original courthouse	Parnell Place	Local (Schedule 5 of LEP)

Appendix D

Appendix D: Heritage items listed within the Newcastle coastal zone.

Suburb	Item number	Item name	Address	Significance
Newcastle East	490	Stevenson Place Precinct (terraces)	1-55 Stevenson Place	Local (Schedule 5 of LEP)
	491	Former John Bull warehouse	28 Stevenson Place	Local (Schedule 5 of LEP)
	493	Tyrell House (façade only)	49 Telford Street	Local (Schedule 5 of LEP)
	A5	Coal River Precinct	32, 40, 51, 72B, 74, 76, 78, 80 Nobbys Road	State Significance
Newcastle	460	Shepherds Hill Defence Group Military Installations	41 The Terrace	State Significance
	381	Buchanan Terrace and footpath	20 Church Street	State Significance
	455	Newcastle Railway Station	110 Scott Street	State Significance
	401	ANZ Bank	102 Hunter Street	Local (Schedule 5 of LEP)
	392	Sun Building (façade only)	48-56 Hunter Street	Local (Schedule 5 of LEP)
	404	Municipal building	122-132 Hunter Street	Local (Schedule 5 of LEP)
	393	AMP building	55 Hunter Street	Local (Schedule 5 of LEP)
	470	Terrace	58 Watt Street	State Significance
	366	The Bowery	37 Bolton Street	Local (Schedule 5 of LEP)
	436	City Arcade and former Corporation Baths	11 Newcomen Street	Local (Schedule 5 of LEP)
	396	National Australia Bank	73 Hunter Street	Local (Schedule 5 of LEP)
	378	Buchanan Terrace and footpath	14 Church Street	State Significance
	454	Former railway pay office	92 Scott Street	State Significance
	464	St Phillips Church	48 Watt Street	Local (Schedule 5 of LEP)
	443	Former Nurses Home	30 Pacific Street	State Significance
	441	Newcomen House (residence)	51 Newcomen Street	Local (Schedule 5 of LEP)
	371	Former Newcastle East Public School	58 Bolton Street	State Significance
	437	The Newcastle Club	40 Newcomen Street	State Significance
	466	Terrace	52 Watt Street	State Significance
	374	Macquarie House	8 Church Street	State Significance
	383	Buchanan Terrace and footpath	24 Church Street	State Significance
	377	Buchanan Terrace and footpath	12 Church Street	State Significance
	402	CML Building	108-112 Hunter Street	Local (Schedule 5 of LEP)
	421	Wheeler House	8 King Street	Local (Schedule 5 of LEP)
	367	Court Chambers	40 Bolton Street	Local (Schedule 5 of LEP)
	442	Newcastle Hospital North Wing	21 Pacific Street and 2 Ocean Street	Local (Schedule 5 of LEP)
	361	Commercial Building	6 Bolton Street	Local (Schedule 5 of LEP)

Appendix D: Heritage items listed within the Newcastle coastal zone.

Suburb	Item number	Item name	Address	Significance
Newcastle	A7	Convict lumber yard – stockade site	92 Scott Street	State Significance
	386	Buchanan Terrace and footpath	30 Church Street	State Significance
	375	Courthouse	9 Church Street	State Significance
	A6	Cathedral Park and Cemetery	93 King Street	State Significance
	472	Terrace	62 Watt Street	State Significance
	380	Buchanan Terrace and footpath	16 Church Street	State Significance
	468	United Service Club	55 Watt Street	Local (Schedule 5 of LEP)
	409	Former School of Arts	182 Hunter Street	Local (Schedule 5 of LEP)
	389	No 1 Lee Wharf Building A	3C Honeysuckle Drive	State Significance
	428	Albert Terraces	164-176 King Street and 3-5 Crown Street	Local (Schedule 5 of LEP)
	411	Former Johns Building	200-212 Hunter Street	Local (Schedule 5 of LEP)
	417	Former Frederick Ash Building	357 Hunter Street	State Significance
	425	Ireland Bond Store	123 King Street	Local (Schedule 5 of LEP)
	410	Crown and Anchor Hotel	189 Hunter Street	Local (Schedule 5 of LEP)
	426	Central Hall	141 King Street	Local (Schedule 5 of LEP)
	412	Former Commonwealth Bank	220 Hunter Street	Local (Schedule 5 of LEP)
	420	Former Police Station	558 Hunter Street	Local (Schedule 5 of LEP)
	407	David Jones (commercial building)	169-185 Hunter Street	Local (Schedule 5 of LEP)
	427	Former Wool Exchange	149 King Street	Local (Schedule 5 of LEP)
	413	Former ANZ bank	227 Hunter Street	Local (Schedule 5 of LEP)
	416	Former tramway substation	342 Hunter Street	Local (Schedule 5 of LEP)
	479	Civic Railway Workshops Group	5 Workshop Way, 1 Wright Lane	State Significance
	414	Lucky Country Hotel	237 Hunter Street	Local (Schedule 5 of LEP)
	415	Remains of AA Co bridge and fence	280 Hunter Street	Local (Schedule 5 of LEP)
	444	Former Victoria Theatre	8-10 Perkins Street	State Significance
	415	Remains of AA Co bridge and fence	280 Hunter Street	Local (Schedule 5 of LEP)
	444	Former Victoria Theatre	8-10 Perkins Street	State Significance
	390	No 2 Lee Wharf Building C	13 Honeysuckle Drive	State Significance
	423	Former Masonic Hall and former Lyrique Theatre	98 King Street	Local (Schedule 5 of LEP)
	429	The Moorings (residential units)	199 King Street	Local (Schedule 5 of LEP)
	477	Retaining walls with sandstone steps	Wolfe Street and King Street	Local (Schedule 5 of LEP)
	476	Argyle House	311 Wharf Road	State Significance

Appendix D: Heritage items listed within the Newcastle coastal zone.

Suburb	Item number	Item name	Address	Significance
Newcastle West	499	Bellevue Hotel	738 Hunter Street	Local (Schedule 5 of LEP)
	495	Former CBC Bank	559 Hunter Street	Local (Schedule 5 of LEP)
	498	Theatre Royale	669 Hunter Street	State Significance
	497	Hunter Water Board Building	599 Hunter Street	Local (Schedule 5 of LEP)
	A8	Palais Royale (Government Farm archaeological site)	684 Hunter Street	Local (Schedule 5 of LEP)
	496	Newcastle Technical College	590-608 Hunter Street	Local (Schedule 5 of LEP)
	500	Bank Corner (former bank of NSW)	744 Hunter Street	Local (Schedule 5 of LEP)
The Hill	590	House	6 The Terrace	Local (Schedule 5 of LEP)
	561	Gate and stairs	52 Church Street	Local (Schedule 5 of LEP)
	579	King Edward Park Group (Bogey Hole Public Baths)	1A Ordnance Street	State Significance
	589	Terrace (Pacific House)	4 The Terrace	Local (Schedule 5 of LEP)
	552	Shalamah (residence)	4 Barker Street	Local (Schedule 5 of LEP)
	578	Merrick House Building – Newcastle Grammar School	60 Newcomen Street	Local (Schedule 5 of LEP)
	580	King Edward Park group (includes public reserve, drinking fountain and rotunda)	3 Ordnance Street	State Significance
	588	Three storey house (Corlette's Cottage)	2 The Terrace	Local (Schedule 5 of LEP)
Bar Beach	32	Acropolis (residential units)	40 Parkway Avenue	Local (Schedule 5 of LEP)
	22	Shed	334A Darby Street	Local (Schedule 5 of LEP)
	26	Empire Park Bowling Club fence	29 Kilgour Avenue	Local (Schedule 5 of LEP)
	33	Brooklyn Court (residential units)	6 Tooke Street	Local (Schedule 5 of LEP)
	24	Cooks Hill Surf Life Saving Memorial	1 Kilgour Avenue	Local (Schedule 5 of LEP)
	30	Parkhurst Flats	17 Parkway Avenue	Local (Schedule 5 of LEP)
	25	Reid Park Tennis Clubhouse and tennis courts	1-7 Kilgour Avenue	Local (Schedule 5 of LEP)
	29	Residence	10 Parkway Avenue	Local (Schedule 5 of LEP)
	20	Kamarem Court (residential units)	289-293 Darby Street	Local (Schedule 5 of LEP)
	23	Empire Park	1 Kilgour Avenue	Local (Schedule 5 of LEP)
	27	Electrical substation	17 Light Street	Local (Schedule 5 of LEP)
	21	Former King Edwards Girls Home	313 Darby Street	Local (Schedule 5 of LEP)
	28	Cooks Hill Surf Life Saving Club	107-109 Memorial Drive	Local (Schedule 5 of LEP)
	31	Residential units	23 Parkway Avenue	Local (Schedule 5 of LEP)

Appendix D: Heritage items listed within the Newcastle coastal zone.

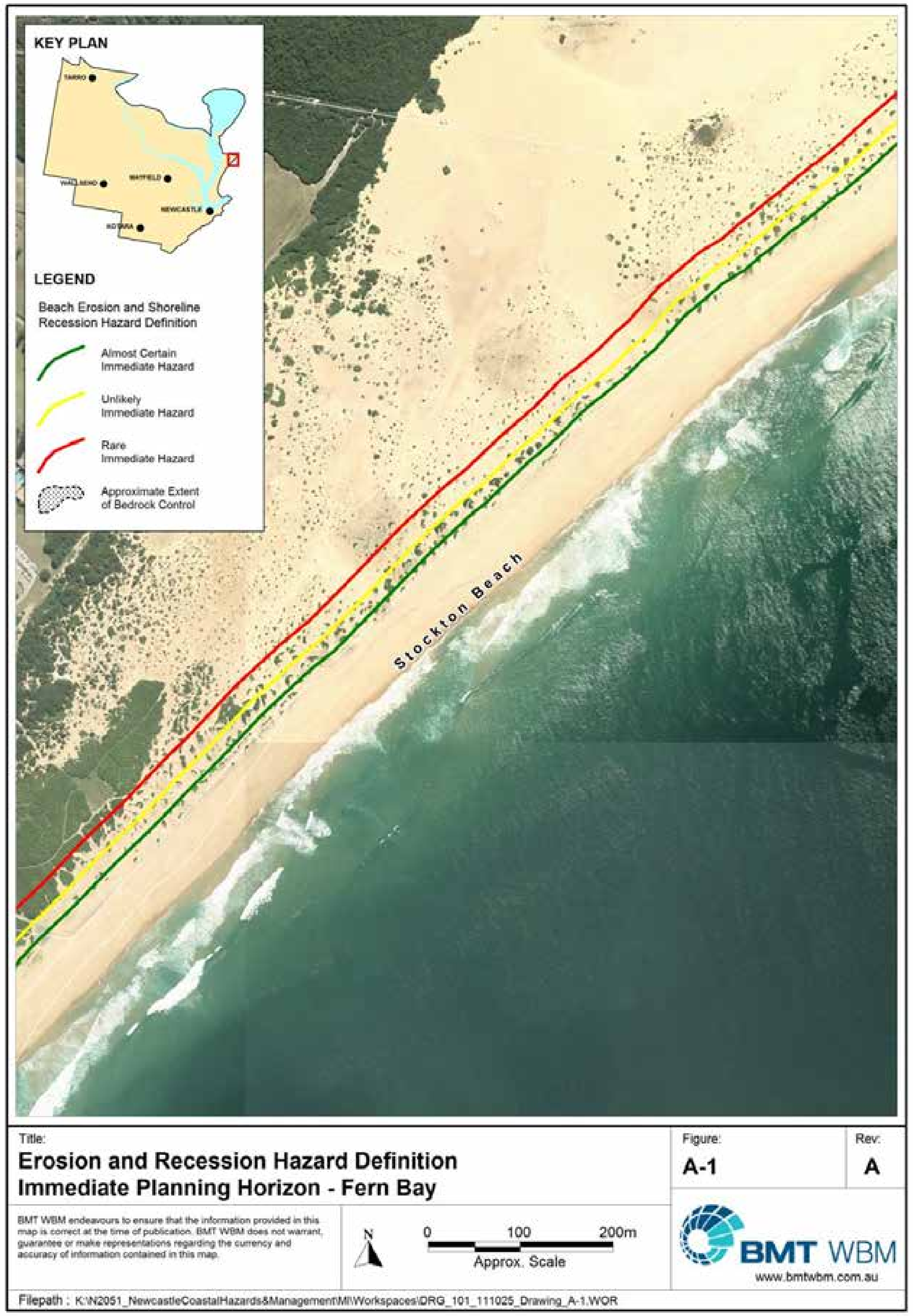
Suburb	Item number	Item name	Address	Significance
Merewether	322	Glenrock Reserve	221 Scenic Drive	Local (Schedule 5 of LEP)
	297	Former Racecourse Inn	65 Frederick Street	Local (Schedule 5 of LEP)
	A3	Newcastle Coke Ovens	3A Ocean Street	Local (Schedule 5 of LEP)
	299	Beach hotel	99 Frederick street	Local (Schedule 5 of LEP)
	313	Blairgowrie (residence)	39 Lloyd Street	Local (Schedule 5 of LEP)
	303	Merewether Baths	27 Henderson Parade	Local (Schedule 5 of LEP)
	306	Holy Family Parish Hall	19 Janet Street (Ridge Street)	Local (Schedule 5 of LEP)
	A2	Remains of smelter	Smelters Beach	Local (Schedule 5 of LEP)
	298	Trialba (residence)	75 Frederick Street	Local (Schedule 5 of LEP)
	305	Brown Sisters convent	8 Janet Street	Local (Schedule 5 of LEP)
	A1	Remains of Glenrock Railway	Merewether Beach	Local (Schedule 5 of LEP)
	304	The Ridge (Hillcrest Hospital)	21 Hillcrest Road	State Significance
	308	Brynhfryd (residence)	44 Kilgour Avenue	Local (Schedule 5 of LEP)
	296	Residence	1A Currey Street	Local (Schedule 5 of LEP)
Wickham	A20	RA Ritchie & Sons and Hudson Bros Engineering (former industrial site)	20 Greenway Street	Local (Schedule 5 of LEP)
	685	Wickham Public School	54 Hannell Street	Local (Schedule 5 of LEP)
	677	Former police lock-up	25 Albert Street	Local (Schedule 5 of LEP)
	686	Former Infants School	64 Hannell Street	Local (Schedule 5 of LEP)
	683	Wickham Railway Station		Local (Schedule 5 of LEP)
	690	Former School of Arts	80 Honeysuckle Drive	Local (Schedule 5 of LEP)
	689	The Salvation Army Men's Hostel	116-120 Hannell Street	Local (Schedule 5 of LEP)
	684	Wickham Signal Box		Local (Schedule 5 of LEP)
	688	The Missions to seamen building	96 Hannell Street	Local (Schedule 5 of LEP)
	687	Albion Hotel	72 Hannell Street	Local (Schedule 5 of LEP)
Carrington	74	Carrington House (residence)	130 Young Street	Local (Schedule 5 of LEP)
	71	Quambi (residence)	110 Young Street	Local (Schedule 5 of LEP)
	66	Carrington fire Station	51 Young Street	Local (Schedule 5 of LEP)
	59	Palms	Gipps Street	Local (Schedule 5 of LEP)
	76	Former Glasgow Arms Hotel	140 Young Street	Local (Schedule 5 of LEP)
	60	Mary McKillop Home	58 Gipps Street	Local (Schedule 5 of LEP)
	67	Carrington Public School	88 Young Street	Local (Schedule 5 of LEP)
	58	Seven Seas Hotel	33 Cowper Street North	Local (Schedule 5 of LEP)
	73	Shop	121 Young Street	Local (Schedule 5 of LEP)

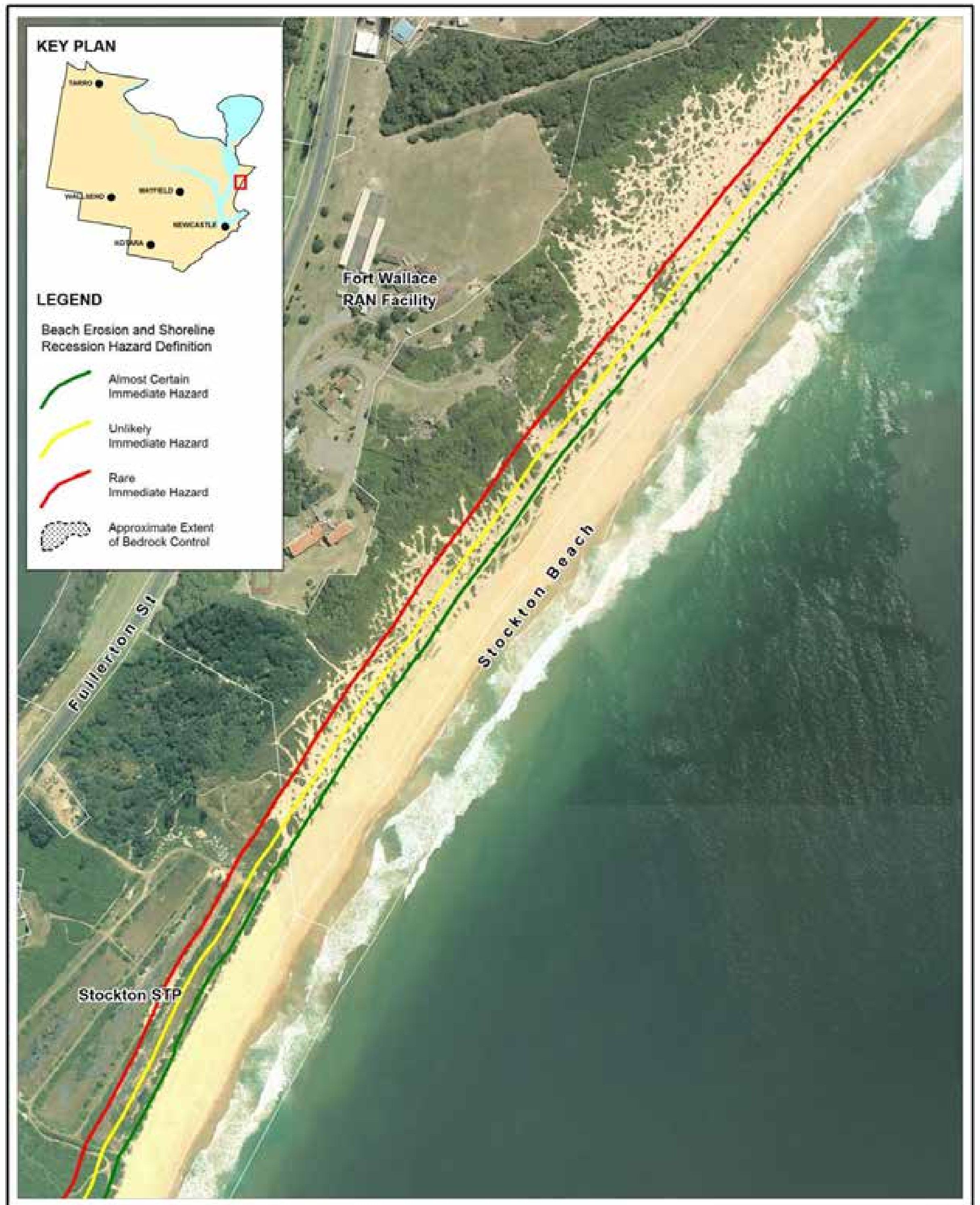
Appendix D: Heritage items listed within the Newcastle coastal zone.

Suburb	Item number	Item name	Address	Significance
Carrington	56	Connolly Park War Memorial Gate	Cnr Cowper Street North and Fitzroy Street	Local (Schedule 5 of LEP)
	72	Almora (residence)	112 Young Street	Local (Schedule 5 of LEP)
	68	Everyone's Theatre	92A Young Street	Local (Schedule 5 of LEP)
	62	Date palms	Hargrave Street	Local (Schedule 5 of LEP)
	55	Former Carrington Club Hotel	83-85 Bourke Street	Local (Schedule 5 of LEP)
	70	Carrington Post Office	97 Young Street	Local (Schedule 5 of LEP)
	65	Mathieson Street Terraces	2-18 Mathieson Street	Local (Schedule 5 of LEP)
	77	Cosmopolitan Hotel	151 Young Street	Local (Schedule 5 of LEP)
	75	Oriental Hotel	132 Young Street	Local (Schedule 5 of LEP)
	57	Club Hotel	26 Cowper Street North	Local (Schedule 5 of LEP)
	63	Former Council Chambers	1A Hargrave Street	Local (Schedule 5 of LEP)
	61	St Francis Xavier Catholic Church	60 Gipps Street	Local (Schedule 5 of LEP)
	69	St Thomas Anglican Church	95A Young Street	Local (Schedule 5 of LEP)

Appendix E: Modelled beach erosion and shoreline recession hazard areas from Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a))

Stockton (immediate planning horizon)





Title:
Erosion and Recession Hazard Definition
Immediate Planning Horizon - Fort Wallace

Figure: A-2 | Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Title:
Erosion and Recession Hazard Definition
Immediate Planning Horizon - Stockton North

Figure: A-3 | Rev: A

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Title:
Erosion and Recession Hazard Definition
Immediate Planning Horizon - Stockton South

Figure: A-4 Rev: A

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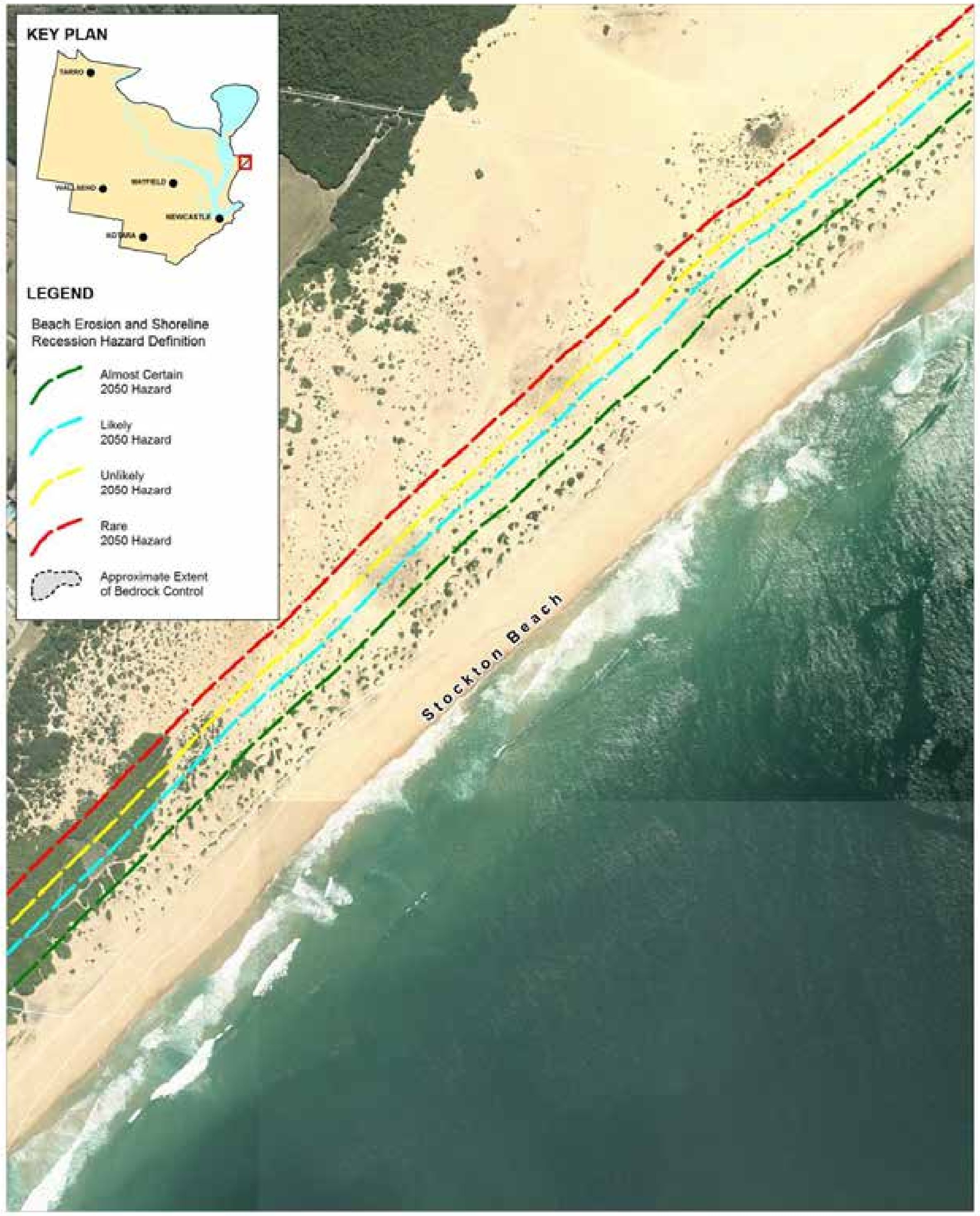
Stockton (2050 planning horizon)



Title:
Erosion and Recession Hazard Definition
2050 Planning Horizon - Fern Bay

Figure: B-1 Rev: A

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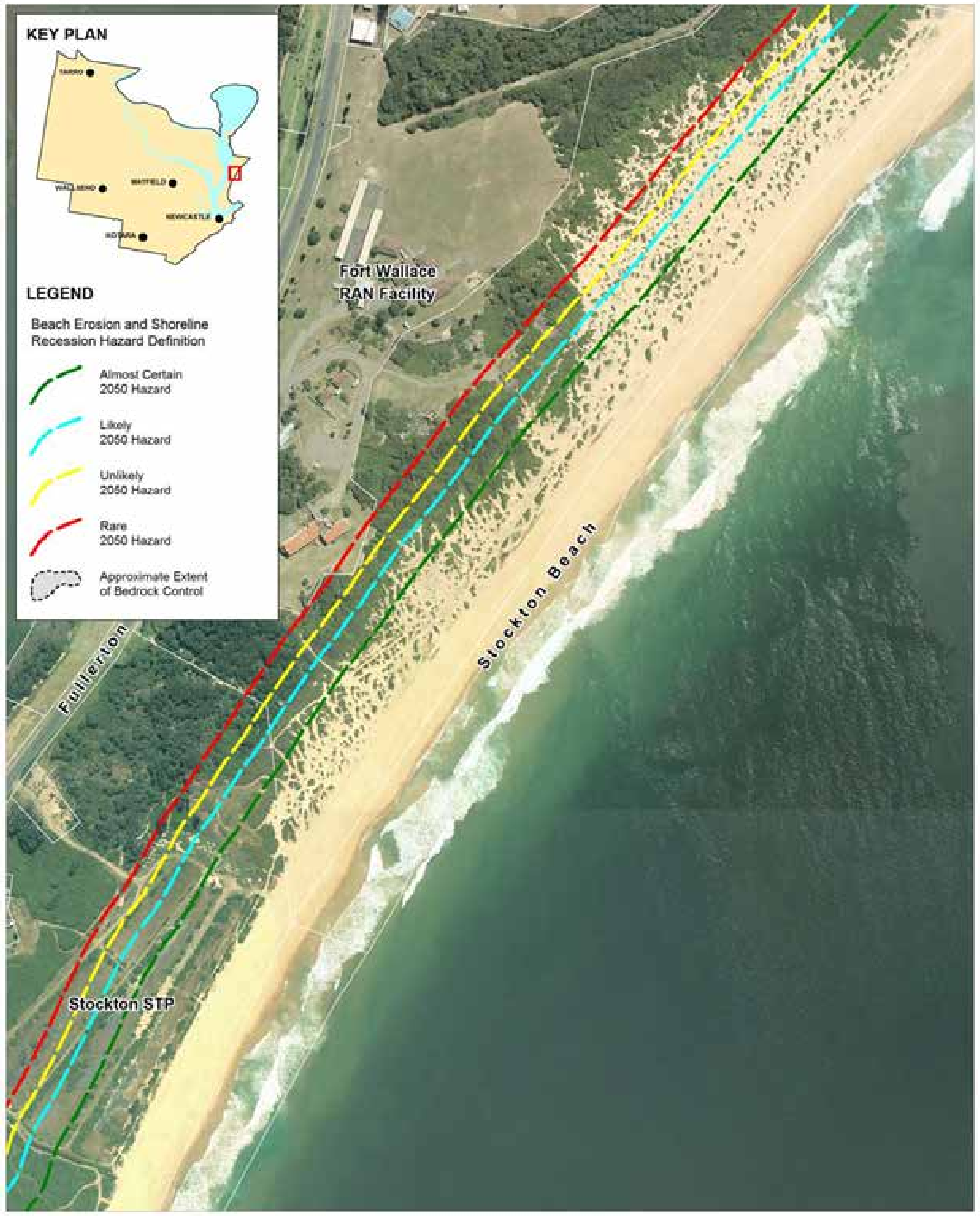

Title:
Erosion and Recession Hazard Definition 2050 Planning Horizon - Fort Wallace

Figure: B-2
Rev: A

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Title:
Erosion and Recession Hazard Definition 2050 Planning Horizon - Stockton North

Figure: B-3
Rev: A

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Approx. Scale

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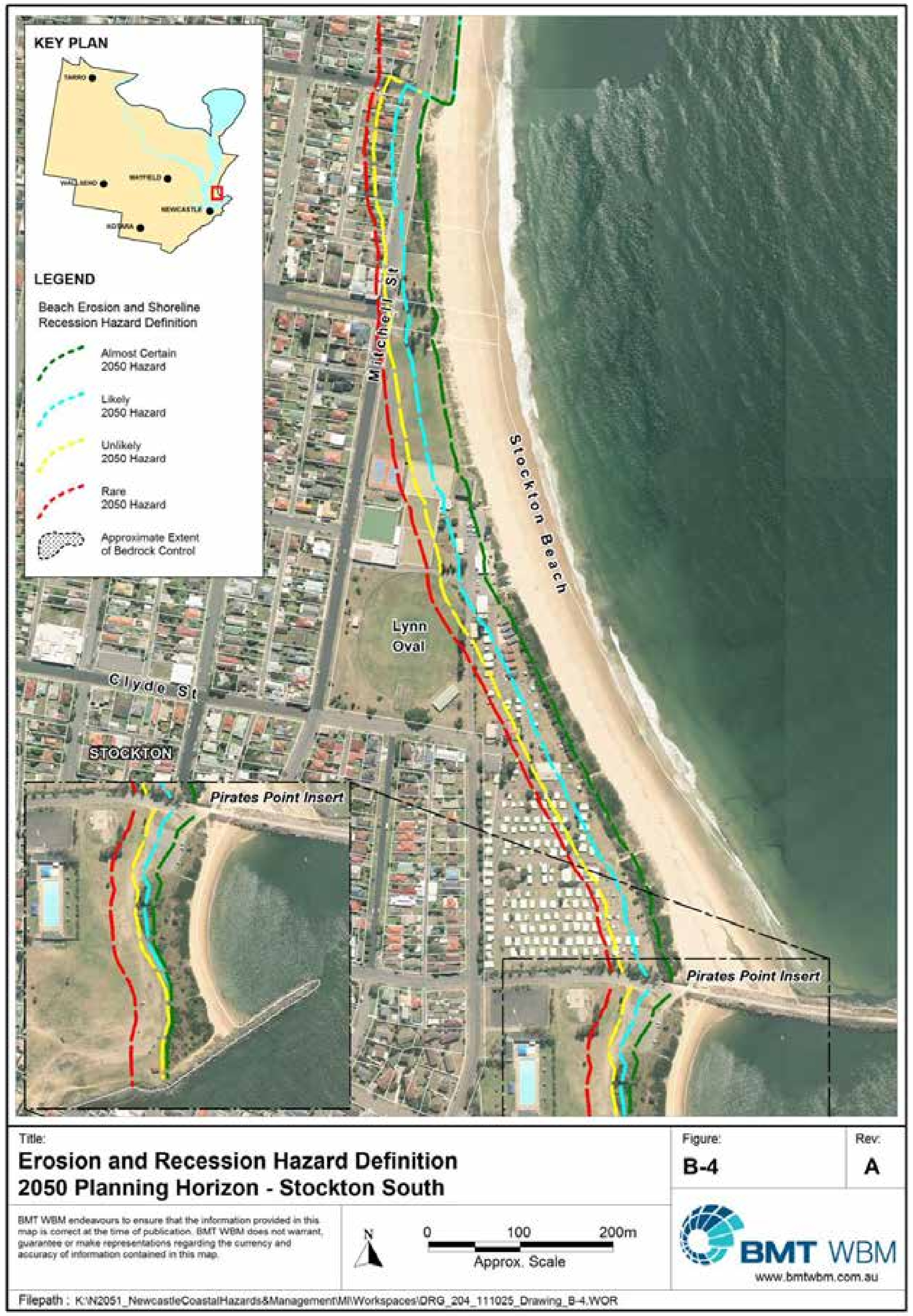
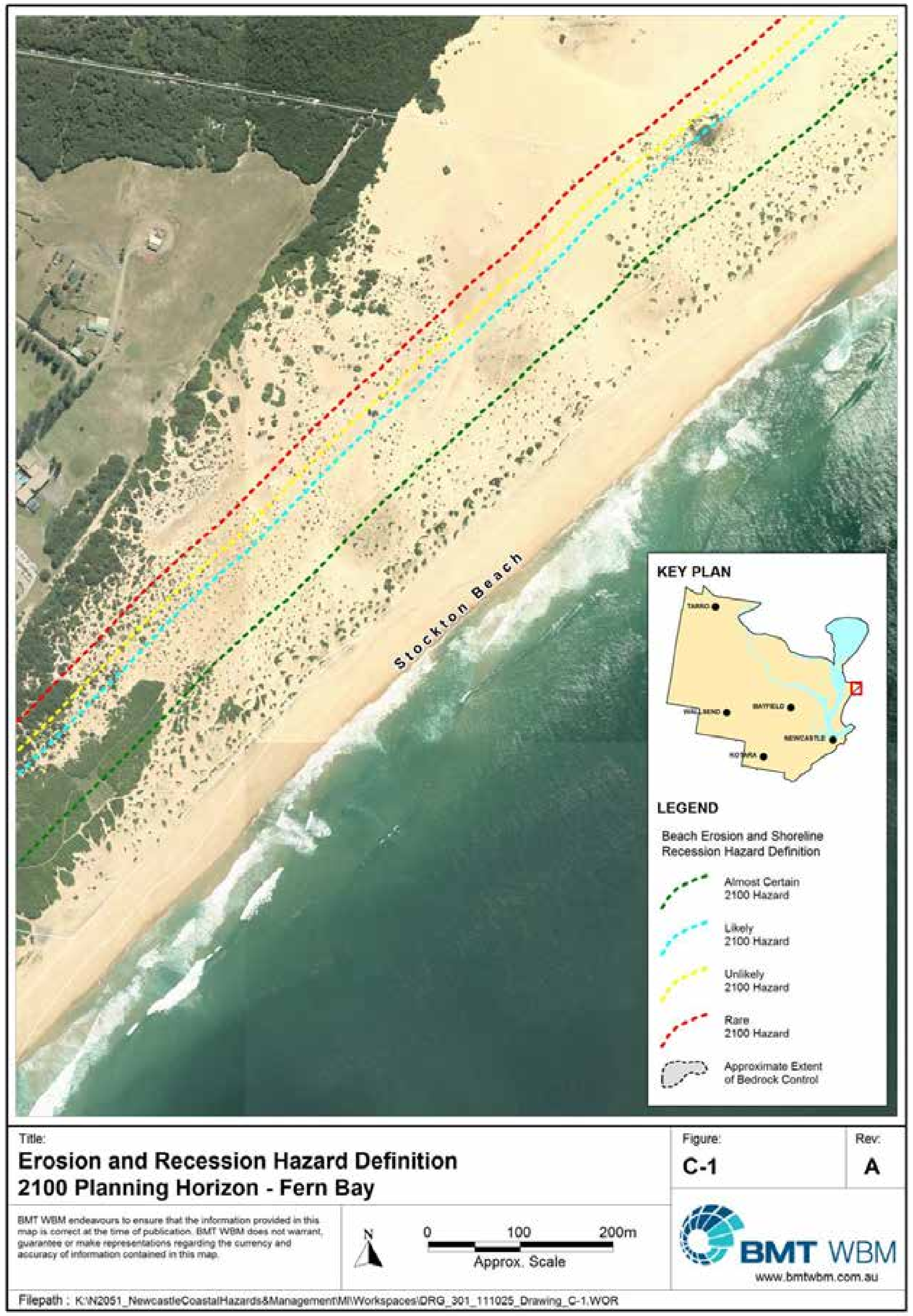


Stockton (2100 planning horizon)



Title: **Erosion and Recession Hazard Definition 2100 Planning Horizon - Fort Wallace**

Figure: C-2 | Rev: A

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N | 0 100 200m | Approx. Scale

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Title: **Erosion and Recession Hazard Definition 2100 Planning Horizon - Stockton North**

Figure: C-3 | Rev: A

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N | 0 100 200m | Approx. Scale

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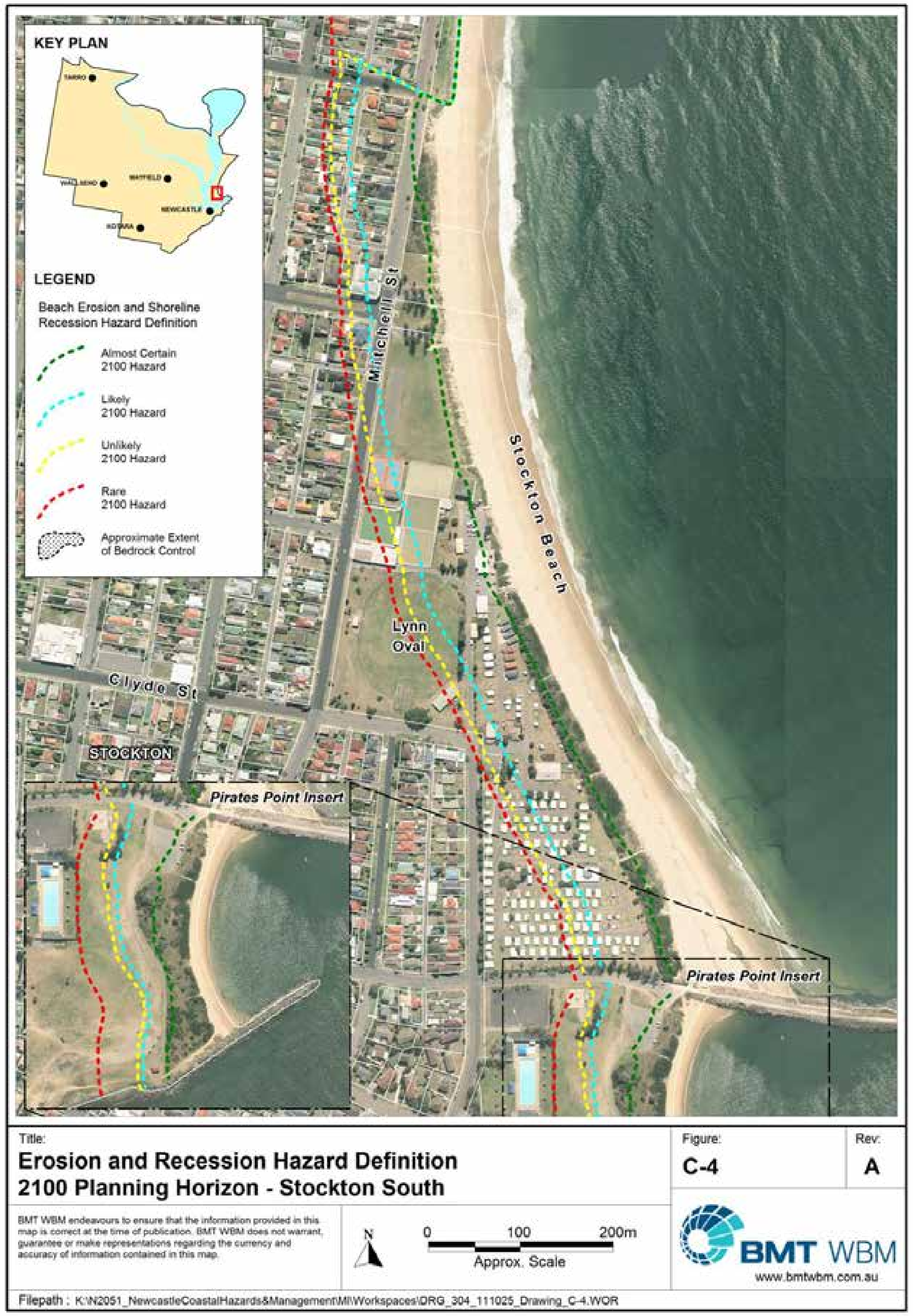
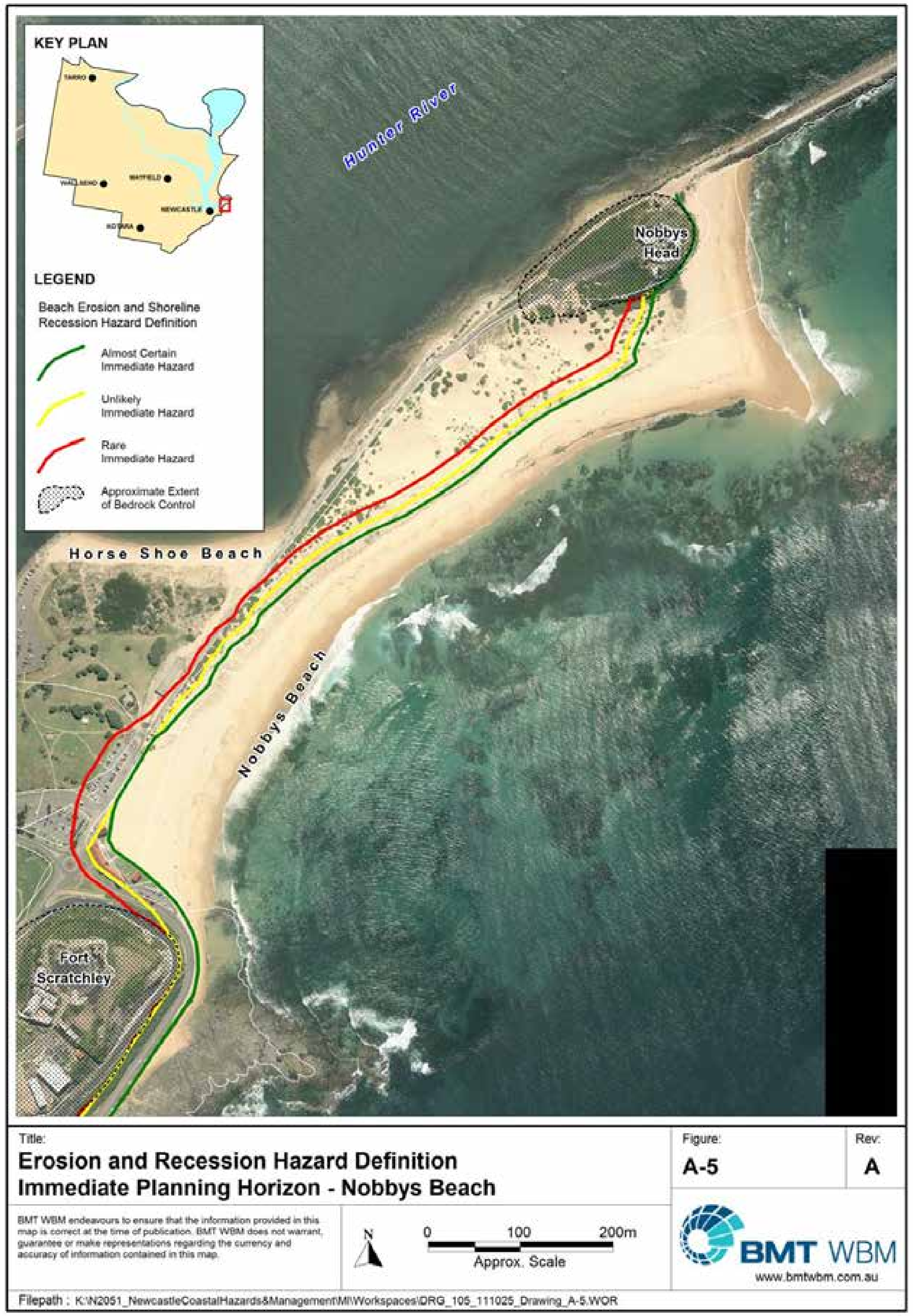
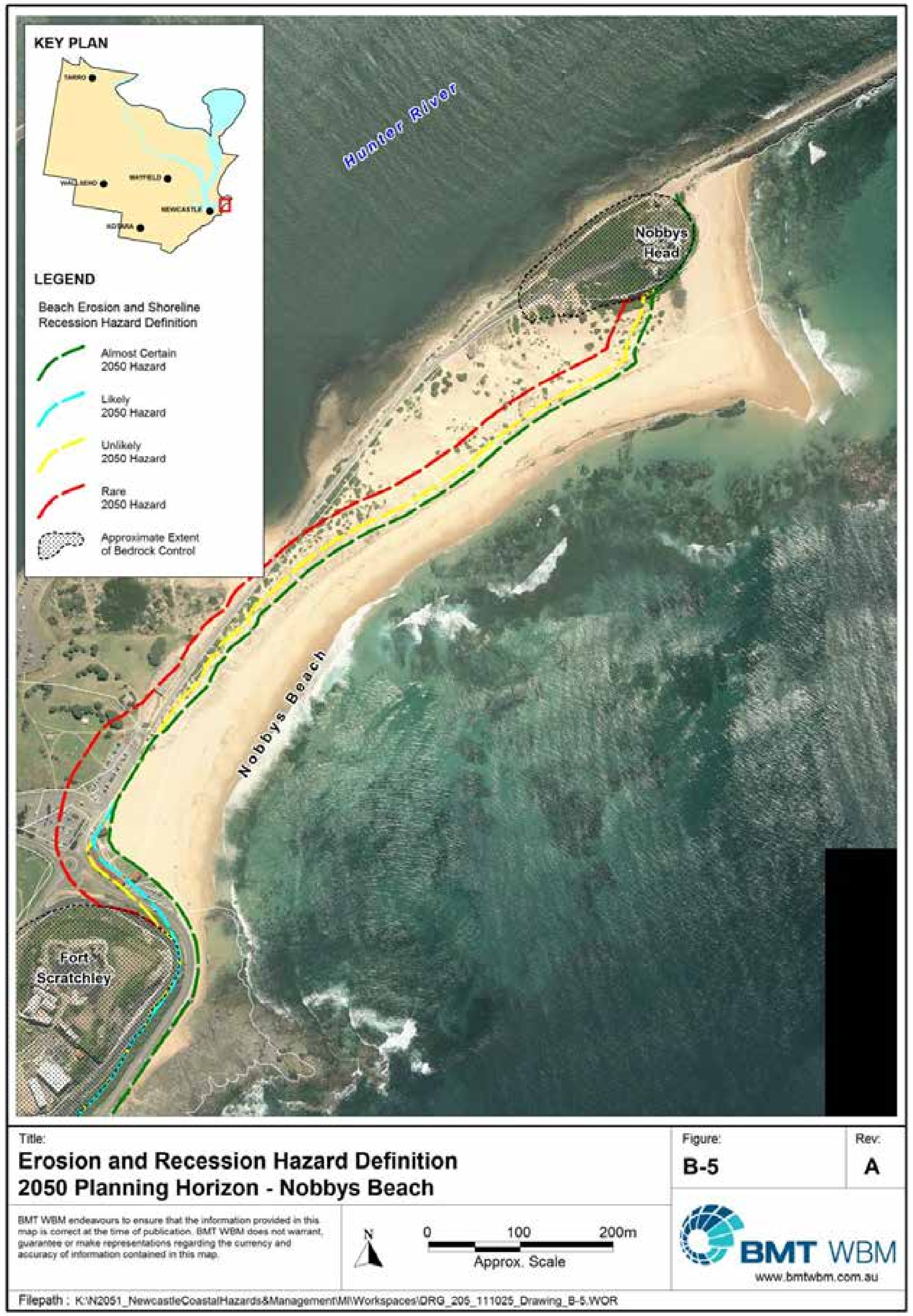


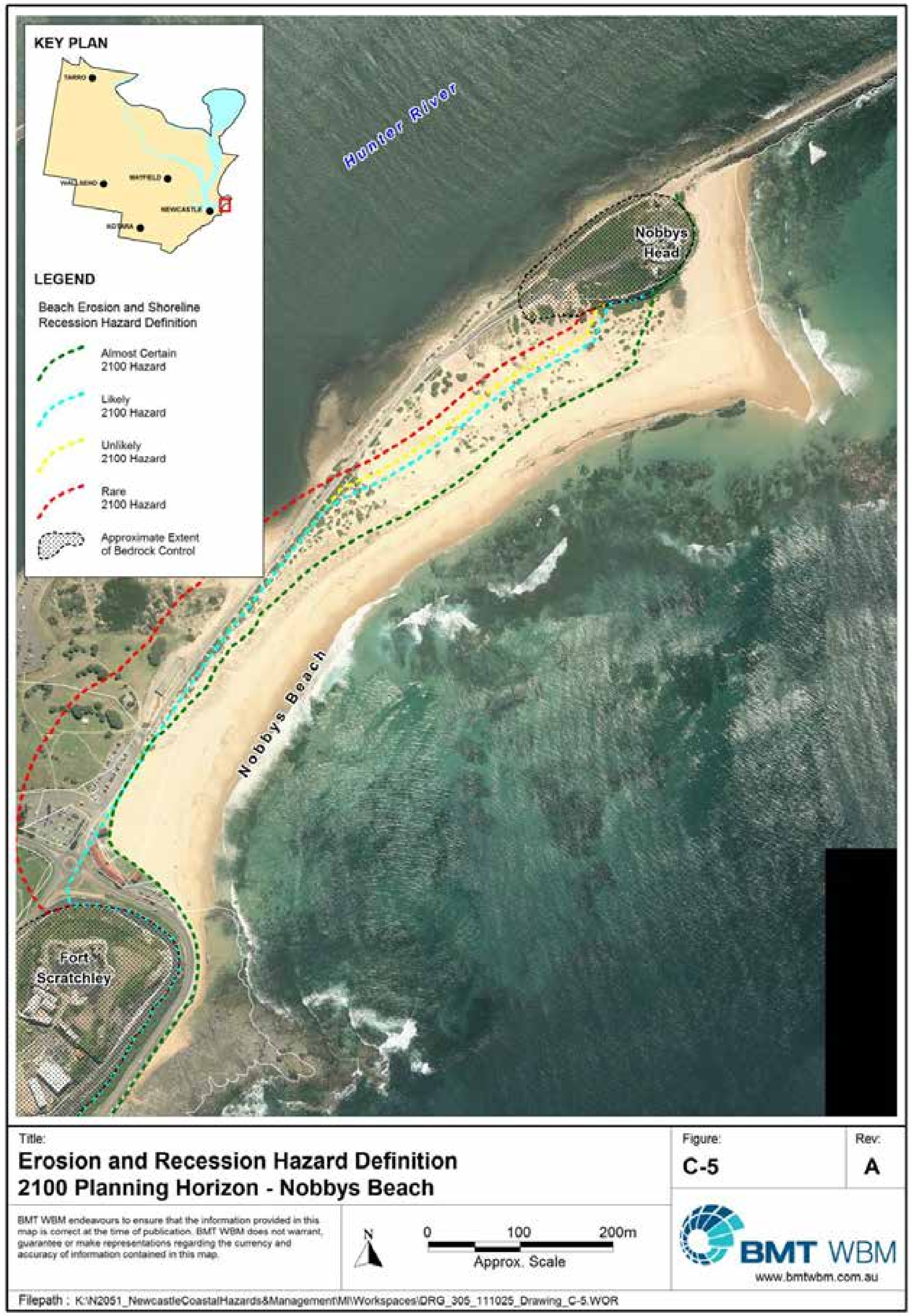
Nobbys Beach (immediate planning horizon)



Nobbys Beach (2050 planning horizon)

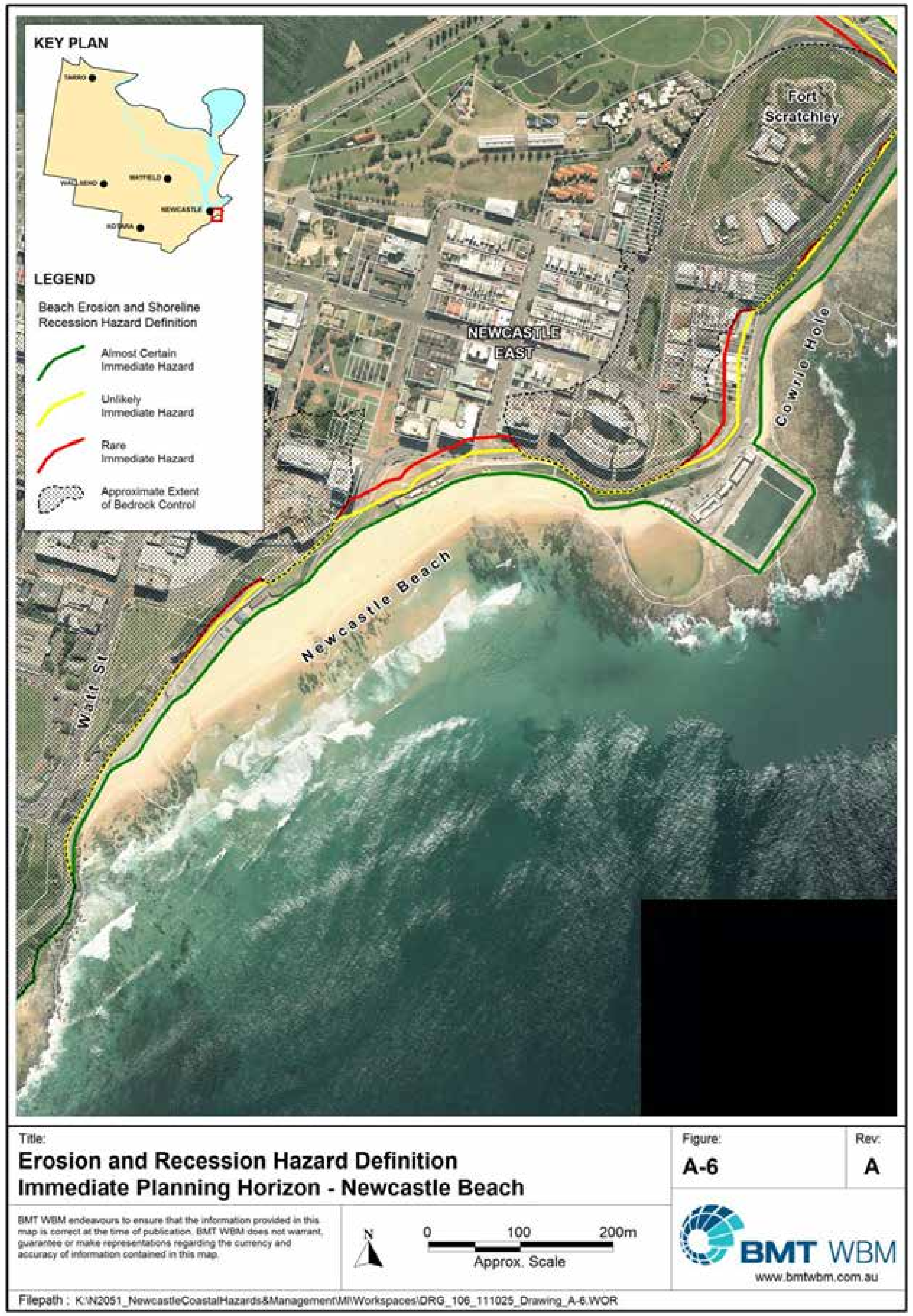


Nobbys Beach (2100 planning horizon)

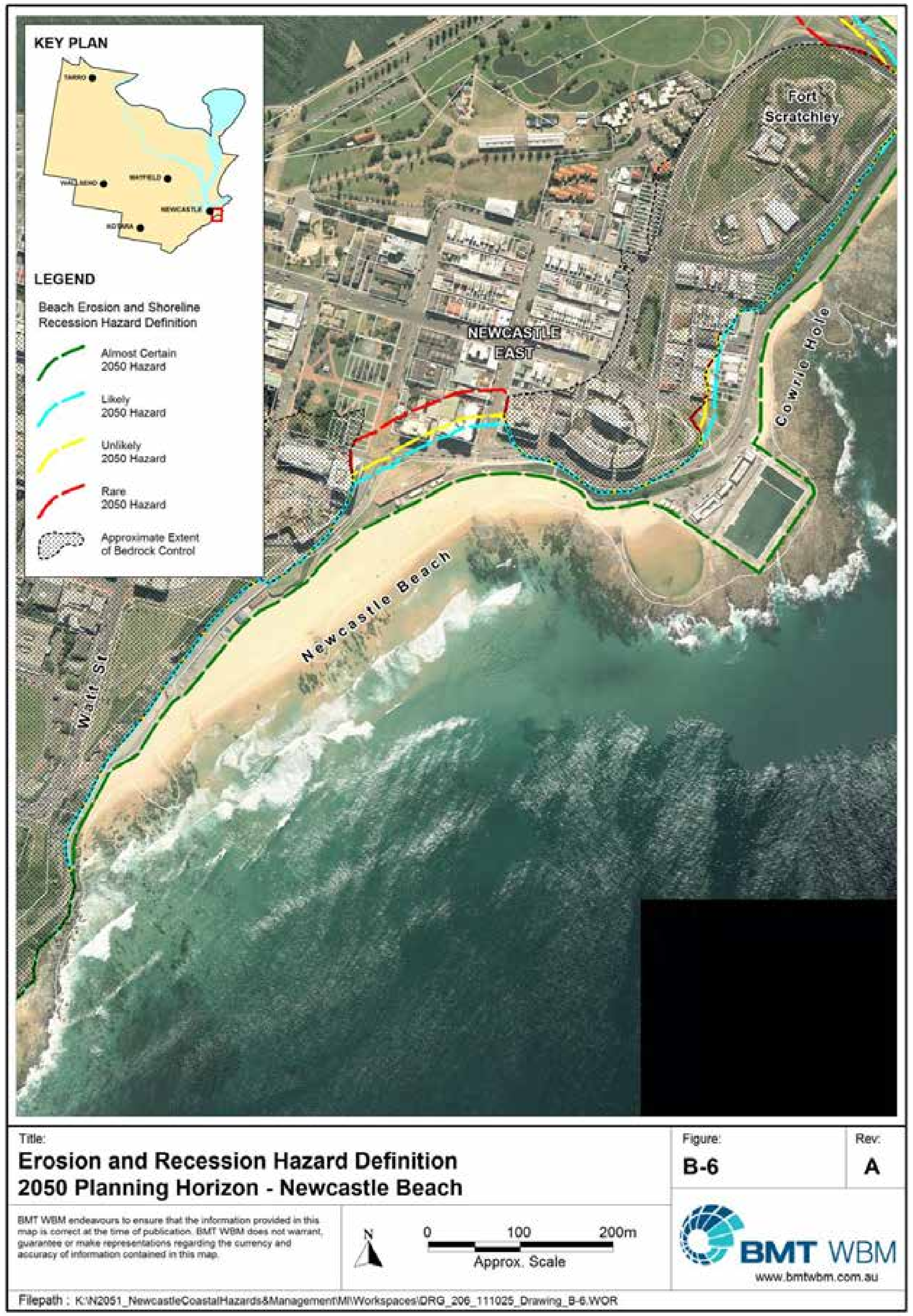


Appendix E

Newcastle Beach (immediate planning horizon)



Newcastle Beach (2050 planning horizon)



Newcastle Beach (2100 planning horizon)

Title:
Erosion and Recession Hazard Definition
2100 Planning Horizon - Newcastle Beach

Figure: C-6
Rev: A

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N
0 100 200m
Approx. Scale

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Filepath : K:\N2051_NewcastleCoastalHazards&Management\MI\Workspaces\DRG_306_111025_Drawing_C-6.WOR

Bar Beach (immediate planning horizon)

Title:
Erosion and Recession Hazard Definition
Immediate Planning Horizon - Bar Beach

Figure: A-8
Rev: A

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N
0 100 200m
Approx. Scale

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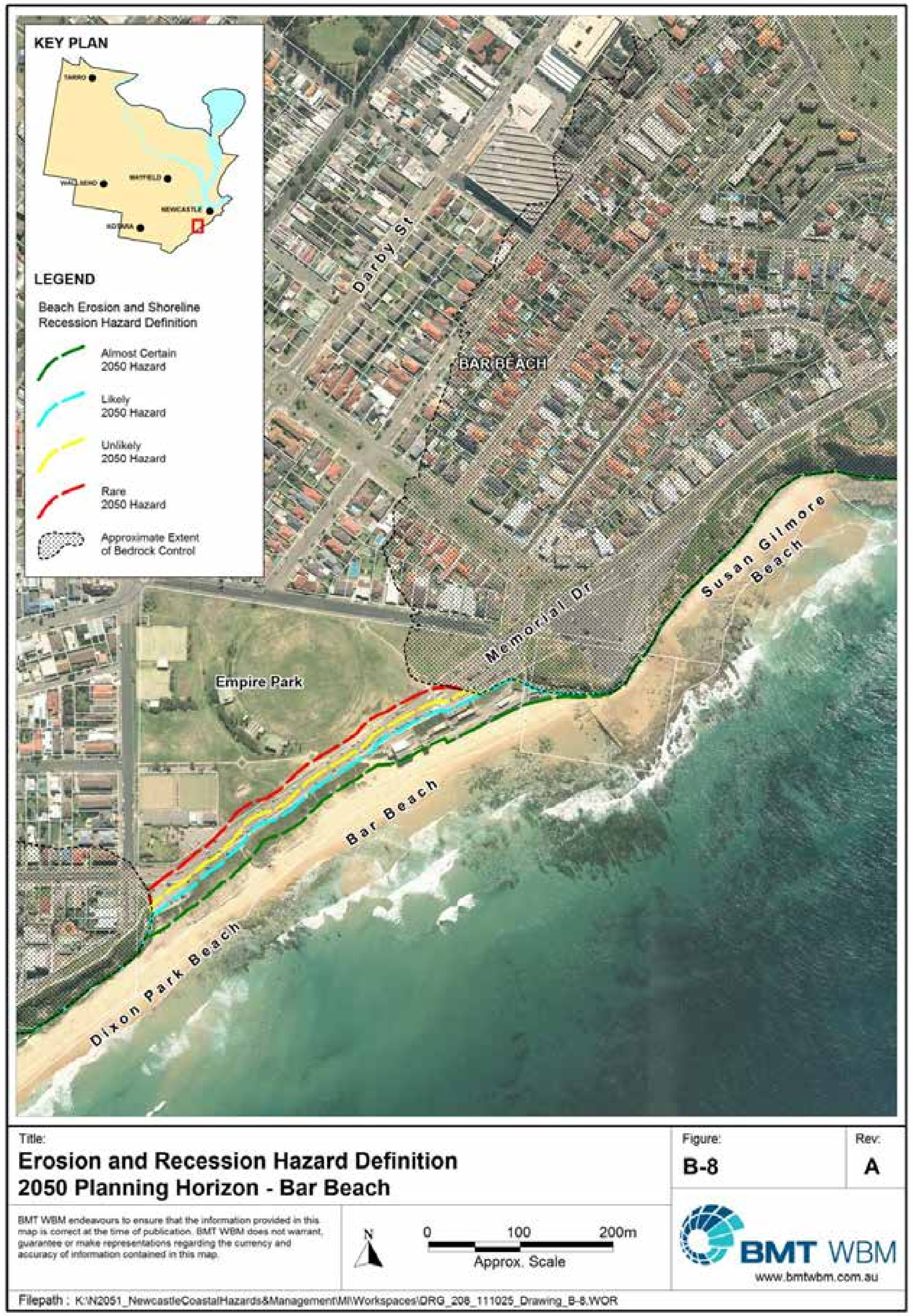
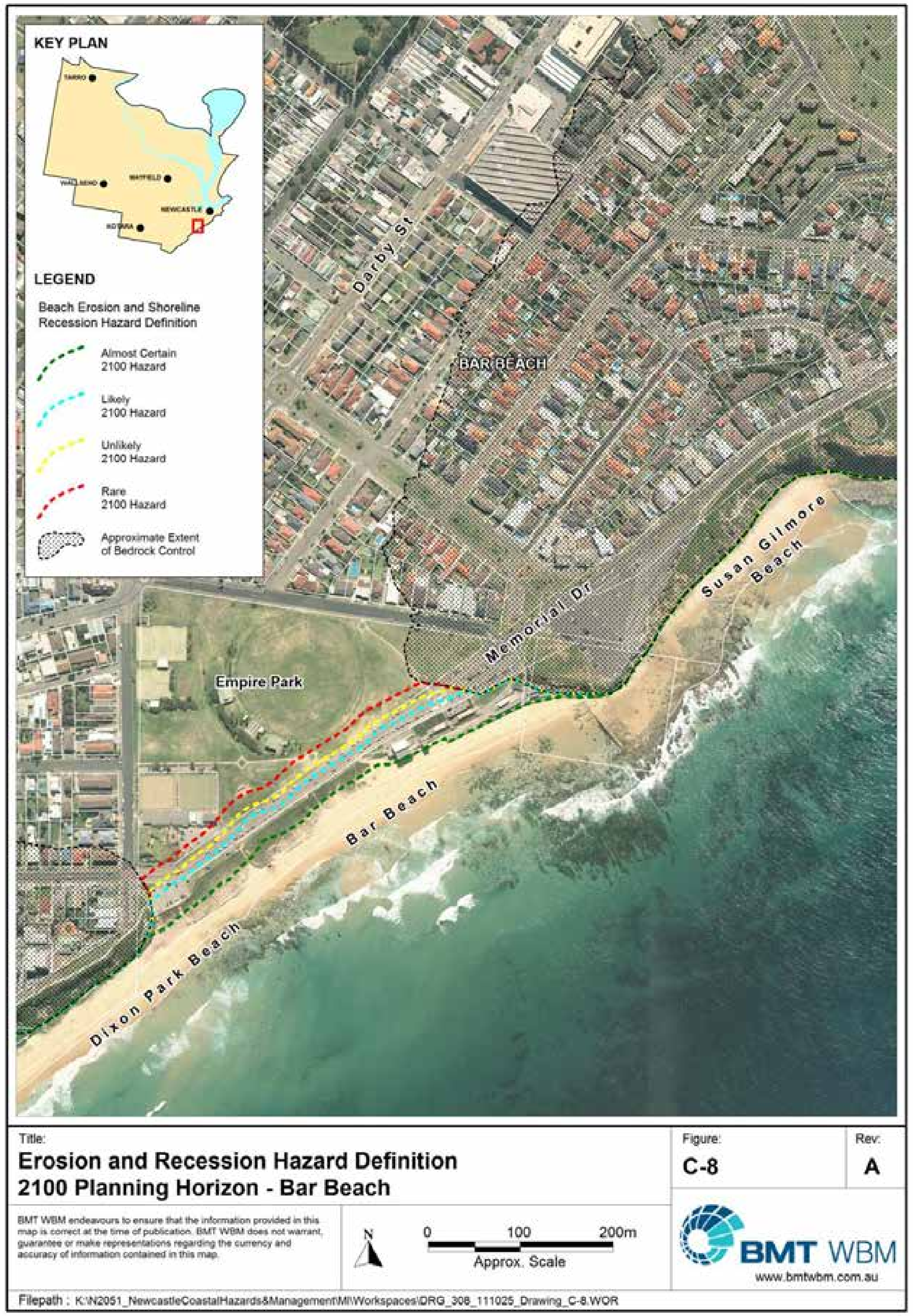
Appendix E

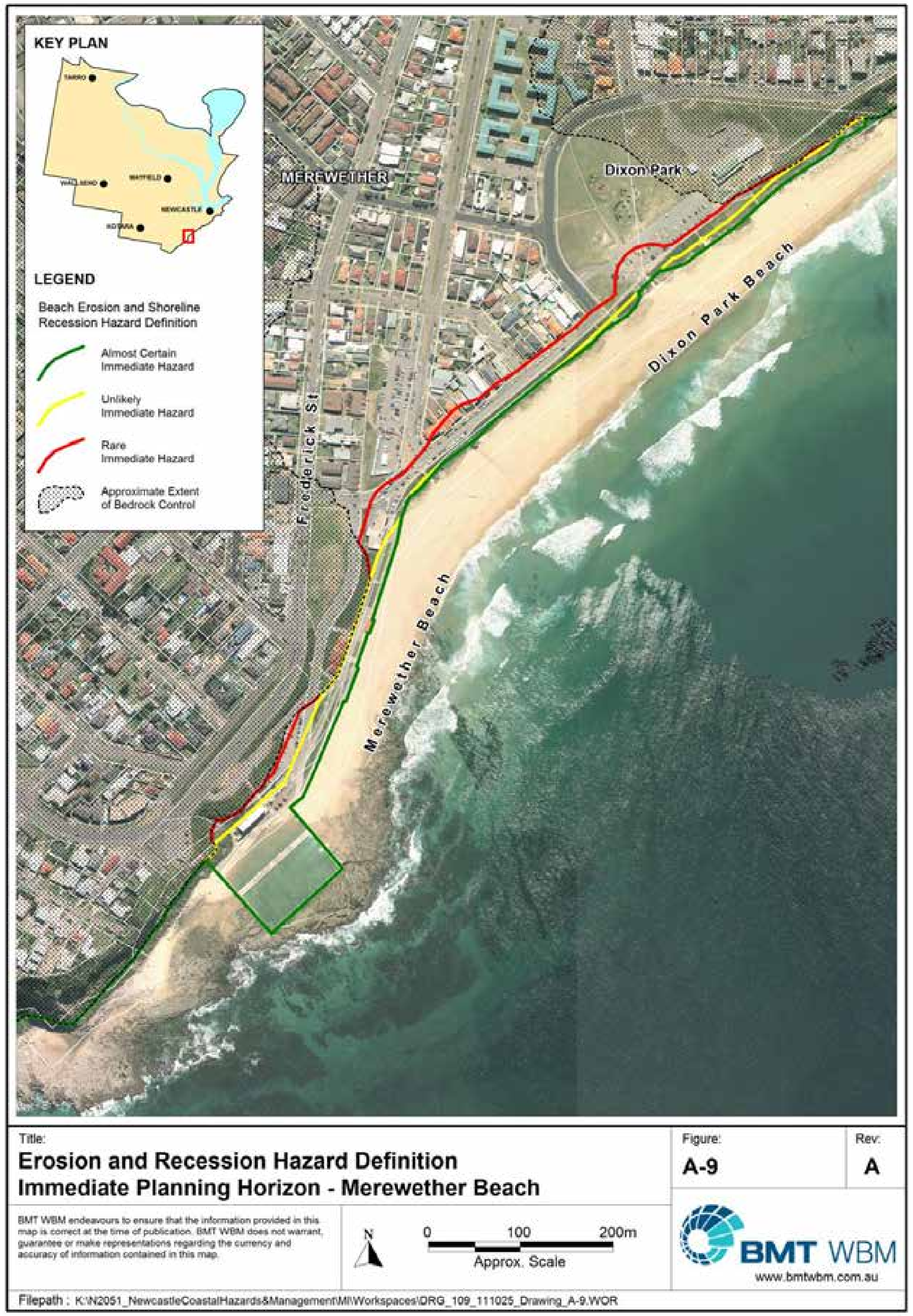
Bar Beach (2050 planning horizon)



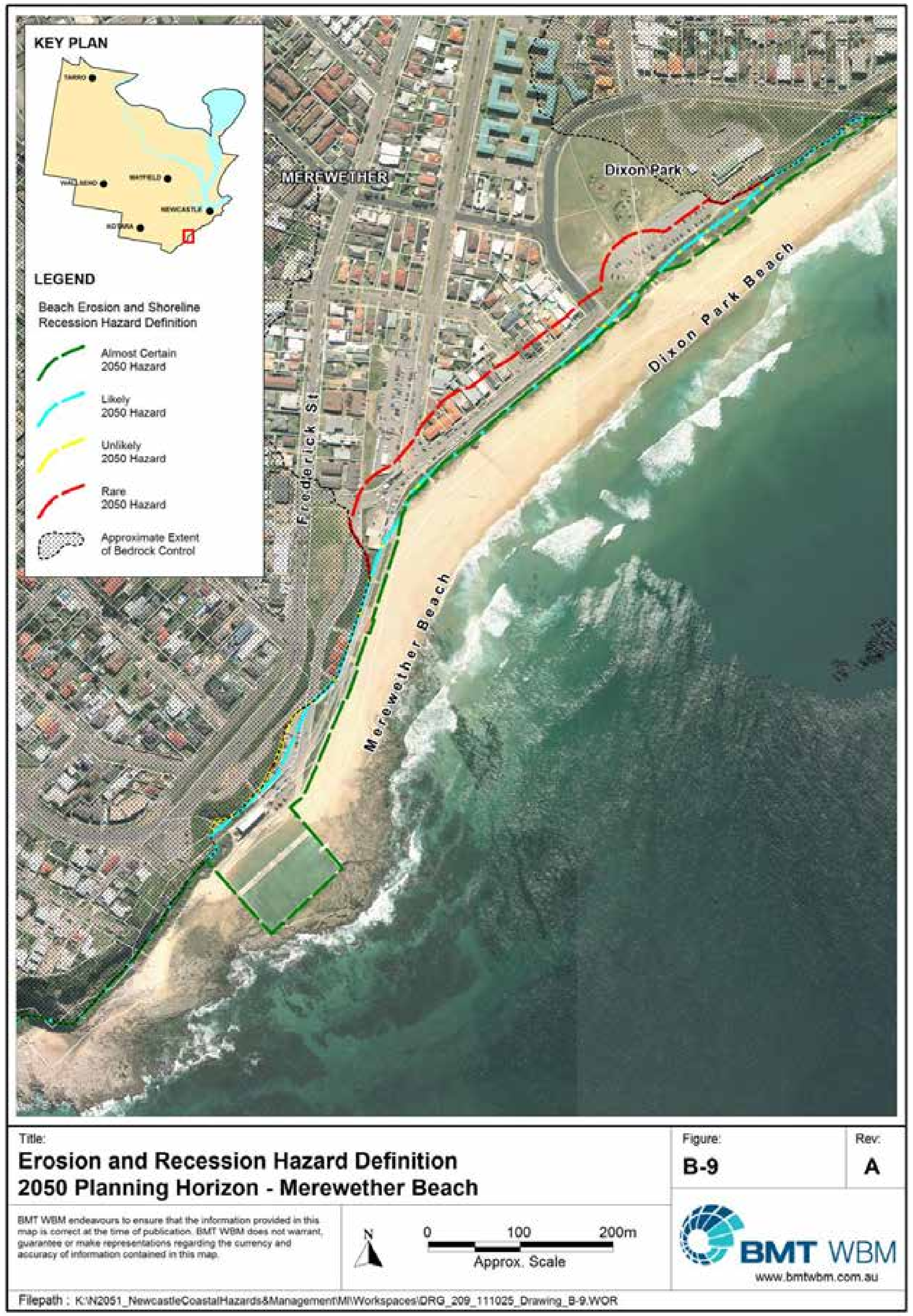
Bar Beach (2100 planning horizon)



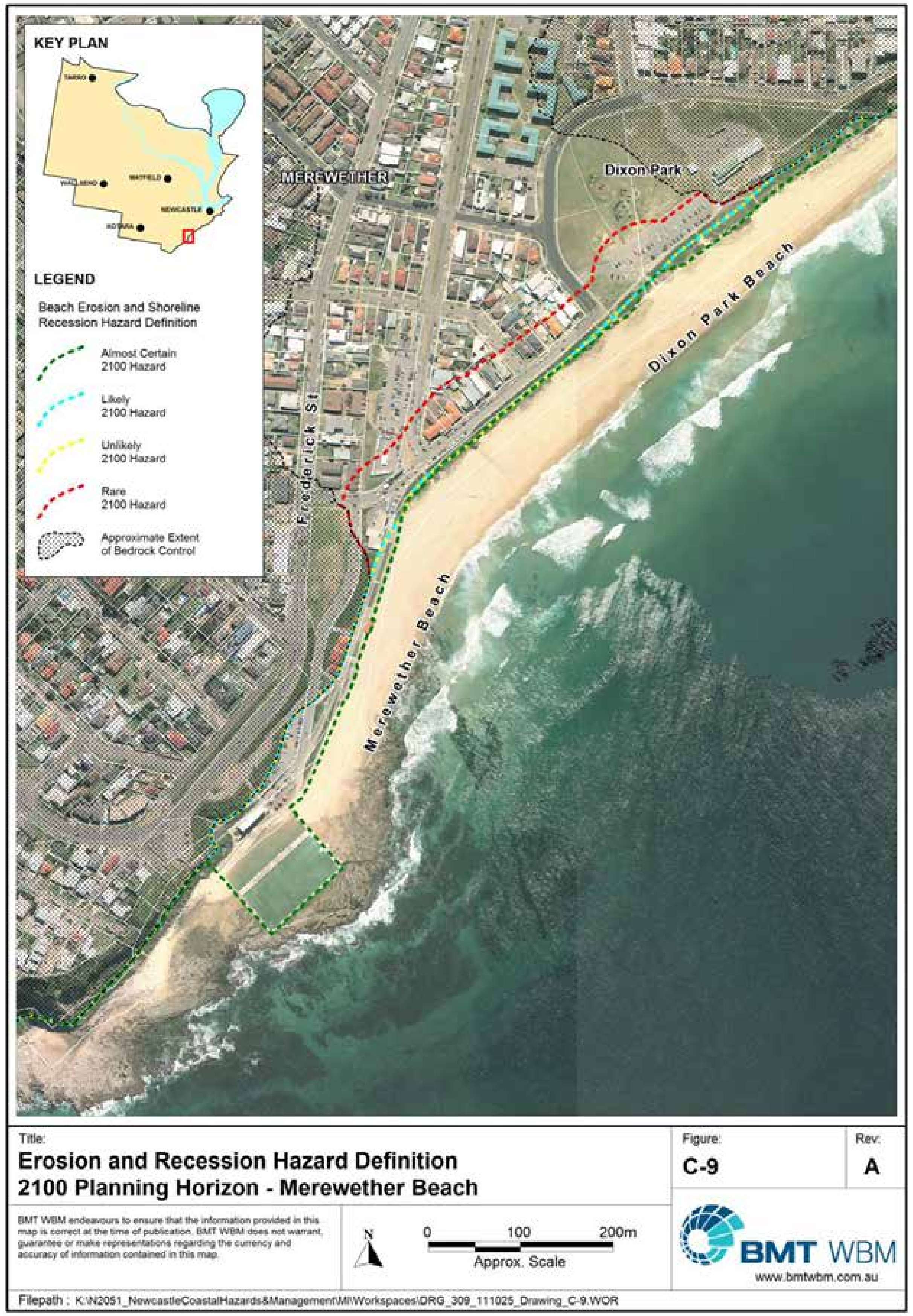
Dixon Park and Merewether Beach (immediate planning horizon)



Dixon Park and Merewether Beach (2050 planning horizon)



Dixon Park and Merewether Beach (2100 planning horizon)



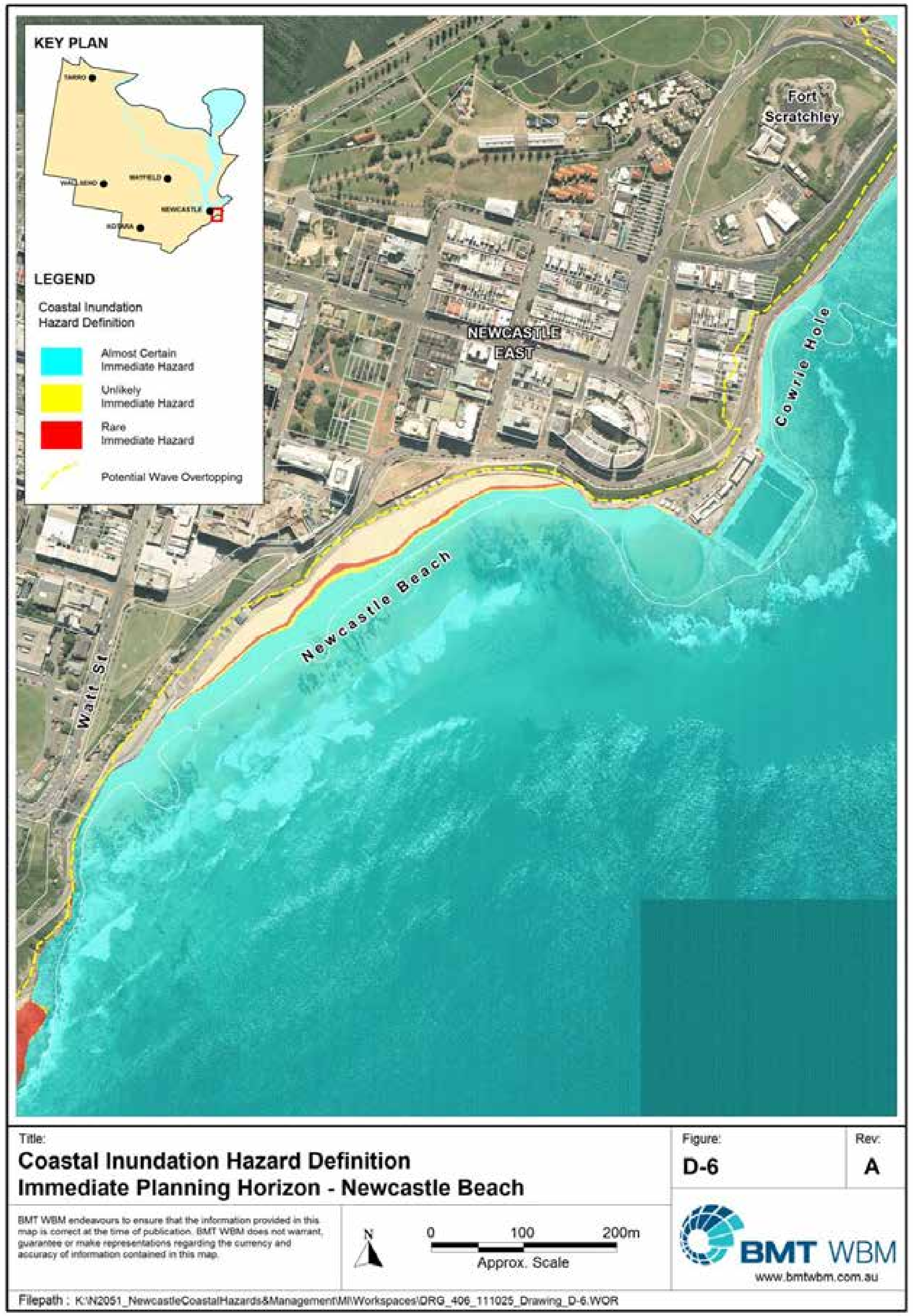
Appendix F: Modelled coastal inundation hazard areas from Newcastle Coastal Zone Hazards Study (BMWT WBM, 2014(a))

Nobbys Beach (immediate planning horizon)

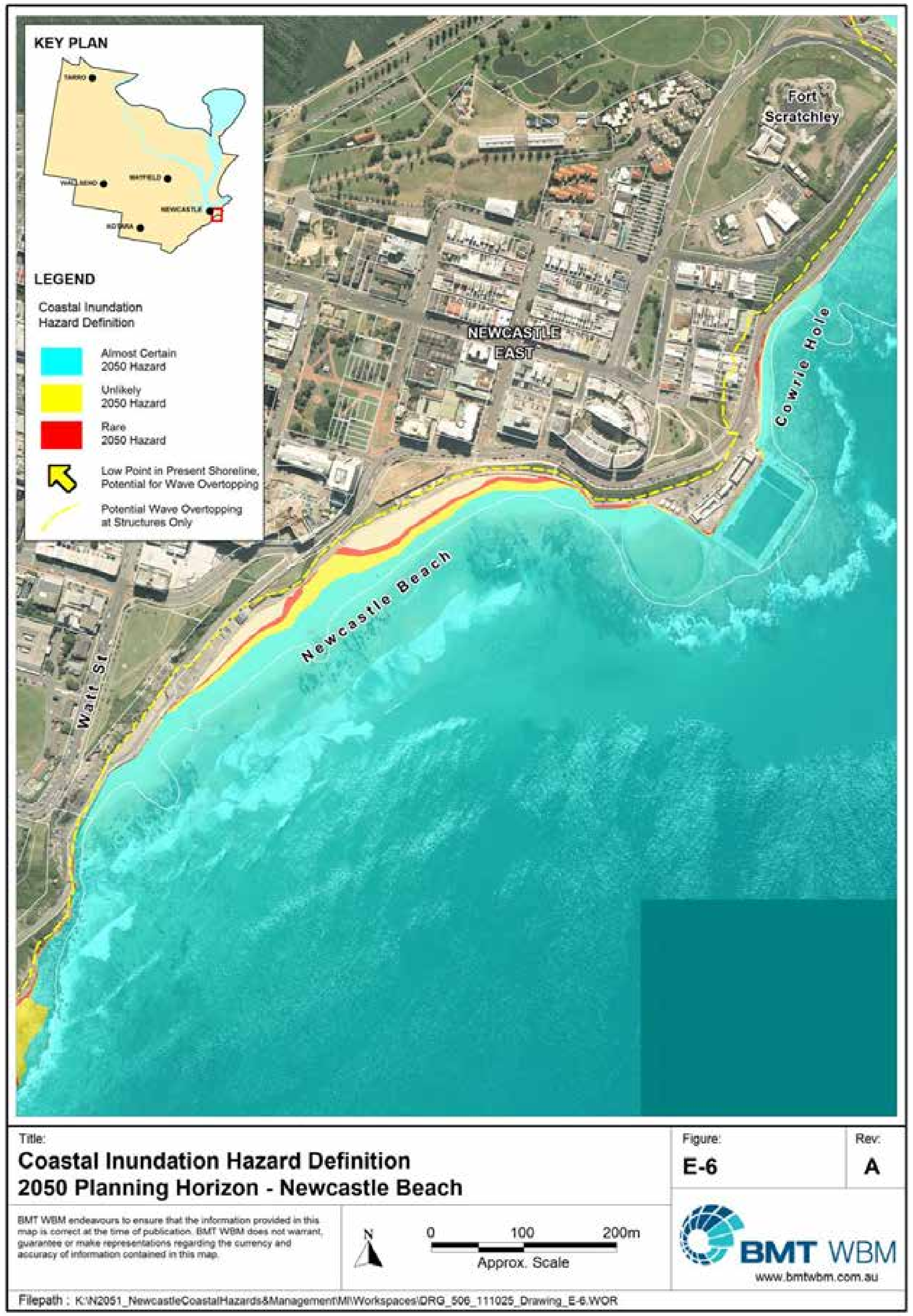
Nobbys Beach (2050 planning horizon)

Nobbys Beach (2100 planning horizon)

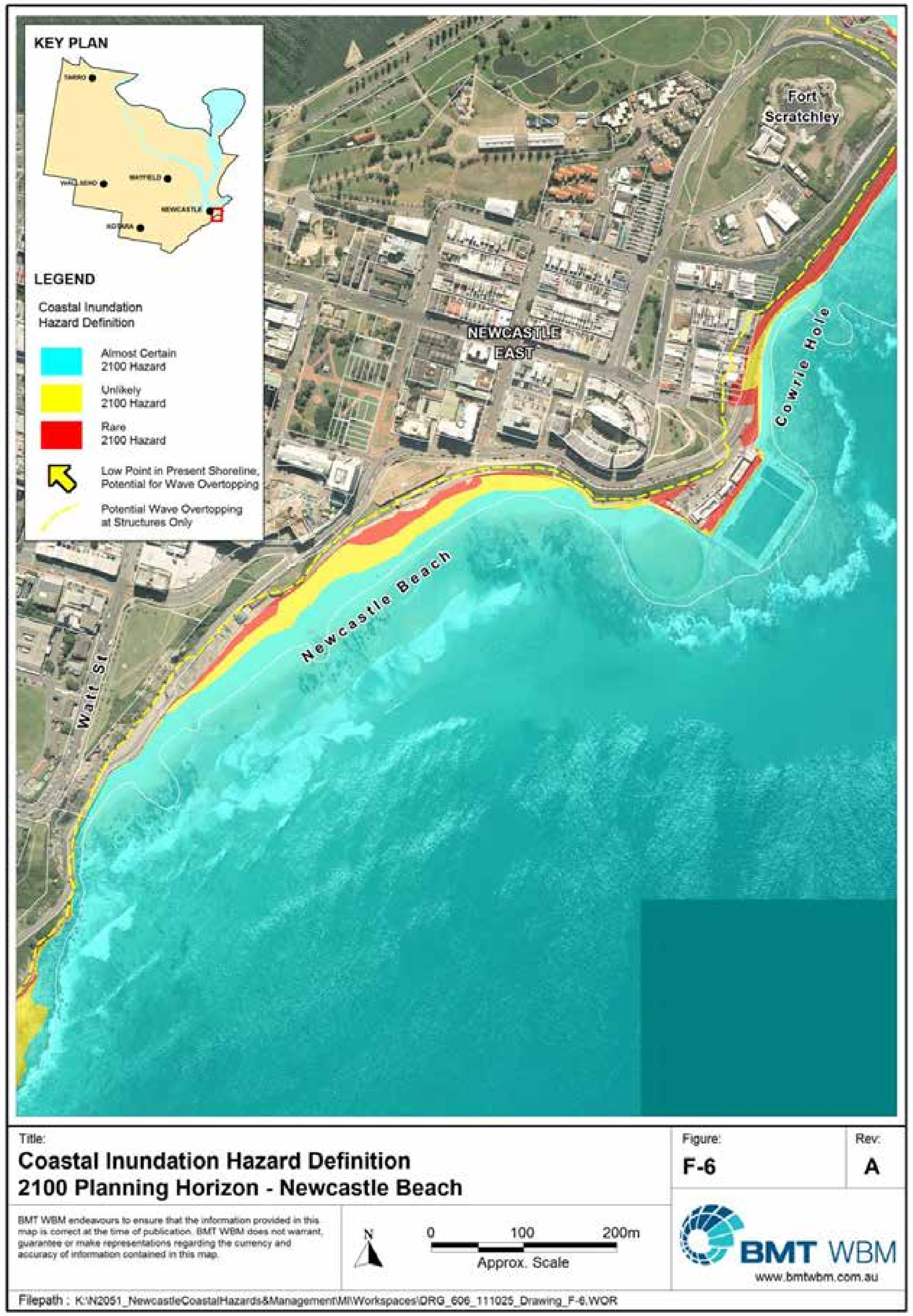
Newcastle Beach (immediate planning horizon)



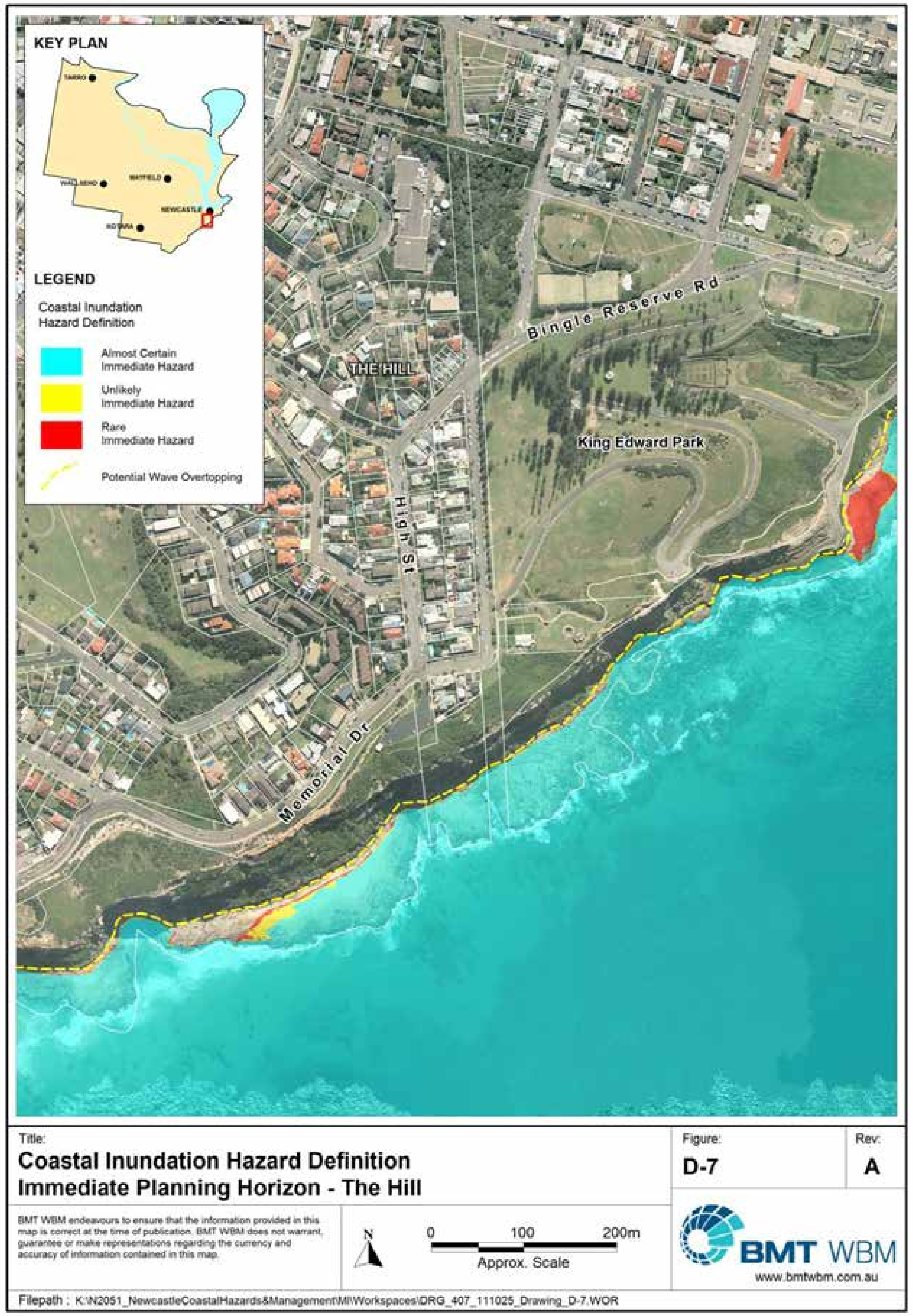
Newcastle Beach (2050 planning horizon)



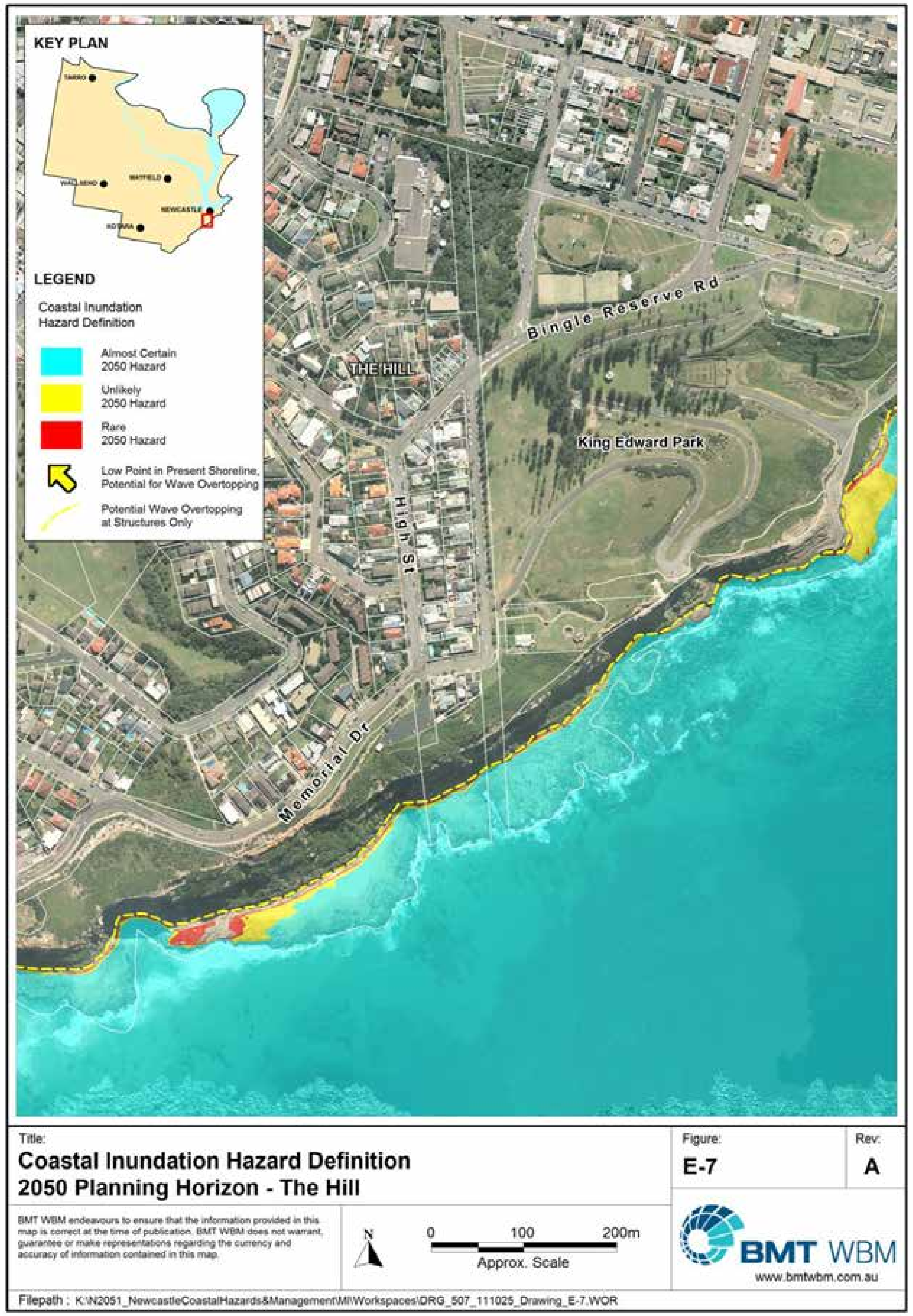
Newcastle Beach (2100 planning horizon)



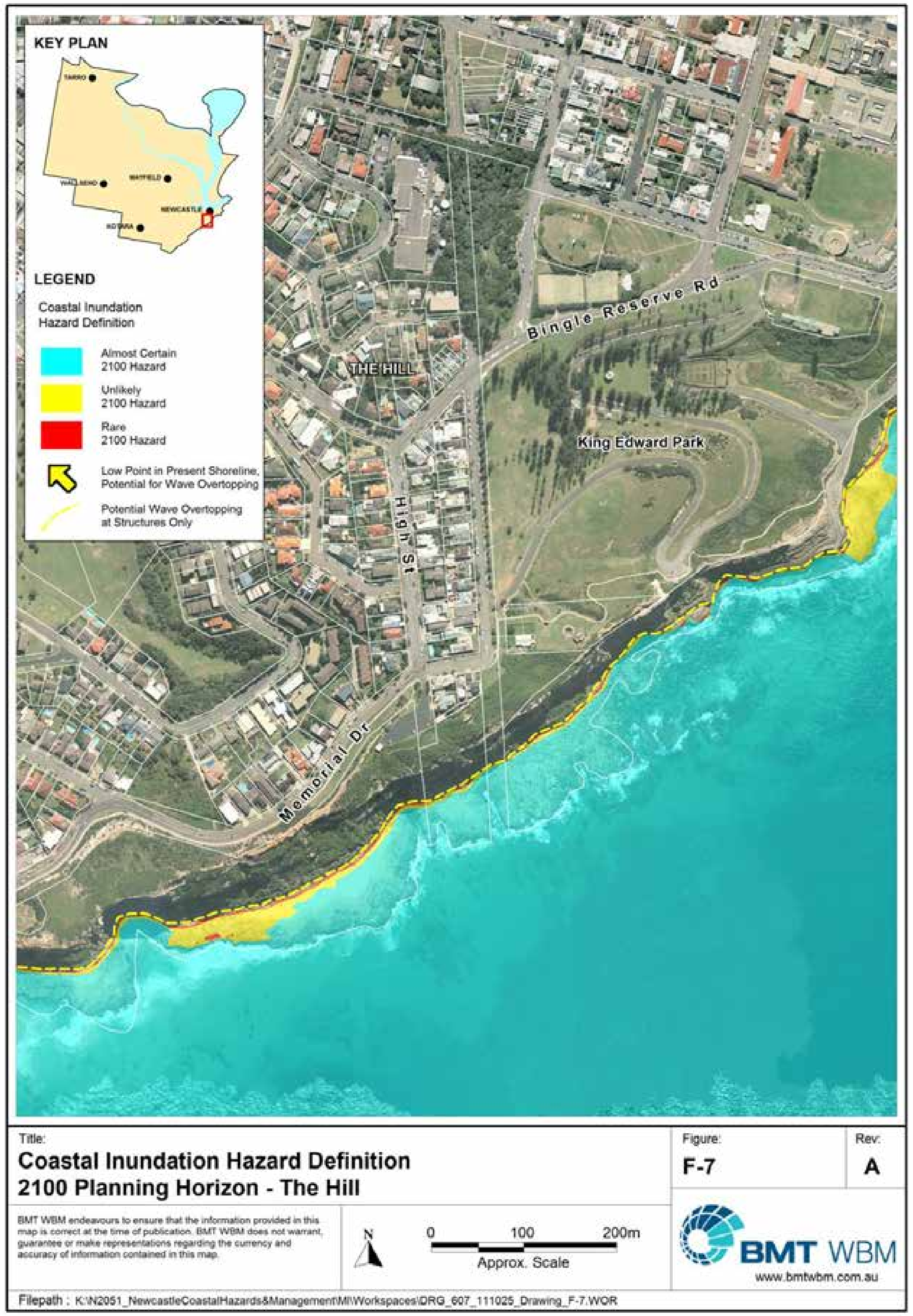
Strzelecki headland (immediate planning horizon)



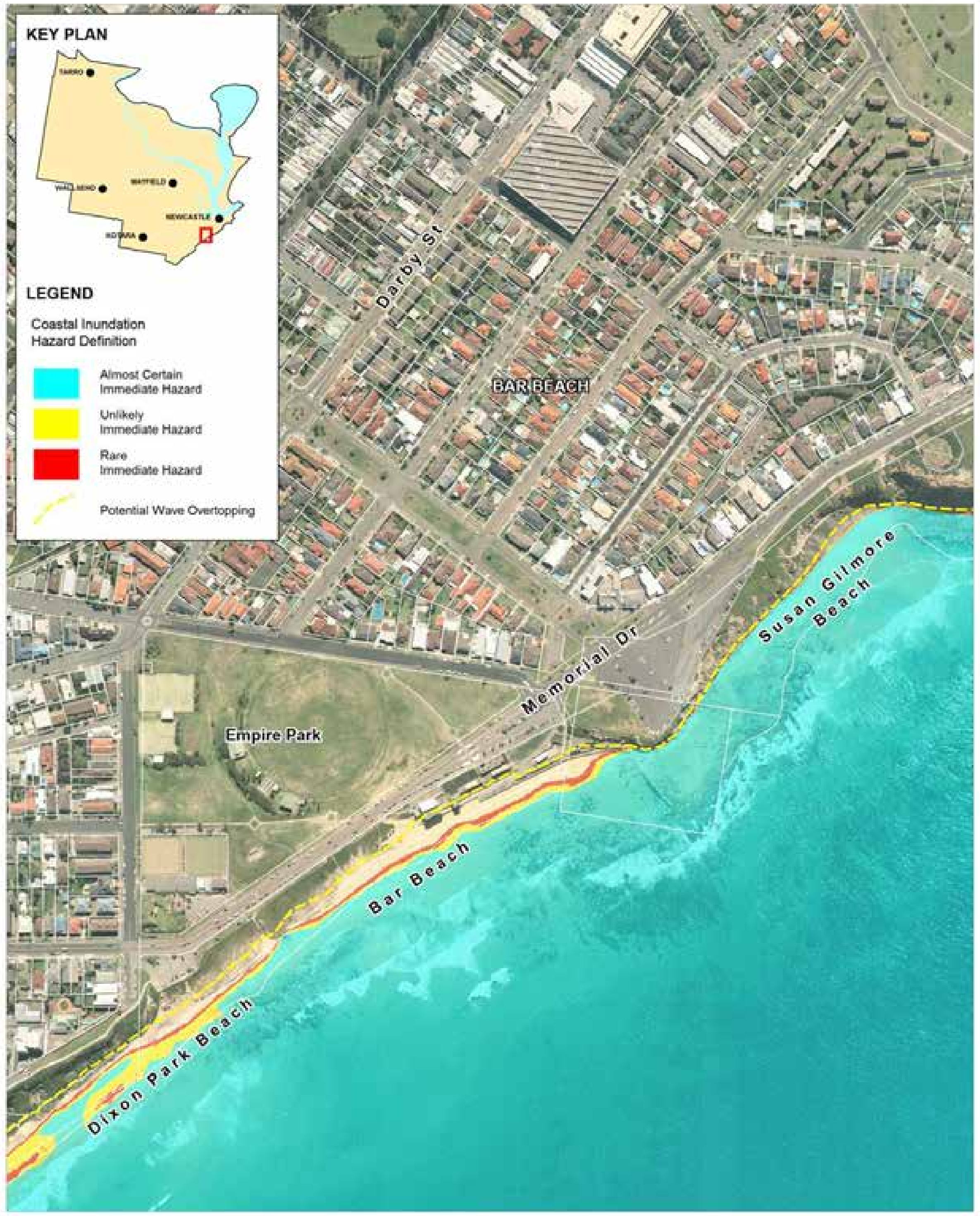
Strzelecki headland (2050 planning horizon)



Strzelecki headland (2100 planning horizon)



Bar Beach (immediate planning horizon)



Title:
**Coastal Inundation Hazard Definition
Immediate Planning Horizon - Bar Beach**

Figure: D-8
Rev: A

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Bar Beach (2050 planning horizon)

Title:
**Coastal Inundation Hazard Definition
2050 Planning Horizon - Bar Beach**

Figure: E-8
Rev: A

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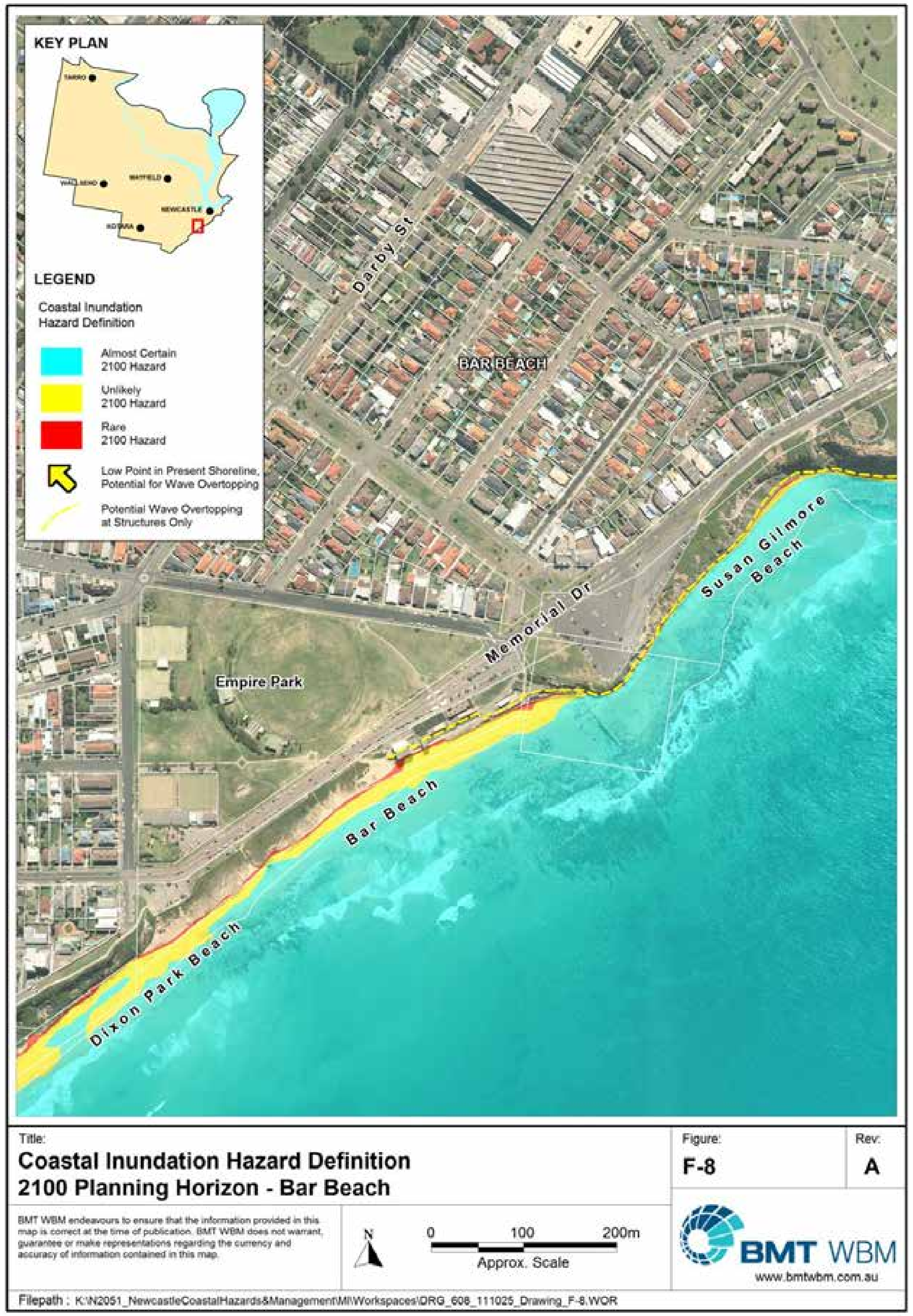
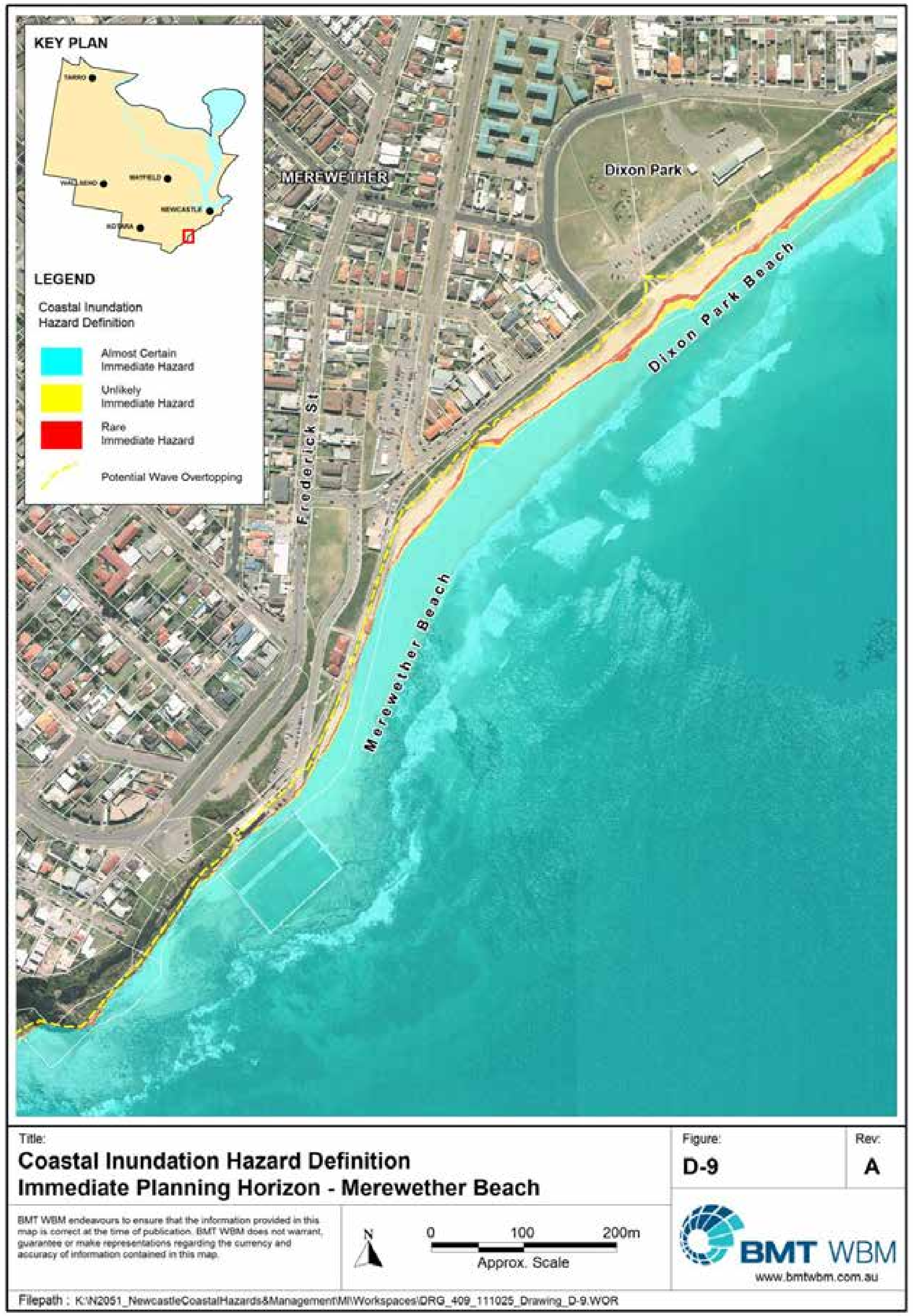
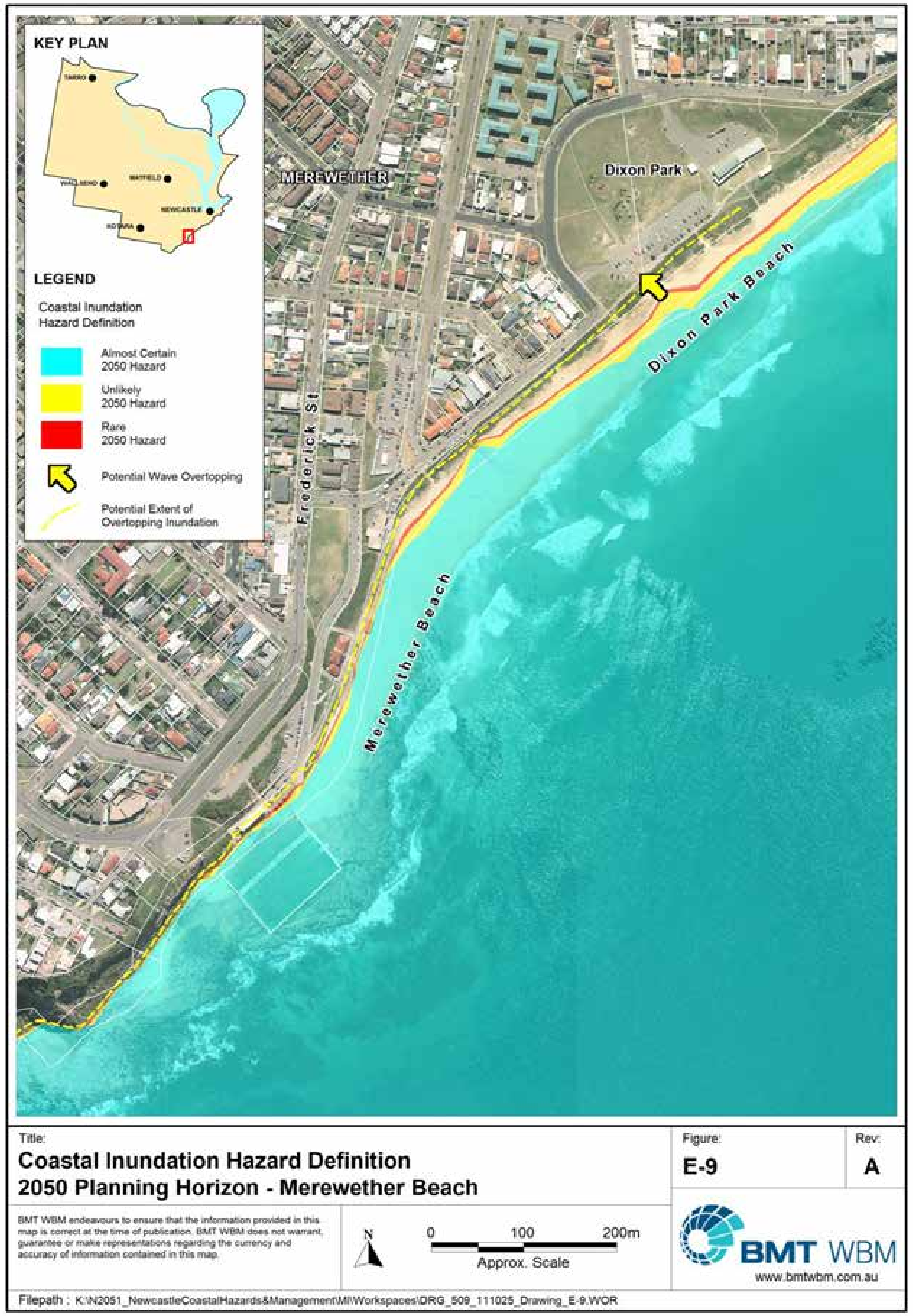
Bar Beach (2100 planning horizon)



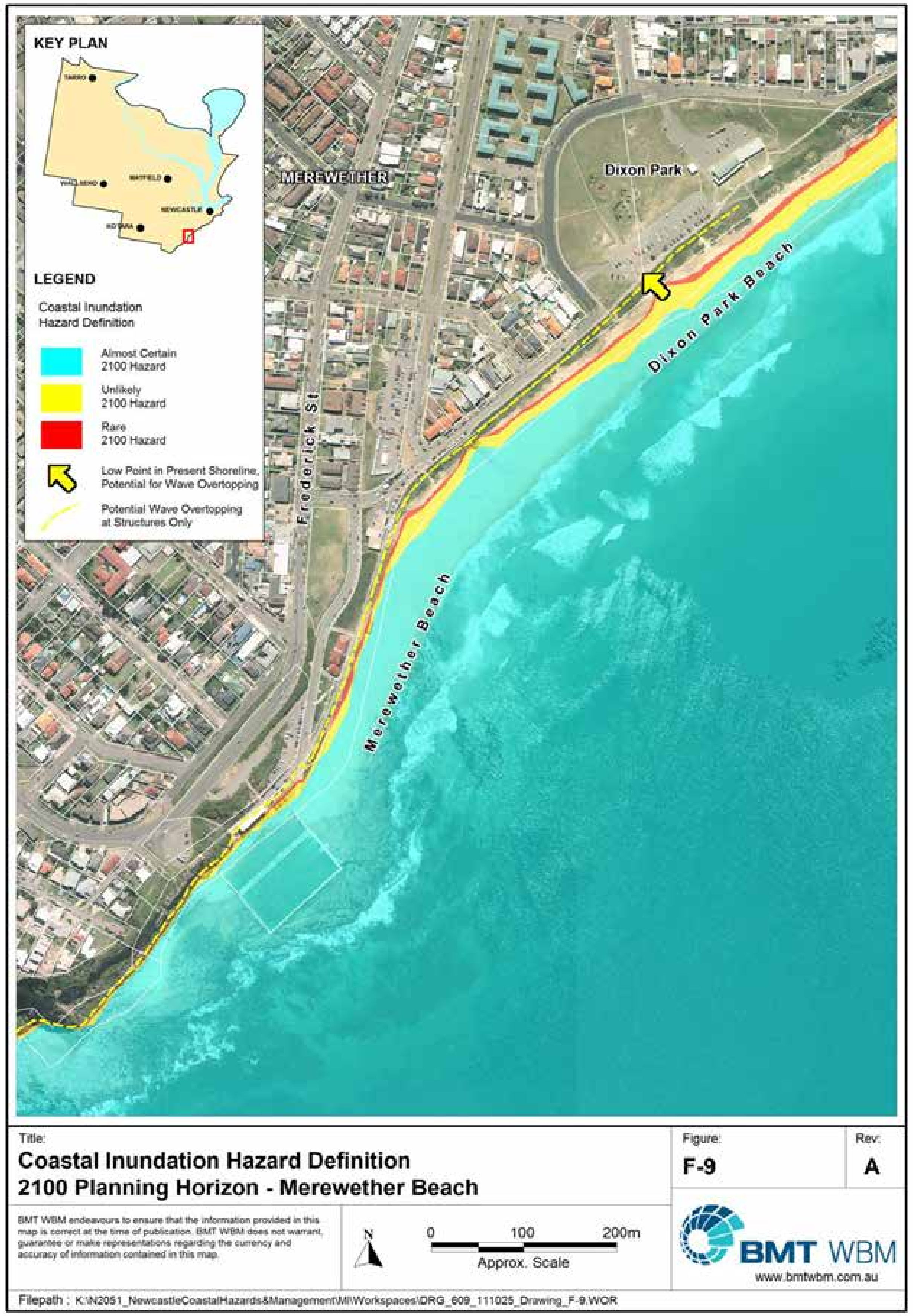
Dixon Park and Merewether Beach (immediate planning horizon)



Dixon Park and Merewether Beach (2050 planning horizon)

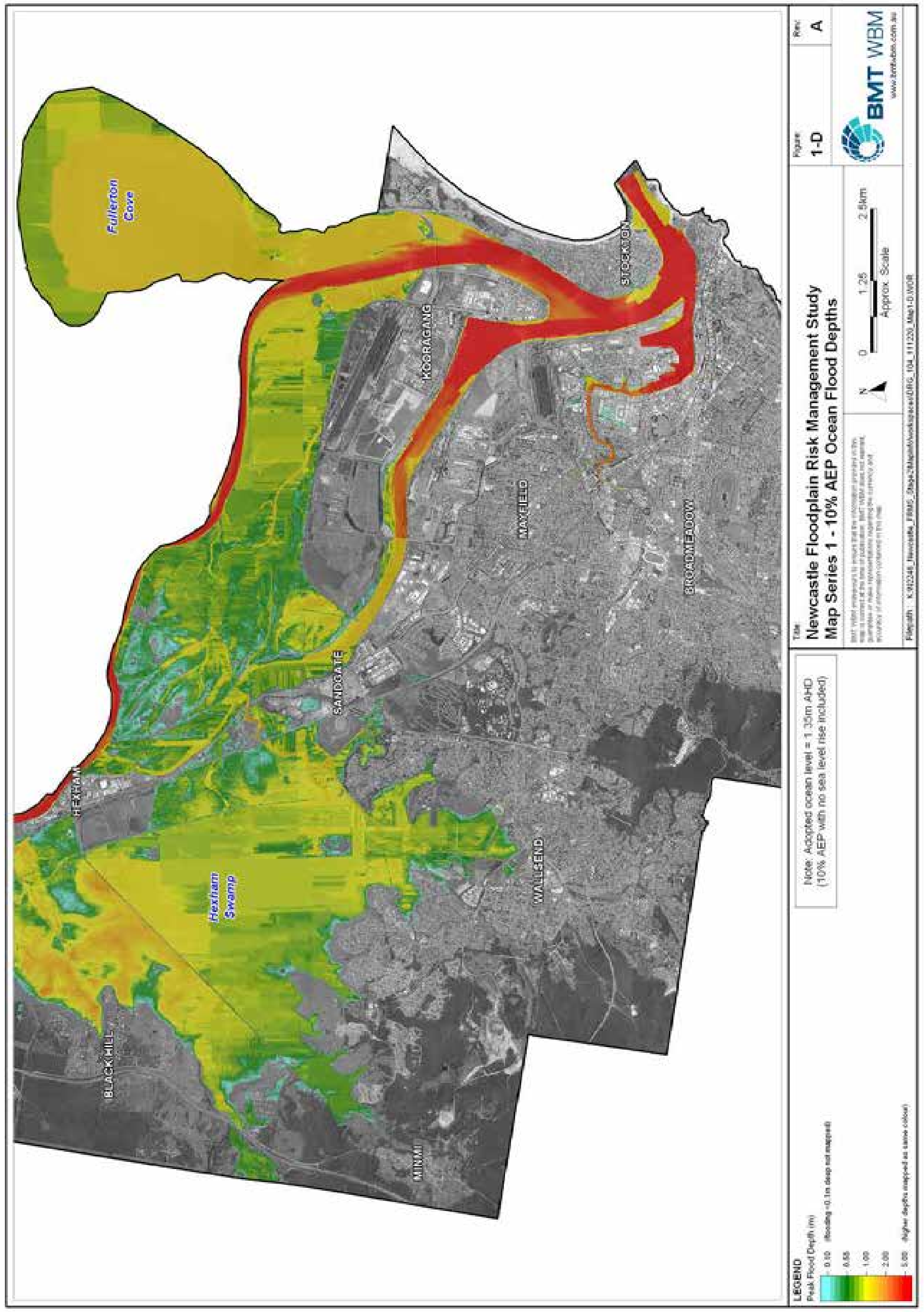


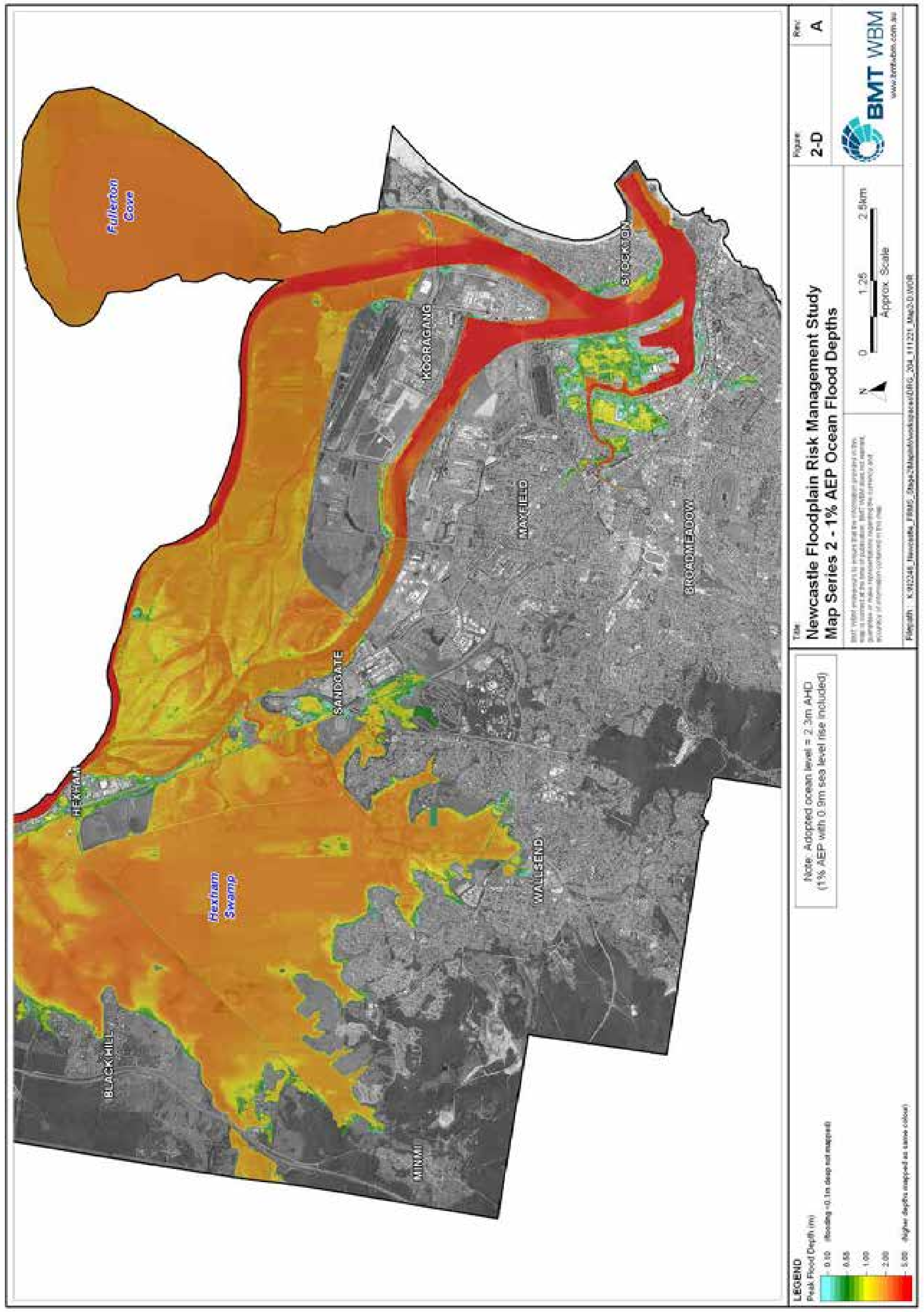
Dixon Park and Merewether Beach (2100 planning horizon)

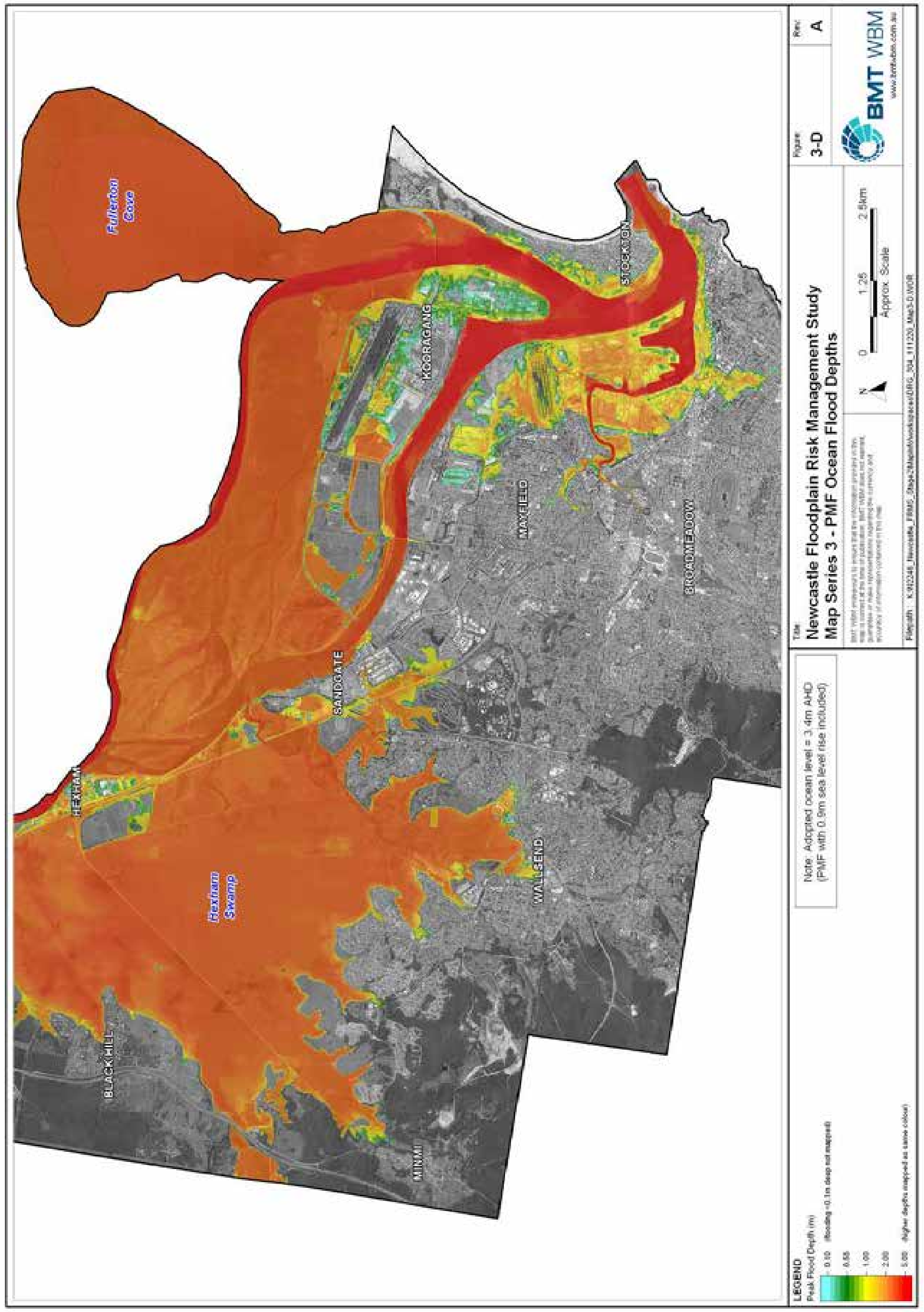


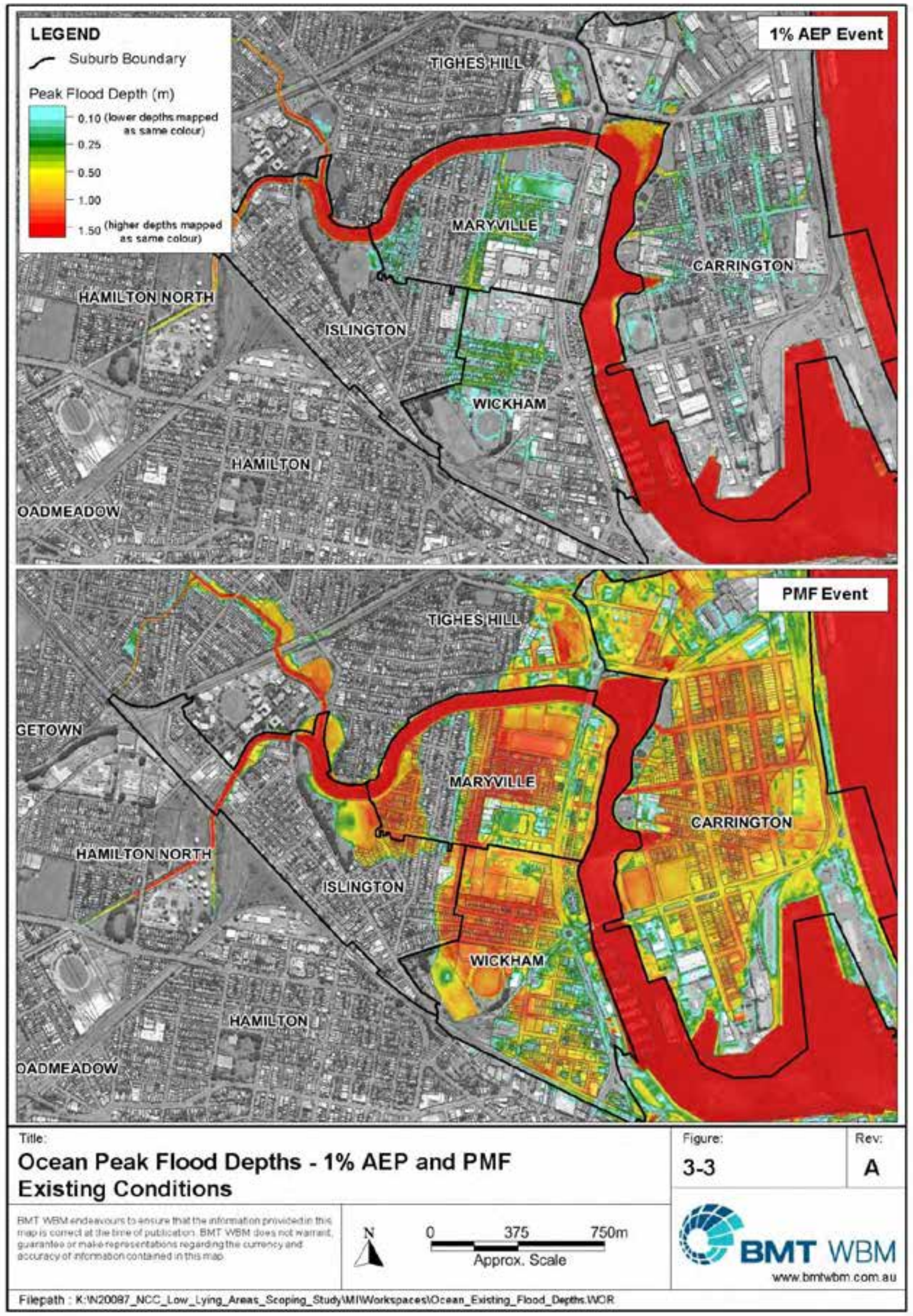
Appendix G

Appendix G: Modelled coastal inundation from Newcastle City-wide Floodplain Risk Management Study and Plan (BMT WBM, 2012) and Strategic Position for the Management of the Low-Lying Areas in Newcastle: Scoping Study (BMT WBM, 2015).






Newcastle Floodplain Risk Management Study
Map Series 3 - PMF Ocean Flood Depths
Figure: 3-D
Rev: A
BMT WBM
Note: Adopted ocean level = 3.4m AHD (PMF with 0.9m sea level rise included)
Fullerton Cove
STOCKTON
KOORAGANG
MAYFIELD
BROADMEADOW
SANDGATE
HEXHAM
Hexham Swamp
WALLSEND
BLACKHILL
MINMI


LEGEND
Suburb Boundary
Peak Flood Depth (m)
0.10 (lower depths mapped as same colour)
0.25
0.50
1.00
1.50 (higher depths mapped as same colour)
1% AEP Event
PMF Event
TIGHES HILL
MARYVILLE
CARRINGTON
HAMILTON NORTH
ISLINGTON
WICKHAM
HAMILTON
OADMEADOW
GETOWN
Title:
Ocean Peak Flood Depths - 1% AEP and PMF Existing Conditions
Figure: 3-3
Rev: A
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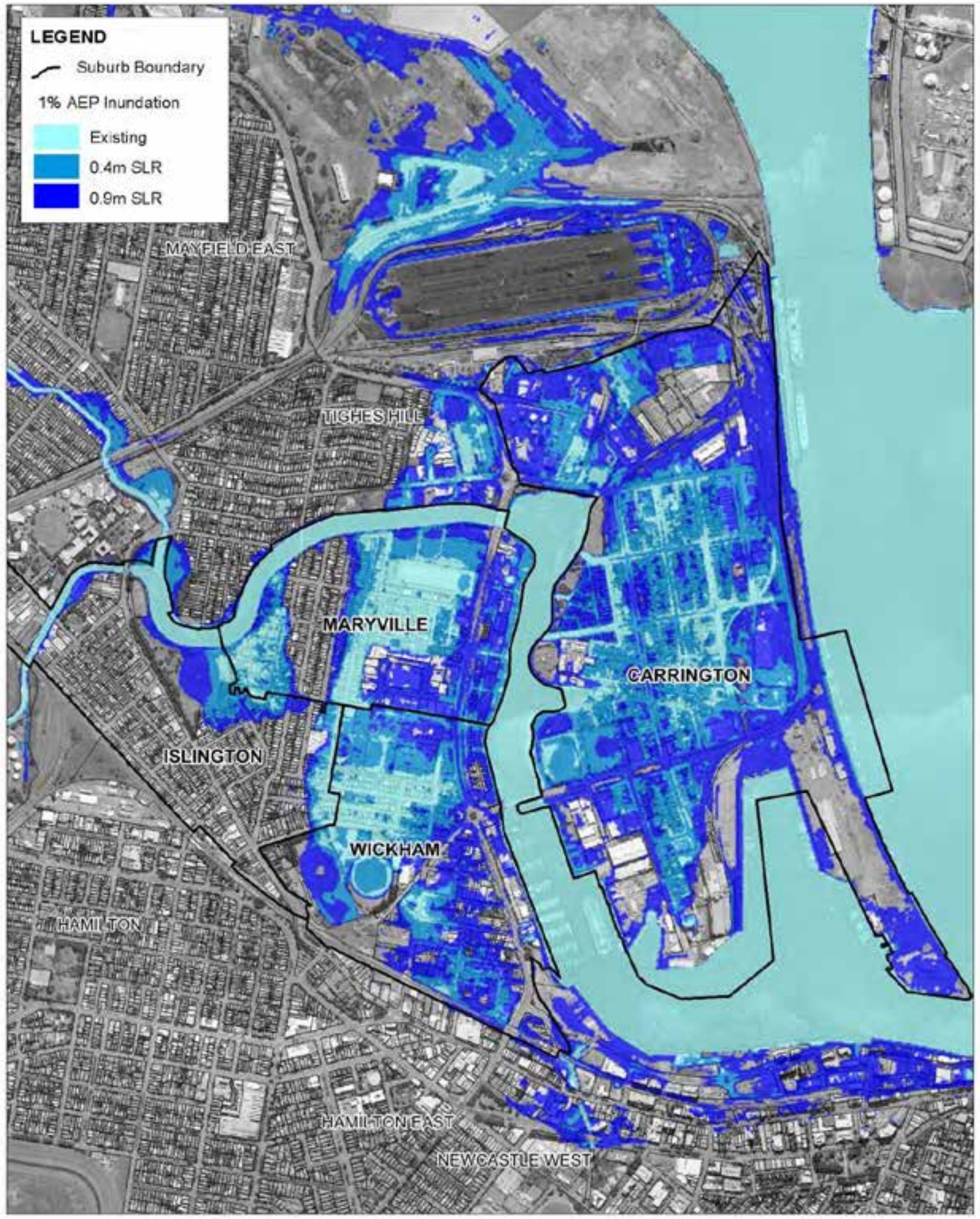
0 375 750m
Approx. Scale
BMT WBM
www.bmtwbm.com.au
Filepath : K:\N20087_NCC_Low_Lying_Areas_Scoping_Study\MI\Workspaces\Ocean_Existing_Flood_Depths.WOR



Title:
1% AEP Ocean Flooding Inundation Extents with Sea Level Rise

Figure: 3-7 | Rev: A

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N
0 375 750m
Approx. Scale

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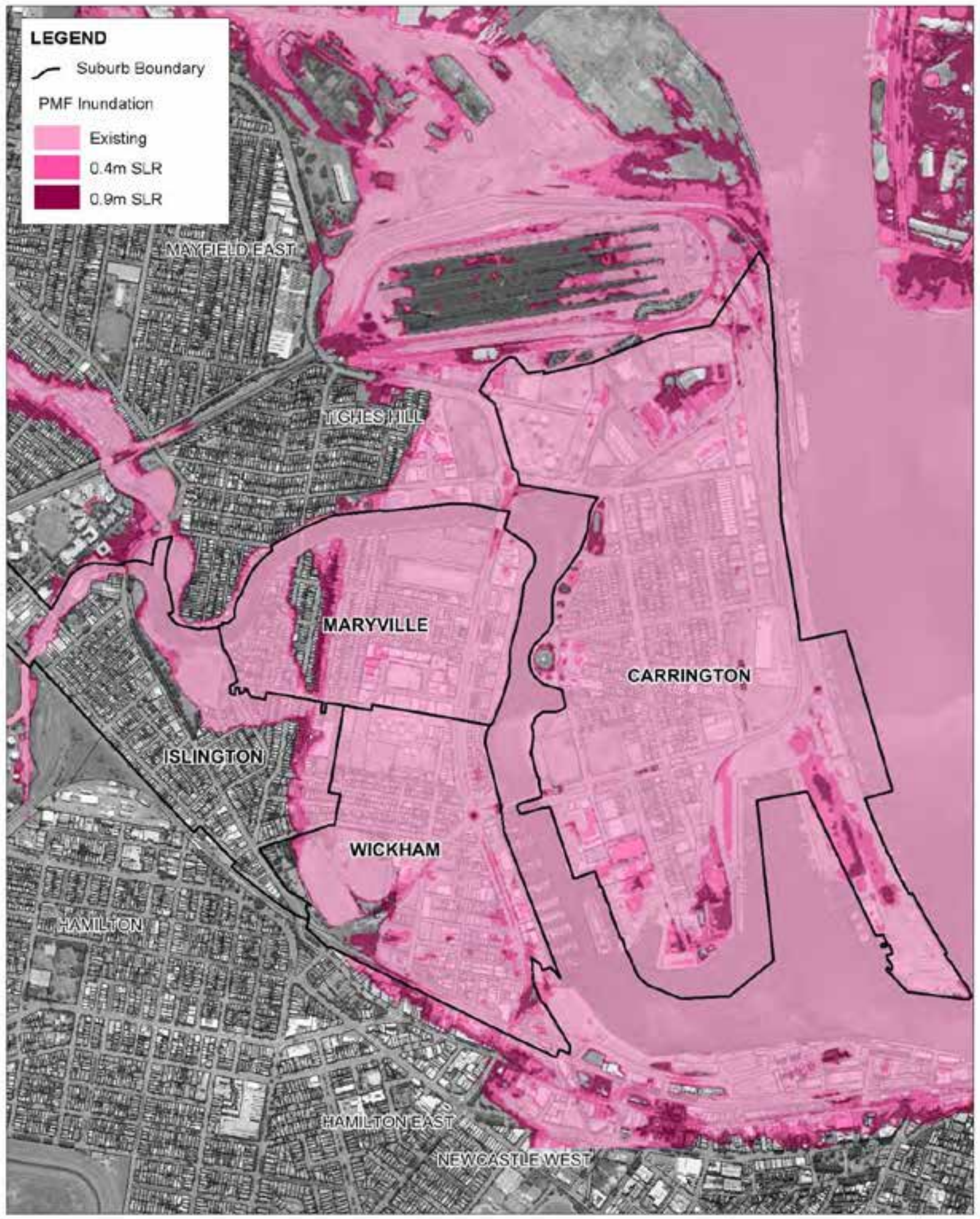
Filepath : K:\N20087_NCC_Low_Lying_Areas_Scoping_Study\MI\Workspaces\1%AEP_Ocean_Inundation.WOR



Title:
PMF Ocean Flooding Inundation Extents with Sea Level Rise

Figure: 3-8 | Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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0 375 750m
Approx. Scale

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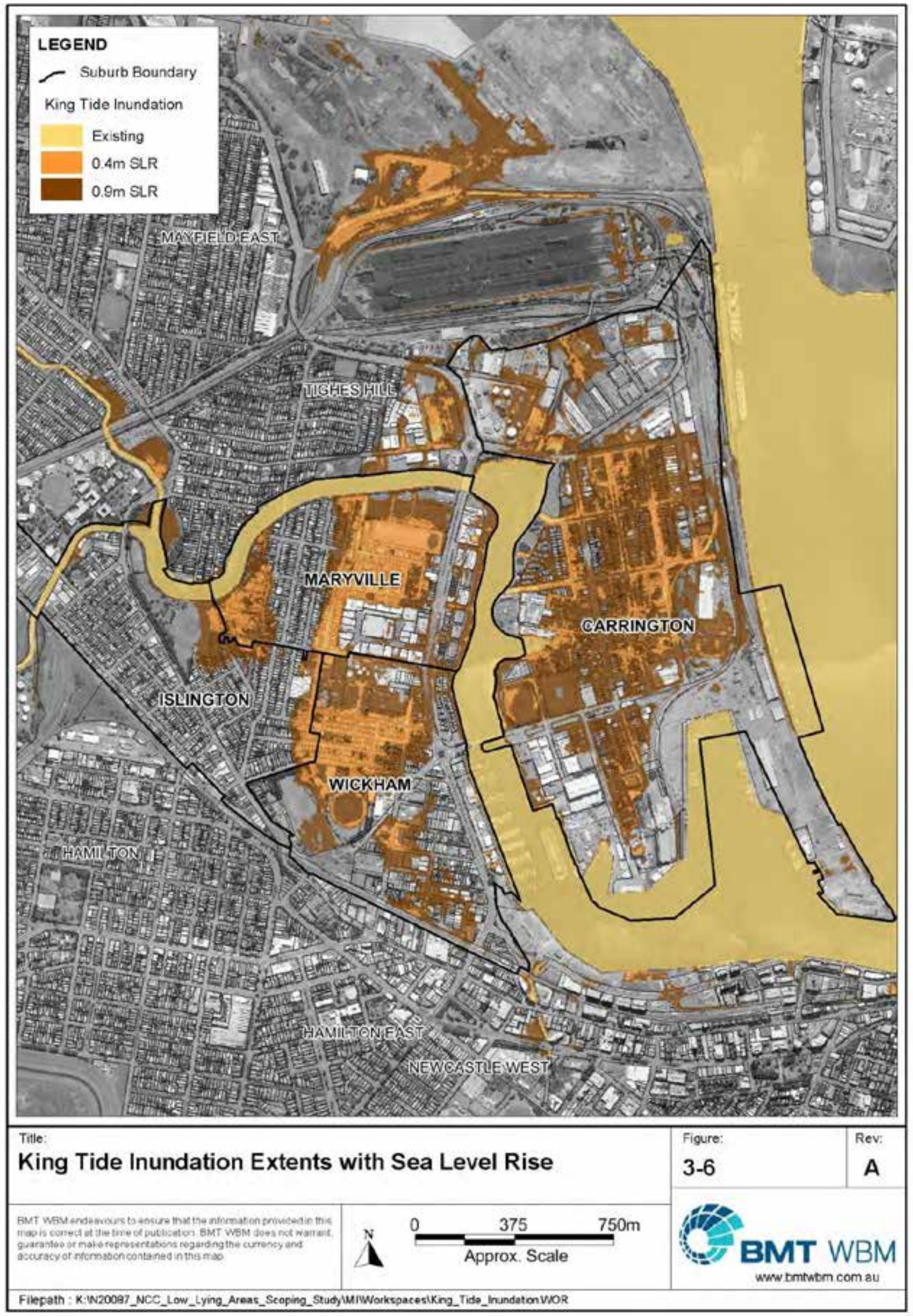
Filepath : K:\N20087_NCC_Low_Lying_Areas_Scoping_Study\MI\Workspaces\PMF_Ocean_Inundation.WOR

Appendix H: Modelled tidal inundation from Strategic Position for the Management of the Low-Lying Areas in Newcastle: Scoping Study (BMT WBM, 2015).



Appendix I 1: Risk assessment for Stockton North

Area: Stockton North
Asset Description: Stockton Centre (342 Fullerton Street)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Moderate	High	Low	Moderate	High	Low	High	High	Low	High	High
Coastal inundation	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Urban development	Low	Moderate	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Invasive species	Low	Moderate	Moderate	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low
Overall risk level	Low	Moderate	High	Low	Low	High	Low	High	High			

Notes: North Stockton and Fern Bay Landuse Strategy will bring potential development into coastal erosion hazard lines after 2100. All development will be landward of unlikely 2100 line.

Area: Stockton North
Asset Description: Fort Wallace (338 Fullerton Street)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	High	High	Low	Moderate	High	Low	High	High	Moderate	High	High
Coastal inundation	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Urban development	Low	Moderate	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Invasive species	Low	Moderate	Moderate	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low
Overall risk level	Low	High	High	Low	Low	High	Low	High	High			

Notes: North Stockton and Fern Bay Landuse Strategy will bring potential development into coastal erosion hazard lines after 2100. All development will be landward of unlikely 2100 line.

Area: Stockton North
Asset Description: Former Hunter Water sewerage treatment facility (330 Fullerton Street)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	Moderate	High	High	High	High	Moderate	High	High	High	High	High
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Urban development	Low	Moderate	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Invasive species	Low	Moderate	Moderate	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low
Water pollution	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Moderate	High	High	High	High	Low	High	High			

Notes: Future assessment based on landfill material remaining at site. North Stockton and Fern Bay Landuse Strategy will be relevant to site.

Area: Stockton North
Asset Description: Dune system between northern end of Corroba Oval and Griffith Avenue

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	High	High	Low	High	High	Moderate	High	High	Moderate	High	High
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Increased community use	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Invasive species	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low
Overall risk level	Moderate	High	High	Low	High	High	Moderate	High	High			

Notes: Inundation based on modelling from BMT WBM 2014.

Area: Stockton North
Asset Description: Corroba Park (2 Meredith Street)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	High	Minimal	High	High	Minimal	High	High	Minimal	High	High
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	High	Minimal	High	High	Minimal	High	High			

Notes: Environment and social risk increases dependant on exposure of former landfill area.

Area: Stockton North
Asset Description: Road network between Meredith street and Griffith Avenue (including utilities) (Eames Avenue, Meredith Street, Beeston Road, Griffiths Avenue)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	High	High	Minimal	High	High	Minimal	High	High
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	High	High	Minimal	High	High			

Notes: Coastal inundation will increase with erosion, but erosion highlighted as issue.

Area: Stockton North
Asset Description: Residential dwellings between Meredith Street and Griffith Avenue

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	High	High	Minimal	High	High	Minimal	High	High
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	High	High	Minimal	High	High			

Notes: Coastal inundation will increase with erosion, but erosion highlighted as issue.

Area: Stockton North
Asset Description: Barrie Street Reserve)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	High	High	Moderate	High	High	Low	Moderate	High	Moderate	High	High
Coastal inundation	Low	Low	Low	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low
Overall risk level	Low	High	High	Low	High	High	Minimal	Low	High			

Notes: Risk from coastal erosion will increase significantly into future.

Area: Stockton North
Asset Description: Former North Stockton Surf Life Saving Club (2 Barrie Crescent)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	High	High	Moderate	High	High	High	High	High	High	High	High
Coastal inundation	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	High	High	Low	High	High	High	High	High			

Notes: Building will be demolished at end of lease. Future planning horizons not applicable, but assessment included as if building remains.

Area: Stockton North
Asset Description: Road network between Griffith Avenue and Stone Street (including utilities) (Griffith Avenue, Booth Street, Stone Street, part Dunbar Street)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	High	Moderate	High	High	Moderate	High	High	Moderate	High	High
Coastal inundation	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	High	Low	High	High	Low	High	High			

Notes: Immediate risks to Stone Street, southern end of Barrie Crescent (where seawall terminates).

Area: Stockton North
Asset Description: Residential dwellings between Griffith Avenue and Stone Street

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Moderate	High	Minimal	Moderate	High	Minimal	Moderate	High
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Moderate	High			

Notes: Coastal inundation will increase with erosion, but erosion highlighted as issue.

Appendix I 2: Risk assessment for Stockton Beach – Central section

Area: Stockton central
Asset Description: Mitchell Street seawall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low
Overall risk level	Low	Low	Low	Low	Low	Low	Low	Low	Low			

Notes: No overtopping noted. On-going cost and maintenance make seawall at moderate risk to community wellbeing. Maintenance in CZMP.

Area: Stockton central
Asset Description: Dune system between memorial Reserve and Mitchell Street seawall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	High	High	Moderate	Moderate	High	Moderate	Moderate	High	Moderate	High	High
Coastal inundation	Moderate	Moderate	High	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	High
Increased community use	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Invasive species	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Moderate	High	High	Low	Moderate	High	Low	Moderate	High			

Area: Stockton central
Asset Description: Mitchell Street roadway between Pembroke Street and Hereford Street

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High	Low	High	High
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Low	High	High	Low	High	High			

Notes: Erosion will continue into future planning horizons. However, impact dependant on potential management solution for beach.

Area: Stockton central
Asset Description: Residential dwellings between Pembroke Street and Hereford Street

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Moderate	High	Minimal	Moderate	High	Minimal	Moderate	High
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Low	High			

Notes: Erosion will continue into future planning horizons. However, impact dependant on potential management solution for beach.

Area: Stockton central
Asset Description: Memorial Reserve (21 Pitt Street)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Low	Moderate	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Low	Minimal	Low	High	Minimal	Low	High			

Notes: Erosion will continue into future planning horizons. However, impact dependant on potential management solution for beach.

Area: Stockton central
Asset Description: Dalby Oval

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Low	Low	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Low	Low	Moderate	Moderate	Moderate	Moderate	Low	Low	Moderate
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	High	Low	Moderate	High			

Notes: Erosion will continue into future planning horizons. However, impact dependant on potential management solution for beach.

Appendix I 3: Risk assessment for Stockton Beach – Southern end

Area: Stockton south
Asset Description: Stockton Surf Life Saving Club seawall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Low	Moderate	Low	Low	Low	Low	Low	Moderate	Low	Low	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Low	Low	Low	Low	Minimal	Minimal	Low			

Area: Stockton south
Asset Description: Stockton Surf Life Saving Club

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Minimal	Low	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Low	Low	Low	Low	Moderate	Moderate	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low			

Notes: Construction of seawall has changed potential risk

Area: Stockton south
Asset Description: Stockton Bowling Club

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Minimal	Minimal	Moderate	Minimal	Minimal	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low			

Area: Stockton south
Asset Description: Stockton surf lifesaving club and pavilion carpark

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal			

Notes: Potential overtopping in future, cost from damage/maintenance.

Area: Stockton south
Asset Description: Surfing pavilion

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Minimal	Low	Low	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low			

Notes: Potential overtopping in future, cost from damage/maintenance.

Area: Stockton south
Asset Description: Lexie's Café

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Minimal	Low	Moderate	Minimal	Low	Moderate
Overall risk level	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low			

Notes: Potential overtopping in future, cost from damage/maintenance.e.

Area: Stockton south
Asset Description: Dune system seaward of Stockton Caravan Park

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	Moderate	High	Minimal	Low	Moderate	Low	Moderate	High	Low	Moderate	High
Coastal inundation	Low	Low	High	Minimal	Low	High	Low	Low	High	Low	Low	High
Increased community use	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	Low	Low	Moderate	Moderate
Invasive species	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	High			

Notes: Overtopping of dune in 2100 horizon.

Area: Stockton south
Asset Description: Stockton caravan Park

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Low	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Coastal inundation	Minimal	Low	Moderate	Minimal	Low	Moderate	Minimal	Low	High	Minimal	Low	High
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Low
Invasive species	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low
Overall risk level	Minimal	Low	High	Low	Low	High	Minimal	Moderate	High			

Notes: Overtopping of dune in 2100 horizon.

Area: Stockton south
Asset Description: King Street roadway near Stockton breakwall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Minimal	Low	Moderate	Minimal	Low	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Minimal	Moderate	Minimal	Minimal	Moderate
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Minimal	Moderate			

Notes: Overtopping of dune in 2100 horizon.

Area: Stockton south
Asset Description: Stockton breakwall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low			

Area: Stockton south
Asset Description: Pitt Street Reserve carpark near Stockton breakwall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Low	High	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Coastal inundation	Minimal	Minimal	Low	Minimal	Minimal	Moderate	Minimal	Minimal	Moderate	Minimal	Minimal	Moderate
Increased community use	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	High	Low	Moderate	High	Minimal	Low	High			

Notes: Overtopping of dune in 2100 horizon.

Area: Stockton south
Asset Description: Little Beach dune system

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	Moderate	High	Low	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate	High
Coastal inundation	Low	Low	Moderate	Minimal	Minimal	Moderate	Minimal	Moderate	Moderate	Minimal	Minimal	Moderate
Increased community use	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Invasive species	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Low	High	Low	Low	Moderate	Low	Moderate	High			

Notes: Overtopping of dune in 2100 horizon

Appendix I 4: Risk assessment for Nobbys Beach

Area: Nobbys
Asset Description: Newcastle southern breakwall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Coastal erosion	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Minimal	Low	Low			

Notes: Increasing risk from overtopping will result in increased maintenance costs. Maintenance by Port of Newcastle

Area: Nobbys
Asset Description: Nobbys Beach dune system

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Low	Moderate	Minimal	Low	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Sand drift	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low
Invasive species	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low
Overall risk level	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low			

Notes: Dune system has minimal risk from coastal hazards.

Area: Nobbys
Asset Description: Nobbys Road

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Low	Moderate	Minimal	Low	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Sand drift	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low			

Notes: Minimal risk from coastal hazards, but will increase in future.

Area: Nobbys
Asset Description: Nobbys Surf Life Saving Club and amenities (35 Nobbys Road)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Low			

Notes: Minimal risk from coastal hazards, but maintenance of seawall in future will result in increased costs.

Area: Nobbys
Asset Description: Shortland Esplanade and Bathers Way walkway (between Nobbys Road and Newcastle Ocean Baths)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	High	Low	Low	High	Low	Low	High
Cliff instability	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Minimal	High			

Notes: Roadway overtops in storm events resulting in inundation. High economic risk into future due to maintenance/retrofit of area.

Area: Nobbys
Asset Description: Nobbys Road and Fort Drive

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low			

Notes: Cliff instability will be reassessed after ten year period.

Area: Nobbys
Asset Description: Fort Scratchley (31 Nobbys Road)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low			

Notes: Increasing economic risk from cliff instability. Risk managed through maintenance program.

Area: Nobbys
Asset Description: Shortland Esplanade residential properties (1-17 Shortland Esplanade)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate	Minimal	Low	Moderate
Overall risk level	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Low	Moderate	Moderate			

Notes: Increasing risk from coastal inundation over Shortland Esplanade.

Area: Nobbys
Asset Description: Residential properties at Fort Drive, Beach Street and Murray Avenue

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low			

Notes: Cliff assessed and considered low risk. Will be reassessed in future.

Area: Nobbys
Asset Description: Rock platform between Nobbys Beach and Newcastle Baths (Cowrie Hole)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Low	Low	Moderate	Minimal	Minimal	Low
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Increased community use	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low
Recreational fishing	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low			

Notes: Platform already has periods of inundation. Management risks considered low.

Area: Nobbys
Asset Description: Nobbys Beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Low	Moderate	Moderate	Moderate	High	Moderate	Moderate	High	Moderate	Moderate	High
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Moderate	Minimal	Low	Moderate
Stormwater erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Climate change	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	Moderate	Moderate	Moderate	Moderate
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Minimal	Low	Low
Overall risk level	Minimal	Low	Moderate	Low	Moderate	High	Low	Low	High			

Notes: Increasing economic risk from cliff instability. Risk managed through maintenance program.

Area: Nobbys
Asset Description: Horseshoe Beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	Moderate	Low	Moderate	Moderate
Stormwater erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Climate change	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	Moderate	Moderate	Moderate	Moderate
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Minimal	Low	Low
Overall risk level	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate	Low	Low	Moderate			

Notes: Subject to coastal inundation due to sea level rise.

Area: Nobbys
Asset Description: Nobbys headland

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Minimal	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Moderate	Moderate	Moderate			

Appendix I 5: Risk assessment for Newcastle Beach

Area: Newcastle
Asset Description: Newcastle ocean baths

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Moderate	Moderate	High	Moderate	Moderate	High	Moderate	Moderate	High
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Low	Moderate	High	Low	Moderate	High			

Notes: Coastal inundation impact on heritage item will increase with sea level rise.

Area: Newcastle
Asset Description: Newcastle ocean baths carpark

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Cliff instability	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low			

Notes: Risk from coastal inundation

Area: Newcastle
Asset Description: Rock platform around Newcastle Baths and canoe Pool

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Coastal inundation	Low	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Increased community use	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low
Recreational fishing	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low			

Notes: Coastal inundation will increase environmental risk due to loss of habitat of shorebirds.

Area: Newcastle
Asset Description: Canoe Pool

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Minimal	Low	Low	Low	Low	Moderate	Moderate	Low	Low	Low
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Increased community use	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low
Overall risk level	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low			

Notes: Coastal inundation will affect social use of canoe pool into the future.

Area: Newcastle
Asset Description: Newcastle Beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	Moderate	Moderate	Low	Low	Low	Moderate	Moderate	High	Moderate	Moderate	High
Coastal inundation	Moderate	Moderate	Moderate	Minimal	Low	Low	Low	Moderate	Moderate	Low	Moderate	Moderate
Cliff instability	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Stormwater erosion	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Climate change	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	Moderate	Moderate	Moderate	Moderate
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Low
Overall risk level	Moderate	Moderate	Moderate	Minimal	Moderate	Moderate	Low	Moderate	High			

Notes: Increasing risk of beach erosion and coastal inundation due to climate change. High social risk from loss of beach asset.

Area: Newcastle
Asset Description: Newcastle surf lifesaving club facility

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Minimal	Moderate	Moderate	Low	Low	Moderate
Cliff instability	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Moderate	Moderate			

Notes: Increasing economic and social risk from beach erosion and coastal inundation. Economic cost of maintenance of building.

Area: Newcastle
Asset Description: Bathers Way promenade (between Ocean Baths and King Edward Park)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Low	Low	Low	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Minimal	Low	Minimal	Minimal	Low
Cliff instability	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Low	Low	Low			

Notes: Some overtopping predicted in 2100 planning horizon.

Area: Newcastle
Asset Description: Newcastle south skate park and amenities

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Cliff instability	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Minimal	Low	Minimal	Minimal	Low
Overall risk level	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Low			

Notes: Some overtopping predicted in 2100 planning horizon.

Area: Newcastle
Asset Description: Shortland Esplanade between Newcastle Baths and Watt Street

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Coastal instability	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Sand drift	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Moderate	Moderate	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Moderate			

Notes: Increased social risk from overcrowding, inability to access beach.

Area: Newcastle
Asset Description: Slope below Shortland Esplanade

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Coastal instability	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low			

Notes: Some overtopping predicted in 2100 planning horizon.

Area: Newcastle
Asset Description: Coastal cliffline at southern end of beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Coastal instability	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Low			

Notes: Some overtopping predicted in 2100 planning horizon.

Appendix I 6: Risk assessment for Strzelecki headland

Area: Strzelecki headland
Asset Description: King Edward Park

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Climate change	Minimal	Minimal	Low	Low	Low	Moderate	Minimal	Minimal	Low	Minimal	Minimal	Low
Increased community use	Low	Moderate	Moderate	Minimal	Low	Moderate	Minimal	Minimal	Low	Minimal	Low	Moderate
Invasive species	Low	Low	Low	Low	Low	Moderate	Minimal	Minimal	Low	Low	Low	Low
Overall risk level	Low	Low	Low	Low	Low	Moderate	Minimal	Minimal	Low			

Notes: Increased economic risk from increased use of recreation facility. Risk from increased invasive species and associated treatment.

Area: Strzelecki headland
Asset Description: Coastal cliffline from King Edward Park to Susan Gilmore Beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Low	Minimal	Minimal	Low	Low	Low	Low	Minimal	Minimal	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Invasive species	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low			

Notes: Cliff instability a low risk and low community use of area below cliffline.

Area: Strzelecki headland
Asset Description: Rock platform below King Edward Park (incl Bogie Hole)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Low	Low	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Low	Low	Moderate	Low	Moderate	Moderate	Low	Low	Moderate	Low	Low	Moderate
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Increased community use	Low	Low	Low	Minimal	Minimal	Low	Low	Low	Moderate	Low	Low	Low
Recreational fishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Low	Low	Low	Minimal	Moderate	Moderate	Low	Low	Moderate			

Notes: Increasing risk from maintaining access to Bogie Hole. Access may become more dangerous over time.

Area: Strzelecki headland
Asset Description: Rock platform below Memorial Drive

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Recreational fishing	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal			

Notes: Low use of platform by public. Minimal management of area.

Area: Strzelecki headland
Asset Description: ANZAC Memorial walkway

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low			

Notes: Cliff instability assessed as part of maintenance program. Potential social risk from increased use of facility.

Area: Strzelecki headland
Asset Description: Shepherds Hill Heritage site

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Low	Low	Low	Low	Low	Low	Low	Low			

Area: Strzelecki headland
Asset Description: Memorial walkway carpark

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low			

Notes: Increasing social risk from increasing use of carpark area.

Area: Strzelecki headland
Asset Description: Residential houses on Nesca Parade and Fenton Avenue

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low			

Notes: Cliff instability area, but low risk

Area: Strzelecki headland
Asset Description: Memorial Drive

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low			

Notes: Cliff instability area, but low risk

Area: Strzelecki headland
Asset Description: Susan Gilmore Beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Coastal erosion	Low	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low
Coastal inundation	Low	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Low
Overall risk level	Low	Low	Moderate	Minimal	Minimal	Minimal	Minimal	Low	Low			

Notes: Risk from coastal erosion increasing, but low level community use of beach.

Area: Strzelecki headland
Asset Description: Coastal heathland (including Themeda grasslands)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Climate change	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Increased community use	Low	Low	Moderate	Low	Low	Moderate	Minimal	Minimal	Low	Low	Low	Moderate
Invasive species	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Low	Low	Low	Low
Overall risk level	Minimal	Low	Low	Low	Low	Low	Minimal	Minimal	Low			

Notes: Environmental risk from increased use of the area by the community. Increased economic risk to maintain habitat quality.

Appendix I 7: Risk assessment for Bar Beach

Area: Bar Beach
Asset Description: Bar Beach carpark

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low			

Notes: Increased economic risk from cliff instability. Increased use may by community may result in parking issues/time restrictions.

Area: Bar Beach
Asset Description: Coastal cliffline below Bar Beach carpark

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Cliff instability	Minimal	Low	Moderate	Minimal	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Low	Moderate
Overall risk level	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Minimal	Minimal			

Notes: Increased future risk from cliff instability. Currently managed by CN.

Area: Bar Beach
Asset Description: Rock platform between Susan Gilmore and Bar Beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Low	Low	Low	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Low	Low	Low
Cliff instability	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low
Water pollution	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low
Recreational fishing	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low			

Notes: Increasing risk from coastal inundation and habitat modification. Coastal inundation may impact community use of Susan Gilmore beach.

Area: Bar Beach
Asset Description: Bar Beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate	High
Coastal inundation	Minimal	Minimal	Low	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate
Stormwater erosion	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Climate change	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	Moderate	Moderate	Moderate	Moderate
Increased community use	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate
Overall risk level	Low	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	High			

Notes: Moderate risk from beach erosion and reduced amenity of beach area. Risk to beach increases over time.

Area: Bar Beach
Asset Description: Cooks Hill Surf Life Saving Club and facilities

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Minimal	Low	Low	Minimal	Low	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	High	Minimal	Low	Low	Minimal	Low	High
Cliff instability	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Minimal	Minimal			

Notes: Increased risk from beach erosion and coastal inundation/overtopping. Economic risk from maintenance of seawall and facilities.

Area: Bar Beach
Asset Description: Bathers Way viewing platform

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Low	Moderate	Minimal	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Low	Moderate
Overall risk level	Minimal	Low	Moderate	Minimal	Moderate	Moderate	Minimal	Minimal	Minimal			

Area: Bar Beach
Asset Description: Bar Beach kiosk and public area

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Minimal	Low	Low	Minimal	Low	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	High	Minimal	Low	Low	Minimal	Low	High
Cliff instability	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Sand drift	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Minimal	Minimal			

Notes: Increased risk from beach erosion and coastal inundation/overtopping.

Area: Bar Beach
Asset Description: Bar Beach dune system (southern end of beach)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Moderate	High	Moderate	Moderate	High	Low	Low	Moderate	Low	Moderate	High
Coastal inundation	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Sand drift	Minimal	Low	Low	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low
Climate change	Minimal	Low	Moderate	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Low	Low
Invasive species	Low	Moderate	Moderate	Low	Moderate	Moderate	Minimal	Low	Low	Low	Moderate	Moderate
Increased community use	Low	Low	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Moderate	High	Low	Moderate	High	Minimal	Low	Low			

Notes: Increasing risk from beach erosion. Dune restoration to be undertaken in near future.

Area: Bar Beach
Asset Description: Bathers Way walkway

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Low	High	Minimal	Low	High
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Cliff instability	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Sand drift	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Moderate	Moderate	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Low	High			

Notes: Increased risk from beach erosion due to loss of dune system above.

Area: Bar Beach
Asset Description: Memorial Drive

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	High	Minimal	Minimal	High	Minimal	Minimal	High
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Sand drift	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	High	Minimal	Minimal	High			

Notes: Increased risk from beach erosion due to loss of dune system above.

Area: Bar Beach
Asset Description: Coastal cliffline below Kilgour Avenue

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Low	Moderate	Minimal	Minimal	Moderate
Cliff instability	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Overall risk level	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Moderate			

Notes: Risk from cliff instability, but currently managed. Increased risk due to access to bottom of cliff by public.

Appendix I 8: Risk assessment for Dixon Park Beach

Area: Dixon Park
Asset Description: Dixon Park Beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate	High
Coastal inundation	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	Moderate	Low	Moderate	Moderate
Stormwater erosion	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Climate change	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	Moderate	Moderate	Moderate	Moderate
Increased community use	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate
Overall risk level	Low	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	High			

Notes: Increasing risk of beach erosion and coastal inundation into the future.

Area: Dixon Park
Asset Description: Dixon Park dune system (between Berner Street and Ocean Street)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Moderate	Minimal	Minimal	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Invasive species	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Moderate			

Notes: Beach erosion will increase with sea level rise. Impacts on dune system and beach access.

Area: Dixon Park
Asset Description: Bathers Way walkway (between Berner Street and Kilgour Avenue)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Cliff instability	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Moderate	Moderate	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low			

Area: Dixon Park
Asset Description: Dixon Park carpark

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Minimal	Moderate	Minimal	Minimal	Moderate
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Low	Moderate			

Area: Dixon Park
Asset Description: Dixon Park seawall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Moderate	Moderate	Moderate
Coastal inundation	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Climate change	Minimal	Low	Low	Low	Low	Moderate	Minimal	Low	Low	Minimal	Low	Low
Overall risk level	Low	Low	Low	Low	Low	Moderate	Minimal	Low	Low			

Notes: Risk from beach erosion and exposure of seawall. Seawall requires monitoring.

Appendix I 9: Risk assessment for Merewether Beach

Area: Merewether
Asset Description: Merewether Beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate	High	Moderate	Moderate	High
Coastal inundation	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	Moderate	Low	Moderate	Moderate
Stormwater erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Climate change	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Low	Moderate	Moderate	Moderate	Moderate
Increased community use	Low	Low	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate
Overall risk level	Low	Moderate	Moderate	Low	Moderate	High	Low	Moderate	High			

Notes: Social impact on loss of beach significant. Erosion and inundation likely to increase due to changing climatic conditions.

Area: Merewether
Asset Description: Merewether seawall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	Moderate	Moderate	Moderate	Moderate	High	Low	Low	Low	Moderate	Moderate	Moderate
Coastal inundation	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Climate change	Minimal	Low	Low	Low	Low	Moderate	Minimal	Low	Low	Minimal	Low	Low
Overall risk level	Low	Low	Low	Low	Low	High	Minimal	Low	Low			

Notes: Impacts will only occur when seawall is exposed. Increased exposure associated with increased storm events. .

Area: Merewether
Asset Description: Merewether Beach dune system (between Berner Street and Watkins Street)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate
Coastal inundation	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal			

Notes: Dune system will be impacted by increasing levels of erosion and inundation.

Area: Merewether
Asset Description: Bathers Way walkway (between Berner Street and Watkins Street)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Sand drift	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Moderate	Moderate	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low			

Notes: No overtopping noted

Area: Merewether
Asset Description: Merewether Surf Life Saving Club (1 John Parade)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Cliff instability	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Sand drift	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal			

Notes: Some risk from slope west of building

Area: Merewether
Asset Description: Surf House (5 Henderson Parade)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Minimal	Minimal	Moderate	Minimal	Minimal	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Cliff instability	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Sand drift	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low			

Area: Merewether
Asset Description: Henderson Parade

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Cliff instability	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low			

Area: Merewether
Asset Description: Merewether Ocean Baths

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	High	Low	Moderate	High	Low	Moderate	High
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Sand drift	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Low	Low	High	Low	Low	High			

Notes: Coastal inundation impact on heritage item will increase with sea level rise.

Area: Merewether
Asset Description: Merewether Ocean Baths rock platform

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Low	Moderate	Moderate	Minimal	Minimal	Moderate
Coastal inundation	Minimal	Low	Low	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Low
Cliff instability	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Water pollution	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Recreational fishing	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low			

Notes: Loss of habitat will occur with sea level rise

Area: Merewether
Asset Description: Merewether Ocean Baths amenities building

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Coastal inundation	Minimal	Minimal	Minimal	Low	Low	Moderate	Minimal	Moderate	Moderate	Minimal	Low	Moderate
Cliff instability	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Low	Low			

Notes: Risk from coastal inundation.

Area: Merewether
Asset Description: Merewether Ocean Baths carparks

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Cliff instability	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low			

Area: Merewether
Asset Description: Frederick Street

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Sand drift	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low			

Area: Merewether
Asset Description: Residential properties at Robinson Street, Lloyd Street and Hickson Street

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Overall risk level	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate			

Notes: Increased risk from cliff instability. Economic risk from loss of property etc.

Area: Merewether
Asset Description: Promenade between Watkins Street and Merewether Ocean Baths

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal inundation	Minimal	Minimal	Minimal	Low	Low	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Low
Cliff instability	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Sand drift	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Increased community use	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low			

Notes: Seawall recently repaired.

Area: Merewether
Asset Description: Coastal cliffline below Lloyd Street and Hickson Street

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Cliff instability	Low	Low	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Overall risk level	Minimal	Minimal	Low	Low	Moderate	Moderate	Low	Moderate	Moderate			

Notes: Risk will increase as sea level rise reaches cliffline base.

Appendix I 10: Risk assessment for Glenrock State Conservation Area

Area: Glenrock
Asset Description: Rock platform between Merewether Beach and Burwood Beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Coastal inundation	Low	Low	Moderate	Minimal	Minimal	Low	Low	Low	Moderate	Low	Low	Moderate
Cliff instability	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Low	Low	Low	Low
Water pollution	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Increased community use	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low
Recreational fishing	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Climate change	Low	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Low			

Notes: Coastal inundation will reduce access to Glenrock SCA from Merewether due to sea level rise.

Area: Glenrock
Asset Description: Northern end of Reserve (incl beach and forest area)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Moderate	Moderate	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate
Coastal inundation	Minimal	Minimal	Moderate	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Moderate
Cliff instability	Low	Low	Low	Low	Low	Low	Minimal	Minimal	Low	Low	Low	Low
Climate change	Minimal	Low	Moderate	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Low	Low	Moderate	Low	Low	Moderate	Moderate	Moderate	Moderate	Low	Low	Moderate
Invasive species	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Moderate	Moderate	Low	Low	Low	Low	Moderate	Moderate			

Notes: Landslide risk at northern end of reserve. Assessed in RCA report (2013) but requires review every ten years.

Area: Glenrock
Asset Description: Hunter Water sewerage outfall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Low
Overall risk level	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate			

Area: Glenrock
Asset Description: Burwood Beach and dune system

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Low
Coastal inundation	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low
Climate change	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Invasive species	Low	Moderate	Moderate	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low
Overall risk level	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal			

Area: Glenrock
Asset Description: Glenrock Lagoon

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Coastal inundation	Low	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Moderate
Coastal entrance instability	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Water pollution	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Climate change	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Low	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Low			

Notes: Potential changes to entrance and habitat surrounding lagoon due to sea level rise (2100 horizon).

Area: Glenrock
Asset Description: Murdering Gully riparian entrance to beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Coastal inundation	Low	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Moderate	Low	Low	Moderate
Coastal entrance instability	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Water pollution	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Climate change	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low
Overall risk level	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low			

Notes: Potential changes to entrance and habitat surrounding riparian area due to sea level rise (2100 horizon).

Area: Glenrock
Asset Description: Remains of Glenrock Railway (Local Heritage item)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Moderate	Low	Low	Low
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Moderate	Minimal	Low	Low
Cliff instability	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Moderate			

Notes: Threat to item from coastal erosion and inundation in future.

Area: Glenrock
Asset Description: Burwood Beach

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal erosion	Low	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Coastal inundation	Low	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Increased community use	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Water pollution	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Low	Low	Moderate	Minimal	Minimal	Minimal	Low	Low	Low			

Notes: Moderate risk from beach erosion and inundation. Low usage of beach by public.

Appendix I 11: Risk assessment for Newcastle City Centre

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Horseshoe Beach carpark

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Minimal	Low	Minimal	Minimal	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Sand drift	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low			

Notes: Coastal inundation based on oceanic flooding from BMT WBM (2012). Tidal inundation based on results from BMT WBM (2015).

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Horseshoe Beach riverwall/training wall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Low	Moderate	Minimal	Minimal	Low	Minimal	Minimal	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Climate change	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low			

Notes: Coastal inundation based on oceanic flooding from BMT WBM (2012). Tidal inundation based on results from BMT WBM (2015).

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Stony Point rock platform (western side of Nobbys breakwater)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Low	Low	Moderate	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Tidal inundation	Minimal	Low	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Coastal entrance instability	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Climate change	Minimal	Low	Moderate	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Low	Moderate	Minimal	Minimal	Minimal	Minimal	Low	Low			

Notes: Roosting migratory shorebirds utilise area. Disturbance from nearby use of dog off leash area at Horseshoe Beach.

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Department of Defence building (40 Wharf Road, Newcastle East)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Climate change	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low			

Notes: Coastal inundation based on oceanic flooding from BMT WBM (2012). Tidal inundation based on results from BMT WBM (2015).

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: RMS buildings, wharf (100 Wharf Road, Newcastle East)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Climate change	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Low			

Notes: Coastal inundation based on oceanic flooding BMT WBM (2012). Tidal inundation based on results BMT WBM (2015). Within Port lease area.

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: River wall (between RMS building and Queens wharf)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	High	High	Minimal	Moderate	Moderate	Minimal	High	High
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Climate change	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Climate change	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	High	High	Minimal	Low	Low			

Notes: Coastal inundation based on oceanic flooding from BMT WBM (2012). Tidal inundation based on results from BMT WBM (2015).

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Walkway promenade (between RMS building and Queens Wharf)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal			

Notes: Promenade unlikely to be inundated in modelling scenarios with exception of PMF event with 0.9m sea level rise.

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Wharf Road, Newcastle East

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Low	Low	Low	Low	Moderate	Moderate	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low			

Notes: Wharf road unlikely to be inundated in any modelling scenario's.

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Queens Wharf buildings (150 Wharf Road, Newcastle)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Low	Moderate	Minimal	Low	High
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Low	Moderate	Minimal	Low	High
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	High	Minimal	Low	Moderate			

Notes: Impacts to building will be dependent on river wall structure at wharf site.

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Queens Wharf outdoor area (170 Wharf Road)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High	Low	High	High
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High			

Notes: Coastal inundation an increasing risk in future planning timeframes. Outdoor area is in Port lease area.

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Queens Wharf ferry terminal (170 Wharf Road)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High	Low	High	High
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Moderate	Moderate	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High			

Notes: Coastal inundation an increasing risk in future planning timeframes. Terminal is in Port lease area.

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Scratchleys building (200 Wharf Road, Newcastle)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High	Low	High	High
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Moderate	Moderate	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High			

Coastal inundation an increasing risk in future planning timeframes. Building is a private building.

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Walkway promenade (between Queens Wharf and 292 Wharf Road)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal			

Notes: Promenade unlikely to be inundated in modelling scenarios with exception of PMF event with 0.9m sea level rise.

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: River wall (between Queens wharf and 292 Wharf Road)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	High	Minimal	Moderate	Moderate	Minimal	Moderate	High
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Climate change	Minimal	Minimal	Minimal	Minimal	Moderate	High	Minimal	Low	Low	Minimal	Low	High
Port operations	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Moderate	High	Minimal	Low	Low			

Notes: Coastal inundation based on oceanic flooding from BMT WBM (2012). Tidal inundation based on results from BMT WBM (2015).

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Promenade and riverwall (9 Honeysuckle Drive, Newcastle)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	High	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Low	Moderate	High	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate
Port operations	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Low	Moderate	High	Minimal	Moderate	Moderate			

Notes: Coastal and tidal inundation based on modelling results from BMT WBM (2015).

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Wharf (9 Honeysuckle Drive, Newcastle)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Minimal	Low	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Minimal	Minimal	Low	Minimal	Minimal	Low
Climate change	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Minimal	Low	Minimal	Low	Low
Boating	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Minimal	Low			

Notes: Coastal and tidal inundation based on modelling results from BMT WBM (2015).

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Lee Wharf Building (3C Honeysuckle Drive, Newcastle)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	Low	Low	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Minimal	Low	Low
Climate change	Minimal	Minimal	Minimal	Low	High	High	Low	Low	Low	Low	High	High
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Low	High	High	Low	Low	Low			

Notes: Coastal and tidal inundation based on modelling results from BMT WBM (2015). Owned by Crown Land.

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Honeysuckle Hotel (13 Honeysuckle Drive, Newcastle)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	Low	Low	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Minimal	Low	Low
Climate change	Minimal	Minimal	Minimal	Low	High	High	Low	Low	Low	Low	High	High
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Low	High	High	Low	Low	Low			

Notes: Coastal and tidal inundation based on modelling results from BMT WBM (2015). Privately owned.

Area: Hunter River lower estuary
Suburb/Beach: Newcastle City Centre
Asset Description: Worth Place park (16 Worth place, Newcastle)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low			

Notes: Owned by HCCDC.

Appendix I 12: Risk assessment for Wickham

Area: Hunter River lower estuary
Suburb/Beach: Wickham
Asset Description: Park (79 Hannell Street, Wickham)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal			

Area: Hunter River lower estuary
Suburb/Beach: Wickham
Asset Description: Newcastle Yacht Club marina (87B Hannell Street, Wickham)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Boating	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Low	Low	Low	Moderate	Moderate	Low	Low	Low			

Area: Hunter River lower estuary
Suburb/Beach: Wickham
Asset Description: Commercial Fisherman's Cooperative (97B Hannell Street, Wickham)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Water pollution	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Boating	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Low	Low	Low	Moderate	Moderate	Low	Low	Low			

Area: Hunter River lower estuary
Suburb/Beach: Wickham
Asset Description: River wall and walkway (between Cowper Street bridge and 50 Honeysuckle Drive)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	High	Low	Low	Low	Low	Low	High
Tidal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Low	Moderate	High	Low	Low	Low			

Area: Hunter River lower estuary
Suburb/Beach: Wickham
Asset Description: Wickham - Commercial and residential properties (See Appendix G and H)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Climate change	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Overall risk level	Minimal	Minimal	Minimal	Low	High	High	Low	High	High			

Notes: Coastal and tidal inundation based on modelling results from BMT WBM (2015).

Area: Hunter River lower estuary
Suburb/Beach: Wickham
Asset Description: Wickham - Roadways and infrastructure (See Appendix G and H)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Climate change	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Overall risk level	Minimal	Minimal	Minimal	Low	High	High	Low	High	High			

Notes: Coastal and tidal inundation based on modelling results from BMT WBM (2015).

Appendix I 13: Risk assessment for Maryville

Area: Hunter River lower estuary
Suburb/Beach: Maryville
Asset Description: Hannell Street Reserve (259 Hannell Street, Maryville)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low			

Notes: Increasing economic risk due to coastal inundation. Potential impacts to cycleway.

Area: Hunter River lower estuary
Suburb/Beach: Maryville
Asset Description: Hannell Street Reserve riverwall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low			

Notes: Increasing economic risk due to maintenance of river wall. Maintenance of river wall will impact Hannell Street Reserve.

Area: Hunter River lower estuary
Suburb/Beach: Maryville
Asset Description: Cycleway and Riverwall (between Islington park and Hannell Street bridge)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low			

Notes: Impacts to cycleway will be dependent on maintenance of river wall. Maintenance undertaken by HWC in recent times.

Area: Hunter River lower estuary
Suburb/Beach: Maryville
Asset Description: Maryville - Commercial and residential properties

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Climate change	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Overall risk level	Minimal	Minimal	Minimal	Low	High	High	Low	High	High			

Notes: Coastal and tidal inundation based on modelling results from BMT WBM (2015).

Area: Hunter River lower estuary
Suburb/Beach: Maryville
Asset Description: Maryville - Roads and infrastructure

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Climate change	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Overall risk level	Minimal	Minimal	Minimal	Low	High	High	Low	High	High			

Notes: Coastal and tidal inundation based on modelling results from BMT WBM (2015).

Appendix I 14: Risk assessment for Carrington

Area: Hunter River lower estuary
Suburb/Beach: Carrington
Asset Description: Mangrove Forest and boardwalk (Throsby Creek)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Water pollution	Low	Moderate	Moderate	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low
Climate change	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Low	Low	Minimal	Low	Low	Minimal	Minimal	Minimal			

Notes: Increasing environment risk due to habitat modification from changing climate. Economic risk due to maintenance of boardwalk.

Area: Hunter River lower estuary
Suburb/Beach: Carrington
Asset Description: Carrington Foreshore Reserve (Between Elizabeth Street and Howden Street)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal			

Notes: Foreshore reserve currently protected by river wall. Most of reserve has been elevated above flooding levels.

Area: Hunter River lower estuary
Suburb/Beach: Carrington
Asset Description: Rowing club building (34 Tully Street, Carrington)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	Moderate	Moderate	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	Moderate	Moderate	Low	High	High
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Erosion	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Overall risk level	Minimal	Minimal	Minimal	Low	High	High	Low	Moderate	Moderate			

Notes: Increasing risk from coastal and tidal inundation. Building does not have river wall. Building owned by Crown Lands.

Area: Hunter River lower estuary
Suburb/Beach: Carrington
Asset Description: Pat Jordan Oval (1 Cowper Street, Carrington)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Low	Moderate	Moderate	Minimal	Moderate	Moderate
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate
Increased community use	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate			

Notes: Increasing risk from coastal and tidal inundation.

Area: Hunter River lower estuary
Suburb/Beach: Carrington
Asset Description: Boat ramp (271 Hannell Street, Carrington)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Minimal	Moderate	Moderate	Minimal	Low	Moderate
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Minimal	Low
Increased community use	Minimal	Minimal	Low	Minimal	Minimal	Low	Low	Low	Low	Minimal	Minimal	Low
Water pollution	Minimal	Low	Low	Minimal	Minimal	Low	Low	Low	Low	Minimal	Low	Low
Boating	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Overall risk level	Minimal	Minimal	Low	Minimal	Minimal	Low	Low	Low	Low			

Area: Hunter River lower estuary
Suburb/Beach: Carrington
Asset Description: Carrington - Commercial and residential properties

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	High	Minimal	Low	Moderate	Minimal	Low	High
Climate change	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Overall risk level	Minimal	Minimal	Minimal	Low	High	High	Low	High	High			

Notes: Coastal and tidal inundation based on modelling results from BMT WBM (2015).

Area: Hunter River lower estuary
Suburb/Beach: Carrington
Asset Description: Throsby Creek (from Hannell Street bridge to Hunter River)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Low
Water pollution	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Urban development	Moderate	Moderate	Moderate	Low	Low	Moderate	Low	Low	Low	Low	Low	Low
Overall risk level	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate			

Notes: Increasing risk from urban water pollution and increasing development. Risk to environment, amenity and community use of Throsby Creek.

Area: Hunter River lower estuary
Suburb/Beach: Carrington
Asset Description: Carrington- Roads and infrastructure

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	High	Minimal	Moderate	High	Minimal	Moderate	High
Climate change	Minimal	Minimal	Minimal	Low	High	High	Low	High	High	Low	High	High
Overall risk level	Minimal	Minimal	Minimal	Low	High	High	Low	High	High			

Notes: Coastal and tidal inundation based on modelling results from BMT WBM (2015).

Area: Hunter River lower estuary
Suburb/Beach: Carrington
Asset Description: Carrington Foreshore Reserve riverwall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Minimal	Low	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Minimal	Low			

Appendix I 15: Risk assessment for Stockton – Western and southern foreshore

Area: Hunter River lower estuary
Suburb/Beach: Stockton west
Asset Description: Mangrove forest (197 Fullerton Street, Stockton)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Tidal inundation	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Water pollution	Low	Low	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Climate change	Minimal	Minimal	Low	Minimal	Low	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Low	Low	Low	Minimal	Low	Low	Minimal	Minimal	Minimal			

Notes: Environmental risk from water pollution from upstream catchment.

Area: Hunter River lower estuary
Suburb/Beach: Stockton west
Asset Description: Crown Reserve (197 Fullerton Street, Stockton - between Stockton bridge and Hereford Street)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Low	Low	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal			

Notes: Risk assessment based on river wall remaining serviceable.

Area: Hunter River lower estuary
Suburb/Beach: Stockton west
Asset Description: North Stockton boat ramp and carpark

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low
Water pollution	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Low
Boating	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Low	Low	Low	Low	Minimal	Low	Low			

Notes: Facility recently upgraded by RMS.

Area: Hunter River lower estuary
Suburb/Beach: Stockton west
Asset Description: Crown Reserve river wall

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Low	Moderate	High	Minimal	Low	Low	Minimal	Low	High
Overall risk level	Minimal	Minimal	Minimal	Low	Moderate	High	Minimal	Low	Low			

Area: Hunter River lower estuary
Suburb/Beach: Stockton west
Asset Description: Stockton boat ramp and carpark

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Low	Low	Low	Low	Low	Minimal	Minimal	Minimal	Minimal	Low	Low
Water pollution	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Low
Boating	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Low	Low	Low	Low	Minimal	Low	Low			

Notes: Facility recently upgraded by RMS.

Area: Hunter River lower estuary
Suburb/Beach: Stockton west
Asset Description: Ballast grounds park (71 Clyde Street, Stockton)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Low	Low	Minimal	Low	Low	Minimal	Minimal	Low	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal			

Notes: Risk assessment based on river wall remaining serviceable.

Area: Hunter River lower estuary
Suburb/Beach: Stockton west
Asset Description: Crown Land building (2 Foreshores, Stockton)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Minimal	Low	Low	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low	Minimal	Low	Low
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low			

Area: Hunter River lower estuary
Suburb/Beach: Stockton west
Asset Description: Griffith Park and carpark

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Tidal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Increased community use	Minimal	Minimal	Minimal	Low	Low	Low	Low	Moderate	Moderate	Low	Moderate	Moderate
Overall risk level	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Moderate	Moderate			

Area: Hunter River lower estuary
Suburb/Beach: Stockton west
Asset Description: Ferry terminal

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Minimal	Minimal
Climate change	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High	Low	High	High
Increased community use	Minimal	Minimal	Minimal	Minimal	Low	Low	Low	Moderate	Moderate	Minimal	Low	Low
Overall risk level	Minimal	Minimal	Minimal	Moderate	High	High	Low	High	High			

Notes: Coastal inundation an increasing risk in future planning timeframes. Terminal is in Port lease area.

Appendix I 16: Risk assessment for Hunter River lower estuary

Area: Hunter River lower estuary
Suburb/Beach: Hunter River
Asset Description: Hunter River

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Low	Low	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Tidal inundation	Minimal	Minimal	Low	Low	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Climate change	Minimal	Minimal	Low	Low	Low	Low	Minimal	Minimal	Low	Minimal	Minimal	Low
Increased community use	Low	Low	Low	Minimal	Minimal	Minimal	Low	Low	Low	Low	Low	Low
Water pollution	Moderate	Moderate	High	Low	Low	Low	Low	Moderate	Moderate	Low	Moderate	High
Boating	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Low	Low	Low	Minimal	Minimal	Low
Port operations	Moderate	High	High	Low	Low	Low	Low	Low	Low	Low	High	High
Urban development	Moderate	Moderate	Moderate	Low	Low	Low	Low	Moderate	Moderate	Low	Moderate	Moderate
Overall risk level	Moderate	High	High	Low	Low	Low	Low	Moderate	Moderate			

Appendix I 17: Risk assessment for Throsby Creek catchment – West of Hannell Street bridge

Area: Hunter River lower estuary
Suburb/Beach: Islington
Asset Description: Islington Park (151A Maitland Road, Islington)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	High	Low	Moderate	Moderate	Low	Moderate	High
Tidal inundation	Minimal	Minimal	Low	Low	Low	Moderate	Low	Low	Low	Low	Low	Low
Climate change	Minimal	Minimal	Minimal	Low	Moderate	High	Low	Moderate	Moderate	Low	Moderate	High
Increased community use	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Low	Moderate	High	Low	Moderate	Moderate			

Notes: Increasing risk from tidal and coastal inundation in future planning horizon due to sea level rise.

Area: Hunter River lower estuary
Suburb/Beach: Islington, Hamilton North and Broadmeadow
Asset Description: Styx Creek stormwater channel

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Low	Low	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Low
Water pollution	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Urban development	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Low	Low	Low	Moderate	Moderate	Low	Low	Low			

Area: Hunter River lower estuary
Suburb/Beach: Islington, Mayfield East and Mayfield
Asset Description: Throsby Creek stormwater channel

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Minimal	Minimal	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Low	Low	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Low
Water pollution	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate
Urban development	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Overall risk level	Low	Low	Low	Low	Moderate	Moderate	Low	Low	Low			

Area: Hunter River lower estuary
Suburb/Beach: Islington
Asset Description: Throsby Creek (from Maitland Road to Hannell Street bridge)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Moderate	Moderate	Minimal	Low	Low
Water pollution	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Urban development	Moderate	Moderate	Moderate	Low	Low	Moderate	Low	Low	Low	Low	Low	Low
Overall risk level	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Moderate			

Notes: Water pollution a current and increasing issue due to increasing urban development in catchment.

Area: Hunter River lower estuary
Suburb/Beach: Maryville
Asset Description: Islington – Residential properties

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	High	Minimal	Moderate	High	Minimal	Moderate	High
Tidal inundation	Minimal	Low	Moderate	Minimal	Low	Moderate	Minimal	Low	Moderate	Minimal	Low	Moderate
Climate change	Minimal	Minimal	Minimal	Minimal	Moderate	High	Minimal	Moderate	High	Minimal	Moderate	High
Overall risk level	Minimal	Minimal	Low	Minimal	Moderate	High	Minimal	Moderate	High			

Notes: Coastal and tidal inundation based on modelling results from BMT WBM (2015).

Area: Hunter River lower estuary
Suburb/Beach: Tighes Hill
Asset Description: Commercial properties (Elizabeth Street and Revelation Close)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Moderate	High	High	Low	Low	Moderate	Low	High	High
Tidal inundation	Minimal	Minimal	Minimal	Low	Moderate	High	Low	Low	Moderate	Low	Low	High
Urban development	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Low	High	High	Low	Low	Moderate			

Area: Hunter River lower estuary
Suburb/Beach: Tighes Hill
Asset Description: River wall (Northern side of Throsby Creek)

Threat	Environment			Economic			Social and cultural			Overall risk level		
	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100	Immediate (2018)	2050	2100
Coastal inundation	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Minimal	Low	Low	Minimal	Low	Low
Tidal inundation	Minimal	Minimal	Minimal	Minimal	Minimal	Low	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Overall risk level	Minimal	Minimal	Minimal	Minimal	Low	Low	Minimal	Low	Low			

Notes: Coastal and tidal inundation based on modelling results from BMT WBM (2015).

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CCL 23/06/2020 - ENDORSEMENT OF THE DRAFT STOCKTON COASTAL MANAGEMENT PROGRAM

ITEM-30	**Attachment C:**	Correspondence – Minister's Direction 17 February 2020 – Stockton CMP Supporting Document A.

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Supporting Documentation A.

NSW Government Directive
to prepare CMP for Stockton Beach
before 30 June 2020

City of Newcastle

The Hon. Shelley Hancock MP
Minister for Local Government

MD19/5832

Mr Jeremy Bath
Chief Executive Officer
City of Newcastle Council
PO BOX 489
NEWCASTLE NSW 2300

By email: mail@ncc.nsw.gov.au

Dear Mr Bath

As you are aware, I have declared Stockton Beach as a location with significant open coastal hazards and have fast tracked the provision of grant funding under the Coastal and Estuary Grants program for emergency actions in response to erosion at Stockton Beach.

I appreciate you are working closely with the Department of Planning, Industry and Environment to implement management actions in the Newcastle Coastal Zone Management Plan and are continuing to work on your coastal management program to identify sustainable long-term management actions for the management of Stockton Beach. Council's willingness to collaborate and work closely with the Department is appreciated.

Given the renewed erosion occurring at Stockton, and Council's recent decision to relocate assets at threat, I am now writing to advise Council that I am issuing a direction to Council to complete their Coastal Management Program (CMP) for Stockton Beach by 30 June 2020.

I understand that the possibility of fast-tracking the CMP using the provisions in the Coastal Management Manual was recently discussed with DPIE officers, and I would encourage you to seriously consider this option.

Please find attached the direction under section 13 of the *Coastal Management Act 2016*. Given the amount of community concern and interest in Stockton Beach, I am issuing the direction to reflect the need to resolve the long-term management at Stockton as quickly as possible. This is not without recognising that extensive engagement with the community will be required as part of this project to ensure the long-term management actions chosen are accepted by the community. This is also consistent with Ministerial Directions that were issued to other councils with areas declared as Significant Open Coast Locations (formerly coastal hot spots).

I am advised that Council has proposed an October 2020 completion date for the CMP for its whole coastline and that the Scoping Study has recently been finalised. It is open to Council to decide whether the CMP completed by 30 June 2020 is only for Stockton or whether it is for the whole of the Newcastle coastal zone. The Department remains available to assist.

I also note that Council has sought additional resources to help prepare its CMP. Staff from the Department of Planning, Industry and Environment Grant will contact Council in the coming days to expedite funding for additional staff resources. It is proposed this occur through a variation to the existing grant to Council for the development of the coastal management program.

If you require any further information or wish to discuss this further, please contact [redacted]

Yours sincerely

The Hon. Shelley Hancock MP
Minister for Local Government

Encl: Direction to prepare a coastal management program for Stockton Beach

17 FEB 2020

Coastal Management Act 2016

Direction under section 13

Under the provisions of section 13 of *the Coastal Management Act 2016* (the Act), I direct the City of Newcastle Council to submit a draft coastal management program in accordance with the requirements under Division 2 of the Act for the coastline at Stockton Beach, to the Minister administering the Act by 30 June 2020.

The Hon Shelley Hancock MP
Minister for Local Government
Minister administering the *Coastal Management Act 2016*

17-2-20
Date

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CCL 23/06/2020 - ENDORSEMENT OF THE DRAFT STOCKTON COASTAL MANAGEMENT PROGRAM

ITEM-30	**Attachment D:**	Summary of Coastal Management Program Mandatory Requirements and Objectives of the Coastal Management Act, Coastal Management SEPP and Coastal Management Manual (Royal HaskoningDHV, 2020) – Stockton CMP Supporting Document H.

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Supporting Documentation H.

Summary of CMP Mandatory Requirements and Objects of the CM Act, CM SEPP and Manual (RHDHV, 2020)

City of Newcastle

REPORT

Stockton Coastal Management Program

Summary of CMP Mandatory Requirements and Objects of the CM Act, CM SEPP and Manual

Supporting Document H

Client: City Of Newcastle

Reference: PA2395-RHDHV-CN-AT-CM-005

Status: S0/P01.01

Date: 15/06/2020

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Document title:	Stockton Coastal Management Program
Document short title:	Supporting Document H
Reference:	PA2395-RHDHV-CN-AT-CM-005
Status:	P01.01/S0
Date:	Monday, 15 June 2020
Project name:	Stockton Coastal Management Program
Project number:	PA2395
Author(s):	Adrian Turnbull
Drafted by:	Adrian Turnbull
Checked by:	Nat Patterson
Date / initials:	15/6/2020 NP
Approved by:	Adrian Turnbull
Date / initials:	15/6/2020 AT

Classification
Internal use only

MANAGEMENT SYSTEM CERTIFICATION DNV·GL ISO 9001 = ISO 14001 ISO 45001

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Table 1 : Statutory requirements set out in the Coastal Management Act 2016.

CM Act 2016	Issue	Requirement met	Where documented in Stockton CMP / Additional notes.
s13(2)	A coastal management program may be made in relation to the whole, or any part, of the area included within the coastal zone.	YES	This statutory requirement has been considered and described in Section 1.1
s14(3)(a)	In preparing a coastal management program, a local council must: consider and promote the objects of this Act	YES	This statutory requirement has been considered and described in Section 1.3 and Section 5. Refer to Table 3 below for detailed response.
s14(3)(b)	In preparing a coastal management program, a local council must: give effect to the management objectives for the coastal management areas covered by the program	YES	This statutory requirement has been considered and described in Section 1.3 and Section 5. Refer to Table 4-7 below for detailed response
s14(3)(c)	In preparing a coastal management program, a local council must: consider the State and regional policies and plans prescribed by the regulations for the purposes of this section.	YES	This statutory requirement has been considered and described in Section 1.3 and the CMP Scoping Study (Supporting Document B)
s15(1)(a)	A coastal management program must: identify the coastal management issues affecting the areas to which the program is to apply	YES	This statutory requirement has been considered and described in Section 2
s15(1)(b)	A coastal management program must: identify the actions required to address those coastal management issues in an integrated and strategic manner	YES	This statutory requirement has been considered and described in Section 4
s15(1)(c)	A coastal management program must: identify how and when those actions are to be implemented, including those to be implemented by local councils under Chapter 13 of the *Local Government Act 1993*, those to be implemented under environmental planning instruments and development control plans under the *Environmental Planning and Assessment Act 1979* and those to be implemented by public authorities (other than the local council)	YES	This statutory requirement has been considered and described in Section 4. Section 4.1 outlines management actions, those responsible, cost estimates, evaluation and timeframes
s15(1)(d)	A coastal management program must: identify the costs of those actions and proposed cost-sharing arrangements and other viable funding mechanisms for those actions to ensure the delivery of those actions is consistent with the timing for their implementation under the coastal management program	YES	This statutory requirement has been considered and described in Section 4 and 6

s15(1)(e)	A coastal management program must: if the local council's local government area contains land within the coastal vulnerability area and beach erosion, coastal inundation or cliff instability is occurring on that land, include a coastal zone emergency action subplan.	YES	This statutory requirement has been considered and described in Section 7 and Appendix A
s15(4)	A coastal management program must not include the following: (a) matters dealt with in any plan made under the *State Emergency and Rescue Management Act 1989* in relation to the response to emergencies, (b) proposed actions or activities to be carried out by any public authority or relating to any land or other assets owned or managed by a public authority, unless the public authority has agreed to the inclusion of those proposed actions or activities in the program.	YES	This statutory requirement has been considered and described in Section 7 and Appendix A in relation to the Stockton Coastal Zone Emergency Action Subplan. Approval has been gained from all relevant public authorities as described in Section 4.2 and Appendix B.
s16(1)	Before adopting a coastal management program, a local council must consult on the draft program with: (a) the community, and (b) if the local council's local government area contains: (i) land within the coastal vulnerability area, any local council whose local government area contains land within the same coastal sediment compartment (as specified in Schedule 1), and (ii) an estuary that is within 2 or more local government areas (as specified in Schedule 1), the other local councils, and (c) other public authorities if the coastal management program: (i) proposes actions or activities to be carried out by that public authority, or (ii) proposes specific emergency actions or activities to be carried out by a public authority under the coastal zone emergency action subplan, or (iii) relates to, affects or impacts on any land or assets owned or managed by that public authority.	YES	Public exhibition was delivered between 13 May 2020 - 10 June 2020. An overview of the consultation process and outcomes is described within Section 1.4, Section 10 and Supporting Document G; and includes the community, relevant agencies and the neighbouring Port Stephens Council. Evidence of correspondence with Port Stephens Council is included in Appendix B in addition to correspondence from relevant landholders or those authorities identified under s15(4)(b) The Stockton Coastal Zone Emergency Action Subplan proposes specific emergency actions or activities to be carried out by a public authority in accordance with the adopted Newcastle EMPLAN. This statutory requirement has been considered and described in Section 7 and Appendix A. Evidence of approval of those authorities in contained within Appendix B.

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Table 2 : Mandatory Requirements set out in NSW Coastal Management Manual (2018) – Part A

Mandatory Requirement	Issue	Requirement met	Where documented in Stockton CMP / Additional notes.
MR2	A CMP is to consider a range of timeframes and planning horizons including immediate, 20 years, 50 years, 100 years and (if council considers it relevant based on expert advice) beyond.	YES	This statutory requirement has been considered and described in Section 1.2
MR3	A CMP is to consider a broad range of coastal management issues and management actions with a focus on achieving the objects and objectives of the Coastal Management Act 2016.	YES	This statutory requirement has been considered and described in Section 1.3 and Section 5. It is demonstrated in Section 4 as outlined below in Tables 3, 5, 6 and 7
MR4	A CMP must include the rationale for selecting the area to be covered by a CMP and identify whether it applies to: i. all or part of the coastal zone of one local government area; or ii. all or part of the coastal zone of adjoining local government areas that share a coastal sediment compartment or estuary (where adjoining local government areas share a coastal sediment compartment or estuary - refer to Schedule 1 of the Coastal Management Act 2016 - a CMP that addresses an area comprising that coastal sediment compartment or estuary must reflect this regional context).	YES	This statutory requirement has been considered and described in Section 1.1
MR5i	A CMP must identify: any proposed amendments to mapping of the relevant coastal management areas	YES	This statutory requirement has been considered and described in Section 5
MR5ii	A CMP must identify: evidence to support any proposed amendments or additions to the area of the four coastal management areas in the relevant area	YES	This statutory requirement has been considered and described in Section 5
MR5iii	A CMP must identify: information about these proposed amendments that can support the preparation of a planning proposal and, in particular, that could be forwarded along with a planning proposal to the Greater Sydney	YES	This statutory requirement has been considered and described in Section 5

	Commission (if the planning proposal relates to the Greater Sydney Region) or the Minister (for elsewhere) to inform a Gateway determination under section 3.34 of the Environmental Planning and Assessment Act 1979.		
MR6i	During preparation of a CMP, a council is to: identify the scope of the CMP	YES	This statutory requirement has been considered and described in Section1 and Supporting Document B.
MR6ii	During preparation of a CMP, a council is to: determine and assess coastal risks, vulnerabilities and opportunities (including without limitation risks to environmental, social and economic values and benefits)	YES	This statutory requirement has been considered and described in Section 2
MR6iii	During preparation of a CMP, a council is to: evaluate and select coastal management options	YES	This statutory requirement has been considered and described in Section 3 and Supporting Document D
MR7i	A council may choose not to repeat steps (or parts of steps) in subparagraphs (ii) or (iii) of mandatory requirement 6 for the area the subject of the proposed CMP (or parts of that area) if those tasks have already been undertaken for the coastal management of that area, provided that council first considers: whether the existing assessment of coastal risks, vulnerabilities and opportunities, or the existing evaluation of coastal management options, that council proposes to rely on enables council to prepare the CMP in accordance with mandatory requirement 8 below and sections 14 and 15 of the Coastal Management Act 2016.	N/A	Actions undertaken as per subparagraphs (ii) or (iii) of Mandatory Requirement 6
MR7ii	A council may choose not to repeat steps (or parts of steps) in subparagraphs (ii) or (iii) of mandatory requirement 6 for the area the subject of the proposed CMP (or parts of that area) if those tasks have already been undertaken for the coastal management of that area, provided that council first considers: the effectiveness of the existing coastal management of that area	N/A	Actions undertaken as per subparagraphs (ii) or (iii) of Mandatory Requirement 6
MR7iii	A council may choose not to repeat steps (or parts of steps) in subparagraphs (ii) or (iii) of mandatory requirement 6 for the area the subject of the proposed CMP (or parts of that area) if those	N/A	Actions undertaken as per subparagraphs (ii) or (iii) of Mandatory Requirement 6

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	tasks have already been undertaken for the coastal management of that area, provided that council first considers: whether any circumstances concerning the coastal management of that area have changed		
MR8i	A CMP must: provide a description of how the objects of the Coastal Management Act 2016 have been considered and promoted in preparing the CMP	YES	This statutory requirement has been considered and described in Section 1.3 and Section 5. Refer to Table 3 below for details.
MR8ii	A CMP must: provide a description of how the objectives of the coastal management areas covered by the CMP have been given effect to in preparing the CMP	YES	This statutory requirement has been considered and described in Section 1.3 and Section 5. Refer to Tables 4 to 7 below for details.
MR8iii	A CMP must: identify the key coastal management issues affecting the areas to which the CMP is to apply and how these have been considered	YES	This statutory requirement has been considered and described in Section 2
MR8iv	A CMP must: identify any coastal management actions required to address those key coastal management issues in an integrated and strategic manner	YES	This statutory requirement has been considered and described in Section 4
MR8v	A CMP must: identify how the coastal management actions in (iv) have been considered and evaluated (including, without limitation, how council has evaluated the coastal management actions in light of the functions and responsibilities council has under legislation other than the Coastal Management Act 2016)	YES	This statutory requirement has been considered and described in Section 4
MR8vi	A CMP must: identify any environmental protection works, on land identified as ‘coastal wetlands’ or ‘littoral rainforests’ on the Coastal Wetlands and Littoral Rainforests Area Map under the State Environmental Planning Policy (Coastal Management) 2018, that are proposed to be carried out by or on behalf of a public authority	N/A	There is no land identified as coastal wetlands or littoral rainforests within the Stockton CMP area. see Table 4 below for detail

MR8vii	A CMP must: identify any coastal protection works that are proposed to be carried out by or on behalf of a public authority	YES	Section 4
MR8viii	A CMP must: set out the recommended timing for the proposed coastal management actions	YES	This statutory requirement has been considered and described in Section 4
MR8ix	A CMP must: identify a proposed monitoring, evaluation and reporting program in relation to the CMP, including by identifying key indicators, trigger points and thresholds relevant to the CMP	YES	This statutory requirement has been considered and described in Section 8 The evaluation method of each action has been identified in Section 4.2
MR8x	A CMP must: include a business plan	YES	This statutory requirement has been considered and described in Section 6
MR9i	The business plan included in the CMP must identify: all proposed coastal management actions identified elsewhere in the CMP	YES	This statutory requirement has been considered and described in Section 6
MR9ii	The business plan included in the CMP must identify: the full proposed capital, operational and maintenance costs, and recommended timing, of proposed coastal management actions	YES	This statutory requirement has been considered and described in Section 6
MR9iii	The business plan included in the CMP must identify: any proposed cost-sharing arrangements and any other viable funding mechanisms for the proposed coastal management actions to ensure delivery of those actions is consistent with the timing for their implementation under the CMP	YES	This statutory requirement has been considered and described in Section 6
MR9iv	The business plan included in the CMP must identify: The distribution of costs and benefits of all proposed coastal management actions	YES	This statutory requirement has been considered and described in Section 6
MR10	Where coastal hazards have been identified in a coastal management area, a CMP must identify proposed coastal management actions for those hazards	YES	This statutory requirement has been considered and described in Section 4

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MR11	If the *Coastal Management Act 2016* requires that a coastal zone emergency action subplan be prepared, it must identify any requirements for how emergency coastal protection works, within the meaning of the *State Environmental Planning Policy (Coastal Management) 2018*, are to be carried out	YES	This statutory requirement has been considered and described in Section 7 and Appendix A
MR12i	A CMP must demonstrate how a council has considered: projected population growth and demographic changes	YES	This statutory requirement has been considered and described in Section 1.3, 2.1.1 and 3.3.1. Stockton is not an identified growth area. Section 4.1 outlines the strategy to enable the provision of ongoing service delivery of essential public assets. Section 4.2 includes various actions to improve public access and use of the beach and foreshore.
MR12ii	A CMP must demonstrate how a council has considered: projected use of coastal land for infrastructure, housing, commercial, recreational and conservation purposes	YES	This statutory requirement has been considered and described in Section 1.3 and 2.1.1. Stockton is not an identified growth area. Section 4.1 outlines the strategy to enable the ongoing provision of the identified land uses while maintaining the presence of a natural foreshore.
MR13i	A CMP must demonstrate how a council has considered: current and future risks, at timeframes of immediate, 20 years, 50 years, 100 years and (if council considers it relevant based on expert advice) beyond	YES	This statutory requirement has been considered and described in Section 2
MR13ii	A CMP must demonstrate how a council has considered: (if council considers it relevant) current and future risks of potentially high consequence, low probability events that may affect the relevant area	YES	This statutory requirement has been considered and described in Section 2.3 and 2.4
MR13iii	A CMP must demonstrate how a council has considered: the effects of projected climate change and how it may affect the relevant area	YES	This statutory requirement has been considered and described in Section 2.3 and 2.4
MR13iv	A CMP must demonstrate how a council has considered: the local and regional scale effects of coastal processes	YES	This statutory requirement has been considered and described in Section 2.3 and 2.4
MR13v	A CMP must demonstrate how a council has considered: the ambulatory and dynamic nature of the shoreline and how it may affect the relevant area	YES	This statutory requirement has been considered and described in Section 2
MR14	A CMP is to include the following sections: i. Executive summary; ii. Introduction;	YES	This statutory requirement has been considered and described in the Table of Contents

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	iii. A snapshot of issues; iv. Actions to be implemented by the council or by public authorities; v. Whether the CMP identifies recommended changes to the relevant planning controls, including any proposed maps; vi. A business plan; vii. Coastal zone emergency action subplan, if the *Coastal Management Act 2016* requires that subplan to be prepared; viii. Monitoring, evaluation and reporting program; ix. Maps; x. Reference list		
MR15	A draft CMP must be exhibited for public inspection at the main offices of the councils of all local government areas within the area to which the CMP applies, during the ordinary hours of those offices, for a period of not less than 28 calendar days before it is adopted. This mandatory requirement does not prevent community consultation, or other consultation, in other ways.	YES	Public exhibition was delivered between 13 May 2020 - 10 June 2020, utilising tools and processes that ensured consultation requirements were meet within the constraints of social distancing and regulated business operations during COVID 19 pandemic. Copies of the draft Stockton CMP were distributed to members of the Stockton Community Liaison Group, accessed via postal requests for hard copies, websites downloads and via local bowling club. Detail is supplied in Section 10
MR16	When implementing a CMP, a council must: i. carry out the monitoring, evaluation and reporting program in the CMP (MER); and ii. monitor key indicators, trigger points and thresholds identified in the MER.	YES	This statutory requirement has been considered and described in Section 7, Section 8 and Appendix A. The evaluation method of each action has been identified in Section 4.2
MR17	Councils must report on the implementation of a CMP through the IP&R framework on an annual, four yearly and ten-yearly basis.	YES	This statutory requirement has been considered and described in Section 8
MR18	When an adjoining council or a public authority is affected, or is likely to be affected, by implementation of some aspect of a CMP, a council must liaise with that authority when implementing that aspect of the CMP	YES	This statutory requirement has been considered and described in Section 1.4 and Section 10 which outlines the consultation to date. Section 6.1 outlines future consultations requirements and commitments. Evidence of the involvement of Port Stephens Council and authorities as per s15(4) are included in Appendix B

MR19	Councils must maintain sufficient information and records about its management of the relevant parts of the coastal zone that will enable it to demonstrate: i. how the CMP has been implemented; and ii. what has been achieved in connection with the CMP, including whether coastal management actions have been carried out within the timeframes identified in the CMP	YES	This statutory requirement has been considered and described in Section 8

Meeting the objects of the *Coastal Management Act 2016* and management objectives for the coastal management areas covered by the Stockton CMP

Table 3: Objects of the Coastal Management Act 2016 (Section 3 CM Act)

Objective	Issue	Requirement met	Where documented in Stockton CMP / Additional notes.
(a)	to protect and enhance natural coastal processes and coastal environmental values including natural character, scenic value, biological diversity and ecosystem integrity and resilience	YES	This object has been considered and promoted via the CMP Scoping Study (Supporting Documentation B) and is included as part of the vision of the CMP described in Section 2. A number of the actions described in Section 4 promote this object.
(b)	to support the social and cultural values of the coastal zone and maintain public access, amenity, use and safety	YES	This object has been considered and promoted via the CMP Scoping Study (Supporting Documentation B) and is included as part of the vision of the CMP described in Section 2. A number of the actions described in Section 4 promote this object.
(c)	to acknowledge Aboriginal peoples' spiritual, social, customary and economic use of the coastal zone	YES	This object has been considered and promoted via the CMP Scoping Study (Supporting Documentation B) and is included as part of the vision of the CMP described in Section 2. A number of the actions described in Section 4 promote this object.
(d)	to recognise the coastal zone as a vital economic zone and to support sustainable coastal economies	YES	This object has been considered and promoted via the CMP Scoping Study (Supporting Documentation B) and is included as part of the vision of the CMP described in Section 2. A number of the actions described in Section 4 promote this object.
(e)	to facilitate ecologically sustainable development in the coastal zone and promote sustainable land use planning decision-making	YES	This object has been considered and promoted via the CMP Scoping Study (Supporting Documentation B) and is included as part of the vision of the CMP described in Section 2. A number of the actions described in Section 4 promote this object. Specifically action CH39 (New subdivisions or greenfield development to

			be located landward of 2120 ZRFC coastal hazard line)
(f)	to mitigate current and future risks from coastal hazards, taking into account the effects of climate change	YES	This object has been considered and promoted via the CMP Scoping Study (Supporting Documentation B) and is included as part of the vision of the CMP described in Section 2. A number of the actions described in Section 4 promote this object.
(g)	to recognise that the local and regional scale effects of coastal processes, and the inherently ambulatory and dynamic nature of the shoreline, may result in the loss of coastal land to the sea (including estuaries and other arms of the sea), and to manage coastal use and development accordingly	YES	This object has been considered and promoted via the CMP Scoping Study (Supporting Documentation B), assessed through the hazard and risk assessments within the CMP, and address as part of the evaluation of management options. A number of the actions described in Section 4 promote this object.
(h)	to promote integrated and co-ordinated coastal planning, management and reporting	YES	This object has been considered and promoted via the actions described in Section 4 and the reporting framework proposed in Section 8.
(i)	to encourage and promote plans and strategies to improve the resilience of coastal assets to the impacts of an uncertain climate future including impacts of extreme storm events	YES	This object has been considered and promoted via the actions described in Section 4.
(j)	to ensure co-ordination of the policies and activities of government and public authorities relating to the coastal zone and to facilitate the proper integration of their management activities	YES	This object has been considered and promoted via the previous and ongoing consultation undertaken as part of the CMP development described in Section 1.4 and in various actions provided in Section 4.
(k)	to support public participation in coastal management and planning and greater public awareness, education and understanding of coastal processes and management actions	YES	This object has been considered and promoted via the previous and ongoing consultation undertaken as part of the CMP development described in Section 1.4 and in various actions provided in Section 4.
(l)	to facilitate the identification of land in the coastal zone for acquisition by public or local authorities in order to promote the protection, enhancement, maintenance and restoration of the environment of the coastal zone	N/A	Council have not identified any requirements for the acquisition of land as the majority of the coastal zone at immediate risk in Stockton is already owned or managed by public authorities.

(m)	to support the objects of the *Marine Estate Management Act 2014*	YES	The MEMA Act and it's interaction with coastal management is considered in Section 1.3. The CMP also considers the priority threats identified in the Marine Estate Threat and Risk Assessment as described in Section 2.2 and within the Scoping Study (Supporting Documentation B).

Table 4: Management objectives for the coastal wetlands and littoral rainforests area (Section 6 CM Act)

Management Objective	Issue	Requirement met	Where documented in Stockton CMP / Additional notes.
(a)	to protect coastal wetlands and littoral rainforests in their natural state, including their biological diversity and ecosystem integrity	N/A	There is no land identified as coastal wetlands or littoral rainforests within the Stockton CMP area.
(b)	to promote the rehabilitation and restoration of degraded coastal wetlands and littoral rainforests	N/A	There is no land identified as coastal wetlands or littoral rainforests within the Stockton CMP area.
(c)	to improve the resilience of coastal wetlands and littoral rainforests to the impacts of climate change, including opportunities for migration	N/A	There is no land identified as coastal wetlands or littoral rainforests within the Stockton CMP area.
(d)	to support the social and cultural values of coastal wetlands and littoral rainforests	N/A	There is no land identified as coastal wetlands or littoral rainforests within the Stockton CMP area.
(e)	to promote the objectives of State policies and programs for wetlands or littoral rainforest management	N/A	There is no land identified as coastal wetlands or littoral rainforests within the Stockton CMP area.

Table 5: Management objectives for coastal vulnerability area (Section 7 CM Act)

Management Objective	Issue	Requirement met	Where documented in Stockton CMP / Additional notes.
(a)	to ensure public safety and prevent risks to human life	YES	The CMP gives effect to this management objective through the management actions proposed in Section 4 and via the CZEAS described in Section 7 and Appendix A.
(b)	to mitigate current and future risk from coastal hazards by taking into account the effects of coastal processes and climate change	YES	The CMP gives effect to this management objective through the management actions proposed in Section 4, with coastal processes and climate change informing the hazard assessment and options evaluation undertaken.
(c)	to maintain the presence of beaches, dunes and the natural features of foreshores, taking into account the beach system operating at the relevant place	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4, including a strong

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			focus on the provision of beach amenity via maintaining the presence of a natural foreshore.
(d)	to maintain public access, amenity and use of beaches and foreshores	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4, including a strong focus on the provision of beach amenity via maintaining the presence of a natural foreshore. Section 4 also includes various actions to improve public access and use of the beach and foreshore.
(e)	to encourage land use that reduces exposure to risks from coastal hazards, including through siting, design, construction and operational decisions	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4. In particular action CH39 (New subdivisions or greenfield development to be located landward of 2120 ZRFC coastal hazard line).
(f)	to adopt coastal management strategies that reduce exposure to coastal hazards: (i) in the first instance and wherever possible, by restoring or enhancing natural defences including coastal dunes, vegetation and wetlands, and (ii) if that is not sufficient, by taking other action to reduce exposure to those coastal hazards	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4, including a strong focus on the provision of beach nourishment to provide a degree of natural defence against coastal hazards. Risk mitigate strategies upon a threshold are identified as a secondary means of reducing expose to coastal hazards, should beach nourishment not prove sufficient of be implementable.
(g)	if taking that other action to reduce exposure to coastal hazards: (i) to avoid significant degradation of biological diversity and ecosystem integrity, and (ii) to avoid significant degradation of or disruption to ecological, biophysical, geological and geomorphological coastal processes, and (iii) to avoid significant degradation of or disruption to beach and foreshore amenity and social and cultural values, and (iv) to avoid adverse impacts on adjoining land, resources or assets, and	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4.

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	(v) to provide for the restoration of a beach, or land adjacent to the beach, if any increased erosion of the beach or adjacent land is caused by actions to reduce exposure to coastal hazards		
(h)	to prioritise actions that support the continued functionality of essential infrastructure during and immediately after a coastal hazard emergency	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4. Further actions are provided in the CZEAS described in Section 7 and Appendix A.
(i)	to improve the resilience of coastal development and communities by improving adaptive capacity and reducing reliance on emergency responses	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4.

Table 6: Management objectives for coastal environment area (Section 8 CM Act)

Management Objective	Issue	Requirement met	Where documented in Stockton CMP / Additional notes.
(a)	to protect and enhance the coastal environmental values and natural processes of coastal waters, estuaries, coastal lakes and coastal lagoons, and enhance natural character, scenic value, biological diversity and ecosystem integrity	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4, including a strong focus on the provision of beach amenity and natural coastal processes via maintaining the presence of a natural foreshore.
(b)	to reduce threats to and improve the resilience of coastal waters, estuaries, coastal lakes and coastal lagoons, including in response to climate change	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4, including a strong focus on the provision of beach amenity and natural coastal processes via maintaining the presence of a natural foreshore. It is noted that the CMP does not cover an area sufficiently large to have an appreciable impact on coastal waters or other water bodies.
(c)	to maintain and improve water quality and estuary health	YES	The CMP does not cover an area where any actions would have an appreciable impact on water quality or estuary health.

(d)	to support the social and cultural values of coastal waters, estuaries, coastal lakes and coastal lagoons	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4, including a consideration of social and cultural values of the coast.
(e)	to maintain the presence of beaches, dunes and the natural features of foreshores, taking into account the beach system operating at the relevant place	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4, including a strong focus on the provision of beach amenity and natural coastal processes via maintaining the presence of a natural foreshore.
(f)	to maintain and, where practicable, improve public access, amenity and use of beaches, foreshores, headlands and rock platforms	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4, including a strong focus on the provision of beach amenity and natural coastal processes via maintaining the presence of a natural foreshore. Various actions proposed in Section 4 relate to improving access and amenity along the coast.

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Table 7: Management objectives for coastal use area (Section 9 CM Act)

Management Objective	Issue	Requirement met	Where documented in Stockton CMP / Additional notes.
(a)	to protect and enhance the scenic, social and cultural values of the coast by ensuring that: (i) the type, bulk, scale and size of development is appropriate for the location and natural scenic quality of the coast, and (ii) adverse impacts of development on cultural and built environment heritage are avoided or mitigated, and (iii) urban design, including water sensitive urban design, is supported and incorporated into development activities, and (iv) (iv) adequate public open space is provided, including for recreational activities and associated infrastructure, and (v) the use of the surf zone is considered	YES	The CMP gives effect to this management objective through the management actions proposed in Sections 4. A subsequent CMP proposed for completion in 2021 for the entire Newcastle coast is expected to further consider these objectives for the broader Newcastle LGA area.
(b)	to accommodate both urbanised and natural stretches of coastline	YES	The CMP gives effect to this management objective through the management actions proposed in Section 4, including a strong focus on the provision of a natural foreshore adjacent to residential areas.

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CCL 23/06/2020 - ENDORSEMENT OF THE DRAFT STOCKTON COASTAL MANAGEMENT PROGRAM

ITEM-30	**Attachment E:**	Public Exhibition Outcomes Report – Stockton CMP Supporting Document G.

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Supporting Documentation G.

Public Exhibition Outcomes Report

City of Newcastle

Supporting Document G – Submissions Response Tables

The draft Stockton CMP was publicly exhibited from a 28 day period from 13 May to 10 June 2020. 155 community submissions were received, and 19 agency submissions were received. CN consulted with various agency stakeholders throughout the exhibition period and received correspondence from these agencies which have been considered in the final draft Stockton CMP.

An outline of the key issues raised from submissions received during the public exhibition period, and CN's response to the issues identified, are outlined in Table 1 below.

Table 1: Overview of community submissions themes and issues identified in response to the Draft Stockton CMP.

THEMES	Cost	Greater diversity of community representation	Environmental Impact	Funding not included in business case	Further Technical Investigations	Groyne and Offshore Barriers	Improvements Required	Increased Parking	Maintaining Beach Profile	Approvals Process needs to be Fast-Tracked
Alternative Protection Works					1	31	4		2	
Community Representation		2					2		1	
Consultants					1		2			
Cost-Benefit Analysis	2						3			
Mass Nourishment	11		4	26	8	6	32		2	39
No Seawalls							1		2	1
Rates	1									
Rates Reduction										
Recreational Assets			2				11		1	
Roads and Parking							2	1		
Strategic direction							1			
Grand Total	**14**	**2**	**6**	**26**	**10**	**37**	**58**	**1**	**8**	**40**
	5%	1%	2%	9%	3%	14%	21%	0%	3%	15%

Table 2: Continued overview of community submissions themes and issues identified in response to the Draft Stockton CMP.

Opportunistic Sand Sources	Desire for Port of Newcastle expanded responsibility	Reduced Property Value	Remove Tank Traps	Road Closure	Seawalls	Social impact of trucking sand	Submission has not referred to supporting documentation	Grand Total	Sub Total	
					12		3	55	54	20%
								5	5	2%
							2	6	5	2%
								5	5	2%
33	9				5	1	2	239	178	65%
								5	4	1%
								2	1	0%
		1						1	1	0%
			2					17	16	6%
				1				4	4	1%
								1	1	0%
33	**9**	**1**	**2**	**1**	**17**	**1**	**7**	**340**	**274**	
12%	3%	0%	1%	0%	6%	0%	3%			

A further analysis of the geographic locations City of Newcastle received submissions from was undertaken and the results are outlined in Table 3 below.

Table 3: Overview of the geographic location of community submissions received in response to the draft Stockton CMP

Suburb	Stockton	Wider NSW	Unknown
Cost	13	1	
Greater diversity of community representation	2	0	
Environmental Impact	5	1	
Funding not included in business case	25	1	
Further Technical Investigations	10	0	
Groyne and Offshore Barriers	27	10	
Improvements Required	55	2	1
Increased Parking	1	0	
Maintaining Beach Profile	4	4	
Mass Nourishment Approvals Process needs to be Fast-Tracked	38	2	
Opportunistic Sand Sources	32	1	
Desire for Port of Newcastle expanded responsibility	8	0	1
Reduced Property Value	1	0	
Remove Tank Traps	2	0	
Road Closure	1	0	
Seawalls	16	1	
Social impact of trucking sand	1	0	
Submission has not referred to supporting documentation	7	0	
Grand Total	**248**	**24**	**2**

The key themes raised within agency submissions are where the corresponding changes have been made within the CMP and are detailed below.

Table 4 – Key themes raised within agency submissions comments and where corresponding changes have been made within the CMP.

CMP Section	Clarification of Roles and Responsibilities	Clarification of Coastal Management Strategy	Clarification of approval and assessment considerations	Clarification of funding	Extra information required from Supporting Documentation	Information added for clarity	New offshore sand source information	New action required
Executive Summary		✓	✓					
1.2		✓						
1.3	✓			✓	✓			
1.4	✓							
2.1.1					✓	✓		
2.3.2					✓			
2.4						✓		
2.4.5					✓			
3.1					✓			
3.2			✓		✓			
3.3						✓		
3.3.2					✓			
3.4		✓			✓			
3.5		✓			✓		✓	
4.1		✓	✓		✓	✓		
4.2	✓							
Table 9	✓	✓		✓				✓
Table 10	✓							
Table 13								✓
5						✓		
6.1			✓	✓		✓		
6.2	✓				✓			
6.3.2	✓			✓				
Table 15	✓	✓		✓	✓	✓		✓
CZEAS						✓		

The CMP was amended to respond to any suggested changes, the number of ticks below indicate the level of changes required to be made to the section within the CMP. A reference to '0' specifies there were no changes made to this section of the CMP.

Table 5 – Changes made to the CMP in response to comments.

	Agency	Community
Executive Summary	✓	0
1.2	✓	0
1.3	✓	0
1.4	✓	0
2.1.1	✓	✓
2.3.2	0	✓
2.4	✓	0
2.4.5	✓	✓
3.1	✓	0
3.2	✓	0
3.3	✓	0
3.3.2	✓	0
3.4	✓	0
3.5	✓	✓
4.1	✓✓✓	✓✓
4.2	✓	✓✓✓
Table 9	✓	0
Table 10	✓	0
Table 13	✓	0
5	✓	✓
6.1	✓	✓
6.2	✓	✓
6.3.2	✓	✓
Table 15	✓	0
CZEAS	✓	0

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CCL 23/06/2020 - ENDORSEMENT OF THE DRAFT STOCKTON COASTAL MANAGEMENT PROGRAM

ITEM-30	**Attachment F:**	Stage 2 Coastal Management Program Sediment Transport Study and Probabilistic Hazard Assessment (Bluecoast, 2020) – Stockton CMP Supporting Document C.

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Supporting Documentation C.

Stage 2 Reports – Sediment Transport Study and Probabilistic Hazard Assessment Summary (Bluecoast 2020, 2020a)

City of Newcastle

City of Newcastle

Sediment transport study within Stockton Bight

Report #: P19028_PartA-StocktonBightStudy_TN0.0A

18 June 2020

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Technical Note

To:	City of Newcastle
From:	Evan Watterson, Holly Watson and Heiko Loehr
Review:	Evan Watterson
Reference:	P19028_PartA-StocktonBightStudy_TN3.0
Date:	18 June 2020
Subject:	Long-term loss of sand from Stockton Beach and other relevant findings from the Stockton Bight sediment transport study to inform the Stockton Coastal Management Program

1 Introduction

Bluecoast Consulting Engineers were engaged by the City of Newcastle (CN) to prepare a sediment transport study of the entire Stockton Bight. This was identified as a knowledge gap in the Scoping Study undertaken as part of Stage 1 of the Newcastle Coastal Management Program (CMP) (CN, 2019). The sediment transport investigation is a technical study under Stage 2 of the CMP processes. It is intended to inform the development of a Newcastle-wide CMP for the higher-risk area of Stockton Beach. Due to a time constraint imposed by Ministerial direction to complete the Stockton CMP by 30 June 2020, CN are preparing a CMP specifically for Stockton Beach. The area included in the Stockton CMP is the area north of the Stockton Breakwater (northern training wall of the Hunter River) to Meredith Street.

The Stockton Beach CMP is being prepared in line with the Coastal Management Act 2016 and the NSW Coastal Management Manual Part A (the Manual). This technical note describes the elements of the sediment transport study undertaken to-date that inform the Stockton Beach CMP.

The Stockton Bight sediment transport study, in its entirety, is expected to be completed by July 2020 for inclusion in Newcastle CMP which will include the full extent from Stockton Breakwater to the LGA boundary. The full study will involve:

- critical review of previous literature on coastal processes in Stockton Bight
- compilation and review of all available data sets, including:
    - metocean data
    - sediment grain size distribution
    - bathymetric, beach and topographic survey
    - geophysical and geotechnical data
- geological and geomorphic description of the Bight, including the sand dunes

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- volumetric analysis of beach and bathymetric surveys to establish observed historical changes in sand volumes
- development of a quantified conceptual sediment transport model to explain the sediment budget and movement of sediments within the Stockton Bight compartment.

The history of long-term sand loss from the coastal profile at Stockton Beach is considered a pivotal piece of information. This key element of the sediment transport study was brought forward along with the following to inform the Stockton CMP:

- a timeline of key anthropogenic changes
- metocean conditions effecting Stockton Beach
- a summary of coastal management issues based on work completed to-date.

2 Statement of assumptions and uncertainty

The approach developed herein is reasonable and valid for estimating the long-term sand loss rate from the coastal profile in the CMP area. However, it is important that decision-makers recognise the assumptions underlining the estimates as well as the inherent uncertainties. The key assumptions and uncertainties in this assessment relate to the comparative volumetric analysis of available survey data. The estimated sand loss rates are therefore subject to the accuracy of these surveys, noting that most recent surveys are more accurate.

It is further recommended that CN:

- communicate the assumptions and uncertainties to the community and stakeholders
- seek to reduce the number of assumptions and degree of uncertainty through the completion of the Stockton Bight sediment transport study
- seek to reduce the degree of uncertainty through on-going monitoring of the full coastal profile at Stockton, nearshore coastal processes (wave, currents etc) and sand movements (e.g. trial groynes or similar).

3 Summary of coastal management issues

Stockton Beach and the adjacent Hunter River has been continually modified over the course of European settlement. Modifications that have impacted the beach response include the construction of the Hunter River breakwaters, capital and maintenance dredging of the navigation channel, revetment construction, beach nourishment, beach scraping and temporary and emergency protection works.

Stockton Beach has been the subject of numerous studies to assess coastal processes. However, further investigation has been identified as being required to underpin the identification of appropriate options for management of coastal hazards on the Stockton coastline. Based on the Stage 2 sediment transport studies completed at this time, a summary of the most relevant processes is provided below.

A key knowledge gap identified in the Scoping Study (CN, 2019) was to determine the changes in the sub-aqueous part of the coastal profile. An assessment of the change in the sand volume in the Stockton Beach area was undertaken. This assessment considered both the sub-aqueous and sub-aerial changes. The combined rate of long-term sand loss from the Stockton CMP area is recommended as 112,000m^3/yr, which is based on the historical observations of:

- 100,000m^3/yr of sand loss from the sub-aqueous part of the coastal profile in the southern Stockton embayment between the northern breakwater and Fort Wallace (inshore of 20m depth contour) between 1988 and 2018.
- 12,000m^3/yr of sand loss from sub-aerial part of the coastal profile in Block A, Block B and Block C between 1985 and 2020.

This rate of sand loss is significantly greater than previously estimated and has implications for the on-going management of the coastal erosion issue at Stockton Beach. Given the long-term nature of the sand loss (i.e. not cyclic) and the accelerated rate of loss observed since the channel deepening project was completed in 1983, the most likely cause is the development and operation of the port within the Hunter River (i.e. breakwater construction and capital and maintenance dredging). However, it is noted that there are other possible causes for the observed erosion that will require further consideration and assessment as part of the Stockton Bight sediment transport study.

Further investigations are required to review the key coastal processes and quantify the sediment pathways that adequately explain these observations. A robust understanding of these processes is fundamental to developing coastal management options. It is recommended that long-term plans for Stockton Beach are reviewed once the sediment transport study is completed.

4 Key anthropogenic influences

A summary of the key anthropogenic influences on the coastal processes at the study site is given by:

1818 The construction of the Macquarie Pier linking Nobbys to the mainland is commenced.

1846 Macquarie Pier completed, but continually breached by storms and wave action.

1859 Continuous dredging began using ladder dredges to remove mud, sand and surface rock.

1861 Work began on Private Point breakwater at the tip of Stockton peninsula (or sand spit). Work was completed by 1866.

1875 First breakwater extension beyond Nobbys. Work was completed by 1883.

1875 Extension to Private Point breakwater. Completed by 1896.

1898 Work began on new northern breakwater, later known as Shipwreck Walk in recognition of the wrecked vessels that were incorporated into the construction.

1941 Dredging at the entrance of the harbour increases depths to 24 feet 6 inches (~7.5 meters).

1952 Dutch dredge carried out contract dredging 2,000,000 cubic yards (~1.5M cubic meters) of material.

1955 Almost 3,500,000 tons of silt and sand removed from Newcastle Harbour and the lower reaches of the Hunter River.

1962 Between 1962 and 1966 approximately 450,000 cubic meters of rock and 620,000 cubic meters of soft sediment were dredged. While most of the material was disposed offshore some of the dredged sand was placed on Stockton Beach via a pipeline (DHI, 2006).

1977 Contract 76/2 was awarded to Westham Dredging for works required to deepen the harbour approaches to 17.7 meters and the harbour channels to 15.2 meters. Works were completed by 1983 and included the removal of approximately 2 million cubic meters of rock and over 8 million cubic meters of sand and clay was dredged from the main entrance to the port and dumped offshore for a total cost of $103,300,000 (NPC, 2014). A special harbour levy of $1 per tonne on overseas exports of coal and interstate imports of iron ore used to fund the cost of channel deepening.

1989 The rock revetment at Mitchell Street was constructed. This structure protects shoreward assets and property for approximately 600m of shoreline in the southern Stockton embayment. A geotextile sandbag wall was also constructed in front of the SLSC club.

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2005 Maintenance dredging of 153,000 cubic meters of sand was dredged from the harbour entrance areas using *TSHD Brisbane* and dumped offshore (DHI, 2006).

2016 The rock revetment fronting the SLSC was constructed. This structure protects shoreward assets for approximately 145m of shoreline in the southern Stockton embayment.

Given their relevance to sediment budgets at Stockton Beach, this summary highlights key activities related to the development and operations of the port within Newcastle Harbour. The beach nourishment volumes placed at Stockton Beach nearshore area during recent years is discussed in Section 5.1.1.

5 Long-term loss of sand from Stockton Beach

A key knowledge gap identified in the Scoping Study (CN, 2019) was to determine the changes in the sub-aqueous part of the coastal profile. The coastal profile is the part of the cross-shore profile that is highly dynamic largely due to the action of waves, as well as tide, wave-driven currents and wind. The coastal profile can be divided into several zones, herein we will discuss the sub-aerial part (i.e. the land-based part above 0m AHD) and of the sub-aqueous part (i.e. the part below the water approximated by 0m AHD).

An assessment of the change in the sand volume in the Stockton Beach area was undertaken. This assessment considered both the:

- Sub-aqueous part of the profile using historical bathymetric surveys from the period from 1866 to 2018, which was deemed to have reliable data (see Table 8, Attachment A).
- Sub-aerial part of the profile using the NSW beach profile dataset for the period from 1953 to 2020 (see Table 8, Attachment A).

5.1 Sub-aqueous sand losses

To determine the changes in the sub-aqueous zone, the sand volume relative to the 2018 survey was calculated for each survey. Where survey coverage allowed volumes were determined for the compartments shown in Figure 2. A timeseries showing the sub-aqueous sand volume change in compartment 4 and compartment 5 offshore of Stockton Beach is shown in Figure 1. Sand volumes are provided in Table 1.

The observations show a long-term trend of sand loss from the sub-aqueous part of the coastal profile. Over the 152-year record, over 8 million cubic meters of sand has been lost from compartments 4 and 5. Using linear regression this is equivalent to a long-term rate of approximately 76,000m^3/yr. Until 1988 the rate of sand loss, as determined by linear

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regression, was 70,000m^3/yr. Since 1988 the rate of loss has increased to just over 100,000m^3/yr. While not presented herein, a similar magnitude of sand loss has been observed to the north in compartments 6 and 7.

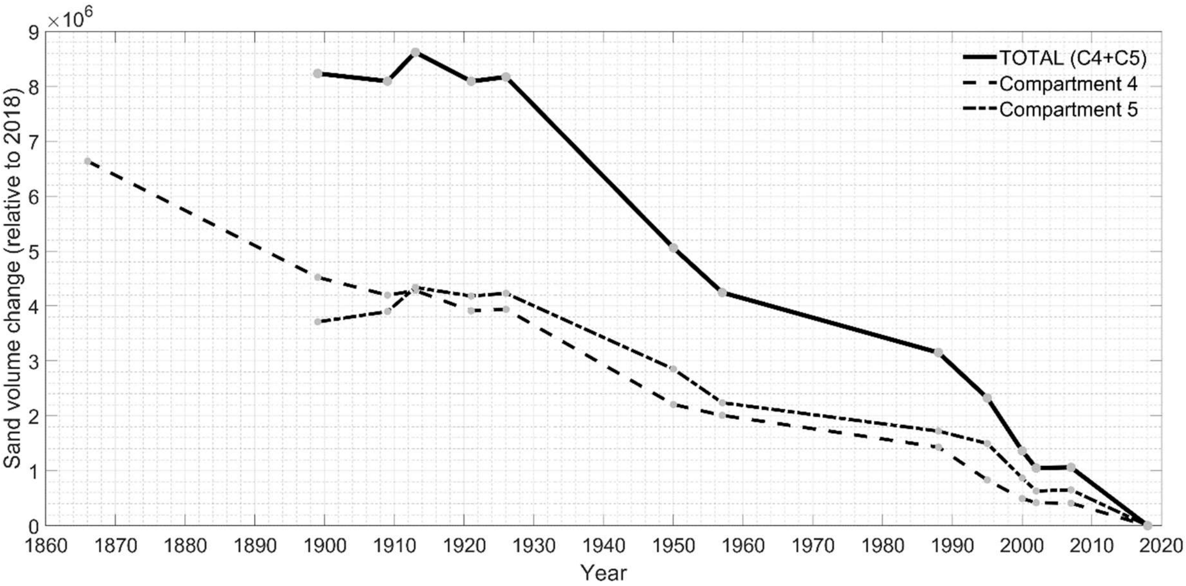

Figure 1: Long-term sand volume change at Stockton Beach (Compartments 4 and 5).

Table 1: Cubic meters of sand relative to 2018 seabed levels in compartments 4 and 5.

Year of survey	Compartment 4	Compartment 5	Sum of compartment 4 and 5
	Area = 2,211,858m^2	Area = 1,642,237m^2	(sub-aqueous)
1866	6,635,863	na	na
1899	4,5217,95	3,710,343	8,232,138
1909	4,1960,72	3,897,621	8,093,692
1913	4,2809,22	4,338,313	8,619,235
1921	3,910,804	4,180,107	8,090,911
1926	3,938,704	4,230,474	8,169,178
1950	2,206,424	2,850,520	5,056,944
1957	2,006,998	2,237,630	4,244,627
1988	1,429,336	1,721,124	3,150,461
1995	829,893	1,494,680	2,324,573
2000	493,237	867,584	1,360,820
2002	417,654	630,852	1,048,507
2007	409,488	651,785	1,061,274
2018	0	0	0

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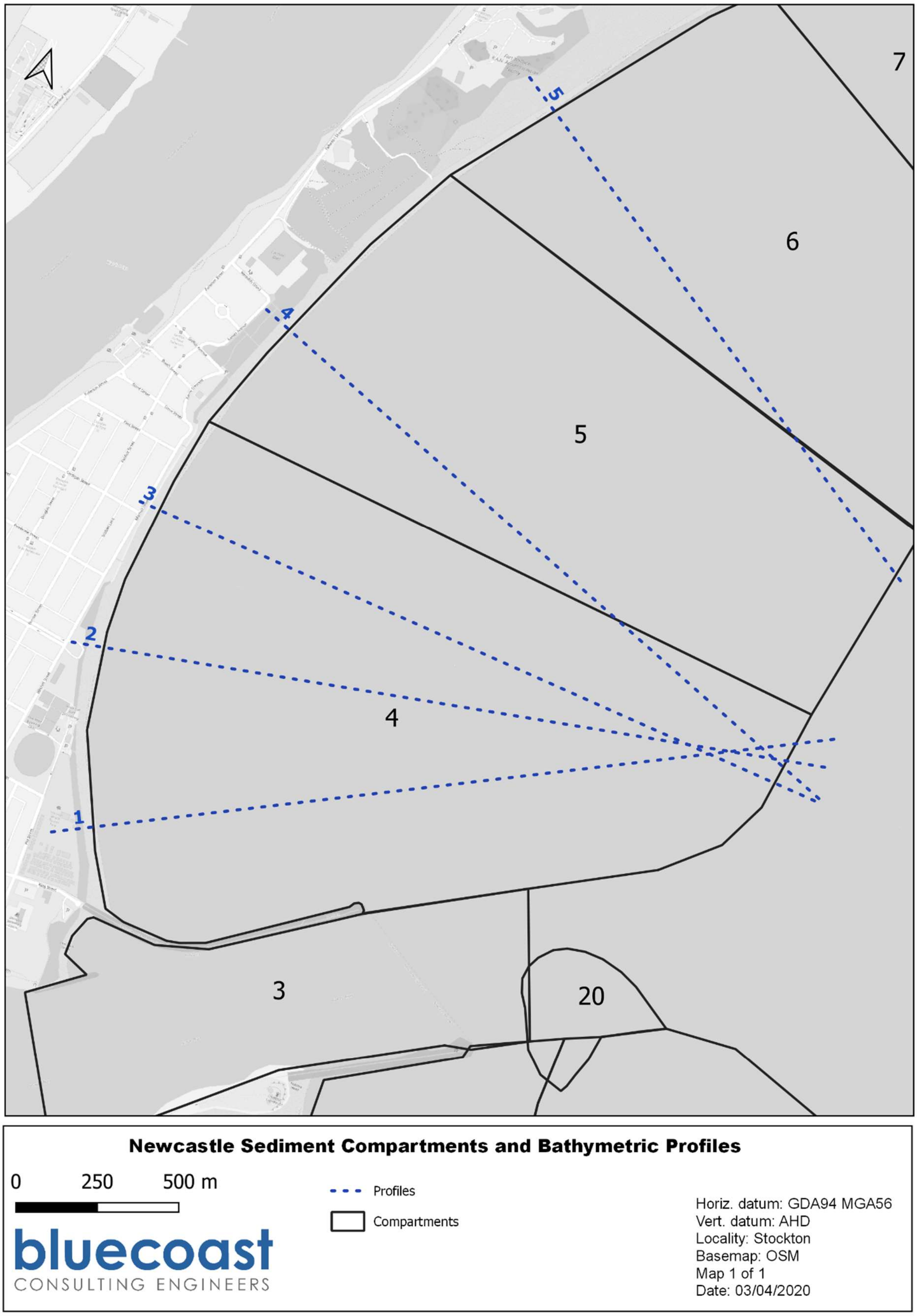

Figure 2: Sediment compartments and coastal profiles in the Stockton Beach area.

5.1.1 Accounting for sand placement activities

The sand volume changes presented in Figure 1 and Table 1 are based on the bathymetric surveys only, they do not consider any sand placed in the compartments as part of beach nourishment efforts.

The Port of Newcastle (PoN)[1] are responsible for maintaining safe depths in the port's navigation channel. This requires maintenance dredging of significant annual quantities of silts and sands (~500,000m^3/yr) from the port's channels. A small proportion of this material is sand dredged from Area E (the port entrance), which PoN place in the nearshore area of Stockton Beach as a beneficial reuse of the dredged material. This sand is placed within an area prescribed by then NSW Office of Environment and Heritage (now DPIE). The placement area is within compartments 4 and 5. The remainder of the maintenance material dredged from the port channels is dumped offshore.

Table 2 presents the known sand nourishment volumes[2] placed in compartment 4 or 5 from Area E. Based on the quantities in the table, approximately 34,000m^3/yr of sand was placed in compartment 4 and 5 between 2009 and 2019. Had this sand not been placed as beach nourishment the rate of sand loss from these compartments would have been higher (i.e. approximately 100,000m^3/yr + 34,000m^3/yr).

It is unclear if beach nourishment placements were carried out prior to 2009 although there is reference to some sand placements in the 1960s. It is known that in May 2005, approximately 150,000 cubic meters of sand from Area A was dredged and dumped offshore (WorleyParsons, 2009) without any additional sand placements on Stockton Beach. Between 1979 and 1983, capital dredging was undertaken to deepen the channel. Approximately 2 million cubic meters of rock and 8 million cubic meters of sand and clay was dredged from the main entrance to the port and dumped offshore for a total cost of $103,300,000 (NPC, 2014). It is also understood that no sand was placed on Stockton Beach during these capital dredging works but further clarification should be sort from the relevant authorities.

Table 2: Cubic meters of beach nourishment sand placed in compartments 4 and 5 because of port operations.

---

[1] Prior to 2014, the Newcastle Port Corporation (NPC) were responsible for the operations of the port, including channel maintenance dredging.

[2] The volumes presented in this table have been sourced from various sources including records from PoN. However, the table may not present a complete and accurate picture and sand volumes placed at Stockton Beach. It is important that efforts are made to ensure full and accurate records are obtained from the relevant authorities such that coastal management can be properly informed.

Year	Sand volume placed at Stockton (m^3)
2009/2010	130,000*
2010-2011	unknown
2012	9,233
2013	29,845
2014	6,309
2015	58,280
2016	27,945
2017	25,839
2018	25,542
2019	30,958**
TOTAL	**343,951**

*Volume sourced from WorleyParsons (2012).
**In December 2019 approximately 3,500m^3 of nourishment material that had been sourced from local quarries and was placed on the upper beach at the southern end of Stockton Beach. This was undertaken as part of a pilot study. Sand sourced from local quarries is finer grained that the native beach sand. This effective sand trial volume has been added to the volume placed by PoN.

5.1.2 Comparisons to previous studies

WBM (1998) presented a volume for one million cubic meters as the net loss of sand from the 3km of beach north of the breakwaters for the period between 1957 to 1995. This is equivalent to a sand loss rate of approximately 26,500m^3/yr. The 3km alongshore extent is similar to that of compartments 4 and 5 but the WBM (1998) sand loss rate is only half of that value that can be obtained from the volumes in Table 1 for the equivalent period. The reason for the difference in the estimated sand loss rates is unknown but may be due to the cross-shore extent of the surveyed area used by WBM.

Umwelt (2002) undertook a comprehensive analysis of historical bathymetric surveys to estimate sand loss rates for two areas (Area 1 and Area 2). Area 2 extends alongshore from the northern breakwater to south of Fort Wallace (see Figure 3) and is similar in extent to the combined area of compartment 4 and 5. Umwelt estimated Area 2 to experience an average sand loss rate of:

- 1921 to 2000: 67,000m^3/yr
- 1988 to 2000: 370,000m^3/yr

The long-term loss rate calculated by Umwelt for Area 2 is consistent with the sand loss rate from 1866 to 1988 calculated herein (70,000m^3/yr). However, the rate of 370,000m^3/yr given for the period from 1988 to 2000 is much higher than the rate of 100,000m^3/yr estimated herein for the period between 1988 and 2018. It is noted that the lower rate presented herein does not discount the beach nourishment quantities. However, when these are included (i.e. equivalent loss rates of 134,000m^3/yr) the rates are still lower than Umwelt's 1998 to 2000 rate and the difference is likely due to the shorter period of the analysis using the data available at the time of Umwelt's 2002 report.

DHI (2006) analysed bathymetry surveys from 1995, 2000 and 2002 and presented survey difference plots that showed erosion occurring in the surf zone, similar to the patterns presented below in Section 5.4. While no volumetric analysis was presented in DHI (2006), that report did refer to the sand loss volumes and rates provided in the Umwelt (2002) report. Sand loss rates from Umwelt's Area 1 were used by DHI to justify the calculated net northward alongshore sediment transport rates of 20,000 to 30,000m^3/yr for the period between 1866 and 2004. However, it is recommended that littoral drift rates and the sediment pathways and fluxes calculated by DHI (2006), see Figure 26, be revisited based on the volumetric analysis completed herein.

Figure 3: Sand loss analysis areas used in the Umwelt (2002) report – (left) Area 1 and (right) Area 2.

5.2 Sub-aerial sand losses

Based on beach profile data from the NSW photogrammetry database, Figure 4 presents a timeseries of sub-aerial beach volumes for Stockton Block A, B and C (see Figure 5). Similar to sub-aqueous extents, the Stockton CMP area (i.e. northern breakwater to Meredith Street) is conservatively considered to cover Block A, Block B and Block C. Between 1985 and 2020 the combined beach volume in these blocks has reduced by approximately 420,000m^3, an average loss rate of 12,000m^3/yr.

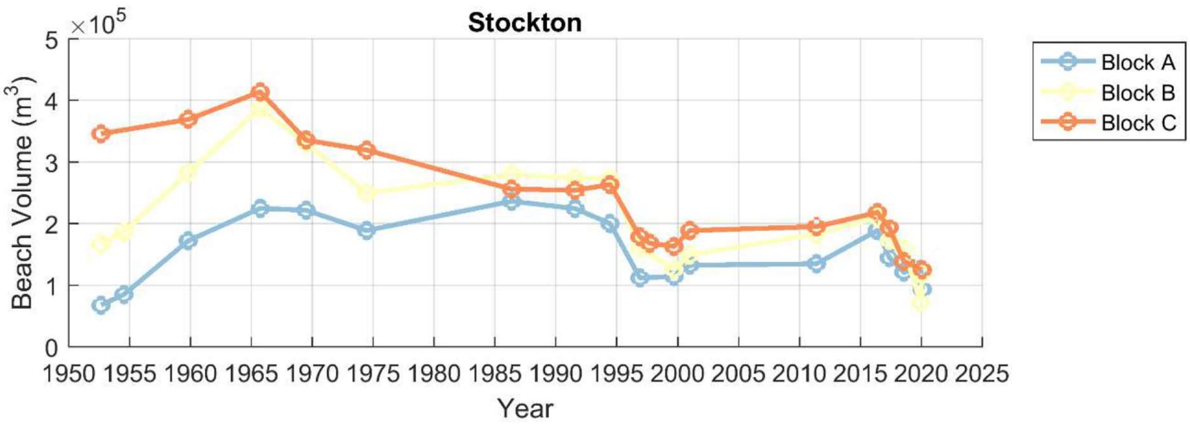

Figure 4: Timeseries of sub-aerial beach volumes for Stockton Block A to C.

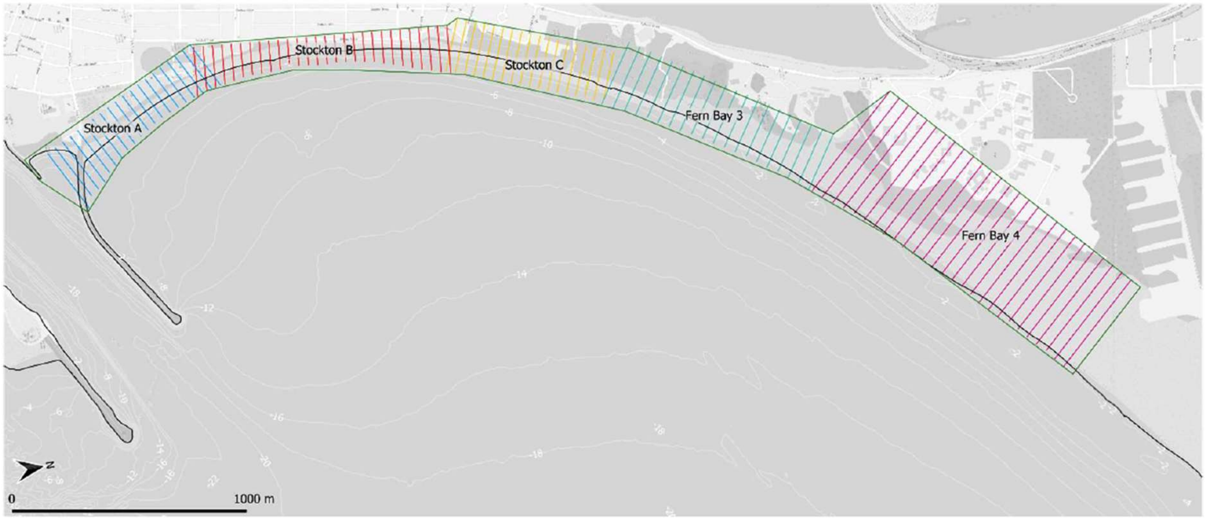

Figure 5: NSW photogrammetry blocks and profiles (coloured lines) at Stockton Beach.

5.3 Combined coastal profile sand losses

The combined rate of long-term sand loss from the Stockton CMP area was estimated to be 112,000m^3/yr, which is based on the historical observations of:

- 100,000m^3/yr of sand loss from sub-aqueous part of the coastal profile in compartments 4 and 5 between 1988 and 2018; and
- 12,000m^3/yr of sand loss from sub-aerial part of the coastal profile in Block A, B and C between 1985 and 2020.

Due to the alongshore extents selected, some conservativism is built into these numbers. However, the beach nourishment quantities delivered by port operations have not been discounted and if these placement activities were to cease the sand loss rates would be higher.

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5.4 Pattern of sub-aqueous losses

To examine the pattern of sub-aqueous sand loss at Stockton Beach, the following analysis results are provided:

- Maps of the changes in seabed levels relative to 2018 were produced for selected surveys and are shown in Figure 6 to Figure 9. In these maps, red indicates areas where the seabed has lowered, either by erosion (e.g. Stockton Beach) or by port dredging (e.g. entrance channel). Blue areas indicate areas of accretion. Areas of accretion are either formed by deposition of sediment (e.g. accumulation of littoral drift in the 'sediment trap' created by the port dredging – see compartment 20) or by sand placement activities (e.g. the effect of the beach nourishment placements that can be observed in compartment 4).
- Plots of the coastal profiles observed in the surveys at profile 3 and profile 4 (see Figure 2) along with the survey differences relative to 2018 are provided in Figure 10 and Figure 11, respectively.

There are several important features noted in these patterns:

- Erosion of the seabed has predominately occurred on the shallow slope inshore of the ~8m AHD depth contour indicating littoral processes by wave driven currents (i.e. alongshore drift). More work is required to interpret the survey differences but it appears that most of the sand lost from the southern embayment has moved north along the surf zone and shoreline. The erosion is likely to be due to sediment starvation from an interruption in the supply from the updrift coast (south of Hunter River).
- The effect of sand placement from Area E are evident. It is noted, however, that sand placements were undertaken shortly before the 2018 Marine LiDAR being captured. The majority of the approximately 340,000m^3 of sand placed in this area since 2009 is no longer evident in the survey difference maps. The bulk of the material is assumed to have moved onshore and then been transport/dispersed by alongshore and cross shore transport process. However, what is evident in the survey difference maps are two pathways, one indicating sand dispersing to the north-east as well as a second potential pathway along the outer surf zone to the south.
- Erosion of the inner surf zone is still observed in compartment 4 inshore of the dispersed sand nourishment, this may be due to the response of the shoreline to erosion occurring to the north (i.e. realignment of the zeta shaped embayment in response to lack of sediment supply), see Figure 12.
- There has been accretion of the north-eastern aspects of the sand lobe (compartment 1), indicating a sediment pathway from the entrance area offshore to the sand lobe located offshore of Nobbys Head. This sand lobe is likely to have been

formed over 100-1,000’s of years. Accretion of littoral sand in this location in recent years is, however, significant as it indicates a potential additional source of sand for beach nourishment for Stockton Beach under a ‘working with nature’ approach (i.e. keep sediment moving along the coast). Other potential sources of offshore sand for beach nourishment also exist (MEG, 2020) and further investigations are recommended to determine the suitability of each source for this purpose.

The question of accuracy is often raised regarding the use of historical surveys. Bluecoast have reviewed all survey data provided and discarded surveys that appeared inconsistent. We also note that the survey differences observed display a consistent pattern of large differences in discrete areas (rather than small differences over large areas). However, as noted in Section 2, a degree of uncertainty remains in these estimates. Quantification of the uncertainty and other validating line of evidence should be sort from the further studies planned as part of the Stockton Bight sediment study.

Previous studies have suggested that the erosion problem at Stockton Beach was progressively worsening, with significant volumes of sand being permanently lost from the beach system (Umwelt, 2002). Moreover, studies have suggested that the on-going erosion is, at least in part, a result of the cessation of littoral drift past the entrance to the Hunter River and into the southern Stockton Bight compartment. These findings are supported by the analysis of long-term sand losses from Stockton Beach completed herein.

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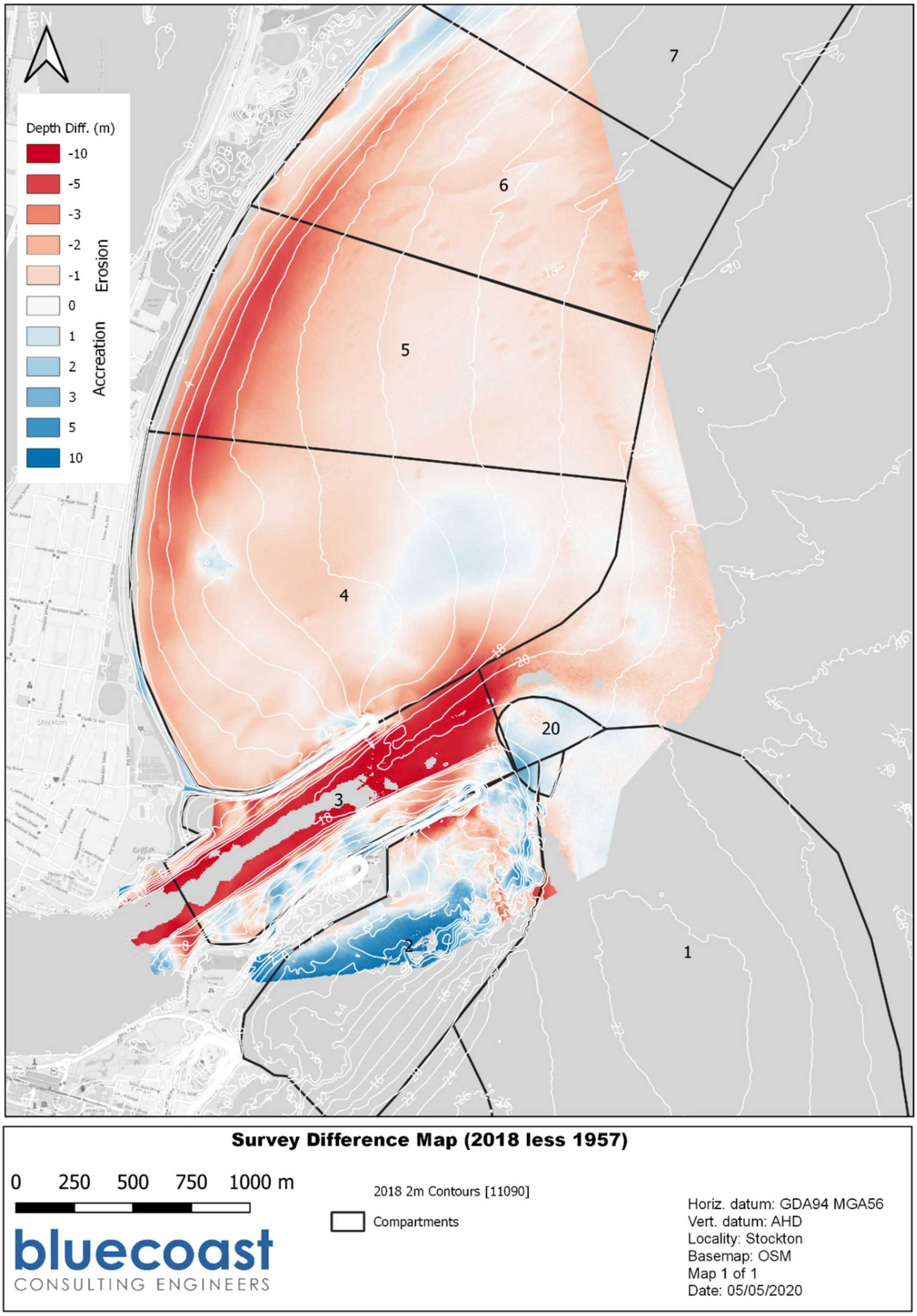

Figure 6: Survey difference map for 1957 relative to 2018.

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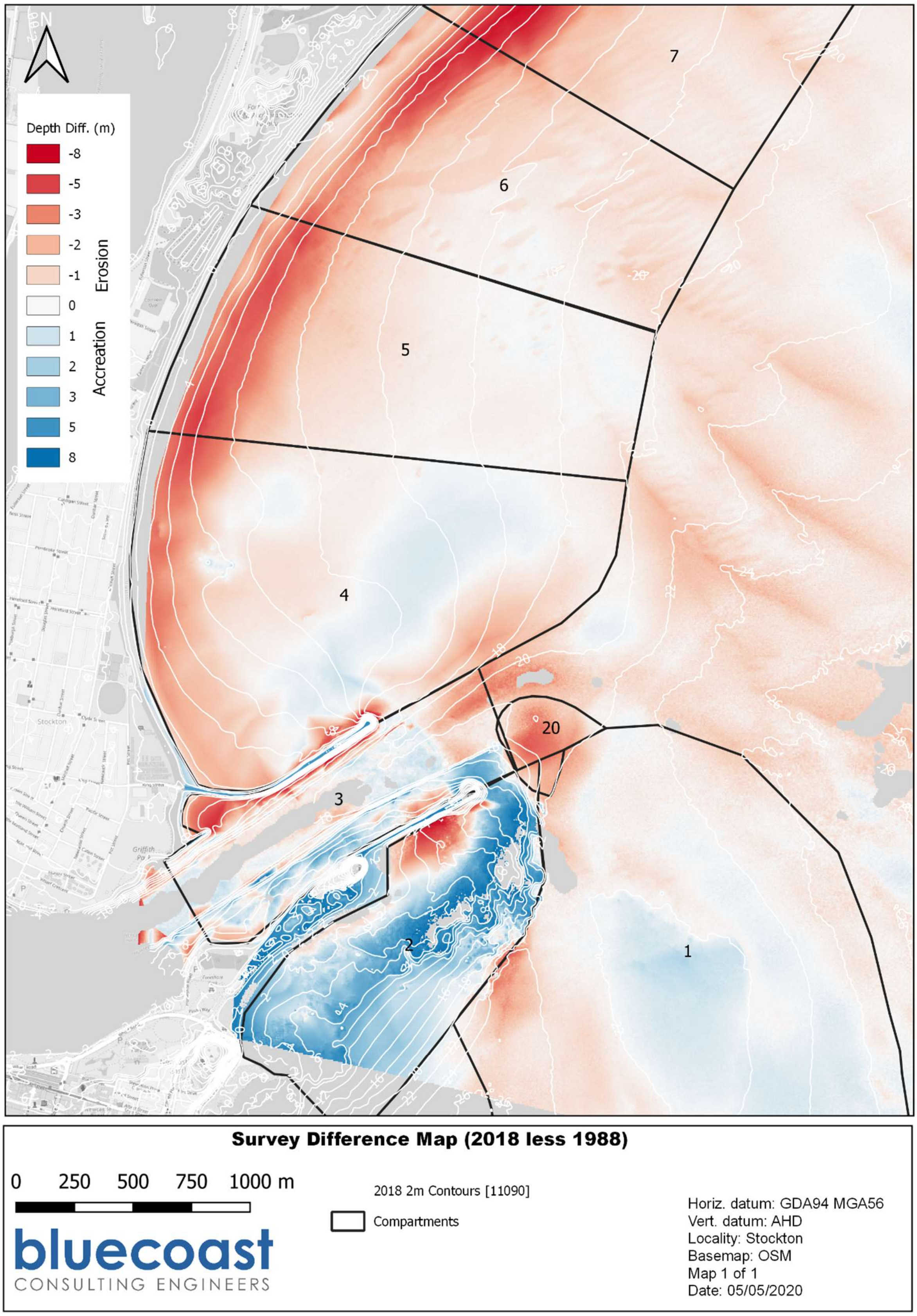

Figure 7: Survey difference map for 1988 relative to 2018.

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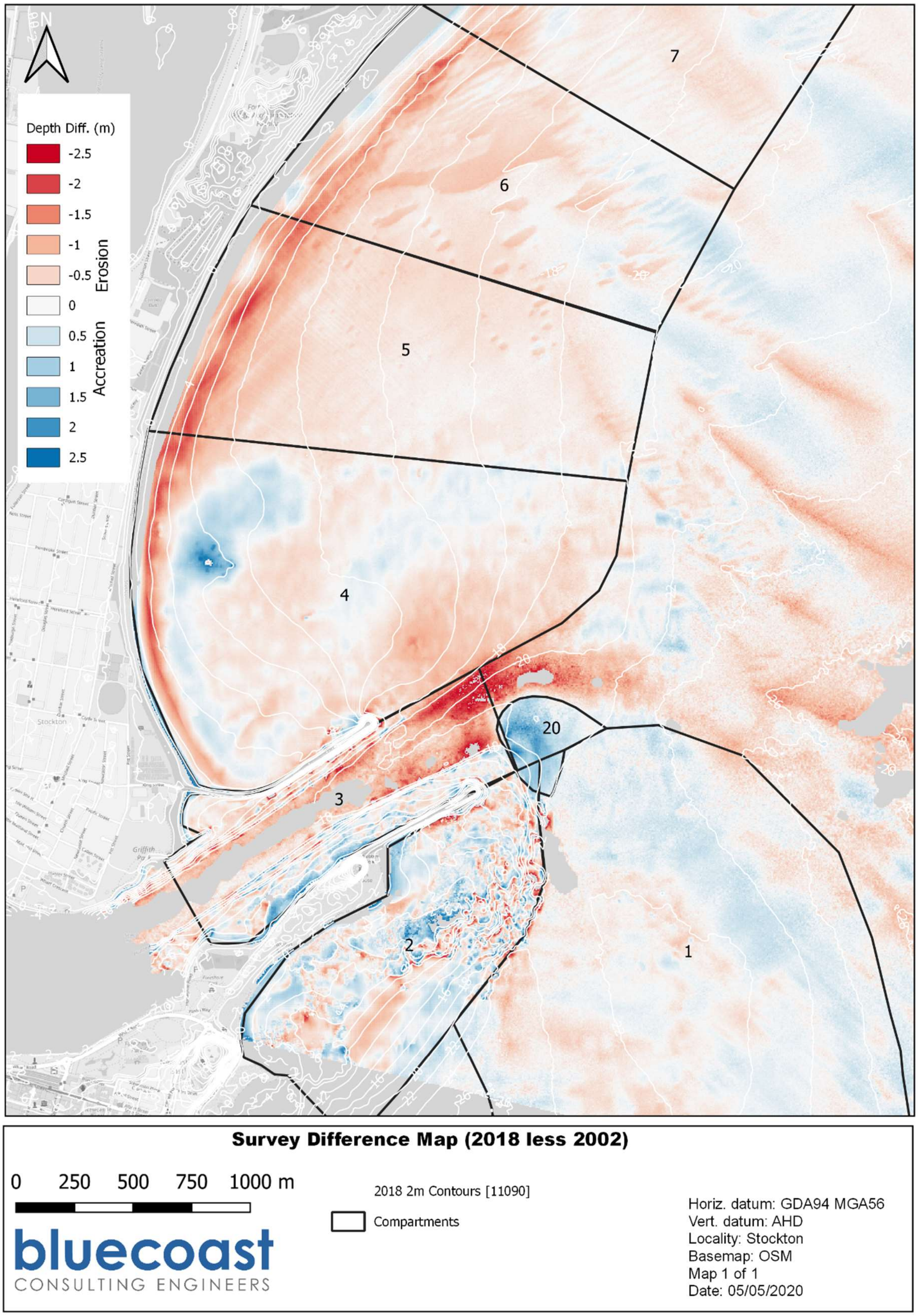

Figure 8: Survey difference map for 2002 relative to 2018.

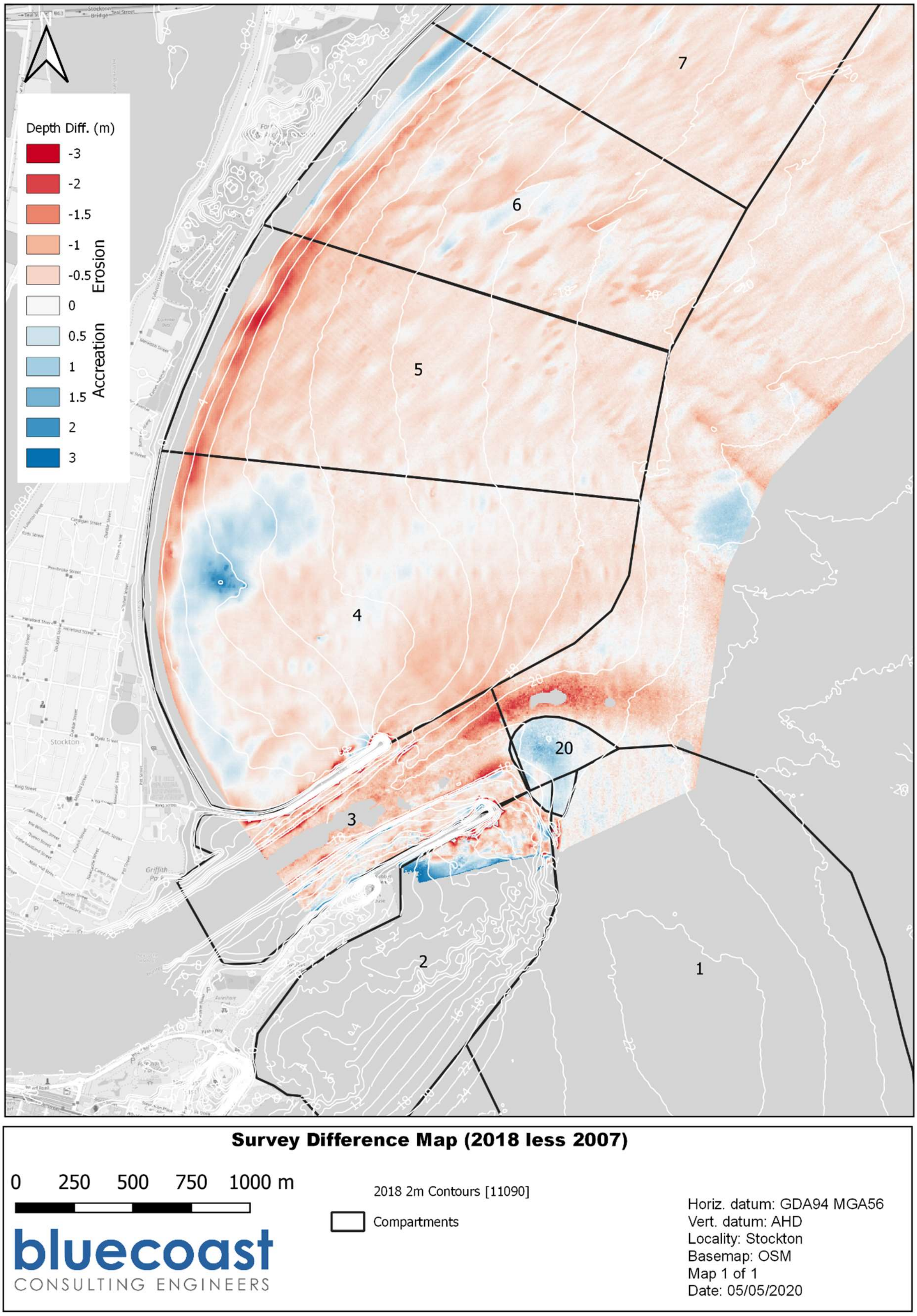

Figure 9: Survey difference map for 2007 relative to 2018.

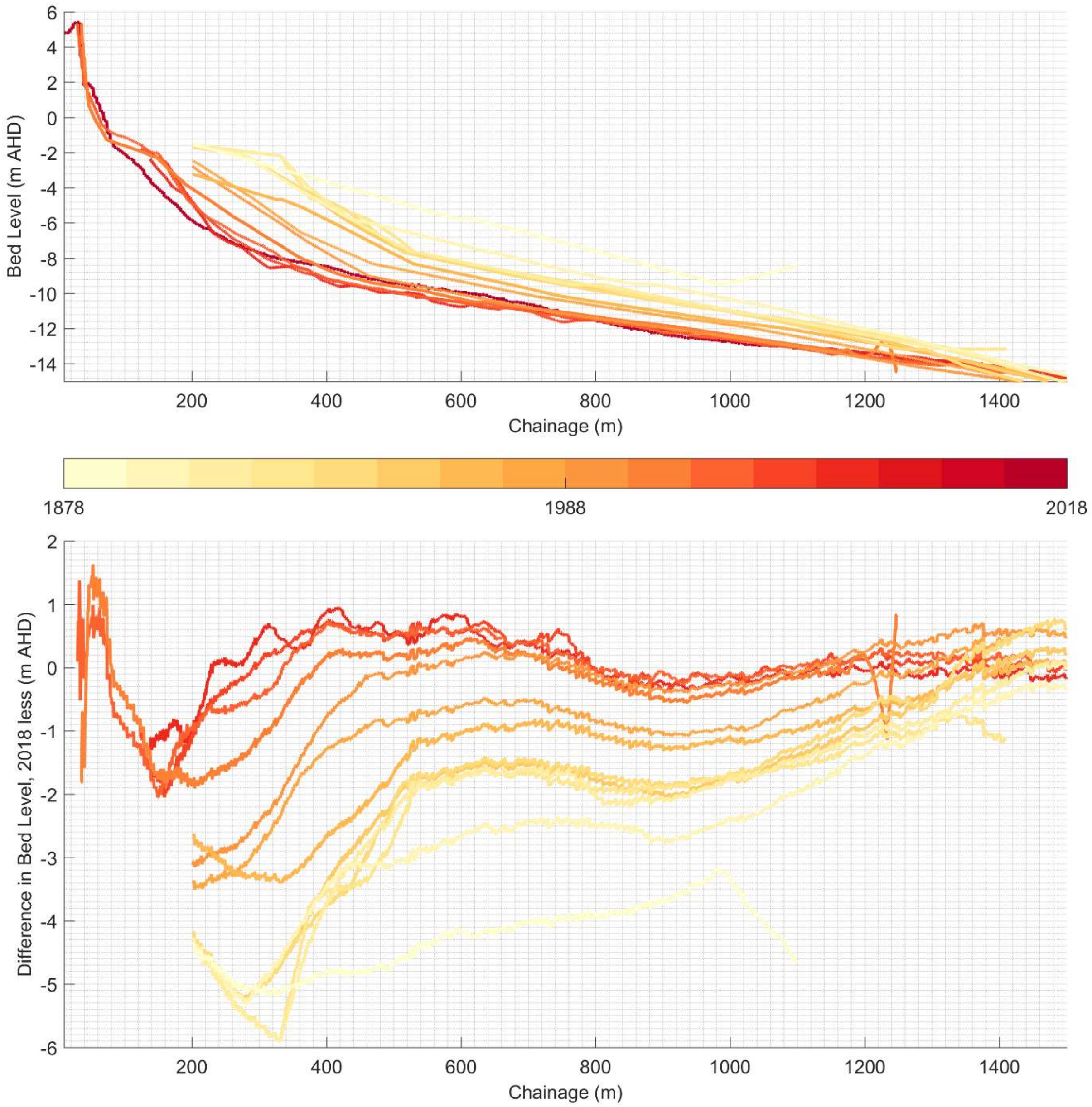

Figure 10: Historical coastal profiles (top) and profile change (bottom) based on historical bathymetric surveys for profile 3.

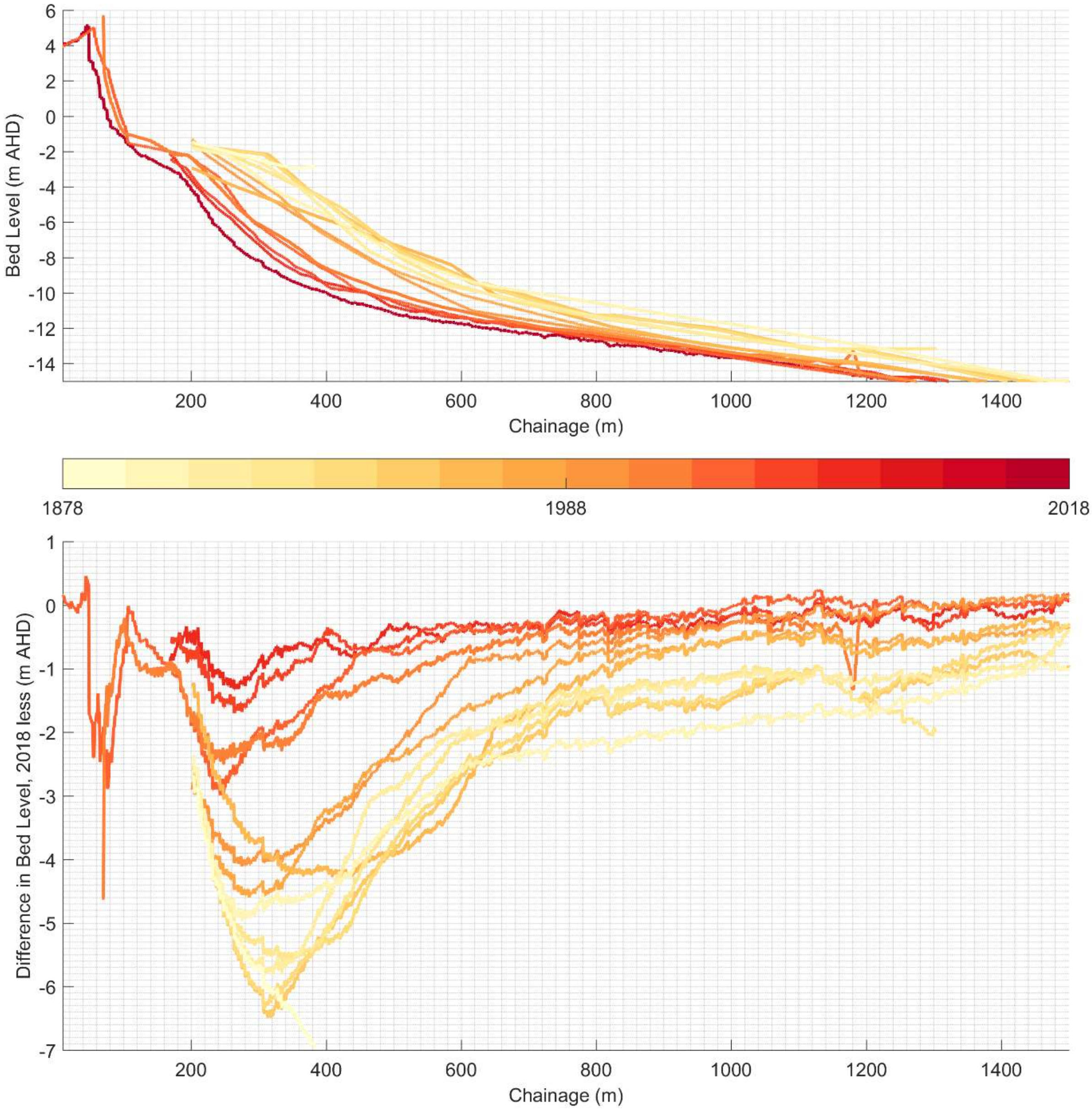

Figure 11: Historical coastal profiles (top) and profile change (bottom) based on historical bathymetric surveys for profile 4.

Figure 12: Mean sea level (0m AHD) shorelines from 2018 (inner) and 1994 (outer) showing realignment of the southern embayment.

6 Metocean setting

This section details the analyses of metocean datasets nearby the Stockton Bight study area. Figure 13 displays the location of the monitoring instruments used within the analysis.

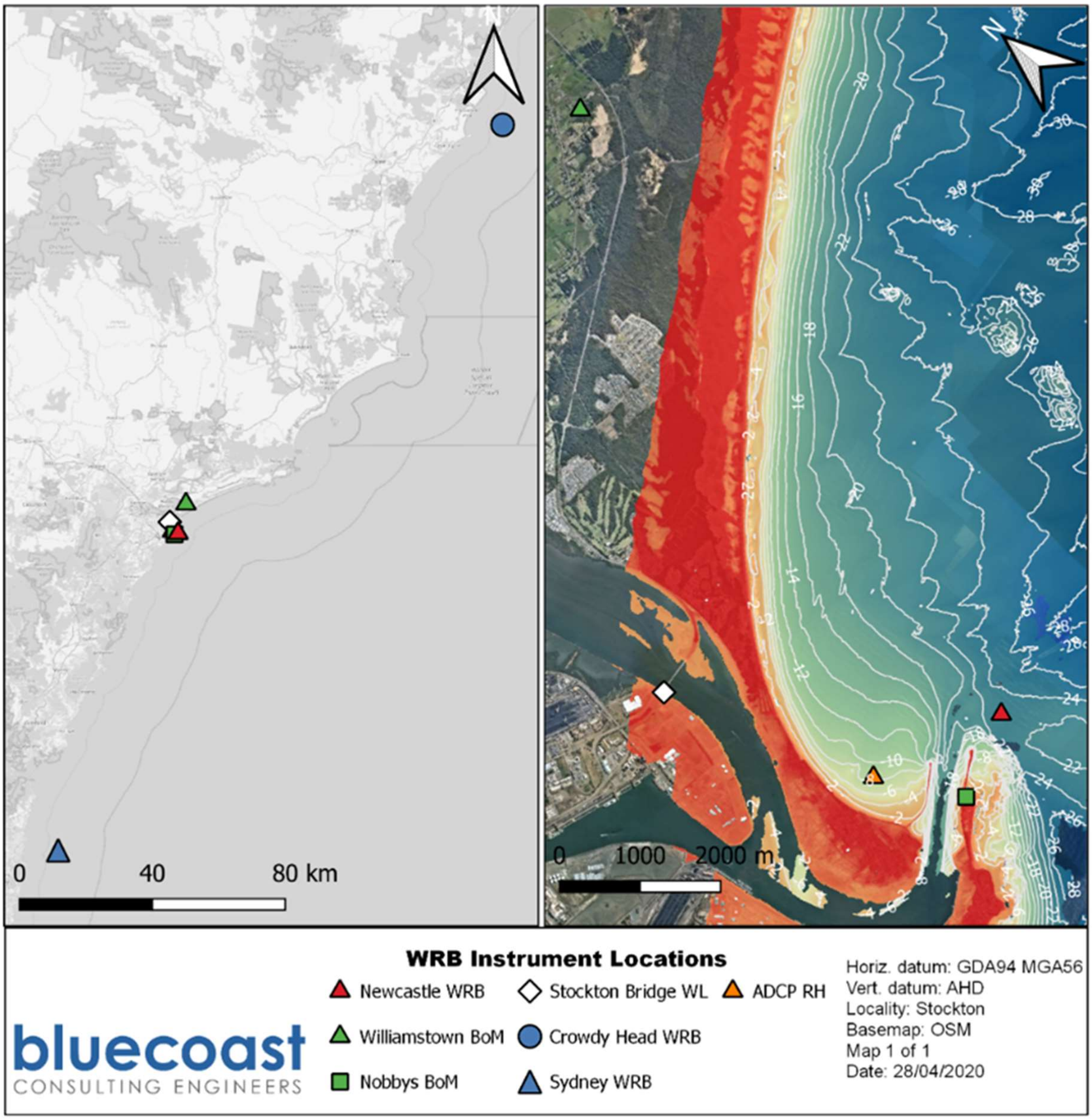

Figure 13: Location of the instruments utilised within the study area and 2018 Marine LiDAR contours.

6.1 Wave climate

The Stockton Bight section of the NSW coastline experiences waves generated from three primary sources: Tasman Sea swells, locally generated wind-waves and waves from East Coast Lows (ECL) systems. At the study site, measured wave data is available from the following directional wave rider buoys (WRBs):

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- Crowdy Head record available from August 2011 to January 2020 (9-years) located 15.5 km to the north of the study site in 79m water depth.
- Sydney record available from March 1992 to January 2020 (28-years) in 90m water depth.
- Newcastle WRB which has data from November 2009 to March 2020 (11-years) and is operated by Port Authority of NSW (PANSW). This WRB is the closest to the study site being located at the entrance to the Hunter River in approximately 22m water depth (see Figure 13).

The average as well as seasonal wave climate statistics for the Newcastle WRB can be seen in Table 3 and the wave roses for swell (swell waves, Tp >8s) and sea (local sea, Tp <8s) are provided in Figure 14. Similar descriptive statistics for the Crowdy Heads WRB are provided in Table 4 and wave roses of the measured wave heights and periods in Figure 15 and in Table 5 and Figure 16 at Sydney WRB.

The deep water Crowdy Head and Sydney sites are dominated by moderate energy, swell waves, with mean significant wave heights of 1.56 m and 1.62 m, respectively. At the nearshore Newcastle WRB, the mean significant wave height is 1.41m, with a 75th percentile wave height of 1.71 m annually and some seasonal variation seen over summer which on average measured lower wave heights. Due to the narrow continental shelf and the orientation of the coastline with the direction of the prevailing storms and ECL events the site is subject to larger wave events. Over the period of measured wave heights at Newcastle, the 99.5th percentile was 4.41 m whereas the maximum was 8.52 m.

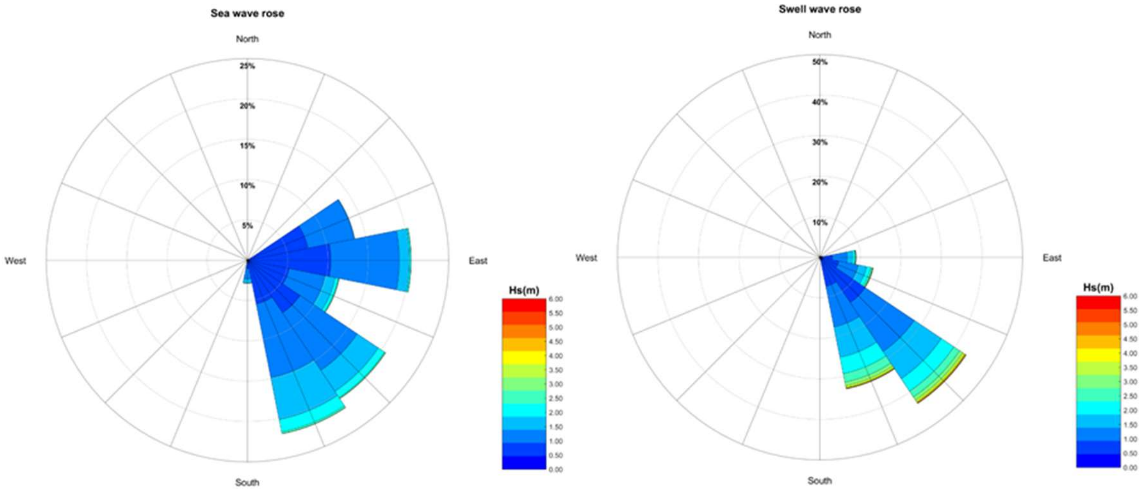

Figure 14: Long-term wave roses at Newcastle WRB for sea conditions (Tp < 8sec) and swell conditions (Tp > 8sec) from November 2009 to March 2020.

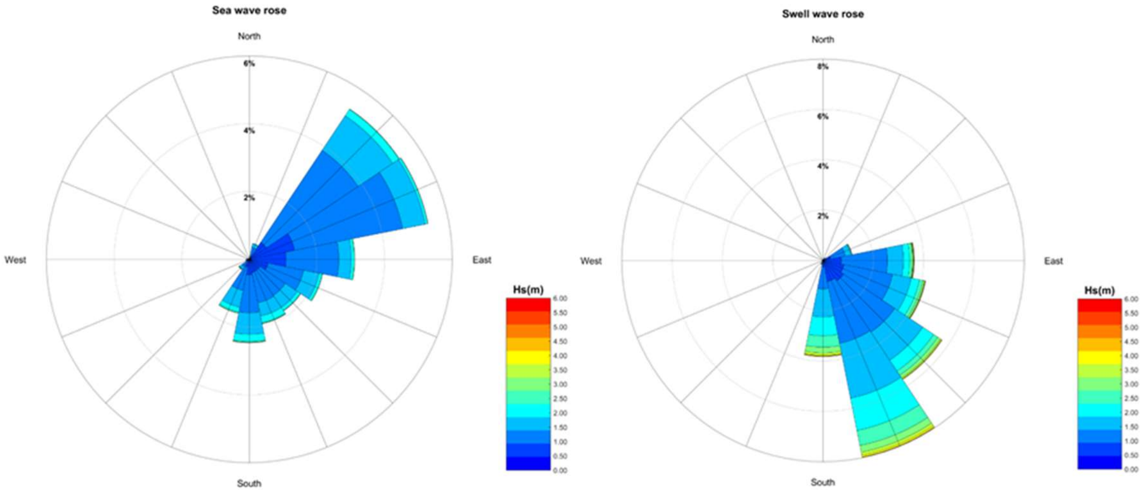

Figure 15: Long-term wave roses at Crowdy Head WRB for sea conditions (Tp < 8sec) and swell conditions (Tp > 8sec) from August 2011 to January 2020.

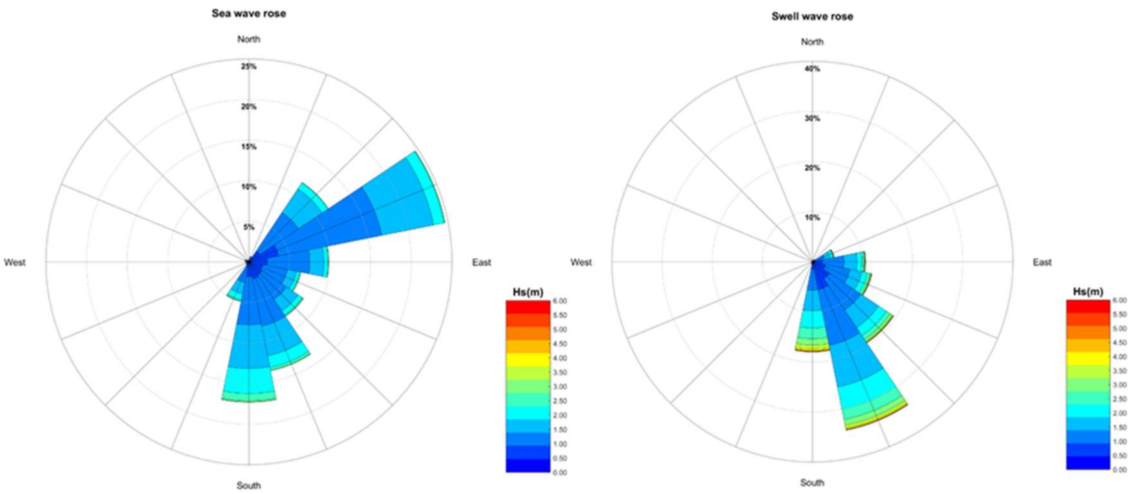

Figure 16: Long-term wave roses at Sydney WRB for sea conditions (Tp < 8sec) and swell conditions (Tp > 8sec) from March 1992 to January 2020.

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Table 3: Wave measurement statistics for the Newcastle WRB from November 2009 to March 2020.

Parameters	Statistics	All Seasons	Long term averages (12 years)			
			Winter	Spring	Summer	Autumn
Significant wave height (H_s) [m]	Mean	1.41	1.49	1.40	1.32	1.43
	20%ile	0.88	0.83	0.88	0.90	0.87
	50%ile	1.24	1.31	1.25	1.18	1.25
	75%ile	1.71	1.86	1.70	1.53	1.78
	90%ile	2.30	2.59	2.24	2.02	2.35
	99%ile	3.90	4.37	3.58	3.49	3.86
	99.5%ile	4.41	4.88	4.13	3.97	4.26
	Max	8.52	8.17	7.14	6.33	8.52
Peak wave period (T_p) [s]	Mean	10.7	11.6	10.6	9.7	11.1
	20%ile	8.5	9.7	8.2	7.5	8.9
	50%ile	10.8	11.5	10.7	9.7	11
	75%ile	12.6	13	12.6	11.5	12.9
	90%ile	13.9	14.6	13.9	12.9	14.3
	99%ile	17.1	17.5	17	15.9	17.4
	% time sea (Tp < 8s)	0.2	0.1	0.2	0.3	0.1
	% time swell (Tp > 8s)	0.8	0.9	0.8	0.7	0.9
Peak wave direction (D_p) [°TN]	Weighted mean	125.7	135.8	144.6	93.5	313.4
	Mean	133.4	136.7	137.5	125.8	133.9
	Standard deviation	23.1	19.2	22.6	27.2	20.9

Table 4: Wave measurement statistics for the Crowdy Head WRB from August 2011 to January 2020.

Parameters	Statistics	All Seasons	Long term averages (10 years)			
			Winter	Spring	Summer	Autumn
Significant wave height (H_s) [m]	Mean	1.56	1.65	1.52	1.51	1.56
	20%ile	1.05	1.04	1.05	1.06	1.05
	50%ile	1.40	1.47	1.39	1.35	1.41
	75%ile	1.84	2.02	1.79	1.72	1.86
	90%ile	2.42	2.65	2.31	2.25	2.43
	99%ile	3.80	4.17	3.37	3.76	3.74
	99.5%ile	4.19	4.45	3.58	4.27	4.09
	Max	6.62	6.62	4.81	6.40	5.15
	Mean	10.0	10.8	9.7	9.3	10.3
	20%ile	8.2	8.9	7.6	7.6	8.5

Parameters	Statistics	All Seasons	Long term averages (10 years)			
			Winter	Spring	Summer	Autumn
Peak wave period (T_p) [s]	50%ile	9.8	10.8	9.8	9.3	10.3
	75%ile	11.5	12.1	11.5	10.8	11.5
	90%ile	12.9	13.8	12.9	12.1	12.9
	99%ile	16.0	16.0	16.0	14.9	16.0
	% time sea (T_p < 8s)	0.2	0.1	0.3	0.3	0.1
	% time swell (T_p > 8s)	0.8	0.9	0.8	0.7	0.9
Peak wave direction (D_p) [°TN]	Weighted mean	146.4	150.7	152.8	133.5	146.5
	Mean	131.0	144.4	134.3	114.8	130.9
	Standard deviation	**37.7**	32.5	41.1	37.5	33.8

Table 5: Wave measurement statistics for the Sydney WRB from March 1992 to January 2020.

Parameters	Statistics	All Seasons	Long term averages (29 years)			
			Winter	Spring	Summer	Autumn
Significant wave height (H_s) [m]	Mean	1.62	1.65	1.59	1.58	1.66
	20%ile	1.05	0.97	1.06	1.06	1.06
	50%ile	1.45	1.43	1.43	1.43	1.48
	75%ile	1.93	2.01	1.87	1.87	2.02
	90%ile	2.55	2.78	2.44	2.44	2.62
	99%ile	4.17	4.65	3.96	3.59	4.10
	99.5%ile	4.64	5.18	4.43	3.93	4.62
	Max	8.43	7.76	6.22	5.53	8.43
Peak wave period (T_p) [s]	Mean	9.8	10.5	9.4	9.0	10.2
	20%ile	7.7	8.8	7.3	7.0	8.3
	50%ile	9.8	10.5	9.3	8.9	10.2
	75%ile	11.5	12.1	10.8	10.5	11.8
	90%ile	12.9	13.5	12.5	12.1	13.3
	99%ile	15.4	16.0	15.4	14.9	16.0
	% time sea (T_p < 8s)	0.2	0.1	0.3	0.3	0.2
	% time swell (T_p > 8s)	0.8	0.9	0.7	0.7	0.8
Peak wave direction (D_p) [°TN]	Weighted mean	150.4	154.3	153.6	141.9	147.5
	Mean	136.6	145.4	136.6	126.1	136.3
	Standard deviation	37.4	32.1	40.1	40.4	34.9

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6.1.1 Wave direction

Changes to the mean wave direction can occur due to seasonal variations as well as with the larger scale oscillations in climate. The average annual wave direction at each measurement location in Figure 17 shows that for the past decade the wave directions were around 130°N. Sydney WRB has the longest record and displays only a small annual oscillation in the change in wave directions. Figure 18 and Figure 19 display the variation in wave direction over the year around the median wave direction, only minor differences are seen over the measured period.

Nearshore waves at the Stockton site were modelled in the DHI (2006) analysis where 12 years of offshore measured data was transformed to give the shallow water wave heights and directions along the Stockton Bight at the 17 m contour (Figure 20). The analysis showed that for north of Fern Bay, at the 17 m contour and for the location reviewed, there was little transformation in wave direction from the measured deep-water waves.

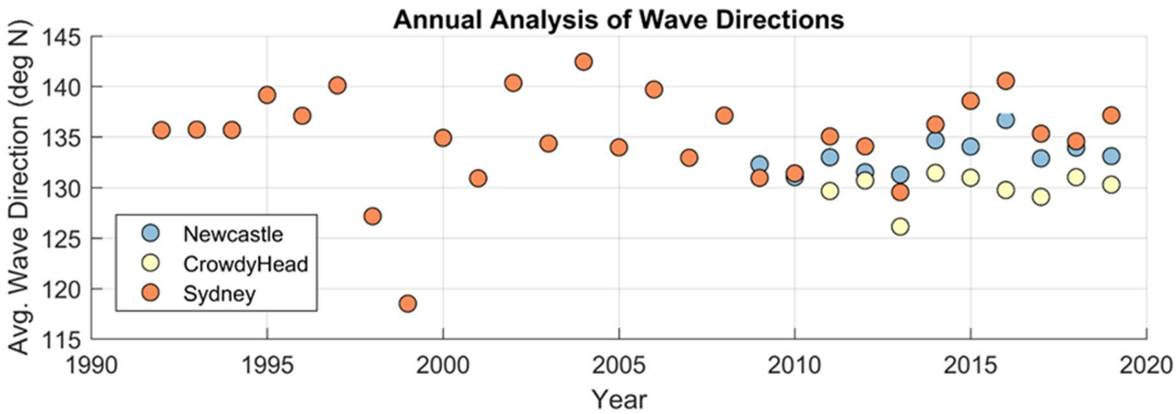

Figure 17: Annual average wave direction at Newcastle, Crowdy Head and Sydney WRB.

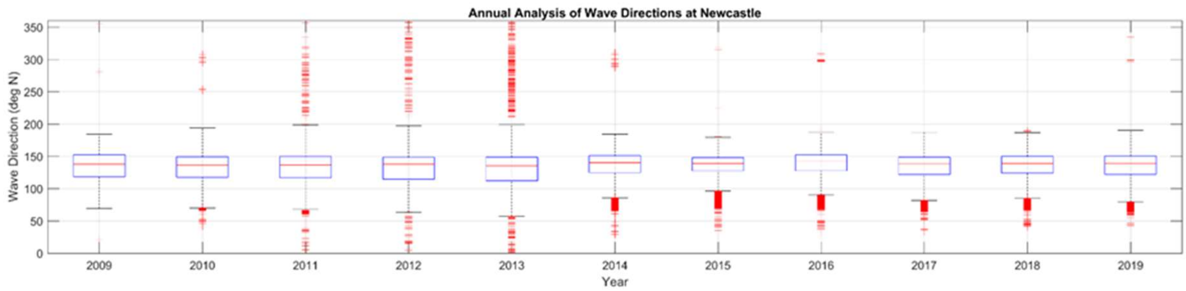

Figure 18: Annual wave directions at Newcastle WRB.

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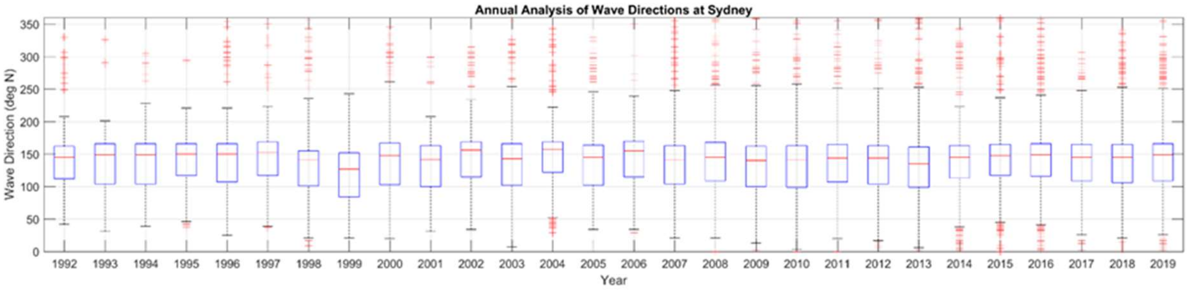

Figure 19: Annual wave directions at Sydney WRB.

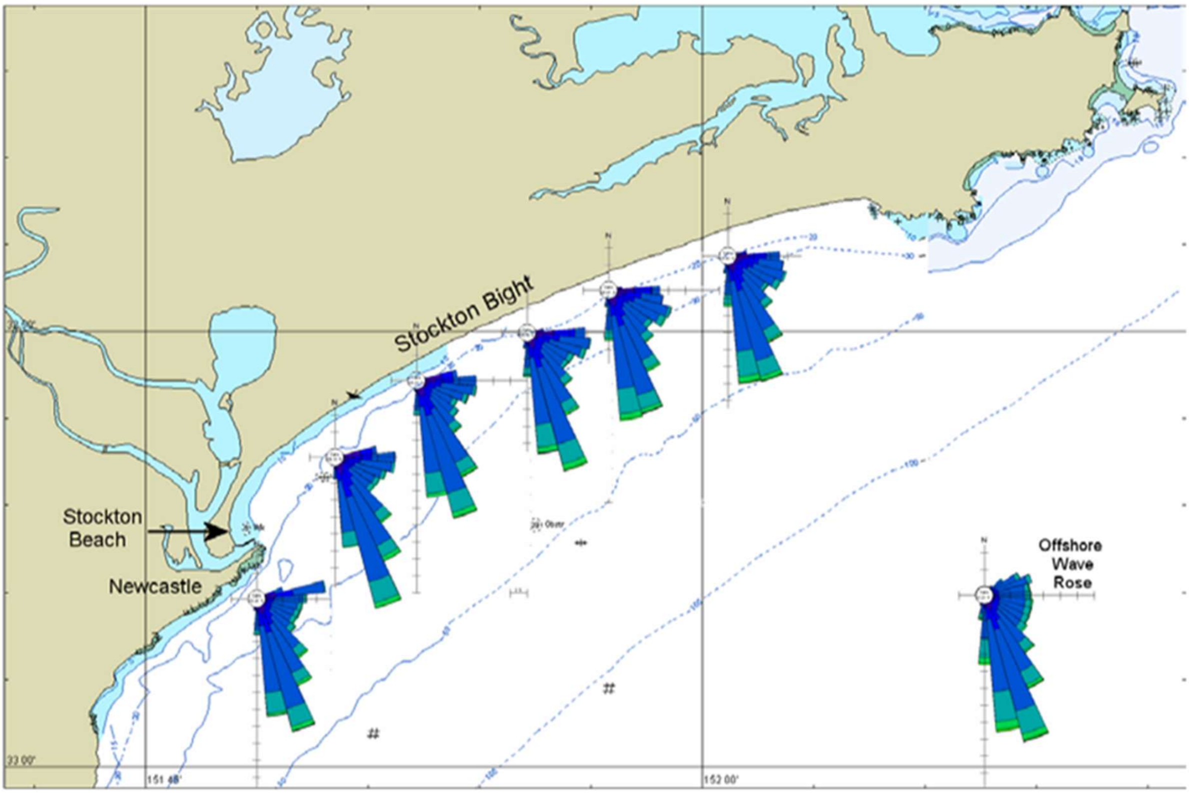

Figure 20: Wave roses from 12 years of transformed offshore measured wave data (Source: DHI, 2006).

6.1.2 Extreme wave events

At the study site, extreme wave events are usually associated with ECL weather systems. An Extreme Value Analysis (EVA) of the Newcastle WRB spanning the 12 years of available data was undertaken. A peak over threshold analysis of the measured wave heights identified the extreme events (Figure 21) and a Weibull distribution was fitted to the extremes wave heights to provide the ARI wave heights in Table 6. These values will be reviewed using longer but offshore wave height records as part of the full Stockton Bight sediment transport study.

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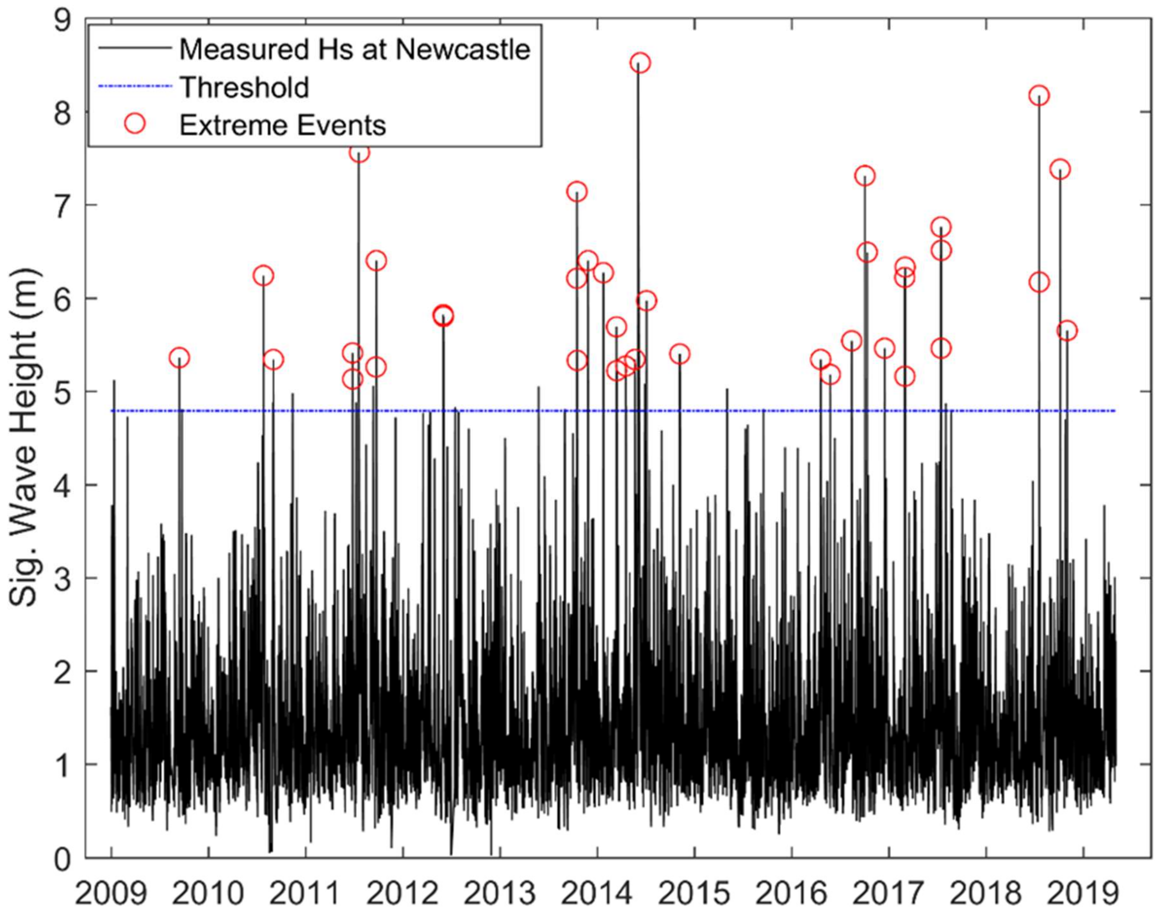

Figure 21: Identification of extreme wave events in measured wave heights at the Newcastle WRB managed by PANSW from all wave directions.

Table 6: Average recurrence interval (ARI) wave heights for Newcastle WRB from the PANSW.

ARI (year)	H_s (m)	98% confidence limits (m)
1	6.3	5.9 - 6.6
5	7.6	7.0 - 8.2
10	8.1	7.4 - 8.8
25	8.8	7.9 - 9.7
50	9.3	8.3 - 10.3
100*	9.8	8.6 - 11.0

*Values should be used with caution given it is derived from a 12-year wave height record.

6.2 Water level climate

The astronomical tide is the periodic rise and fall of the sea surface caused by the combination of the gravitational force exerted by the moon and the sun upon the earth and the centrifugal force due to rotations of the earth and moon, and the earth and the sun around their common centre of gravity. Tides are subject to spatial variability due to hydrodynamic, hydrographic and topographic influences. The Stockton Bight experiences semi-diurnal tides (two highs and two lows a day) with tidal planes shown in Table 7 from the Australian Tidal Planes produced by the National Tide Centre.

Measured water levels at the site are available at Stockton Bridge tide gauge within Newcastle Port from October 2017 to March 2020 displayed in Figure 13. Water levels observed in 2019 are displayed in Figure 22.

Table 7: Tidal planes at Newcastle from the National Tide Centre 2013.

Tidal planes	Elevation (m CD)	Elevation (m AHD)
HAT	2.1	1.1
MHWS	1.7	0.7
MHWN	1.4	0.4
MSL	1.0	0.0
MLWN	0.6	-0.4
MLWS	0.4	-0.6
ISLW	0.1	-0.9

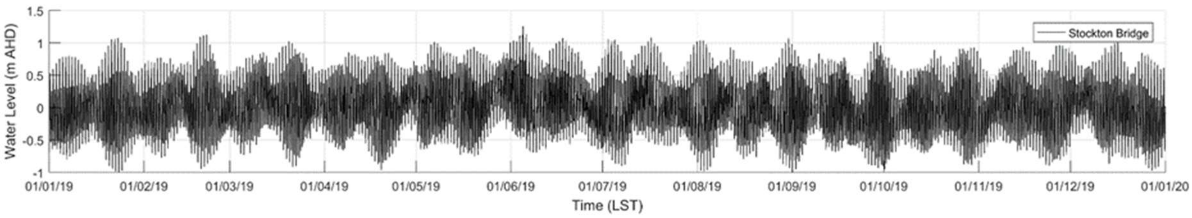

Figure 22: Measured water levels at Stockton Bridge

6.3 Tidal, fluvial and other currents and circulation patters

Complex currents at the study site have been documented in previous studies on the impacts of the anthropogenic developments at the location. The impacts of port structures (e.g. breakwaters) and seawalls on the sediment transport pathways and resulting shoreline position was presented in the 2006 study undertaken by DHI.

Measured currents from both bottom mounted ADCP and ADCP transects were collected within the entrance channel over a spring and neap tide, recording stronger currents on the eastern side of the channel on both the ebb and flood tides. Measured ebb currents were swifter than flood currents (i.e. ebb velocity asymmetry). Modelled tidal and fluvial current speeds at the Hunter River entrance for a spring tide are presented in Figure 23. Current magnitudes through the entrance reach approximately 0.6 m/s on a flood and 0.8 m/s on an ebb tide which is expected with the addition of seaward fluvial currents on the ebb tide; however these current vectors are directed offshore (northeast) of the study site and diminish in magnitude after 1 km from the entrance channel. Overall, DHI (2006) found that the role of fluvial included currents at Stockton is minimal.

Further analysis on the hydrodynamics at the site during different wave propagation directions in Figure 24 showed that waves propagating from the east and east south-east produce uniform longshore currents north of the study site and minimal currents at the southern end of Stockton Beach due to wave refraction and a resulting perpendicular approach to the shoreline (DHI, 2006). Also evident in some of the east south east cases was the nodal point at the north of the seawall where the currents split north and south due to the different angles in wave approach. Whereas waves propagating from the south to south-east in Figure 24 show the largest impact on flow it is the breakwaters which induce secondary circulation currents. On the leeward side of the breakwaters, the differences in wave setup from the sheltered areas as well as diffracted waves generate circulation currents. At the northern end of the seawall the longshore currents are uniform. The few spatial variations evident are produced by wave focusing. The study also identified the complex flow patterns at Nobbys Head which was identified as being due to the uneven bathymetry and sand lobe present offshore (DHI, 2006).

Larger-scale ocean currents offshore of the study area are dominated by the East Australian Current. The southerly ocean current (Figure 25) is located along eastern seaboard of NSW offshore of Newcastle (CSIRO, 2014).

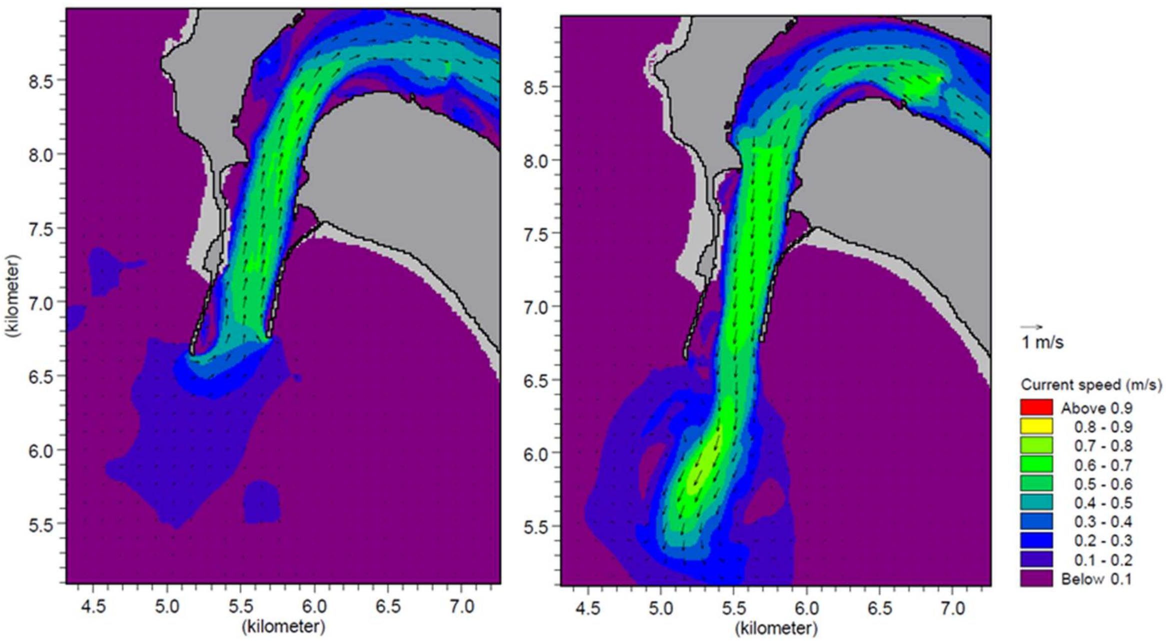

Figure 23: Peak flood (left) and ebb (right) tidal current speed map for a spring tide at the Hunter River entrance (source: DHI, 2009).

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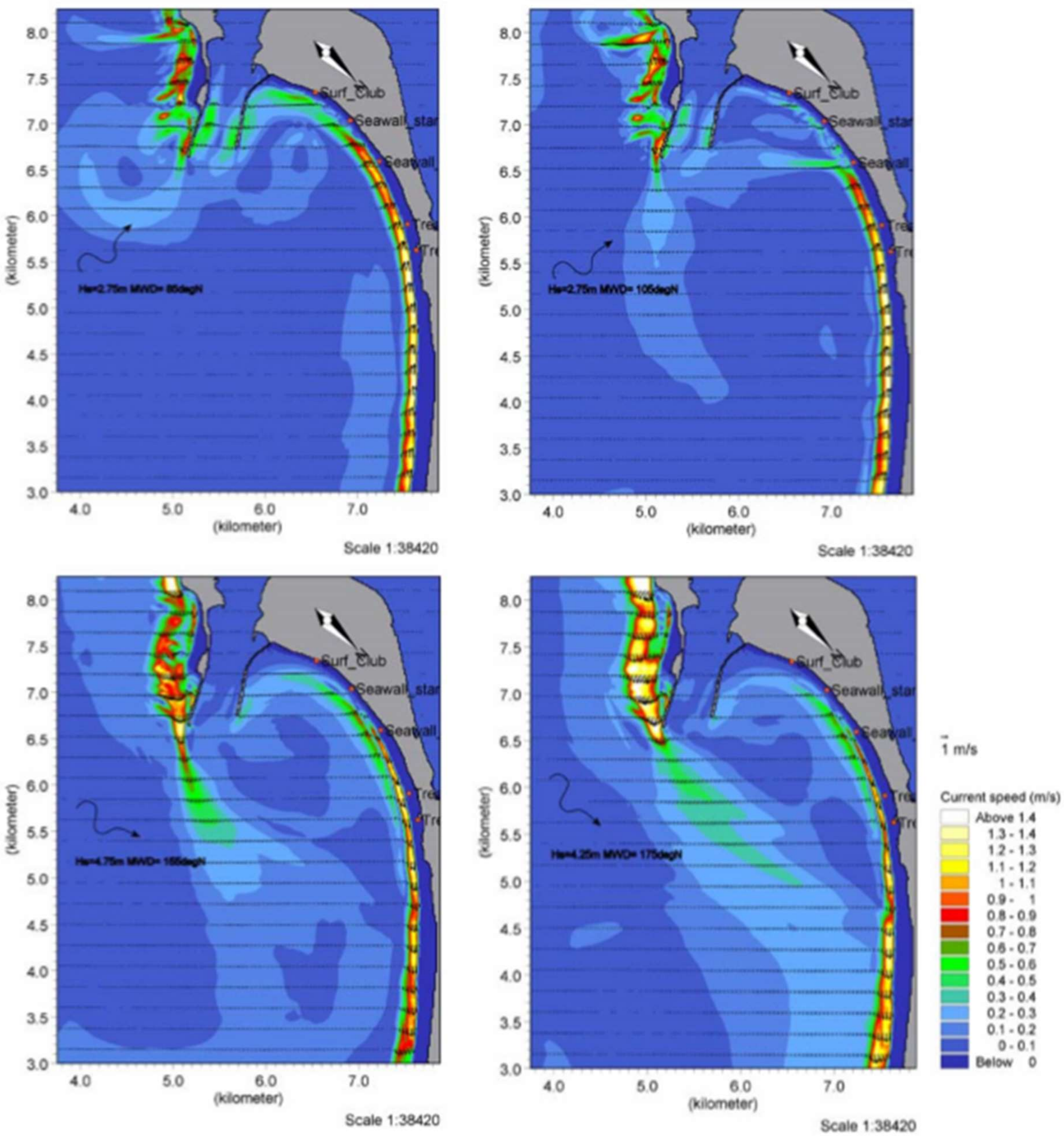

Figure 24: Average currents over a full tidal cycle at Newcastle for four wave cases propagating from (top) east to east southeast and (bottom) south to southeast (source: DHI, 2006).

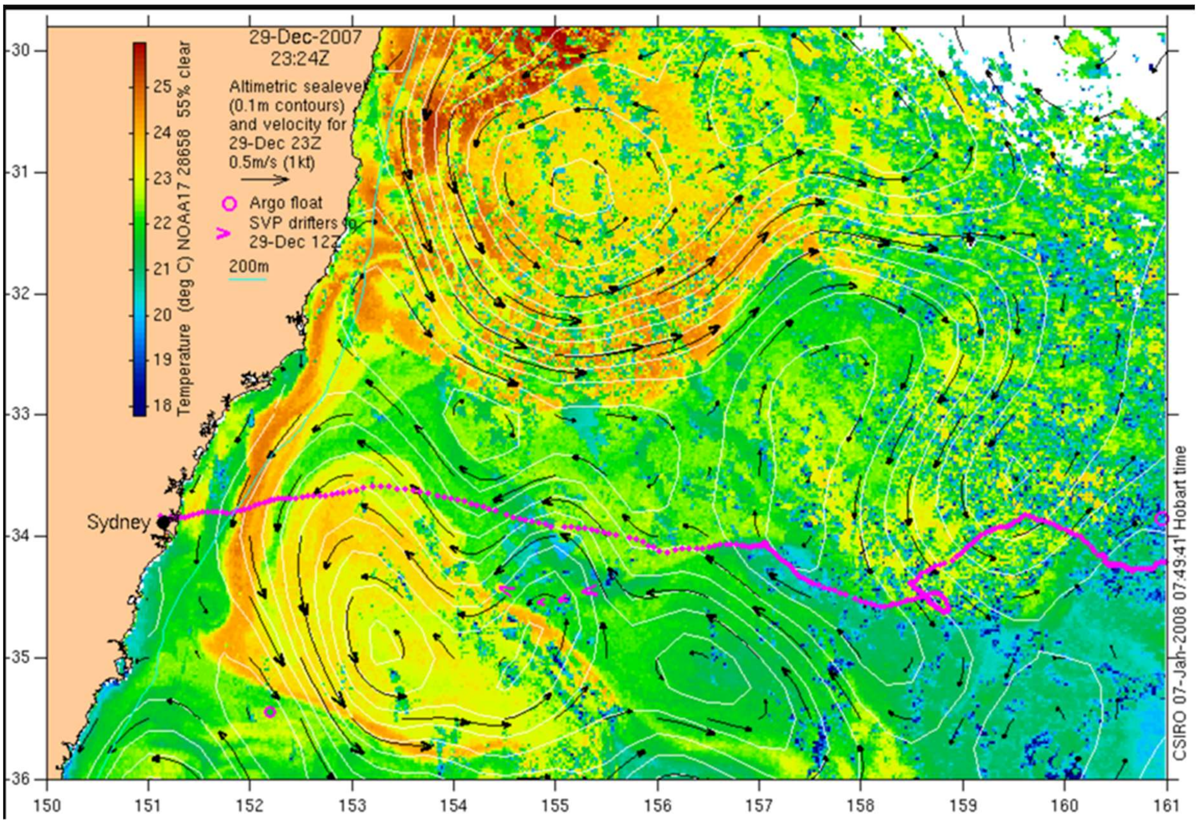

Figure 25: Snapshot of the East Australian Current along eastern seaboard of NSW showing southerly ocean currents offshore of Newcastle (source: CSIRO).

The DHI 2006 study presented current vectors and predicted sediment transport from wave driven currents at Stockton based on a typical yearly condition from, 1992-2005 in Figure 26. Wave-driven current along the coastline are influenced by the port structures which diffract waves from the southeast around the tip of the breakwater. Currents at the shoreline in front of the Mitchell Street seawall are driven by differences in wave setup and have a southerly and northerly alongshore movement from a nodal point located at the northern end of the seawall (DHI, 2006).

It is too soon in the process of the full 2020 sediment transport study to validate the sediment pathways and fluxes presented in Figure 26. However, the findings of the volumetric analysis for the Stockton Beach embayment outlined above (Section 5) raises questions about the cross-embayment pathway (i.e. the pathway from south of the river entrance to Stockton Bight).

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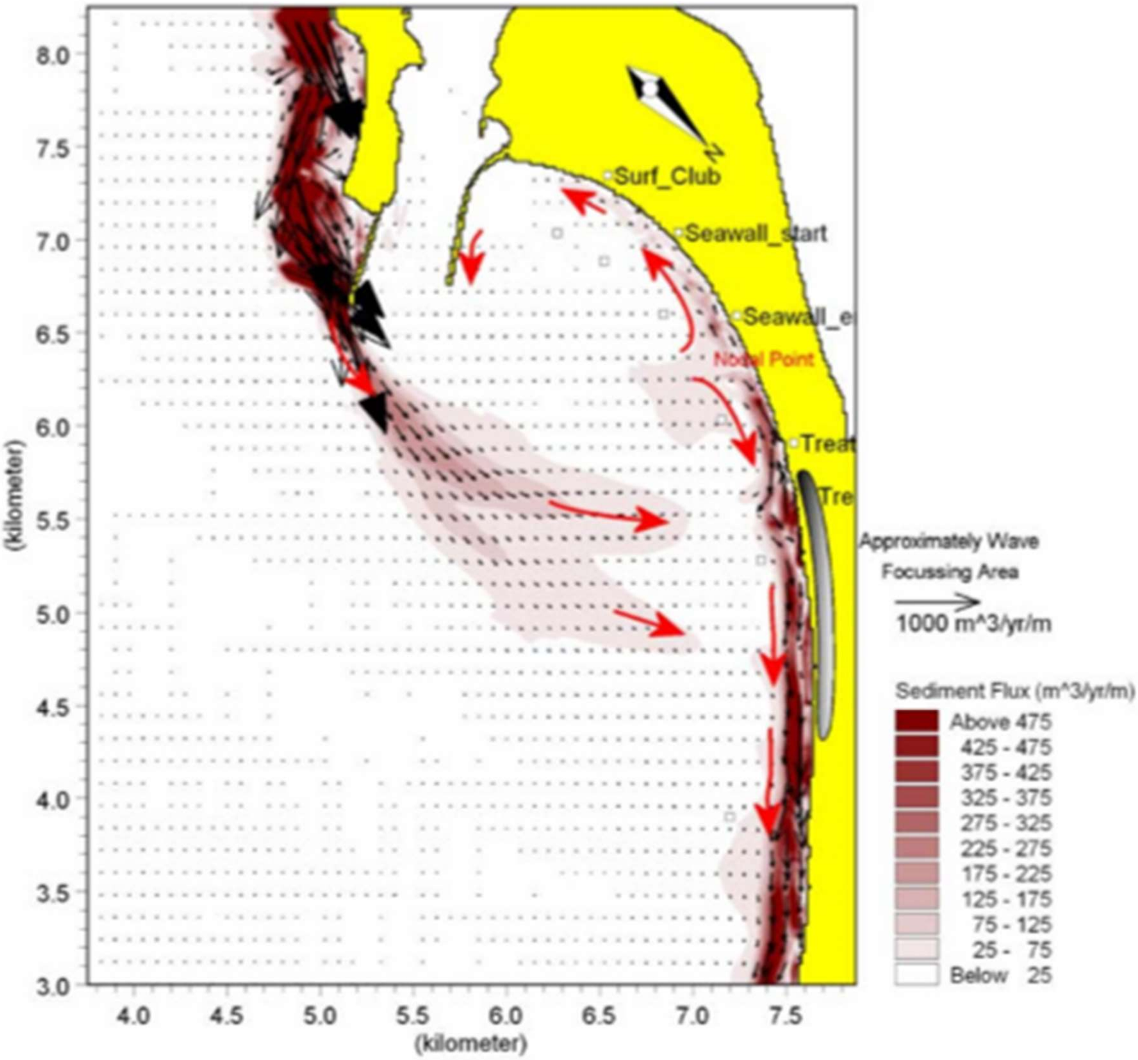

Figure 26: Current Vectors and predicted sediment transport at Stockton based on a typical yearly condition from 1992-2005 (source: DHI, 2006).

Local measured currents are available from four deployments of an Aquadopp ADCP undertaken by Royal Haskoning DHV offshore of Stockton Beach (Figure 13). The measured data available covers the 3rd to 21st December 2019 and 18th January to 1st February 2020. A time series of the measured data for the first period is displayed in Figure 27 and current speeds in U (east-west) and V (north-south) directional space for the depth averaged currents during both periods are displayed in Figure 28. Figure 28 shows the depth averaged currents during both deployment periods were predominately offshore towards south-east. Maximum current speeds were measured at the surface (Figure 27) and reached over 0.8 m/s and 0.45 m/s in the first and second deployment periods respectively, with the highest current speeds occurred at the bottom of the ebb tide.

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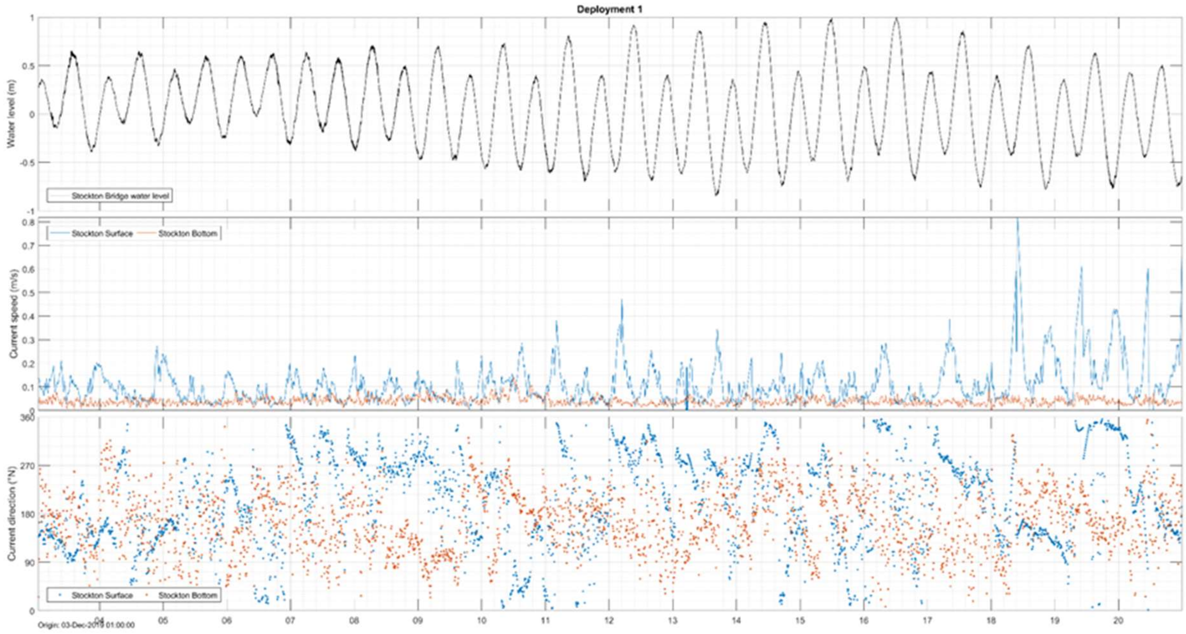

Figure 27: Measured currents at Stockton during deployment 1 and 2 and water levels at Stockton.

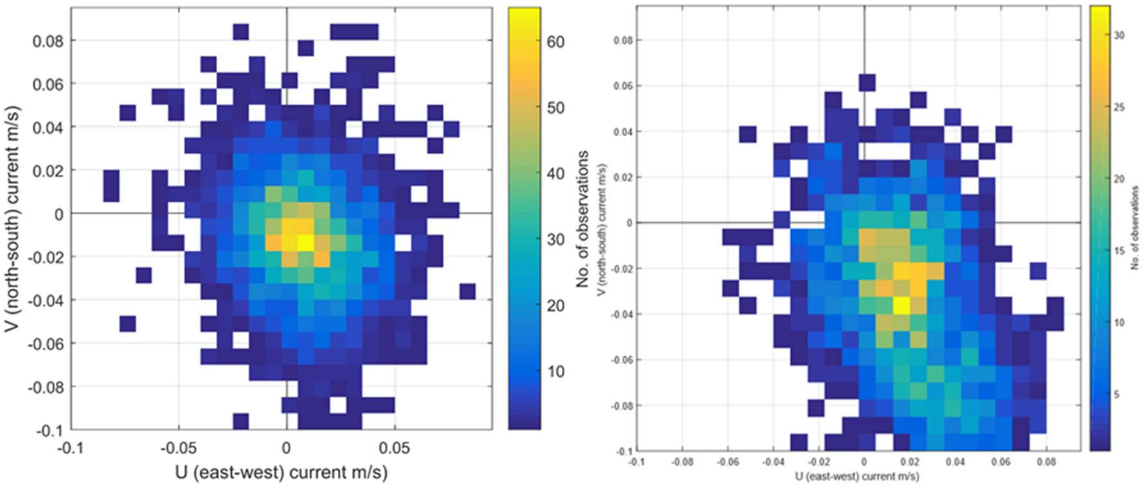

Figure 28: Depth averaged current speeds at SB01 during (left) deployment 1 and 2 (18 days duration) and (right) deployment 4 (14 days duration).

6.4 Wind climate

Measured wind data at Newcastle is available at Nobbys and Williamstown BoM weather station (Figure 13) with three hourly, half hourly and one minute temporal frequencies recorded from 1979. One-minute wind data has been collected from July 2004 at Nobbys and August 1999 at Williamstown.

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Overall and seasonal wind roses for Nobbys BoM station are presented in Figure 29 for the one-minute data. Over the summer period, winds predominantly arrive from the north-east to the south whereas over the winter synoptic period, winds are predominantly from a north-westerly direction. Similar descriptive wind roses are presented for the one minute wind speeds and directions at Williamstown in Figure 30 which also show winds coming from a predominately north-westerly direction. The Summer synoptic period has the largest percentage of onshore winds at the Williamstown location.

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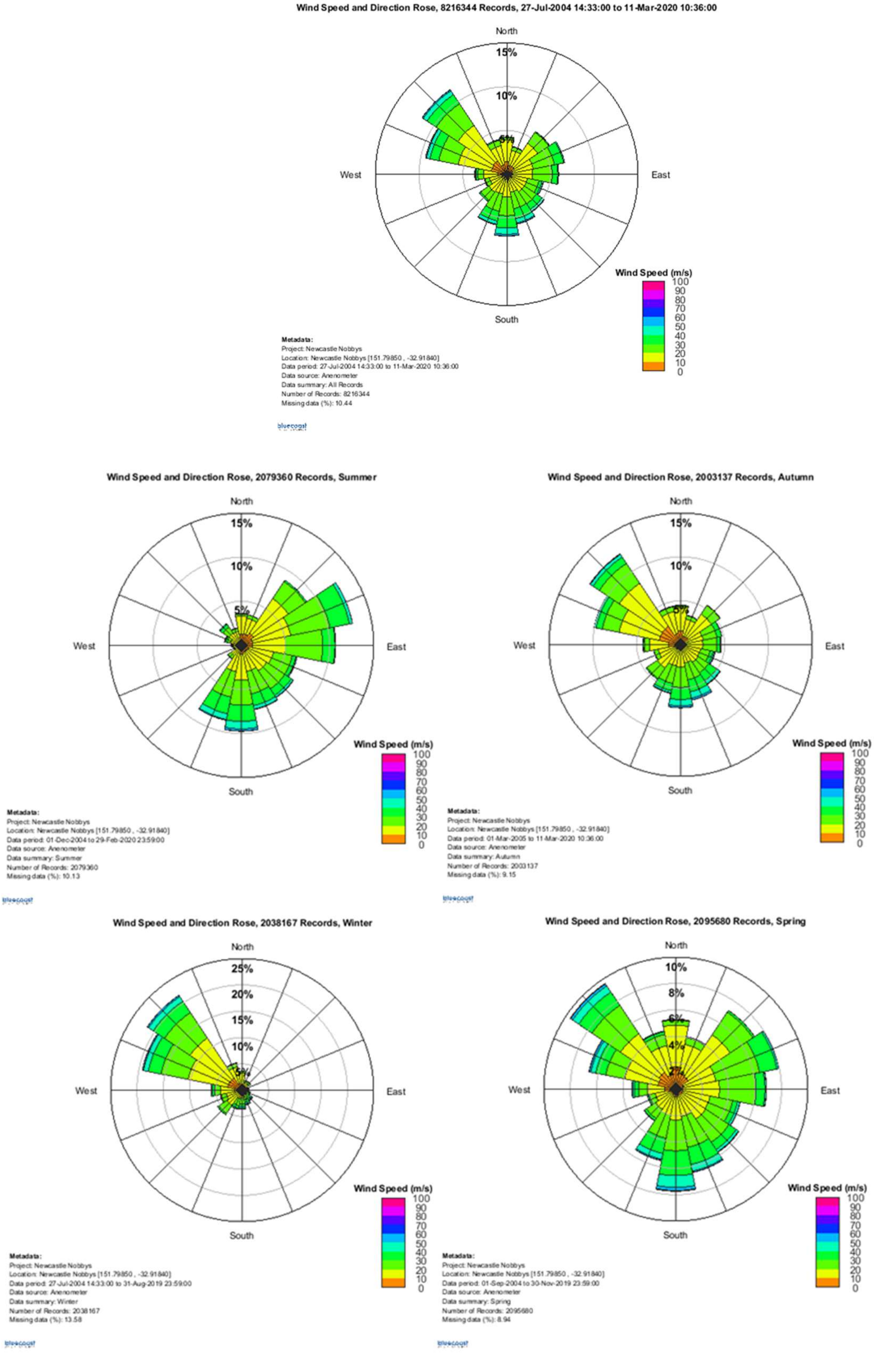

Figure 29: Annual (top) and seasonal wind roses at Nobbys Newcastle BoM station from one-minute data between July 2004 and March 2020.

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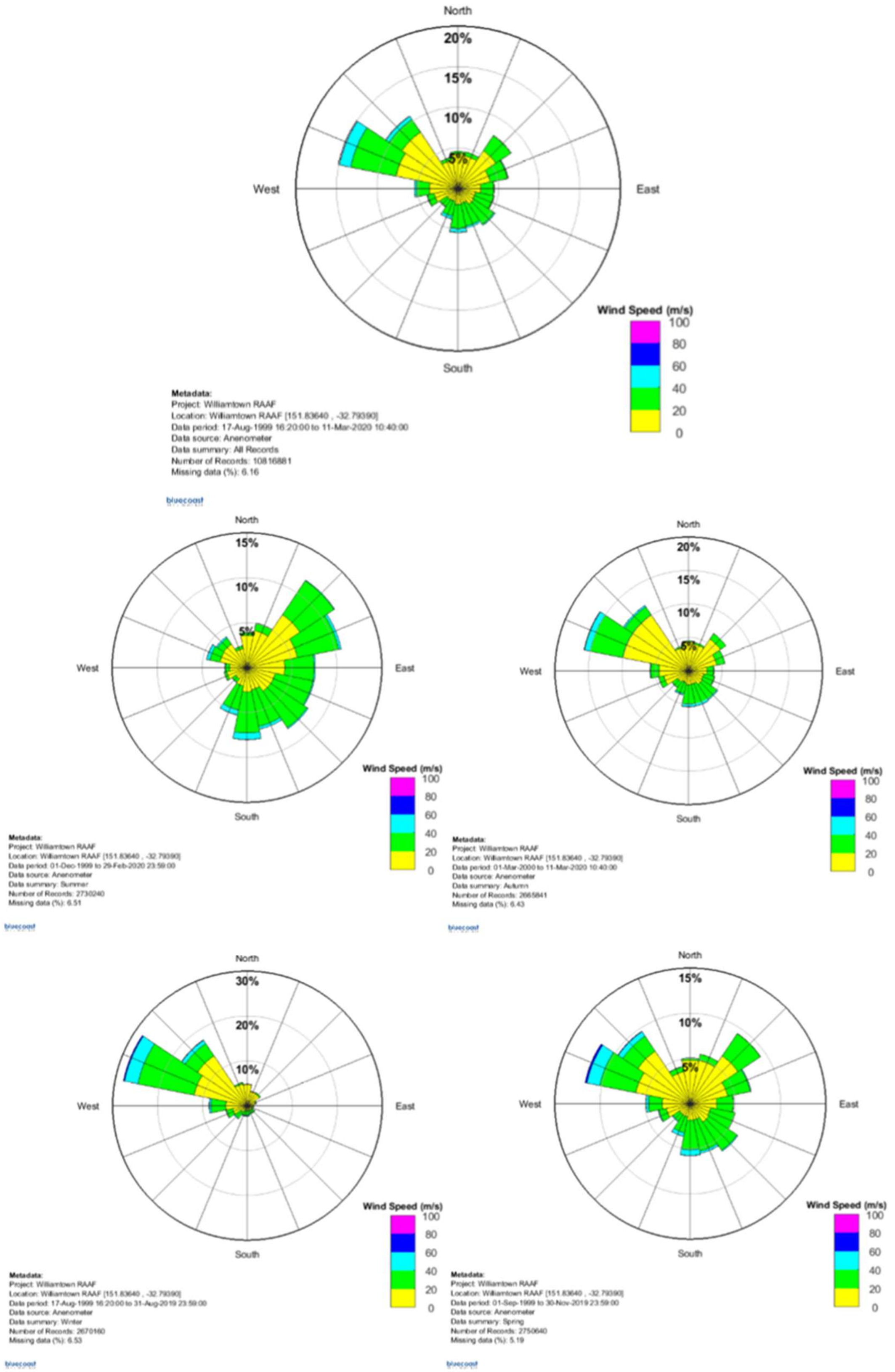

Figure 30: Annual (top) and seasonal wind roses at Williamstown BoM station from one-minute data between August 1999 and March 2020.

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7 References

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Attachment A – Summary of datasets

Summary of the datasets available for the preparation of this technical note is presented in Table 8. The list of data will be expanded for the full sediment transport study.

Table 8: Overview of coastal monitoring datasets used in this study.

ID	Description	Source	Dates
Topography and bathymetry	LiDAR at 5 m resolution	DPIE	2018
	High-resolution UAV derived topography	CN	2019 and 2020
	Beach profile data (photogrammetry)	DPIE	1953 – 2020
	Hydrographic surveys from assorted periods and coverage extents	DPIE, Umwelt, CN, PoN	1816 - 2018
	Satellite Derived Bathymetry	Bluecoast/Eomap	
Aerial imagery	High resolution, rectified aerial imagery	Nearmap	2020
Metocean and meteorological			
Water levels	Water levels from Stockton Bridge at a one-minute measurement period	Port Authority of NSW (PANSW)	Oct 2017 -Mar 2020
Waves	Measured wave heights, directions periods and directional spreading at Sydney and Crowdy Head directional WRB at a 1-hour sampling period	MHL	1992-2020 2011-2020
	Measured wave heights, directions and periods at Newcastle WRB at a 10-minute sampling period	PANSW	2009-2020
Currents	Measured currents at Stockton at 8 m water depth over four deployments	Royal HaskoningDHV	Dec 2019 and Jan 2020
Winds	Measured wind speeds, directions at atmospheric pressure at 10m for Newcastle Nobbys and Williamstown RAFF at three hourly, half hourly and one-minute sampling periods	BoM	1979-2020 (1 min since 2004 and 1999 respectively)

City of Newcastle

Stockton Beach coastal erosion hazard assessment

Report #: P19028_PartB_R00.0A

18 June 2020

Document history

Version	Date	Author(s)	Reviewer(s)	Status	Signature
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2.0	5-May-20	H. Loehr, D. Wainwright and E. Watterson	E. Watterson	FINAL DRAFT	
0.0	7-May-20	H. Loehr, D. Wainwright and E. Watterson	E. Watterson	ISSUED FOR PUBLIC EXHIBITION	
0.A	18-Jun-20	H. Loehr, D. Wainwright and E. Watterson	E. Watterson	FINAL	

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1. INTRODUCTION

1.1 General

In line with the Coastal Management Act 2016 and the NSW Coastal Management Manual Part B (the Manual), a probabilistic coastal hazard assessment for Stockton Beach has been undertaken. The City of Newcastle (CN) engaged Bluecoast Consulting Engineers (Bluecoast) and their sub-consultants Salients Pty Limited (Salients) to undertake the coastal hazard assessment. The hazard assessment is limited to the area north of the Stockton Breakwater (northern training wall of the Hunter River), and the northern boundary of the Stockton Centre, which marks the boundary of CN's Local Government Area (see Figure 1).

The hazard assessment for Stockton Beach (Part B) is being undertaken concurrently to a sand transport study for Stockton Bight (Part A), namely the 'Stockton Bight Study'. During Stage 1 of the Newcastle coastal management program (CMP) processes, CN identified the need for the two investigations. The two studies are being delivered as part of Stage 2 of the Newcastle CMP. Due to a time constraint imposed by Ministerial direction to complete a Stockton CMP by 30 June 2020, CN are preparing a CMP within the area bound by the northern breakwater of the Hunter River and Corobba oval, Stockton. In addition, a cost benefit analysis (CBA) has been undertaken for the Stockton Beach CMP informed by findings of the Part A and Part B investigations (Bluecoast, 2020c). Given the urgency for coastal management actions at Stockton Beach, the CBA was fast-tracked and undertaken concurrently to the Part A and Part B investigations incorporating information readily available during the study time frame.

Furthermore, the studies were undertaken during state and federal government enforced restrictions on public gatherings, in response to the COVID-19 pandemic. This, in conjunction with the truncated timeframes, has meant, that a proposed stakeholder workshop could not be completed to inform the risk assessment. Necessary assumptions were made through desktop review of previous assessment and relevant literature and are described in more detail where relevant in this report.

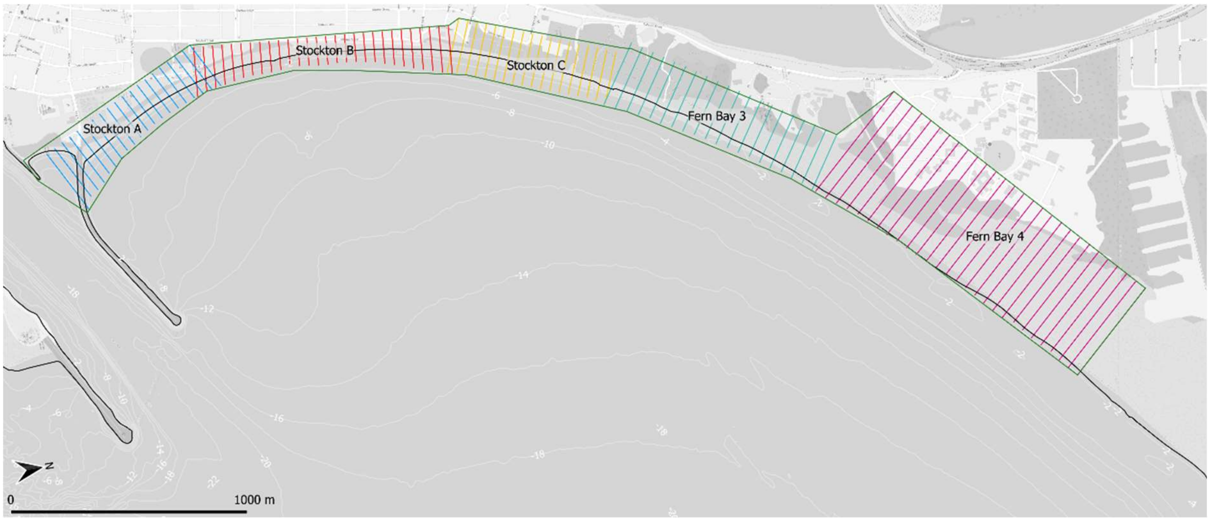

Figure 1: Coastal hazard assessment study area and NSW photogrammetry (DPIE, 2020) blocks and transects (coloured lines) at Stockton Beach.

1.2 Study objectives

CN are in the process of developing a CMP in accordance with the Coastal Management Act (2016) and are developing long-term actions to address on-going beach erosion and shoreline recession. The main objective of this assessment is to inform the planning of long-term actions via the erosion hazards identified herein.

1.3 Scope of this report

This report sets out the approach and results of the probabilistic erosion hazard assessment and the associated mapping. An inundation hazard assessment is deferred and will be completed for inclusion in the Newcastle CMP.

A brief summary of the key findings from the Stockton Bight Study most relevant to the hazard assessment is provided in Section 2.1.

2. BACKGROUND

2.1 Previous hazard assessments

A deterministic coastal hazard assessment for Stockton Beach was undertaken by DHI in 2006 and a re-assessment of the 2050 and 2100 hazard lines by DHI in 2011. More recently, an LGA-wide coastal hazard assessment was undertaken for CN by BMT WBM in 2014. This study mapped coastal hazards using a risk-based approach that defines the likely extent of the hazards for 2014, 2050 and 2100 planning periods. However, the likelihoods for the erosion hazard were qualitatively assigned by combining estimated storm erosion and long-term recession values. The storm erosion extent was adopted as the most-eroded profile in the photogrammetry data while long-term recession was determined using a simplified numerical modelling approach and analysis of photogrammetry data.

The LGA-wide hazard assessment was undertaken according to the Guidelines for Preparing Coastal Zone Management Plans (OEH, 2013; now DPIE). These guidelines have been superseded by the abovementioned Coastal Management Act 2016 and the associated Manual.

The probabilistic assessment described herein, include the following updates to the hazard assessment approach:

- a detailed, quantified coastal processes investigation as part of the Part A – Stockton Bight Study being undertaken in parallel (Bluecoast, 2020a)
- recommendations set out in the Manual (OEH, 2019)
- probabilistic modelling approach to account for uncertainties in the coastal processes definitions and provide robust risk levels (likelihoods), i.e. not qualitatively assigned
- use of high quality 2020 and 2018 topography data as baseline
- latest sea level rise projections
- consideration of built coastal protection structures.

2.2 Stockton Bight Study

Beach erosion processes and quantitative sediment transport estimates for the coastal zone within the Stockton Bight sediment compartment have been assessed as part of the Stockton Bight study (Part A) in Bluecoast (2020a). A brief summary of the most relevant key findings is presented in the following paragraphs.

Stockton Beach and the adjacent Hunter River has been continually modified over the course of European settlement. Modifications that have impacted the beach response include the construction of the Hunter River breakwaters, capital and maintenance dredging of the navigation channel, revetment construction, beach nourishment, beach scraping and temporary and emergency protection works.

Stockton Beach has been the subject of numerous studies to assess coastal processes. However, further investigation has been identified as being required to underpin the identification of appropriate options for management of coastal hazards on the Stockton coastline. Based on the Stage 2 sediment transport studies completed at this time, a summary of the most relevant processes is provided below.

A key knowledge gap identified in the Scoping Study (CN, 2019) was to determine the changes in the sub-aqueous part of the coastal profile. An assessment of the change in the sand volume in the Stockton Beach area was undertaken. This assessment considered both the sub-aqueous and sub-aerial changes. The combined rate of long-term sand loss from the Stockton CMP area is recommended as 112,000m^3/yr, which is based on the historical observations of:

- 100,000m^3/yr of sand loss from the sub-aqueous part of the coastal profile in the southern Stockton embayment between the northern breakwater and Fort Wallace (inshore of 20m depth contour) between 1988 and 2018.
- 12,000m^3/yr of sand loss from sub-aerial part of the coastal profile in Block A, Block B and Block C between 1985 and 2020.

This rate of sand loss is significantly greater than previously estimated and has implications for the on-going management of the coastal erosion issue at Stockton Beach. Given the long-term nature of the sand loss (i.e. not cyclic) and the accelerated rate of loss observed since the channel deepening project was completed in 1983, the most likely cause is the development and operation of the Port of Newcastle (i.e. breakwater construction and capital and maintenance dredging).

Further investigations are required to review the key coastal processes and quantify the sediment pathways that adequately explain these observations. A robust understanding of these processes is fundamental to developing coastal management options. It is recommended that long-term plans for Stockton Beach are reviewed once the sediment transport study is completed.

2.3 Key coastal hazards

The assessment relates to risks arising from coastal hazards as defined by the *Coastal Management Act 2016*. A simplistic assessment would see beach erosion as comprising that hazard relating to the erosion and recovery of a beach around a stable 'equilibrium' position. However, these beach fluctuations are often super imposed on a trend of ongoing shoreline recession or gradual adjustment of the shoreline location with time. Additional shoreline recession is expected to result from future sea level rise along the NSW coast. Hazard lines prepared herein incorporate the below hazards as required by that Act:

- Long term recession – historic shoreline recession due to deficits in longshore sediment transport.
- Sea level rise and associated recession – future shoreline recession as a result of projected sea level rise.
- Beach erosion – upper beach erosion as a result of large wave events and high-water levels.
- Coastal slope instability – selecting the Zone of Reduced Foundation Capacity (ZRFC) following the schema published by Nielsen et al. (1992), the ZRFC represents the extent landward behind an eroded beach where special considerations would need to be adopted when designing footings for structures.

2.3.1 Long-term recession

The NSW beach profile (photogrammetry) data (DPIE, 2020) was analysed to determine appropriate input parameters for long-term recession for the probabilistic hazard assessment. The adopted analysis period included photogrammetry data collected between 1955 and 2018. Where survey extents allowed the photogrammetry record was extended to February 2020 using recent drone survey data collected by CN. The drone survey only covered analysis blocks Stockton Block A, B and C. A series of historic beach profiles for selected profile locations within each of the analysis blocks are shown in Figure 2.

The historic recession rates were estimated by extracting the cross-shore position of a defined elevation contour for each year in the data set. A linear regression analysis was then undertaken to estimate the long-term trends in recession or accretion. An appropriate contour elevation used for the analysis was determined for each analysis block. Where possible, the 4m AHD elevation contour was specified to avoid accounting for any short-term profile changes. Given the anthropogenic influence on the coastal processes at Stockton Beach, various time periods were considered as part of the analysis. It was concluded that the most representative time period for the historic analysis was between 1985 and 2020. Prior to 1985, the year of the channel deepening of the

Port of Newcastle entrance, the recession rates are not representative of the more recent shoreline change at Stockton Beach (i.e. the changes observed following that perturbation). Beach profiles at the Surf Club and Mitchell Street seawalls have been excluded from the analysis. Cyclic rotation of the beach, particularly expected to affect southern areas of Stockton, typically occur over time periods of months to several years (DHI, 2006) and was not found to affect the long-term (35-years) recession analysis presented herein.

Results of the linear regression analysis for selected profiles used to derive historic recession statistics is provided in Figure 6. A statistical summary of the calculated average rates of shoreline change for each analysis block (see Figure 1) is provided in Table 1. Note that positive values indicate shoreline accretion, and negative values indicate shoreline recession. The variation in estimated recession rates for each profile within the analysis blocks and over the study area is demonstrated in Figure 4.

The presented recession rates were adjusted to account for any recession caused by sea level rise (SLR) during the analysis period between as this is considered independently. As described in Section 3.3.2, the SLR recession was estimated using the Bruun Rule (Bruun, 1962 and 1983). An average SLR rate of 1.2mm/year based on historic tide gauge records between 1966 to 2010 (White et al., 2014) was adopted to estimate the SLR recession during the analysis period. While appreciating the uncertainty in this simplified analysis, this resulted in a minor reduction of 0.06m/year (Fern Bay, Block 4) to 0.09m/year (Stockton, Block A) from the historic recession rates.

Overall, the trends identified in this analysis were verified with volumetric changes in the full coastal profile as observed in bathymetric analyses undertaken as part of Part A (Bluecoast, 2020a). The results of both recession analyses agree reasonably well as a long-term volumetric rate of sand loss over the full profile was estimated at 112,000m^3/year between the northern breakwater and the Hunter Water site (Block C).

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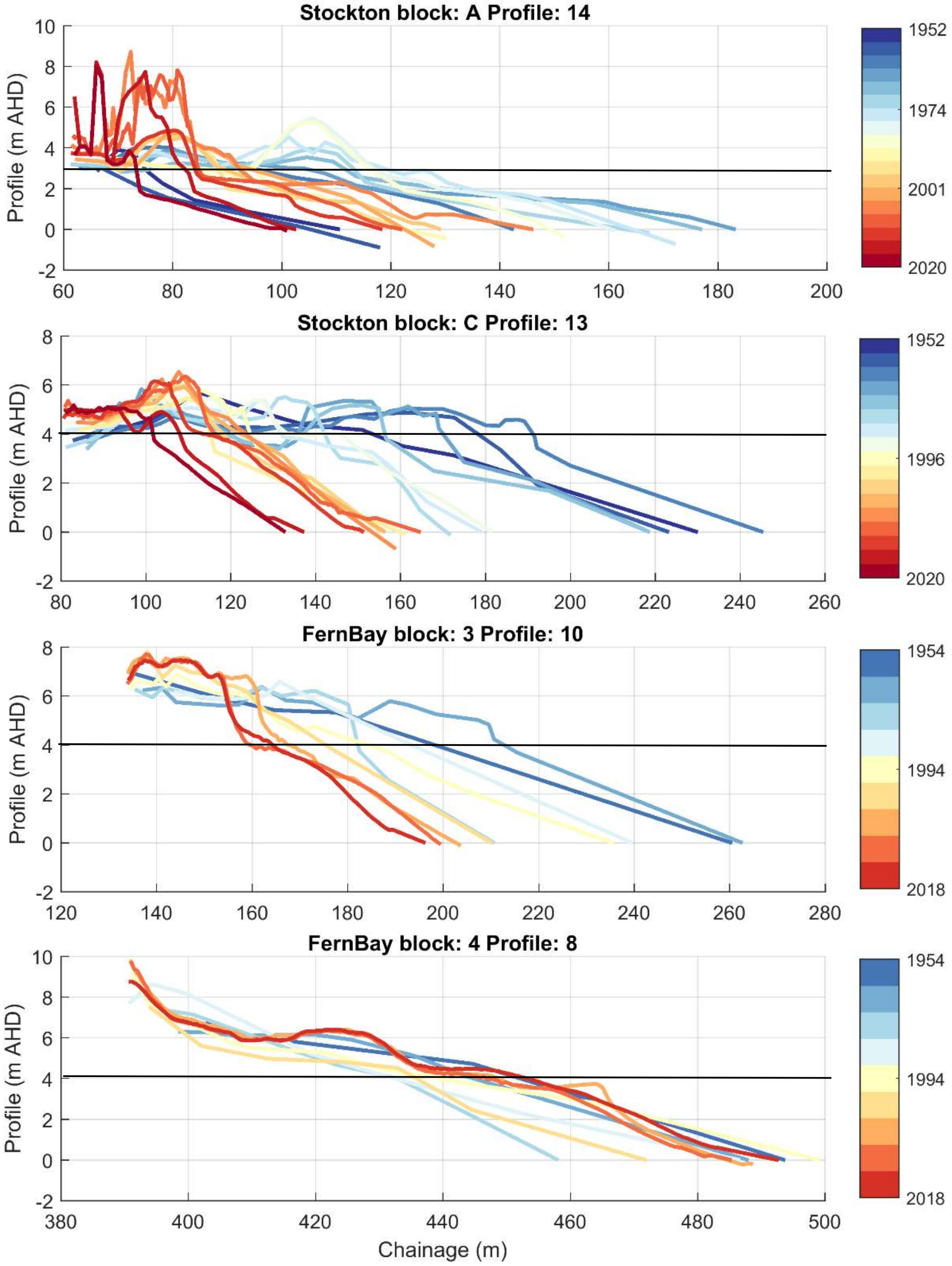

Figure 2: Photogrammetry profiles at blocks Stockton A to Fern Bay 4. The contour elevation adopted for recession analysis is shown in black.

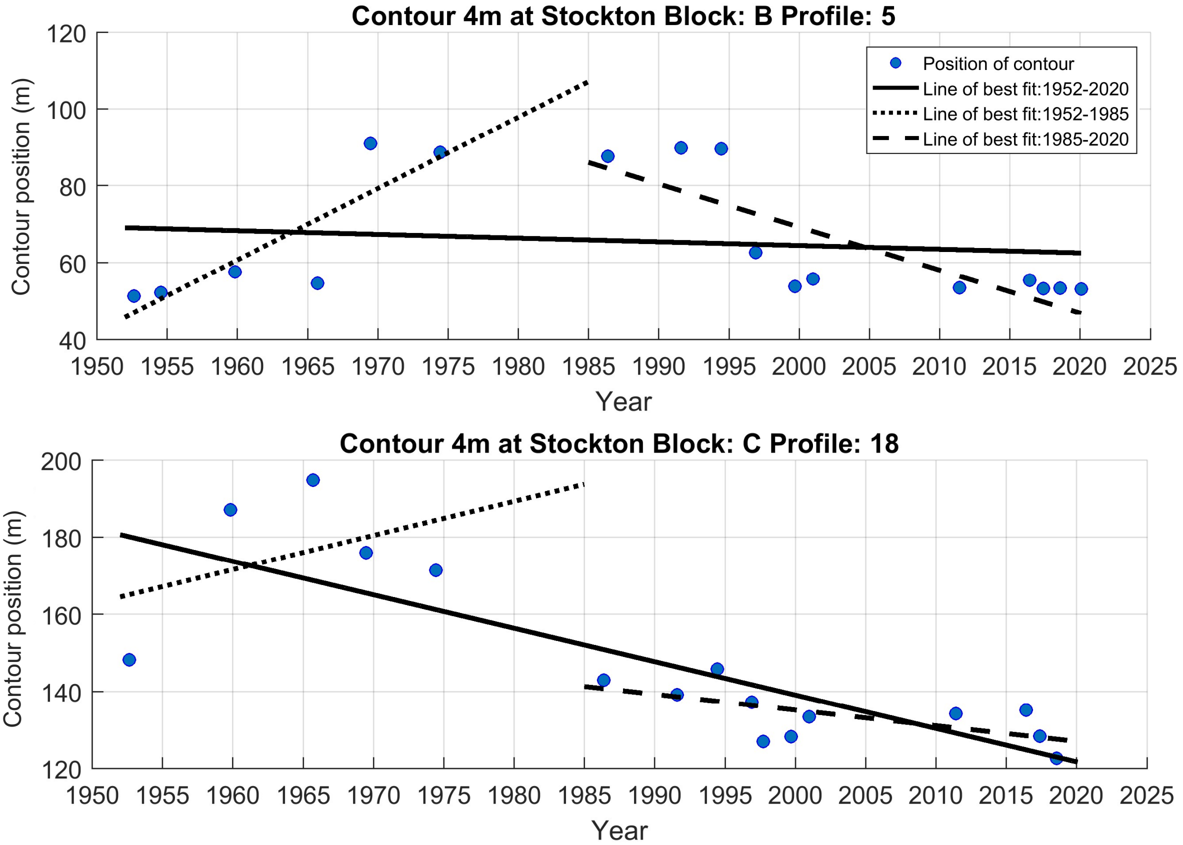

Figure 3: Results of linear regression analysis of 4m contour position for three defined time periods for Stockton (top) Block B, Profile 5 and (bottom) Block C, Profile 18.

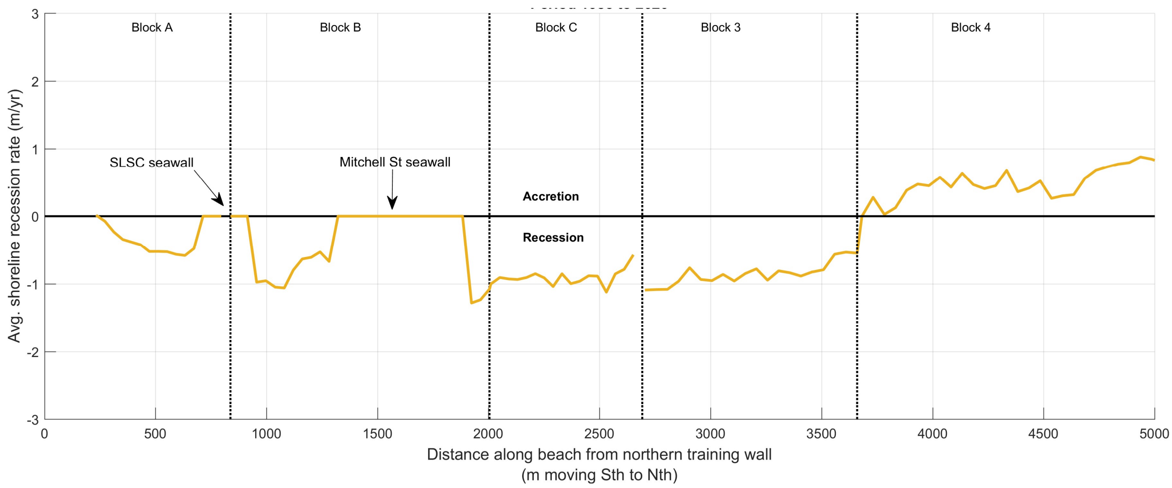

Figure 4: Estimated average shoreline change rates for the period 1985 to 2020.

Table 1: Spatial statistics of calculated average recession rates (discounted for SLR recession).

	Average long-term recession rates (m/year)					
	Stockton A	**Stockton B**	**Downdrift Mitchell St seawall**	**Stockton C**	**Fern Bay 3**	**Fern Bay 4**
Contour (m AHD)	3	4	4	4	4	4
Minimum	-0.36	0.56	-	-0.32	-0.47	0.06
Maximum	-1.25	-1.19	-	-1.03	-1.03	0.94
Median	**-0.99**	**-0.86**	**-1.08**	**-0.82**	**-0.79**	**0.52**
Mean	-0.88	-0.78	-	-0.79	-0.79	0.54
5th percentile	**-0.39**	**-0.39**	**-0.92**	**-0.38**	**-0.48**	**0.08**
95th percentile	**-1.22**	**-1.18**	**-1.20**	**-1.00**	**-1.02**	**0.91**

2.3.2 Sea level rise

The latest advice from IPCC (2019) on sea level rise calls for increases to the allowances in previous documents. The latest global SLR (above 1986 - 2005 baseline) projections for the 'likely' scenario are 0.43m and 0.84m (i.e. 0.1m higher than AR5 projections in IPCC, 2013) by 2100 for RCP2.6 and RCP8.5, respectively (see Figure 5). The adopted sea level rise values and associated recession calculations are described in Section 3.3.2.

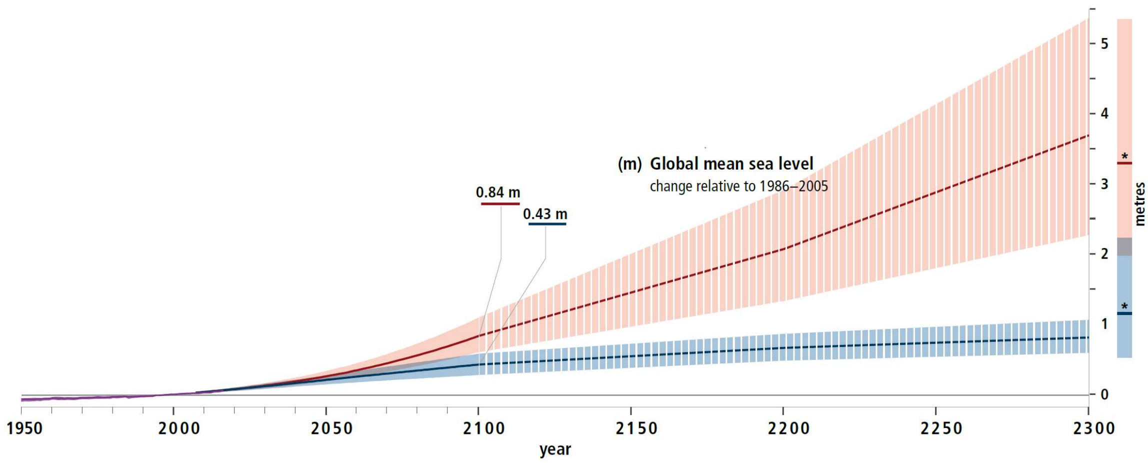

Figure 5: Global sea level rise projections above 1986 to 2005 baseline (IPCC, 2019): (blue) low (RCP2.6) and (red) high (RCP8.5) greenhouse gas emission scenarios.

2.3.3 Beach erosion

Historical measurements of beach erosion volumes due to major storm events, or a series of storms in succession, at Stockton Beach are limited to recent drone surveys and approximate values that can be obtained from the photogrammetry profiles. Potential short-term erosion for Stockton Beach was analysed by DHI (2006) using a dune erosion model and application of storm conditions from May and June 1974, as well as a storm in June 1999 that arrived from a more easterly direction. Both historical measurements and DHI's dune erosion modelling indicate that the extent of storm erosion experienced at Stockton increases from south to north in line with increased wave exposure from southerly storms. However, the alongshore distribution of storm erosion is sensitive to storm wave direction with more easterly or northerly storms leading to higher storm demands in the southern parts of the beach, as occurred in February 2020. A summary of measured and modelled beach erosion values along Stockton Beach are presented on Table 2.

Stockton Beach is experiencing long term recession, and therefore it is difficult to separate short term events from the long-term recession signal in beach survey and photogrammetric data. The maximum erosion estimates adopted by DHI (2006) ranged from 5 m at the Stockton Holiday Park to 17 m at Meredith Street, and 24.5 m at the LGA Boundary. The deepening of the sub-aqueous profile due to an on-going sediment deficit in the Stockton Beach compartment is likely to increase storm erosion volumes into the future. DHI (2016) completed an analysis to determine the impact on deepening on dune face erosion. It was estimated that a further deepening of the nearshore zone by 1 m would increase erosion rates by 5%.

Table 2: Measured and estimated storm erosion recession and volumes along Stockton Beach.

Alongshore area (south to north)	**Calculated based on photogrammetry/surveyed profiles**		**Predicted maximum storm erosion (DHI, 2006)**
	Landward movement of the erosion scarp (m)	**Storm erosion volume (m^3/m)**	
Holiday Park	-	May 1974: 35* June 2016: >55 February 2020: 38***	5m or ~20m^3/m
SLSC	June 1945: 15**** May 1974: na May 1997: na July 1999: 5-10 June 2016: na	June 1945: 63 May 1974: >50* May 1997: 130** July 1999: 42 June 2016: >40	5m or ~20m^3/m
Hereford Street to Pembroke	June 1945: 15**** May 1974: na May 1997: na July 1999: 5-10 June 2016: na	June 1945: 63 May 1974: >100* May 1997: 130** July 1999: 50 June 2016: >35	8.6m or ~38m^3/m
Barrie Crescent	-	June 1945: na May 1974: >85* May 1997: 150-200** July 1999: na June 2016: >40	12.1m or ~71m^3/m
Meredith Street	-	June 1945: na May 1974: >55* May 1997: 150-200** July 1999: na June 2016: >40	17.0m or 94m^3/m
Sewage ponds **CN boundary**	May 1997: 20	May 1997: 12	17.9m or 99m^3/m 24.5m or ~135m^3/m

*NSW beach profile database – volume change from 1-7-69 to 19-6-74
**Moratti (1997)
***Based on UAV survey data from 19-12-19 to 5-02-20
****DHI (2016)

Table 3: Offshore wave conditions during storm events listed in Table 2 based on Sydney Waverider Buoy.

Storm event/sequence of events	**Significant wave height (Hs (m))**	**Peak still water level (m AHD)**	**Approximate ARI of wave height (year)**	**Storm direction**
June 1945	Unknown			
May 1974*	9.1	1.5	25-50-year	South-south east
May 1997	9.9	1.2	100-year	South-south east
July 1999	6.1	1.2	5-year	East-south east
June 2016	6.6	1.3	10-year	East
February 2020	4.8	1.2	1 to 2 year	East

*Reconstructed by Foster et al. (1975)

3. HAZARD ASSESSMENT

3.1 Approach

The probabilistic approach allows adopting probability distribution functions for each input parameter to the erosion hazard model. Random sampling of input parameters (within limits) is considered a more 'realistic' approach in comparison to deterministic (fixed or single value) inputs and allows calculation of likelihoods. In this study, a Monte-Carlo model is applied that repeatedly combines these inputs (one million simulations) and produces probability curves for shoreline erosion during the defined planning periods. Shoreline erosion curves are produced for each of the NSW photogrammetry transects within the study area, as shown in Figure 1.

Based on the probability curves for each profile location erosion hazard lines for the extent of the study area were extracted for a series of probabilities.

During the development of the hazard model, the approach and proposed inputs and outputs were discussed with CN and DPIE as outlined in Bluecoast (2020c).

3.2 Planning periods

The adopted planning periods for which the coastal erosion hazards have been determined are present day (2020), 2040, 2060 and 2120.

3.3 Probabilistic input parameters

To incorporate ranges associated to the hazard parameters simple triangular distributions were defined as input to the hazard model. A triangular distribution is defined by three values, a minimum value, a maximum value and a peak/mode (most likely) value, as schematised in Figure 6. These inputs and justification for adopted ranges are described in detail in the following sections.

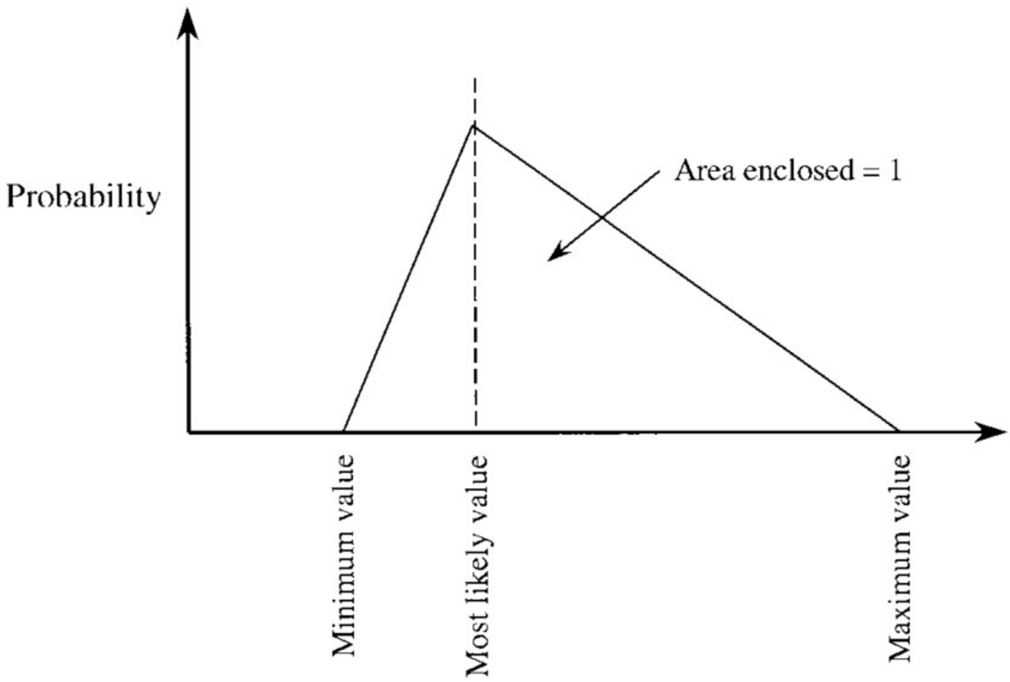

Figure 6: Schematic of a triangular distribution to describe probabilities of input parameters.

3.3.1 Long-term recession

The adopted minimum and maximum values for the triangular distribution correspond to the 5th and 95th percentile values of shoreline change of each block, see Table 4. To exclude any potential outliers, the actual statistical spatial minimum and maximum values were neglected. In a similar fashion, the mode or most likely value is suggested as the median rate of change for each analysis block.

It can be seen in Figure 4 that downdrift of the Surf Club and Mitchell Street seawalls higher recession rates are observed. This is particularly the case north of the Mitchell Street seawall and hence higher recession rates compared to the block averages have been adopted for profiles immediately downdrift from the northern end of the seawall.

Table 4: Adopted long-term recession rates for the hazard assessment.

	Adopted long-term recession rates (m/year)					
	Stockton A	**Stockton B**	**Downdrift Mitchell St seawall**	**Stockton C**	**Fern Bay 3**	**Fern Bay 4**
Minimum (5th percentile)	-0.39	-0.39	-0.92	-0.38	-0.48	0.08
Mode (median)	-0.99	-0.86	-1.08	-0.82	-0.79	0.52
Maximum (95th percentile)	-1.22	-1.18	-1.20	-1.00	-1.02	0.91

3.3.2 SLR recession

The minimum and maximum sea level rise projections were adopted as the corresponding RCP 2.6 (median) and RCP 8.5 (upper bound) projections from IPCC (2019) whereas the mode (most likely) values was adopted as mean value between the two scenarios. A summary of the adopted sea level rise allowances for the relevant planning periods are presented in Table 5.

Table 5: Adopted sea level rise allowances above 2020 baseline (adjusted from IPCC, 2019).

Planning period	Sea level rise (m)		
	Minimum (RCP2.6 - median)	**Mode (average)**	**Maximum (RCP8.5 – upper bound)**
2020	0.00	0.00	0.00
2050*	0.14	0.18	0.21
2100	0.33	0.63	0.93
2120**	0.41	0.87	1.33

*based on IPCC (2018) range 2046 to 2065, as not provided in IPCC (2019)
**extrapolated using 4mm/year and 20mm/year SLR rate for RCP2.6 - likely and RCP8.5 – upper bound scenario, respectively (IPCC, 2019)

For the purposes of this study, SLR recession can be estimated using a simplified predictive equation termed 'the Bruun Rule' (Bruun, 1962 and 1983). The Bruun Rule is based on the concept that sea level rise will lead to erosion of the upper shoreface, followed by re-establishment of the original equilibrium profile. This profile is re-established by shifting it landward and upward. SLR recession (R) is therefore a function of both SLR and the inverse beach slope, or the so-called Bruun factor (i.e. R = SLR × BF).

It is noted that the application of the Bruun Rule is a highly simplified method to estimate SLR recession and its use in complex coastal processes areas such as the southern end of Stockton Beach and its proximity to the entrance is challenging. While it is common practice in NSW to adopt this approach, careful consideration of the input parameters and engineering judgement is required. Again, to allow consideration of value ranges, statistical sampling is adopted for the depth of closure, as described in the following sections.

Depth of closure
The offshore beach slope extends to the depth of closure which is defined by Bruun (1962) as 'the outer limit for the nearshore littoral drift and exchange zone of littoral material between the shore and the offshore bottom area'. In this study, the closure bed contour was established having regard to the following methods:

- The depth of the seaward limit of surf related processes after Hallermeier (1983) taken to be 1.75 times the local significant wave height exceeded 12 hours per year.
- Slope discontinuity in the offshore profile.
- DHI (2006) numerical modelling.
- Consideration of entrance training wall and channel on offshore limits of the active profile.

DHI (2006) estimated a depth of closure of -9m AHD at Stockton based on the offshore wave height exceedance and confirmed this with numerical modelling (1D profile model location approx. 4km north of training wall). However, they also determined the discontinuity of the offshore profile to be at -20m AHD. Finally, an average value of -15m AHD was adopted for the 2006 hazard assessment.

As inputs for this study, DHI's 2006 closure depths were reviewed and adjusted to account for spatial variation throughout the study area due to effects of the northern breakwater and entrance channel on wave exposure and bathymetry. At the northern areas (Stockton C to Fern Bay), a conservative maximum closure depth of -35m AHD was selected in consideration of the 100-year planning time frame. The profile slopes were determined using the 2018 LiDAR bathymetry. A summary of the adopted parameters is shown in Table 6.

Table 6: Overview of closure depth and Bruun factor range adopted in this study.

		Minimum	Mode	Maximum
Stockton A	Closure depth (m AHD)	-7	-12	-15*
	Bruun factor	17	37	77
Stockton B	Closure depth (m AHD)	-9	-15	-20*
	Bruun factor	20	50	80
Stockton C	Closure depth (m AHD)	-9	-15	-30*
	Bruun factor	23	50	142
Fern Bay 3	Closure depth (m AHD)	-12	-18	-35
	Bruun factor	25	50	150
Fern Bay 4	Closure depth (m AHD)	-12	-18	-35
	Bruun factor	25	50	150

*Closure depth at southern areas of Stockton is controlled by entrance channel and reduced wave exposure.

3.3.3 Beach erosion

Probabilities of beach erosion volumes for each year in the planning period in the probabilistic hazard modelling were determined. Randomly generated AEP values were used to sample from the adopted distribution of storm erosion volumes. This adopted distribution of storm erosion volumes were based on the observed and modelled volumes presented in Section 2.3.3 and findings of the Stockton Bight Study (Part A; Bluecoast, 2020a). To account for the spatial variation of the storm erosion volumes over the study area (due to sheltering effects of the breakwater), a 50-year ARI erosion volume of 80m^3/m was adopted for the areas just north of the breakwater and an erosion volume of 220m^3/m for the more exposed areas at the northern end of the study area and linear interpolation was applied for areas in between. The adopted 50-year ARI storm erosion volumes are presented in Table 7.

To extrapolate the adopted 50-year ARI storm erosion volumes for each area to higher and lower occurrence probabilities (e.g. a 100-year ARI event), curve-fitting to the commonly used distribution of storm demands in NSW by Gordon (1987) was undertaken. An example for the Block B distribution of storm erosion volumes is provided in Figure 7. The associated slope stability zones for each profile have been calculated as described in the following paragraphs.

Table 7: Adopted storm erosion volumes.

	50-year ARI storm erosion				
	Stockton A	Stockton B	Stockton C	Fern Bay 3	Fern Bay 4
Volume (m³/m)	80	120	150	170	220

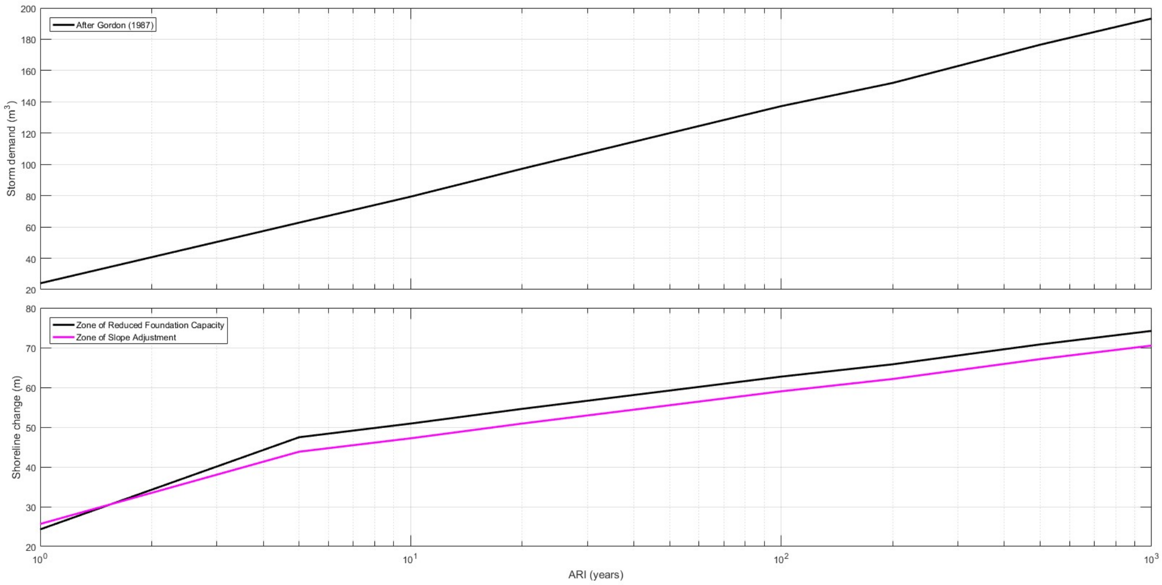

Figure 7: Results of (top) the distribution of storm erosion volumes for Block B, Profile 2 based on curve-fitting of the 50-year ARI erosion volume to Gordon (1987) and (bottom) associated setback of the ZRFC and ZSA.

The storm demand volumes have been converted to horizontal erosion distances to the back of the Zone of Slope Adjustment (ZSA) and Zone of Reduced Foundation Capacity (ZRFC) in accordance with the Wedge Failure Plane Model after Nielsen et al (1992), see Figure 8. These calculations have been performed for each beach profile location in the study area adopting the following uniform parameters:

- Baseline beach profile year: 2020 (Block A to C) and 2018 (Block 3 and 4)
- Scour level: -2m AHD
- Swash level: 1m AHD
- Angle of repose: 33 degrees
- Factor of safety: 1.5

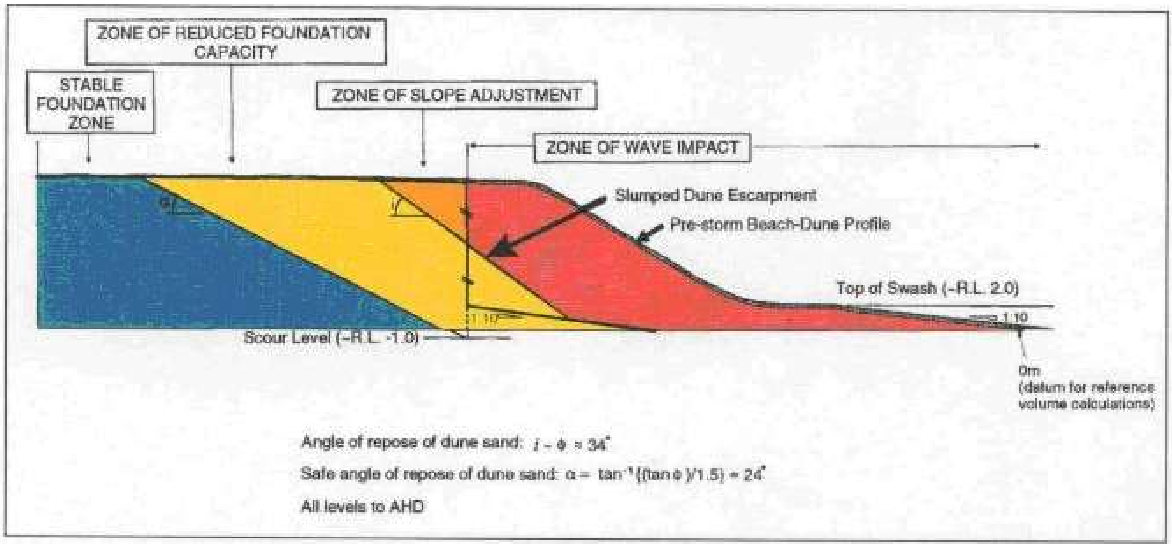

Figure 8: Wedge Failure Plane Model (Source: Nielsen et al., 1992).

3.4 Influence of coastal structures

The SLSC and Mitchell Street seawalls have been included in the hazard modelling as terminal protection (i.e. non-erodible) as CN have committed to maintaining these structures to their current level of protection throughout the planning periods. Seawall end effects (i.e. increased erosion risk at downdrift areas) have not been assessed in detail. Given the adoption of the 2020 beach profiles as the baseline for the hazard modelling the additional erosion hazard has been somewhat included due to the eroded state of the profiles in downdrift areas of the seawalls. Moreover, by including the higher shoreline recession rate for the section at the northern end of the Mitchell Street seawall, as has been observed, the model inherently includes the influence the coastal structures.

3.5 Probability distribution curves

Following the millions of Monte-Carlo simulations of combining the three erosion hazards of long-term recession, sea level rise recession and storm erosion, probability curves of the position of the Zone of Reduced Foundation Capacity (ZRFC) were produced. An example of the combining of the coastal hazards and resulting probability distribution is provided in Figure 9. A further example showing the probability curves for long-term recession and sea level rise recession and the position of ZRFC for year 2120 is provided in Figure 10. For demonstration, the results are shown for a representative profile within the centre of each analysis block.

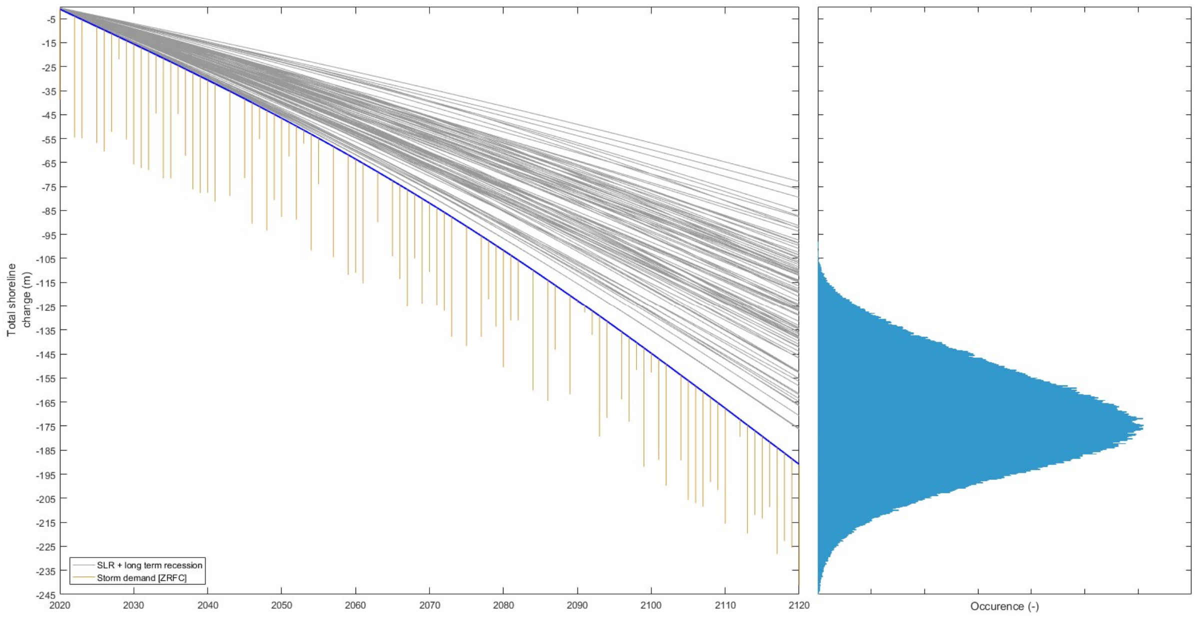

Figure 9: Probabilistic hazard model results for Block A, Profile 7: (left) Monte-Carlo simulation of long-term and sea level rise recession (grey lines) and superimposed storm erosion (yellow lines) (right) probability distribution of the position of ZRFC in year 2120.

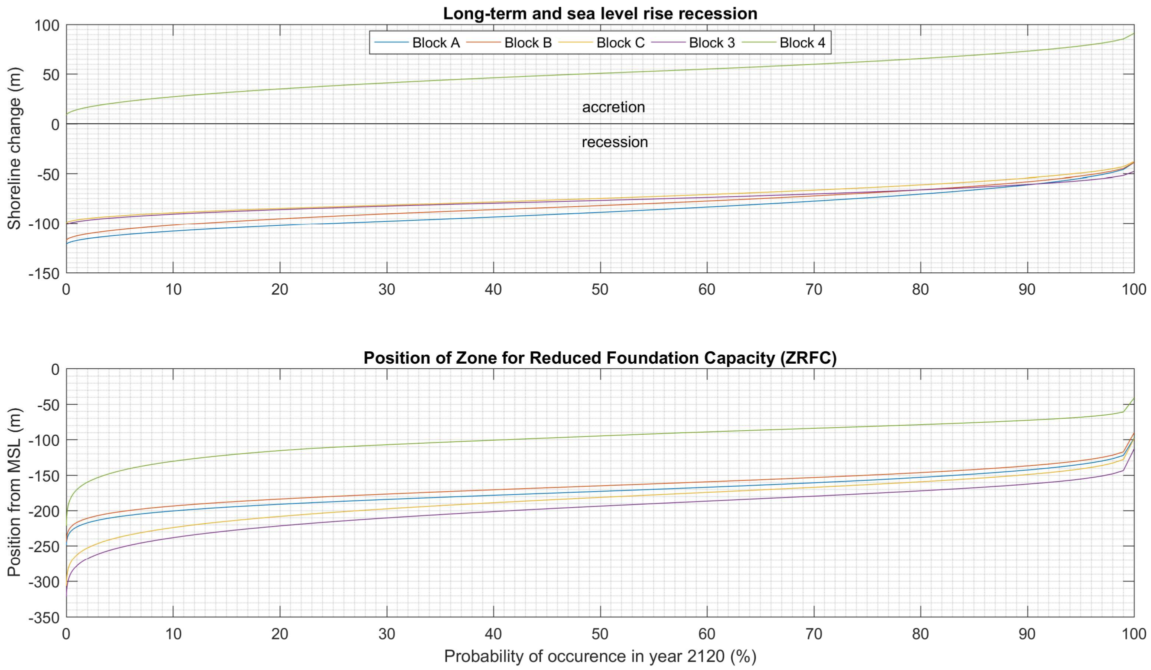

Figure 10: Probabilities of combined long-term and sea level rise recession and position of ZRFC in year 2120.

3.6 Probabilistic hazard lines

For the purpose of mapping the erosion hazard the 50%, 10% and 1% exceedance probabilities were selected, see Figure 11 to Figure 14. The associated lines represent the annual exceedance probability (AEP) of the landward end of the ZRFC for the specified planning years. The 1% AEP is comparable to the 100-year annual recurrence interval (ARI) event for the presented years.

Further presentation and mapping of the probabilistic hazard assessment results are provided in the remainder of this report.

Figure 11: Hazard lines for the erosion hazard in year 2020.

Figure 12: Hazard lines for the erosion hazard in year 2040.

Figure 13: Hazard lines for the erosion hazard in year 2060.

Figure 14: Hazard lines for the erosion hazard in year 2120.

3.7 Risk assessment

3.7.1 Risk assessment process

The risk assessment has been prepared using guidance provided by the international risk management standard, ISO 31000. That standard suggests the following steps for risk assessment:

- Establish the risk management context.
- Identify the risks.
- Assess the likelihood and consequences of those Risks.
- Evaluate the risks.

Management strategies can then be suggested for those risks which are assessed as being unacceptable, with these later stages normally falling under the scope of subsequent studies to inform a CMP. The risk assessment presented here deals with the 'Base Case' management scenario, following a 'Business as Usual' approach to managing Stockton Beach, being (Bluecoast, 2020a):

'The on-going implementation of all actions as listed under the current CZMP 2018 Part A (Stockton) as the gradual realisation of erosion in accordance with the hazard mapping and associated loss of assets at risk.'

3.7.2 Context of the assessment

The extents of the lines considered herein have certain probabilities associated with them (50%, 10% and 1% chance) and are assessed at several time frames (present day (2020), 2040, 2060 and 2120). This represents an appropriate range of lines for consideration by stakeholders as part of risk assessment, and maps showing the extents are presented below.

An important aspect of risk assessment context is understanding which stakeholders will suffer from the risks being assessed (noting that benefits may also result if risks eventuate) and who is best placed to take responsibility for those risks. Generally, coastal management in NSW is a responsibility borne by local government (e.g. CN) and, under the *Coastal Management Act 2016*, coastal councils are typically required to prepare and implement a CMP, consistent with the requirements of the Act and the *Coastal Management Manual* (NSW Government, 2018). The relevant Minister administering the Act may prepare a CMP in certain circumstances, such as a failure of the council to comply with a relevant coastal management direction of the Minister or if the Minister refuses to certify a draft CMP prepared by a council.

The above paragraph reflects how the responsibilities of local government in NSW fall under the general direction and jurisdiction of the State. Accordingly, in setting a geographical boundary around the risk assessment, it is meaningful to consider the following:

- Impacts that may be felt by stakeholders with a direct interest in the geographical extent of the coastal hazards being considered, including the local community and landowners.
- The impacts that may be felt by the broader LGA and its stakeholders, noting that costs for repairs to CN infrastructure or loss of income from caravan parks owned and/or operated by CN (as examples) need to be funded by the CN, which derives much of its income from rates levied on residents across the LGA.
- The impacts that may be felt by the State, if a local council fails in managing the coast and/or is overwhelmed by the burden which falls upon it in managing the coast.

Therefore, the local community, local council and the state government all have an interest in coastal management. In the case of Stockton, its geographical isolation from the remainder of the LGA, and the fact that it doesn't represent a thoroughfare between localities (there is presently only a single access road) means that direct impacts will be predominantly felt by the local community. Indirect impacts will also be of significance to CN and its broader community. State government also has an interest in making sure that coastal management does not become an onerous burden to local government and for this reason provides funding support alongside oversight which aims to help avoid missteps in management.

ISO 31000 formally defines risk as the *'effect of uncertainty on objectives'*. CN's Community Strategic Plan (The City of Newcastle, 2018) contains seven '*Strategic Directions*'. Laid out under each of those directions is a set of objectives under the heading '*Where do we want to be'*. Strategies to achieve each objective are also provided. Those objectives and strategies most threatened by coastal erosion are summarised in Table 8.

Table 8: Potential coastal erosion/recession hazard effects on Stockton community objectives (extracted from The City of Newcastle, 2018).

Strategic Direction	Threatened Community Objective	Relevant Strategy/Indicators
1. Integrated and Accessible Transport	1.3 Safe, reliable and efficient roads and parking networks	1.3(a) Ensure safe road networks through effective planning and maintenance. Roads and footpaths are to be in a good condition.
2. Protected Environment	2.2 Our unique natural environment is maintained, enhanced and connected	2.2.a Provide and advocate for protection and rehabilitation of natural areas
	2.3 Environment and climate change risks and impacts are understood and managed	2.3a Ensure decisions and policy response to climate change remains current and reflects community needs 2.3b Support individuals and communities to prepare, respond and recover from emergency events
3 Vibrant, Safe and Active Public Places	3.1 Public places that provide for diverse activity and strengthen our social connections	3.1a Provide quality parkland and recreation facilities that are diverse, accessible and responsive to changing needs 3.1b Enhance our beaches and coastal areas through upgraded facilities
5 Liveable Built Environment	5.1 A built environment that maintains and enhances our sense of identity	5.1a Protect and promote our unique built and cultural heritage. 5.1b Ensure our suburbs are preserved, enhanced and promoted, while also creating opportunities for growth.
7 Open and Collaborative Leadership	7.1 Integrated, sustainable long-term planning for Newcastle and the Region	7.1a Encourage and support long term planning for Newcastle, including implementation, resourcing, monitoring and reporting. 7.1b Ensure long-term financial sustainability through short, medium and long-term financial planning.

In the context of Stockton, the objectives and strategies in Table 8 point towards ensuring that Stockton remains a feasible, liveable place for its community, with some emphasis placed on natural areas, beaches and parklands.

3.7.3 Risk identification

Considering the context outlined in the preceding section, risks are going to arise from direct impacts of erosion on assets within and behind Stockton Beach. Formal identification of the risk has been made using the following word formula:

There is a risk that a **cause** will lead to **an event (or chain of events)** resulting in an **outcome** with a set of **consequences/impacts**.

In this case, a catch all description of the risk is that:

There is a risk that **ongoing coastal processes at Stockton** will lead to **the beach receding/eroding to such an extent** that **assets are either destroyed or their functionality compromised** such that the value those assets provide to the community **is permanently lost**.

There are a few notable things with this risk descriptor:

- Permanent loss is seen as the most likely outcome if assets are compromised or destroyed. Given the present legal and planning context it seems highly unlikely that land at the rear of the beach would be artificially reclaimed from the sea once it has eroded past a given landward location. With enough permanent loss of value from Stockton, the objective of retaining Stockton as a liveable place in future could become impossible.
- Loss of functionality includes erosion occurring to such an extent that an asset is considered unsafe. In recent years, this process was seen at the old North Stockton Surf Club (operating as a childcare centre). The facility was affected by erosion, initially with its beachfront playground being relocated to the side of the building, and the building eventually demolished as the erosion progressed such that its structural integrity could not be appropriately guaranteed.
- Assets can have environmental and/or less tangible values (i.e. difficult to place a monetary value upon). For example, the beach is the frontline asset threatened by coastal processes. The beach provides a sandy barrier offering a level of protection against coastal erosion and inundation. It also holds environmental values such as its own ecosystem (incorporating the services that ecosystem provides) alongside less tangible values associated with amenity and community identity. The values can be difficult to evaluate. A first pass risk assessment would ideally be informed by community consultation and stakeholder input. In early 2020, COVID-19 and the truncated timeframe of this project, made this difficult to complete. However, community consultation activities undertaken by CN have identified strong opinions regarding Stockton Beach, including:
    - The beach is highly valued and represents a critical asset to the local community.
    - The preference to maintain a clean beach area providing enough width for recreational space, including uses such as Nippers, and which supports the current foreshore amenity and character.
    - Stockton has a strong surf culture with a desire to maintain surf amenity nearby the residential areas.
    - The preference to ensure any nourishment programs utilise sand that matches the existing visual profile of Stockton Beach.
    - The preference to maintain beach connectivity along the entirety of the beach.

3.7.4 Likelihoods

Measures of likelihood

It is important that coastal risk assessment in the face of climate change is completed within the broader risk management framework adopted by a local council (Wainwright and Verdon-Kidd, 2016). CN provided its standard risk assessment tables, which have been reproduced in Appendix A.

The three hazard probabilities selected have been aligned with CN's Likelihood Selection Table (Appendix A) as presented in Table 9.

Table 9: Assignment of selected hazard lines to CN's likelihood descriptors.

CN Likelihood Descriptor	CN Frequency	Matching Hazard Line
Almost Certain	Likely to occur at least once every year	None
Likely	Likely to occur once every 1-2 years	50%
Possible	Likely to occur once every 2-5 years	None
Unlikely	Likely to occur once every 5-20 years	10%
Rare	Not Likely to occur more than once in 30 years	1%

We note that assignment of a qualitative descriptor based on an actual calculated probability degrades the level of understanding of the risks involved. For example, descriptors such as 'Possible' have been found to have a wide range of interpretation within the general public (Maboussin and Maboussin, 2018). The hazard lines have been assigned based on the description of 'Likely' in CN's likelihood selection table as having a 50 to 80% chance of occurring over the time frames indicated by the frequency descriptors.

Hazard lines
The processing of spatial data was completed to support the concurrent cost benefit analysis and three hazard lines ('Zone of Reduced Foundation Capacity' for 1% likelihood, 10% likelihood, 50% likelihood) at four future time periods (2020, 2040, 2060, 2120). Maps showing the relevant lines for the four time periods are presented in Section 3.6.

3.7.5 Consequences

Threatened assets

Spatial data were provided by CN, including value information where available, for several different classes of assets. These assets were then clipped to the zones bounded by the hazard lines enabling the assessment of consequences relating to each likelihood.

The assets for which data were provided, and for which assessment was completed have been classified for illustration into:

1. Surface and Drainage Assets: including road reserve and land parcels, surface pavements (including roads and footpaths), kerbs and stormwater pipes. For clarity, kerbs are not shown in the figures presented in Appendix B, recognising that they typically occur at the edge of road pavements.
2. Above Surface Assets: including buildings (both CN owned and private), shelters, play spaces, park and street furniture, and walls.

Due to time constraints for study completion, there are notable omissions from the data provided, including services (telecommunications, water and sewer, electricity, gas) and some delineation of environmental assets, such division of land parcels containing sandy beach and dune assets would also provide useful information.

Maps showing the distribution of affected assets, seaward of the 1% likelihood ZRFC hazard line, alongside the three hazard lines at each time period are presented in Appendix B.

Measures of consequences assessment

Similarly, to the likelihood descriptors, CN has also provided a table with its standard risk consequence categories. This table is provided in Appendix A. There are seven risk impact categories considered:

1. Financial
2. Environmental
3. Health and Safety
4. Infrastructure / ICT Systems / Utilities
5. Legislative Compliance
6. Reputation / Image
7. Service Delivery

Categories 2 through 7 cannot be easily evaluated without consulting key stakeholders. Due to the constraints on completing this assessment outlined in Section 1.1, it has not been possible to undertake that consultation within the time frame required. A qualitative assessment of those categories is provided in Section 4.

A preliminary consequences assessment has been completed using the financial category only (see Table 10). Herein, the valuation has adopted the results of analysis completed in developing the CBA (Bluecoast, 2020b), which utilised the mapping data presented in Appendix B. Use of the financial category in isolation would result in under representation of the full range of impacts that would be felt by the local community and CN, if the beach continues to erode without intervention.

Table 10: CN financial consequence classification.

CN Consequence Category	CN Description	Value of Incurred Losses
Insignificant	Minimal financial impact that can be managed within the program or services budget.	<$10,000
Minor	A financial loss that can be managed within the departmental budget.	$10,000 - $100,000
Moderate	A financial loss that can be managed within the organisational budget.	$100,000 - $500,000
Major	A financial loss unable to be managed within the organisational budget, resulting in reduction in a program or service	$500,000 - $2,000,000
Severe	A critical financial loss resulting in closure of, or significant reduction in a program or service	>$2,000,000

A mitigating factor is that the loss of assets will occur over time (e.g. for the 2120 timeframe, the shoreline is projected to erode over time, not all at once). Therefore, loss is amortised with the full amount more likely to be realised in a series of smaller losses from severe storm events. CN may well be able to absorb some of these intermittent losses.

A cost benefit analysis would commonly aim to account for intermittent losses through the process of discounting, but such analysis is beyond the scope of this risk assessment. A CBA which includes discounting has been prepared concurrently with this study (Bluecoast, 2020b).

Valuation and categorisation

The total financial loss has been calculated and categorised for the time periods and likelihoods adopted for the analysis, with results presented in Table 11.

Table 11: Valuation and classification of coastal erosion hazard consequences[1].

Chance	Loss of Value by Year: ($M AUD)			
	2020	2040	2060	2120
50%	0.18 (Moderate)	9.1 (Severe)	37 (Severe)	117(Severe)
10%	1.9 (Major)	18 (Severe)	44 (Severe)	157 (Severe)
1%	2.2 (Severe)	29 (Severe)	49 (Severe)	184 (Severe)

Within Table 11, it could be argued that the future loss totals should be processed by discounting as is done during cost benefit analyses. For present considerations, the cumulative profile of risk at different time frames has been retained for clarity and to support stakeholder consultation, should it be required at a later stage.

3.7.6 Risk evaluation

A risk matrix enables risk evaluation by combining likelihoods and consequences. The default CN risk matrix, reproduced in Appendix A, was modified (Table 12) to include only those likelihoods represented by the hazard lines being considered here.

[1] Values here are totals from Tables 17, 19 and 22 from the CBA (Bluecoast, 2020b). They represent total loss up to the time frame indicated and future values have not been discounted. The future values presented here are therefore not equivalent to present day values. The values cover private property and buildings, council property and assets, council buildings and structures, paved areas, stormwater pipes and shelters. Services not managed by CN are not included, nor intangible costs.

Table 12: Extract from CN's risk matrix.

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Severe
Likely	Low	Medium	High	Extreme	Extreme
Unlikely	Low	Low	Medium	High	High
Rare	Low	Low	Medium	High	High

By combining the findings of Table 10,Table 11 and Table 12, the current and future financial risk levels at Stockton Beach have been determined as presented in Table 13.

Table 13: Assessed financial risk profiles at various time frames.

Chance	Risk level by year			
	2020	2040	2060	2120
50% (Likely)	High	Extreme	Extreme	Extreme
10% (Unlikely)	High	High	High	High
1% (Rare)	High	High	High	High

Results such as those obtained herein should be considered alongside a risk manager's level of 'risk tolerance'. When combined, these considerations govern the urgency with which risks should be treated. AS5334 (Australian Standards, 2013) regards that the following treatments are suitable when considering climate change risks for settlements and infrastructure:

- *Low* risks would typically be addressed through routine maintenance and day to day operations.
- *Moderate* risks would require a change to the design or maintenance regime of assets.
- *High* risks require detailed research and appropriate planning (or design).
- *Extreme* risks would require immediate action to mitigate.

Prompt research, planning and design, as a minimum, are presently indicated to manage coastal erosion at Stockton Beach. However, these risk levels must be interpreted recognising that only financial risks have been considered. There is a strong possibility that the present-day risk profile for the suburb of Stockton would be assessed as 'Extreme' if social and environmental values were also considered
.

4. IMPACTS ON PEOPLE, INFRASTRUCTURE AND ENVIRONMENT

4.1 Preamble

Complementing the risk assessment, this discussion is viewed as a precursor to inform other activities associated with coastal management for Stockton Beach. It includes a 'high level' overview of current and future coastal hazards which were not able to be included in the risk assessment but may warrant further consideration.

4.2 Impacts on infrastructure

Several impacts on infrastructure have not been examined by this study including services such as:

- Water
- Sewer
- Gas (noting there is a gas pipeline that runs along Mitchell Street)
- Electricity
- Communications

The main issue relating to these services is that they commonly perform as a network and damage to one part of a network will degrade performance at other locations across the network. The physical nature of the different types of services affects their resilience and/or adaptability to the impacts of erosion. One example which is common in low-lying areas adjacent to beaches, is sewerage infrastructure where connectivity is necessary for the operation of gravity and/or pumping main lines. It seems likely that, for example, sewer mains exist in the vicinity of the most threatened length of public roadway within Stockton, at the southern end of the Mitchell St seawall.

The protection/retention of safe and well maintained roads, as per Strategy 1.3(a) of the current Community Strategic Plan (The City of Newcastle, 2018) will help to protect much of the buried services networks across the suburb as they are most commonly located within the road reserve.

Over the 100-year (2120) time frame, there remains a small chance that Fullerton Street is made unsafe at the northern end of the Stockton residential area (see Figures 19 & 20 in Appendix B), effectively cutting off access to Stockton from the north. Clearly, this would have an impact on CN's ability to provide services to Stockton. Worth considering is that, even if terminal protective works were provided across northern Stockton as the sole strategy for mitigating against erosion risks, outflanking of the structure to the north could possibly threaten Fullerton Street in a more northerly location. It is understood that these matters will ultimately be addressed by CN's completed CMP due in 2021.

4.3 Impacts on the environment

Considering Strategic Direction 2 of the Community Strategic Plan, protection of the environment and natural areas is an important matter for CN. Embedded within the table outlining that Strategic Direction is a strategy which encourages decisions and policy that support an up to date understanding and response to climate change.

An ongoing understanding of the potential for erosion to affect land is required. This can be maintained by revisiting and updating coastal hazard lines with reasonably regularity, as understanding improves and climate change projections are revised. By ensuring information is up to date, parts of the shoreline that could foreseeably be affected, in the short term, by a severe coastal storm can be managed to ensure that appropriate emergency management strategies are in place.

The key environmental asset at Stockton is the beach. If the beach is lost, which is possible depending on how the situation is managed, many of the environmental and social values derived from the beach are lost. This can presently be seen at the Mitchell Street seawall, as much of the usable beach width has already been lost in-front of this seawall in recent years.

There are also values associated with remnant dune systems to the rear of the beach, although the remaining vegetated dunes are typically narrow and far less significant than the dune system which exists to the north of Stockton.

4.4 Impacts on people

The CBA (Bluecoast, 2020b) reports that approximately 100,000 people utilise the beach annually. The beach has been popular for swimming, fishing, surf lifesaving, beachgoing and surfing. Coastal erosion has the potential to threaten several of the *Strategic Directions* in CN's CSP:

- **Vibrant Safe and Active Public Places:** These include the beach, which is the first asset to be lost to erosion and potentially the parkland and facilities that are behind the beach.
- **Liveable Built Environment:** The loss of parkland and public spaces, services, and the road network present a serious risk to the overall 'Liveability' of Stockton. Of course, liveability can be affected before severe physical impacts occur. It could be argued that the liveability of Stockton is already being impacted even though the loss of facilities has been limited to date. A lack of confidence in the future viability of an area affects the sense of liveability.
- **Open and Collaborative Leadership:** This follows from the previous point and the 'sense of identity' of an area. The strategies around this Direction relate to long term planning and financial sustainability. It is vitally important that planning is as strategic as it can be to appropriately follow this *Key Strategic Direction*. This implies that planning should consider the longer term (say 100 year) time frame, to ensure viability, minimise any future financial shocks and to increase the confidence of the Stockton Community in the place where they live.
- **Health and Safety:** Through appropriate strategic planning, severe health and safety impacts from coastal erosion should be appropriately mitigated. At Stockton, it appears that the current risks are close to being considered 'Severe'. The safety of structures and people need to be maximised wherever possible. One limitation of the present risk analysis is that the risks associated with inundation hazards (e.g. wave overtopping of the foreshore) have not been considered as updated information on those hazards, while it is being prepared, was not available as background information for this risk assessment. The health and safety risks to people can be largely avoided through *Open and Collaborative Leadership* and strategic planning. Unfortunately, legacy planning issues often remain and conflict with this strategic direction.

4.5 Intangible values

Some of the values discussed in the immediately preceding sections have aspects that are intangible, or less amenable to valuation. Herein, we have provided a brief comment on some of the more intangible risks outlined in CN's standard Risk Consequence Table.

- **Legislative Compliance**: Compliance with legislation is largely a risk that needs to be borne by CN. In the context of Coastal Management, compliance with the requirements of the *Coastal Management Act 2016*, the Coastal Management Manual (NSW Government, 2018) and related directions from the relevant Minister will assist CN in minimising these risks.
- **Reputation/Image:** These risks are primarily political and beyond the scope of this assessment, although we note that a positive reputation is useful in progressing projects in a timely manner.

4.6 Discussion

A risk assessment relating to coastal erosion hazards at Stockton Beach was completed. The assessment was undertaken under the limitations stated in Section 1.1.

On the consideration of financial risks alone, the current risk profile for Stockton Beach is assessed as 'High', meaning that detailed research, planning and study are indicated. If other risk categories were considered, it seems likely that the current risk profile would be assessed as 'Extreme', indicating that immediate action is required. On balance, an approach somewhere between that for a 'High' and 'Extreme' risk level is justifiable.

Given the restrictions related to the COVID-19 pandemic, the difficulty to complete community consultation as part of the risk assessment is unfortunate. However, CN's regular engagement with the Stockton Community Liaison Group has given valuable insights into the values of the community, including an appreciation of the appetite for the risk and response to coastal hazards. If required, the community can be specifically canvased in relation to this risk assessment later. Even so, the findings of this risk assessment are that prompt attention to management options which mitigate against coastal erosion is justified.

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APPENDIX A – CN'S STANDARD RISK TABLES AND MATRIX

LIKELIHOOD SELECTION TABLE

Likelihood	Description
Almost Certain	Expected to occur in most circumstances (>80% probability). Likely to occur at least once in every year.
Likely	Will probably occur in most circumstances (50 to 80% probability). Likely to occur once every >1 -2 years.
Possible	Might occur at some time (25 to 49% probability). Likely to occur once every >2-5 years.
Unlikely	Could occur but unlikely (2 to 24% probability). Likely to occur once every >5-20 years.
Rare	May occur in exceptional circumstances (<2% probability). Not likely to occur more than once in 30 years.

Risk Consequence

Graded Consequences of risk for each Risk Impact Category.

Impact Category	Insignificant	Minor	Moderate	Major	Severe
Financial	Minimal financial impact that can be managed within the program or service budget. Less than $10,000.	A financial loss that can be managed within the department budget. $10,000 to less than $100,000.	A financial loss that can be managed within the organisational budget. $100,000 to less than $500,000.	A financial loss unable to be managed within the organisational budget resulting in reduction in a program or service. $500,000 to less than $2M.	A critical financial loss resulting in closure of or significant reduction in a program or service. Greater than $2M.
Environmental	Negligible damage that is contained on-site. The damage is recoverable with no permanent effect on the environment or the asset, The resource or asset will take less than 6 months to recover.	Minor damage to the environment or heritage asset or area that is immediately contained on-site. The resource or asset will take less than 2 years to recover or it will only require minor repair.	Moderate damage to the environment or a heritage listed asset or area, which is repairable. The resource or asset will take up to 10 years to recover.	Significant damage to an *environmentally significant* area or asset from which it will take more than 10 years to recover. OR Extensive damage to a non-heritage listed area or asset that has heritage values. OR Significant damage to a *Council Heritage Listed* area or asset that involves either extensive remediation or will take more than 10 years to recover.	Irreversible and extensive damage is caused to a *World Heritage Listed* Area, *a National Heritage Listed* Site, *a Register of the National Estate Site or a Council Heritage Listed* area or asset. OR Irreversible and extensive damage is caused to a *Matter of National Environmental Significance* under the Act (e.g. endangered species, RAMSAR wetland, marine environment).
Health and Safety	No injury / minor First Aid treatment only.	First Aid treatment or precautionary medical attention only. Person likely to immediately resume normal duties.	Person unable to resume normal duties in the short-medium term.	Hospitalisation with potential to result in permanent impairment.	Single or multiple fatality.

Impact Category	Insignificant	Minor	Moderate	Major	Severe
Infrastructure/ICT Systems/ Utilities	Minor damage where repairs are required however, assets or infrastructure are still fully operational. OR Loss of utilities/systems resulting in minor disruption to a service for up to 12 hours.	Short term loss or damage where repairs are required to allow the assets or infrastructure to remain operational using existing internal resources. OR Loss of utilities/systems resulting in minor disruption to a service (>12 hours - 24 hours).	Medium term loss of key assets and infrastructure, where are repairs required to allow them to remain operational. Cost moderate and outside of budget allocation. OR Loss of utilities/systems resulting in disruption to a department for up to 12 hours.	Widespread, medium term loss of key assets and infrastructure, where repairs required to allow the infrastructure to remain operational. Cost significant and outside of budget allocation. OR Loss of utilities/systems resulting in serious disruption to several services or more than 1 department for up to 12 hours.	Widespread, long-term loss of substantial key assets and infrastructure. Infrastructure requires total rebuild or replacement. OR Failure of utilities/systems resulting in the loss of function for several departments (> 12 hours).
Legislative Compliance	Minor technical breach but no damages. No monetary penalty. Internal query.	Minor technical non-compliances and breaches of Corporate/Council Policy or State/Commonwealth regulations with potential for minor monetary penalty.	Compliance breach of regulation with investigation or report to authority with possible fine. AND/OR Special audit by outside agency or enquiry by Ombudsman.	Major compliance breach with potential exposure to large damages or awards. Potential prosecution with penalty imposed. District court action. OR Multiple compliance breaches that together result in potential prosecution with penalty imposed.	Severe compliance breach with prosecution and/or maximum penalty imposed. Supreme Court or criminal action. OR Multiple compliance breaches that together result in prosecution with maximum penalty imposed.
Reputation/Image	Customer complaint. AND/OR Not at fault issue, settled quickly with no impact.	Non-headline community media exposure. Clear fault. Settled quickly by NCC response. Negligible impact.	Negative local (headline) and some regional media coverage. Council notification. Slow resolution.	Negative regional (headline) and some national media coverage. Repeated exposure. Council involvement. At fault or unresolved complexities impacting public or key groups.	Sustained national media coverage. Maximum multiple high-level exposure. Direct Council intervention. Loss of credibility and public/ key stakeholder support.

Impact Category	Insignificant	Minor	Moderate	Major	Severe
Service Delivery	Some non-essential tasks will not be able to be achieved. AND/OR Unable to provide service for <1 business day. AND/OR Major Project in progress delay for < 1 month.	Less than 5% of essential tasks will not be achieved. AND/OR Unable to provide service for 1-2 business days. AND/OR Major Project in progress delay for 1 - 2 months.	5% - 10% of essential tasks will not be achieved AND/OR Unable to provide service for 2-5 business days. AND/OR Major Project in progress delay for 2-3 months.	10% - 20% of essential tasks will not be achieved. AND/OR Unable to provide service for 5-10 business days. AND/OR Major Project in progress delay for 3-6 months.	Greater than 20% of essential tasks will not be achieved. AND/OR Unable to provide service for >10 business days. AND/OR Major Project in progress delay for > 6 months.

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Severe
Almost Certain	Medium	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	Extreme	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Low	Medium	High	High
Rare	Low	Low	Medium	High	High

APPENDIX B – COMBINED RISK MAPPING

Note: This map is provided for risk assessment, and should not be used for other purposes

Figure 5: Affected Surface Assets for 2020 (South)	0 50 100 150 m APPROX SCALE		
Stockton Beach Coastal Hazard Risk Assessment	REV C	DRAWN EN	CHECK DJW
GIS File:\Projects\P00083_StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresC.qgs			Salients

Note: This map is provided for risk assessment, and should not be used for other purposes

Figure 6: Affected Above Ground Assets for 2020 (South)

0 50 100 150 m
APPROX SCALE

Stockton Beach Coastal Hazard Risk Assessment

REV	DRAWN	CHECK
C	EN	DJW

Salients

GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresC.qgs

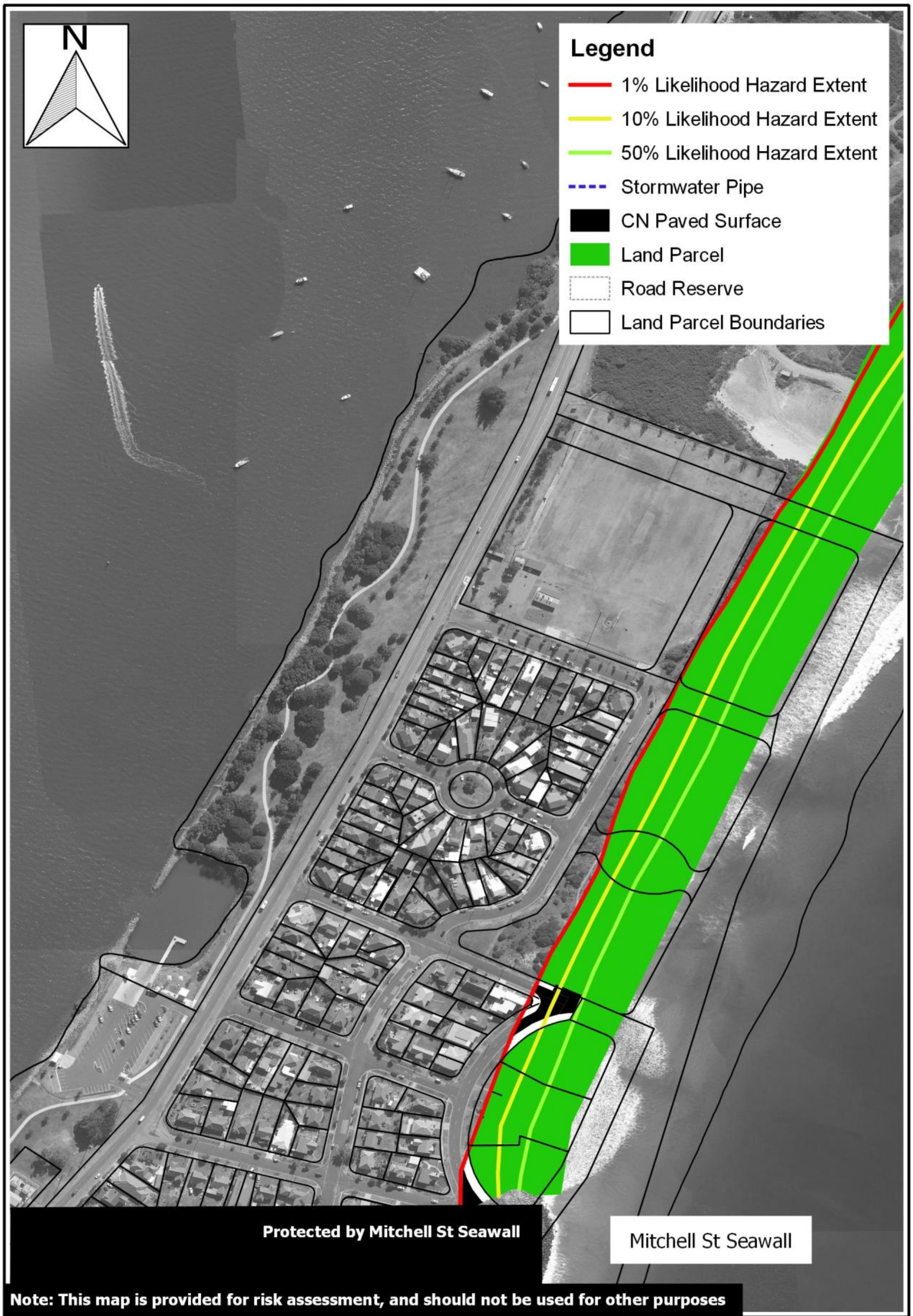

Figure 7: Affected Surface Assets for 2020 (North)

0 50 100 150 m

APPROX SCALE

Stockton Beach Coastal Hazard Risk Assessment

REV	DRAWN	CHECK
B	EN	DJW

Salients

GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresB.qgs

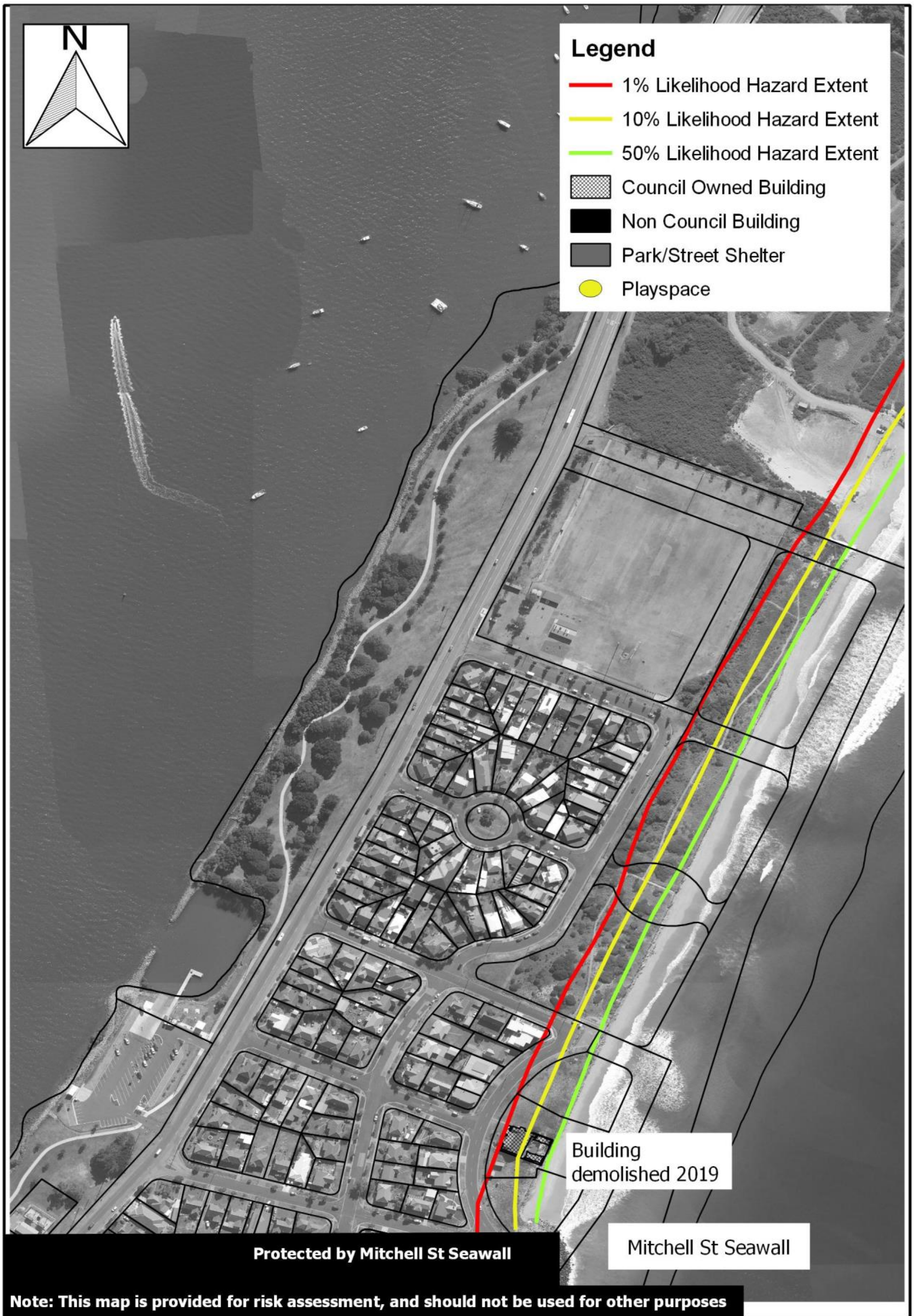

Figure 8: Affected Above Ground Assets for 2020 (North)

Stockton Beach Coastal Hazard Risk Assessment	REV C	DRAWN EN	CHECK DJW	Salients
GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresC.qgs				

Note: This map is provided for risk assessment, and should not be used for other purposes

Figure 9: Affected Surface Assets for 2040 (South)

Stockton Beach Coastal Hazard Risk Assessment

REV	DRAWN	CHECK
C	EN	DJW

Salients

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Figure 10: Affected Above Ground Assets for 2040 (South)

Stockton Beach Coastal Hazard Risk Assessment

REV	DRAWN	CHECK
C	EN	DJW

Salients

GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresC.qgs

Figure 11: Affected Surface Assets for 2040 (North)

0 50 100 150 m
APPROX SCALE

Stockton Beach Coastal Hazard Risk Assessment

REV	DRAWN	CHECK
B	EN	DJW

Salients

GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresB.qgs

Figure 12: Affected Above Ground Assets for 2040 (North)

Stockton Beach Coastal Hazard Risk Assessment

REV	DRAWN	CHECK
C	EN	DJW

Salients

GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresC.qgs

Figure 13: Affected Surface Assets for 2060 (South)

Stockton Beach Coastal Hazard Risk Assessment

REV	DRAWN	CHECK
C	EN	DJW

Salients

GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresC.qgs

Figure 14: Affected Above Ground Assets for 2060 (South)

Stockton Beach Coastal Hazard Risk Assessment	REV C	DRAWN EN	CHECK DJW

GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresC.qgs

Salients

Note: This map is provided for risk assessment, and should not be used for other purposes

Figure 15: Affected Surface Assets for 2060 (North)

0 50 100 150 m
APPROX SCALE

Stockton Beach Coastal Hazard Risk Assessment

REV	DRAWN	CHECK
B	EN	DJW

Salients

GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresB.qgs

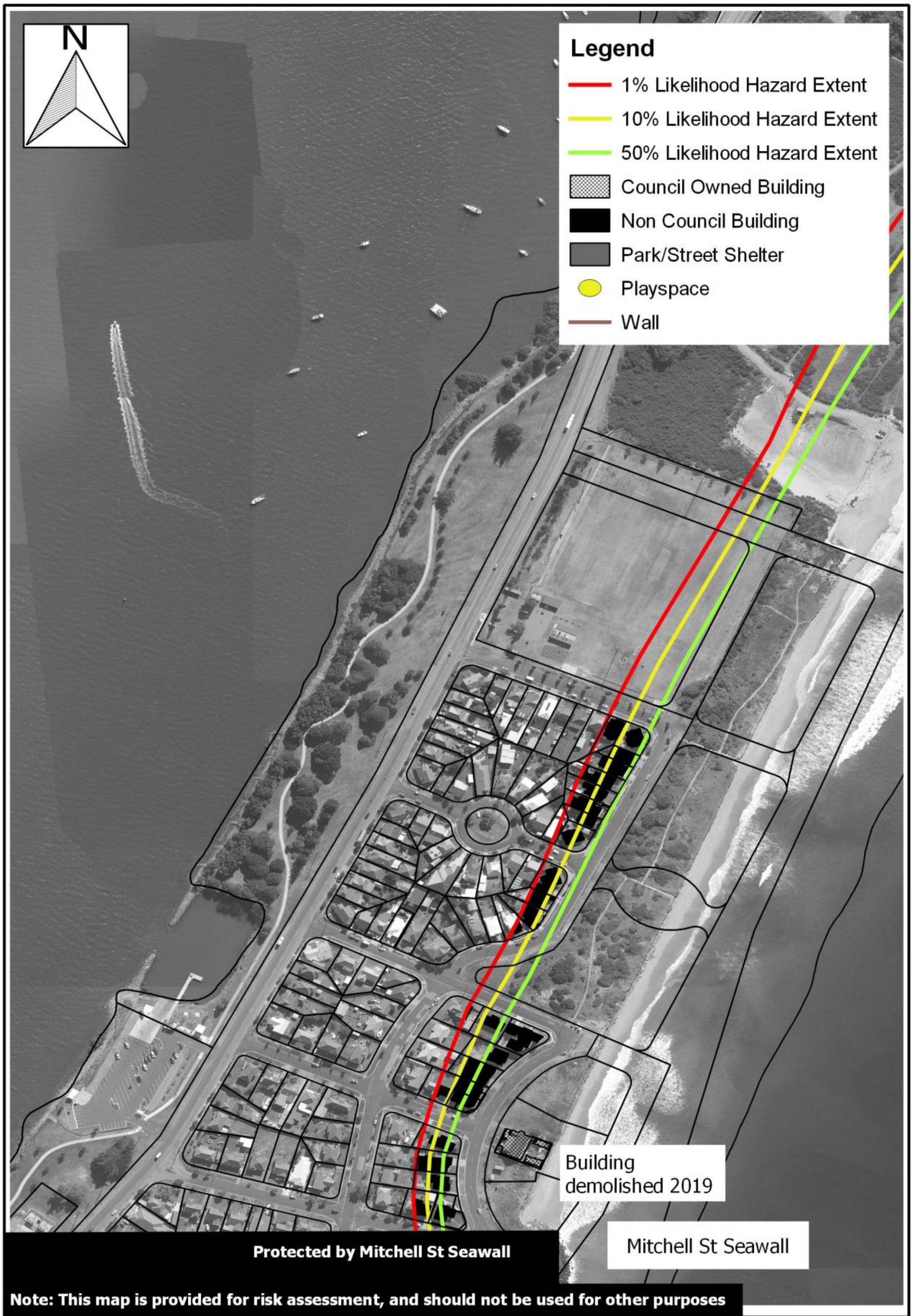


Figure 16: Affected Above Ground Assets for 2060 (North)

0 50 100 150 m
APPROX SCALE

Stockton Beach Coastal Hazard Risk Assessment	REV C	DRAWN EN	CHECK DJW	Salients
GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresC.qgs				

Figure 17: Affected Surface Assets for 2120 (South)

Stockton Beach Coastal Hazard Risk Assessment	REV C	DRAWN EN	CHECK DJW	Salients
GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresC.qgs				

Figure 18: Affected Above Ground Assets for 2120 (South)

0 50 100 150 m

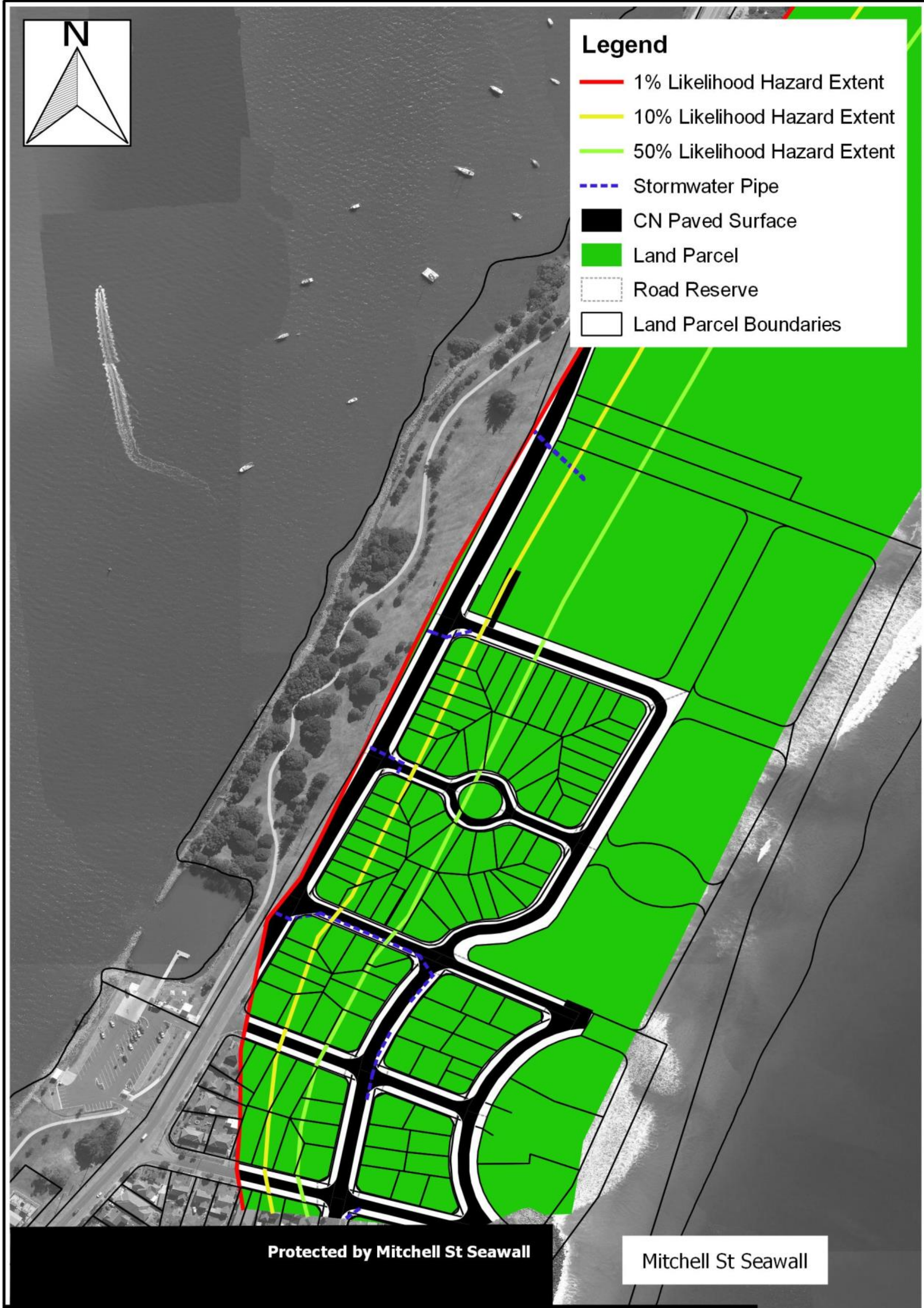
APPROX SCALE

Stockton Beach Coastal Hazard Risk Assessment

REV	DRAWN	CHECK
C	EN	DJW

Salients

GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresC.qgs



Note: This map is provided for risk assessment, and should not be used for other purposes

Figure 19: Affected Surface Assets for 2120 (North)	0 50 100 150 m APPROX SCALE			
Stockton Beach Coastal Hazard Risk Assessment	REV B	DRAWN EN	CHECK DJW	Salients
GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresB.qgs				

Figure 20: Affected Above Ground Assets for 2120 (North)

Stockton Beach Coastal Hazard Risk Assessment

REV	DRAWN	CHECK
C	EN	DJW

Salients

GIS File:\Projects\P00083 StocktonSedimentandHazards\GIS\ThreatenedAssetFiguresC.qgs

City of Newcastle

ATTACHMENTS DISTRIBUTED UNDER SEPARATE COVER

CCL 23/06/2020 - ENDORSEMENT OF THE DRAFT STOCKTON COASTAL MANAGEMENT PROGRAM

ITEM-30	**Attachment G:**	Cost-Benefit Analysis for Stockton Beach, Coastal Management Program (Bluecoast & Rhelm, 2020) – Stockton CMP Supporting Document F.

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Supporting Documentation F.

Cost Benefit Analysis (Bluecoast, 2020b)

City of Newcastle

City of Newcastle

Cost benefit analysis for Stockton Beach coastal management program

Report #: P19028_R0.01

18 June 2020

Document history

Version	Date	Author(s)	Reviewer(s)	Status	Signature
1.0	17-Apr-20	L. Drynan, E. Watterson and H. Loehr	na	PRELIMINARY DRAFT	na
2.0	23-Apr-20	L. Drynan, E. Watterson and H. Loehr	E. Watterson B. Nicholls	DRAFT	
3.0	28-Apr-20	L. Drynan, E. Watterson and H. Loehr	E. Watterson B. Nicholls	FINAL DRAFT	
0.0	4-May-20	L. Drynan, E. Watterson and H. Loehr	E. Watterson B. Nicholls	FINAL (For public exhibition)	
0.1	18-Jun-20	L. Drynan, E. Watterson and H. Loehr	E. Watterson B. Nicholls	Revised following public exhibition	

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bluecoast CONSULTING ENGINEERS | Rhelm engineering | environmental | economics | engagement | City of Newcastle

1. INTRODUCTION

1.1 General

A cost benefit analysis (CBA) was undertaken in support of the coastal management program (CMP) being prepared by the City of Newcastle (CN) for the area north of the Stockton Breakwater (northern training wall of the Hunter River) to Meredith Street, Stockton. CN engaged Bluecoast Consulting Engineers (Bluecoast) and their sub-consultants Rhelm to undertake the CBA for the proposed CMP options. After extensive discussion with community and agency stakeholders, CN have identified three coastal management options for Stockton Beach to be assessed in the CBA.

This report sets out the approach and results of the CBA and the associated sensitivity and distribution analysis (partitioning of benefits to affected property and asset owners). The CBA has been prepared in accordance with the Coastal Management Act 2016 and the NSW Coastal Management Manual (the Manual) and consideration of the *Guidelines for using cost-benefit analysis to assess coastal management options* (OEH, 2018).

1.2 Study area

Stockton Beach is in the City of Newcastle Local Government Area (LGA) in the Hunter region of the NSW coast. It is located on a peninsula on the southern end of Stockton Bight. Stockton Bight stretches along 32km from the Hunter River to Birubi Point. The area of Stockton Beach for inclusion in Newcastle CMP will extend from northern breakwall to LGA boundary. Due to time constraints imposed by Ministerial direction to complete a Stockton CMP by 30 June 2020, the current study area has been defined as the area of Stockton Beach between the northern breakwall and Meredith Street, as shown in Figure 1. Key features in the study area are also noted in Figure 1.

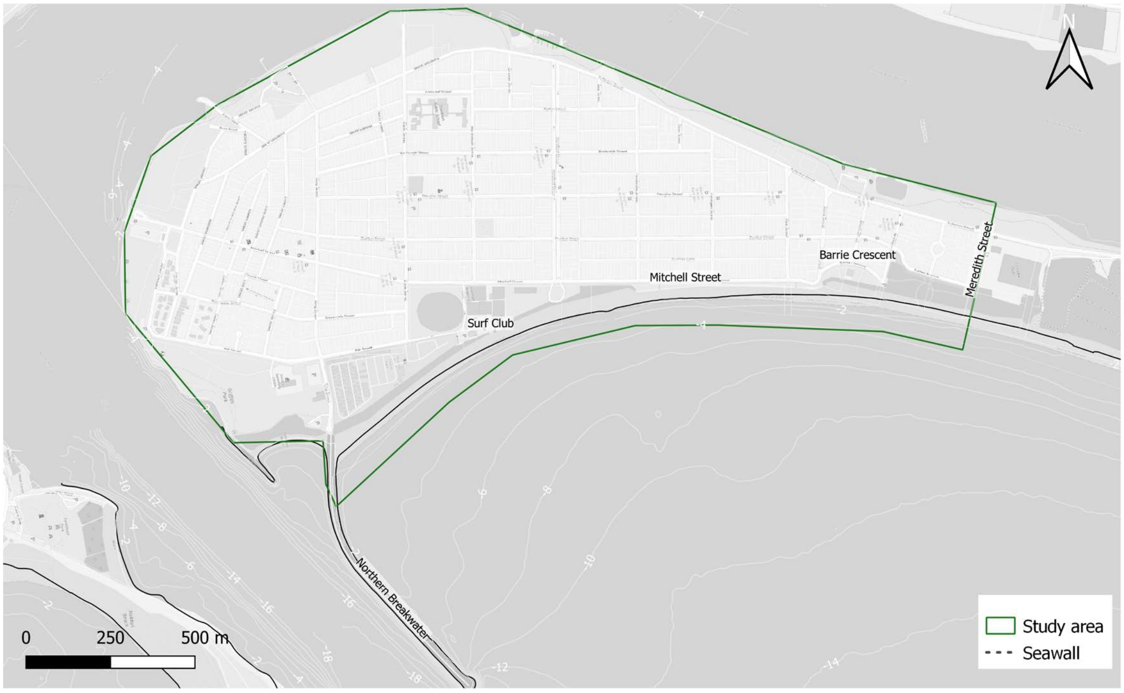

Figure 1: Stockton Beach CMP study area and key features.

1.3 Study objectives and context

CN are looking to address the on-going erosion issues at Stockton Beach. The beach has experienced episodes of erosion over many years and CN has undertaken a series of actions to address this issue over the past decades. As recently as earlier in 2020 storm wave conditions led to significant beach erosion and associated emergency works, damage to property, loss of amenity, closure of Lexis's café and restricted access to the Stockton beachfront.

CN are in the process of developing a CMP in accordance with the Coastal Management Act (2016) and are developing long-term actions to address on-going beach erosion and shoreline recession. It is understood that following the consideration of a range of potential options, CN have identified three broad options including programs of sand nourishment and response to residual risk through protection structures.

The objective of this study is to undertake an economic assessment and evaluation of the coastal protection options outlined in RHDHV (2020), demonstrate their economic feasibility and identify potential options for further development.

1.4 Statement of assumption and uncertainty

The approach developed herein is reasonable and valid for evaluating coastal management options in the CMP area. However, it is important that decision-makers recognise the assumptions underlining the development of the CBA as well as the uncertainty. These relate to the assessment of coastal hazards, data availability and to the application of the cost benefit analysis. The assumptions that relate to specific future scenarios (i.e. base case and options) are provided in the relevant sections of this report. Set out below are the overarching assumptions and uncertainties.

Assumptions and uncertainty related to coastal hazards and the performance of the options in a dynamic coastal environment:

- Detailed numerical and/or physical modelling of the performance outcomes of the coastal management options have not been undertaken.
- Climate change projection and the future climate at Stockton Beach cannot be predicted precisely.
- All areas to the north of Corroba Oval were not considered within the economic analysis study area (Figure 1) as no foreshore protection (seawall or nourishment) is proposed for this section. For the purposes of the economic analysis it was assumed that the rate of erosion of these sections would not be materially different between the base case (Section 3.2) or project case scenarios (Section 3.3 – Section 3.5).

Assumptions and uncertainty related to the CBA include:

- Benefit transfer approach was adopted to identify reasonable dollar value estimates of non-market costs and benefits for Stockton Beach (e.g. Deloitte, 2016; Pascoe et al., 2017). The use of benefit transfer approaches introduces uncertainty within models as the degree to which the 'transferred' values are representative of actual values of Stockton Beach is not validated. This uncertainty has not been validated. This approach was adopted given the time and scope available for this CBA. The alternative to benefit transfer valuations of non-market goods is the adoption of techniques that are typically time and labour intensive (i.e. revealed preference, stated preference, input-output modelling). No site-specific valuation of beach usage to assess importance to fisheries, tourism or the regional economy has been undertaken.

- The CBA undertakes an assessment over four time periods (2020, 2040, 2060, 2120). Within each time period the impacts to private and public assets was evaluated across three 'probability of exceedance' levels: 50%, 10% and 1%. The use of only three probabilistic points requires the interpolation and extrapolation of risk and costs within and beyond these horizons, introducing further uncertainty within the model. This approach was adopted given the time and scope available for this CBA. A higher degree of certainty within the model could be achieved through running a greater range of exceedance levels and assessment timeframes.
- The CBA does not currently include consideration of inundation impacts associated with storm surge events. Inundation avoidance can form a significant component of coastal protection work benefits and the CBA is considered conservative in this regard. This approach was undertaken as the inundation results were not available within given the CBA development timeframe.
- This CBA aims to quantify the important benefits and costs for the specified community in monetary terms. This includes social and environmental impacts as well as economic impacts. However, it is not possible to quantify all impacts and, where this is the case, the document highlights what has not been quantified and valued. The remaining impacts have then been described qualitatively. To test robustness of the CBAs and account for some uncertainties outlined above, sensitivity testing was conducted on the quantified results.

Given these high order uncertainties, where relevant the CBA has adopted conservative assumptions to attempt to minimise the risk of over estimation of project benefits and false justification of project feasibility. The further range of more detailed assumptions adopted within the CBA are outlined as relevant within Section 5.

2. BACKROUND INFORMATION

2.1 Coastal management issues to be addressed by CMP

Stockton Beach currently experiences significant erosion and inundation following large storm events, leaving several CN assets at risk, and requiring installation of a range of temporary (e.g. sandbagging) and permanent protection measures. These risks are recognised in the Coastal Zone Management Plan 2018 (CZMP) that was prepared under the Coastal Protection Act (1979). However, as this Act has now been repealed and planning and management of coastal regions within NSW is now managed under the Coastal Management Act (2016), Councils are required to prepare Coastal Management Programs (CMPs) to manage their coastal assets. The CMP is currently in preparation, and this economic analysis forms a component therein, assisting in the evaluation of management options.

Specifically, it has been identified that the management options identified for Stockton Beach within the CZMP, while potentially effective in addressing the hazards currently realised at the beach, do not include consideration of a solution to the long-term erosion hazard. The erosion hazard has been quantified by Bluecoast ,2020 and coastal management options were identified by Royal HaskoningDHV (RHDHV, 2020). The key coastal management issues identified in the Stage 1 report of the CMP included:

- Beach erosion and shoreline recession: on-going loss of sediment within the compartment.
- Protection of assets.
- Management options not impacting on the northern coastline.

Ongoing community consultation is captured through a variety of mediums including the establishment of the Stockton Community Liaison Group (CLG) in 2018 which is continuing to provide valuable input into the CMP process.

2.2 Socio-economic profile of Stockton

The residential suburb of Stockton is located on the peninsula at the southern end of the larger embayed section of sandy coast known as Stockton Bight. The suburb comprises 360 hectares of land area and a population of 4,179 with a population density of 12.32 per hectare (CN, 2019). The Mitchell Street seawall, which was constructed between Pembroke Street and Stone Street in 1989, is largely protecting residential development and infrastructure west of the beach along the central section of Stockton. This section comprises primarily residential development with public recreation areas (Dalby Oval) south of the Mitchell Street seawall (CN, 2019).

The southern section of Stockton is primarily residential and accommodates the beach front Stockton Beach Holiday Park. Community facilities exist along the former hind dune areas of the beach, including the Stockton Surf Life Saving Club, Lexie's café and Lynn Oval.

The beach is popular for primarily locals and visitors from the Hunter Valley for activities including swimming, fishing, nippers, beach going and surfing. Visitation data for Stockton Beach is limited but it is estimated that approximately 100,000 people currently utilise the beach annually[1]. In addition, no beach user survey information (e.g. frequency, duration, purposes, expenditure, etc.) was available for this study. Visitors from Australia and international visitors regularly stayi at Stockton Beach Holiday Park. Indeed, the Holiday Park is the only caravan/motorhome, camping park close to the Newcastle CBD, Stockton and Newcastle beaches. The surf club hosts surf carnivals and surf boat carnivals and the Royal Australian Airforce (RAAF), who have a base nearby at Williamtown, have an annual surf boat carnival with teams from all over Australia attending. The Northside Boardriders club host surfing events and Surfest also holds the team's event at Stockton Beach.

Community consultation activities undertaken by CN have identified strong opinions regarding Stockton Beach, including:

- The beach is highly valued and represents a critical asset to the local community.
- The preference to maintain a clean beach area providing enough width for recreational space, including uses such as Nippers, and which supports the current foreshore amenity and character.
- Stockton has a strong surf culture with a desire to maintain surf amenity nearby the residential areas.
- The preference to ensure any nourishment programs utilise sand that matches the existing visual profile of Stockton Beach.

[1] Based on 2013/14 30-week beach user counts, grown in proportion to local growth rates (approx. 1% p.a.) to 2020 values.

- The preference to maintain beach connectivity along the entirety of the beach. The available socio-economic data and community concerns regarding beach development were utilised in establishing assumptions adopted within the economic model developed for the CBA.

2.3 Environmental values

The local community at Stockton has a strong connection to the beach and the foreshore area. Beach amenity is critical for locals and visitors the like to pursue their endeavours. The key environmental values include:

- A dune system and vegetation seaward of the Stockton Beach Holiday Park.
- Dune systems along the coast north of the former Hunter Water Corporation site (310 Fullerton Street).
- An urbanised area along the central section of Stockton Beach with exotic grasses and planted landscape species (CN, 2019).

2.4 Data used in CBA

A summary of the datasets available for this study is presented in Table 1.

Table 1: Overview of datasets used in this study.

ID	Description	Source	Dates
Economic data			
Land values	Land parcels, including land valuation and sales from the past 5 years (where available)	CN	2016-2020
Council assets	CN asset database	CN	2020
Buildings	Laser-scanning outlines	CN	2020
Revenue/ spending	Holiday park revenue, coastal management spending	CN	2020
Coastal hazards			
Topography and bathymetry	LiDAR at 5m resolution	DPIE	2018
	High-resolution UAV derived topography	CN	2019, 2020
	Beach photogrammetry	DPIE	1953 to 2018
	Various hydrographic surveys	DPIE, Umwelt Pty Ltd, CN, Port of Newcastle	1816 to 2019
Aerial imagery	High resolution, rectified aerial imagery	Nearmap	2020

3. CBA OPTIONS

3.1 Introduction

The base case and three options to be assessed in this CBA have been developed by the City of Newcastle and their consultant Royal HaskoningDHV (RHDHV). These options are described in RHDHV's (2020) technical note entitled *RHDHV input information for a Cost Benefit Analysis for Stockton Beach*, dated 18 June 2020 and provided in **Appendix A**. **Appendix A** has been prepared by RHDHV directly for CN. The views and opinions expressed in **Appendix A** are those of the authors and do not necessarily reflect the opinions of Bluecoast.

Figure 2 and Figure 3 provide a map that show the key features of the management options. An overview of all project cases assessed is provided in Table 2. Broadly, the discrete options consist of:

- **Base case** – involves the continued delivery of the actions in the certified Newcastle Coastal Zone Management Plan (CZMP). The main element of this is the maintenance of the two existing rock revetments, at the SLSC and fronting Mitchell Street and the provision of emergency works as required. Combined these structures extend over 717 linear metres of the shoreline.
- **Option 1** – involves mass beach nourishment along with the construction of 'Stage 1' coastal protection structures. The extent of Stage 1 structures varies between project cases considered as part of the sensitivity analysis. Table 3 provides a summary of the extent of structures applied in each case. In Figure 2 and Figure 3, the nourishment areas are shown as nearshore placement boxes. This assumes the nourishment sand will be placed by a dredger (e.g. a Trailer Hopper Suction Dredger) using rainbowing (see Figure 4) and bottom dumping. These processes are described in RHDHV, 2020.
- **Option 2** – involves the construction of Stage 1 and Stage 2 coastal protection structures and beach nourishment for a defined beach area objective. Stage 2 works would be constructed, when triggered by further erosion adding further coastal protection structures and a short rock groyne as outlined in Table 3. Beach nourishment under this option is aimed at providing a minimum annual average beach width of 5m at the narrowest point along the CMP area measured at 1.5m AHD (approximately 1m above mean high water (MHW) to account for wave runup) accommodating a volume for a 1-year ARI storm each year. This was calculated to equate to an ongoing nourishment of 112,000m^3 of native beach sand supplied on an annual basis (RHDHV, 2020).
- **Option 3** – involves the construction of the Stage 1 and Stage 2 coastal protection structures as outlined in Table 3 as well as a relatively modest amount of beach nourishment. The sand quantities for beach nourishment were based on what would be realistically obtainable from available terrestrial sources of sand.

Table 2: Overview of nine project cases and four associated cost sensitivity tests.

Description	Option 1				Option 2			Option 3	
	O1a	O1b	O1c	O1d	O2	O2b	O2c	O3a	O3b
Initial nourishment campaign									
Total initial nourishment volume – native	1.8Mm^3 **	2.4Mm^3	1.8Mm^3	2.4Mm^3	210,000m^3 **	610,000m^3	610,000m^3	80,000m^3 **	20,000m^3 **
Source	Terrestrial	Marine (offshore)	Hunter River (South Arm)	Marine (offshore)	Terrestrial	Marine (offshore)	Hunter River (South Arm)	Terrestrial	Terrestrial
Method	Trucks, back passing pipeline and earthmoving equipment	Dredge (TSHD with rainbowing capability)	Dredge (CSD with pumping ashore capability)	Dredge (TSHD)	Trucks, back passing pipeline and earthmoving equipment	Dredge (TSHD)	Dredge (CSD)	Trucks, and earthmoving equipment	Trucks, and earthmoving equipment
Placement area	Upper beach (sub aerial), Holiday Park & Dalby Oval	Surf zone and lower profile	Upper beach	Surf zone and lower profile	Upper beach (sub aerial), Holiday Park & Dalby Oval	Surf zone and lower profile	Upper beach	Upper beach (sub aerial), Holiday Park & Dalby Oval	Upper beach (sub aerial), Holiday Park & Dalby Oval
Maintenance nourishment campaign									
Annual nourishment volume	112,000m^3/yr**	112,000m^3/yr	112,000m^3/yr	112,000m^3/yr	112,000m^3/yr**	112,000m^3/yr	112,000m^3/yr	80,000m^3/yr **	20,000m^3/yr **
Renourishment period (years)	5	10	5	10	1	5	5	1	1
Nourishment volume	560,000m^3**	1.12Mm^3	560,000m^3	1.12Mm^3	112,000m^3**	560,000m^3	560,000m^3	80,000m^3 **	20,000m^3 **
Cost sensitivity included:				4 cases		Results of this case are report in Section 5.2.	Results of this case are report in Section 5.2.		

Description	Option 1				Option 2			Option 3	
	O1a	O1b	O1c	O1d	O2	O2b	O2c	O3a	O3b
Summary of structures									
Stage 1 linear meters of works	458m	458m	458m	225m	458m	458m	458m	458m	225m
Stage 2 linear meters of works	na	na	na	na	995m	995m	995m	995m	1,186m
Griffith Avenue car park structure	Not included	Not included	Not included	Not included	Included	Included	Included	Included	Not included
Griffith Avenue car park groyne	Not included	Not included	Not included	Not included	Included	Included	Included	Included	Not included

***Nourishment volumes converted to native sand volumes using the specified overfill factor of 2.5 in RHDHV (2020).*

Table 3: Overview of Stage 1 and Stage 2 structures.

Description	Original		Revised	
	Stage 1	Stage 2	Stage 1	Stage 2
Total linear meters of proposed terminal erosion protection works (vertical seawall with rock scour protection at the toe)	458m	995m	225m	1,186m
Minimum width between beach erosion scarp and protection line used as trigger for construction works to commence	-	25m	-	20m
Barrie Crescent/Griffith Avenue car park vertical seawall	Included	-	Not included	-
Barrie Crescent/Griffith Avenue car park groyne	Included	-	Not included	-
Applied to:	Option 1a Option 1b Option 1c Option 2 Option 3	Option 2 Option 3	Option 1d Option 3b	Option 3b

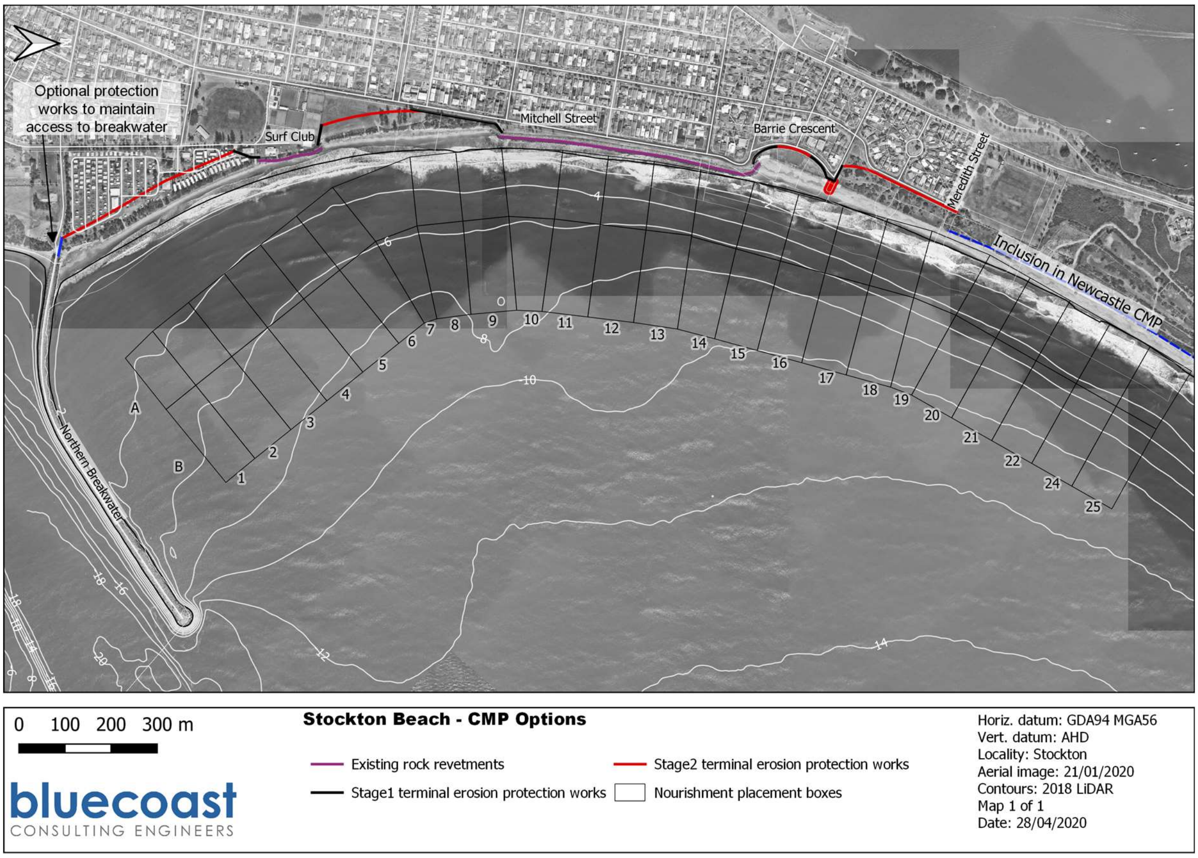

Figure 2: Stockton Beach CMP options (RHDHV, 2020) and preliminary nourishment placement boxes.

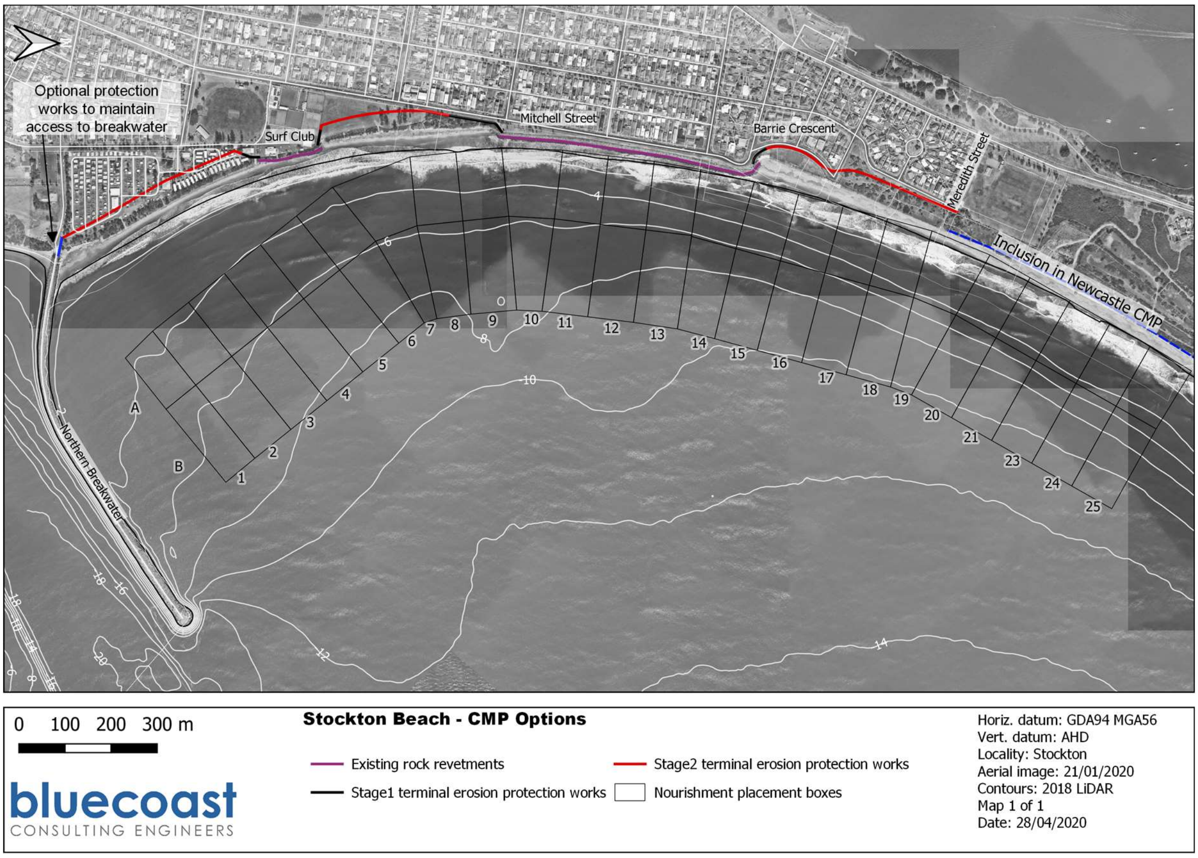

Figure 3: Revised Stockton Beach CMP options (RHDHV, 2020) and preliminary nourishment placement boxes.

As noted in RHDHV's (2020) technical note, Option 1 and Option 2 involve significant quantities of beach nourishment from terrestrial sources. Existing extraction limits from licensed sand quarries in the local region and practical limitations associated with transporting and placing sand on Stockton Beach using trucks and earth moving equipment have however been acknowledged. It is considered that these actions are not currently feasible, although this may alter in the future. Option 3 involves a lower quantity of terrestrial sourced beach nourishment that is legally and technically feasible at the present time. In addition to the above assessment, the future feasibility of mass nourishment using marine sand sources has been included within the CBA through a series of cost and scope of work sensitivity scenarios within Option 1 (Option 1b, 1c and 1d) as described below. CN advised that despite marine sand sources being currently unfeasible, they were to be assessed in the CBA due to the preference of beach nourishment. CN's intention was to also establish the framework to pursue other actions as they become available in the future.

This section describes the identification and quantification of costs and benefits associated with the base case and each of the options. It should be read in conjunction with RHDHV's (2020) technical notes (see **Appendix A**) as a detailed description of the options is not repeated herein.

3.2 Base case – Business as usual

A business as usual base case was assumed for the comparator as part of the CBA. The base case assumes the on-going implementation of all actions as listed under the current CZMP 2018 Part A (Stockton) as the gradual realisation of erosion in accordance with the hazard mapping and associated loss of assets at risk as detailed in Section 4.1.2.

It is noted that all actions listed within the CZMP would still be required to be undertaken as part of all project case scenarios and, therefore, have been excluded from the analysis as the works will effectively net off against each other. The one exception to this is the current forecast budget for emergency works response (e.g. sandbagging) at specific locations that have been identified as being redundant under project cases. This currently represents an expense of $200,000 p.a to CN. The provision of any of the options will avoid the need for this expenditure.

3.3 Option 1 – Mass nourishment and essential protection

RHDHV indicate that terrestrial sand is currently the only available source (RHDHV, 2020). The mass nourishment option and all other options have therefore been developed using this sand as the standard supply source. As previously discussed, it is CN's direction to have Options 1 to 3 considered within the Stockton CMP cost benefit analysis. Recognising that alternative marine sand sources may become available, a range of alternative cost estimate have been developed based on the sand source, vessel sizes, methodology and volumes required. Specifically, the standard option and three additional variants were identified, including:

- **Option 1a**: Mass beach nourishment and essential protection works as above with nourishment sand sourced from a **terrestrial** source.
- **Option 1b**: Mass beach nourishment and essential protection works as above with nourishment sand sourced from an **offshore marine** source.
- **Option 1c**: Mass beach nourishment and essential protection works as above with nourishment sand sourced from a **Hunter River** source.
- **Option 1d**: Mass beach nourishment as under Option 1b, however, the delivery of this is delayed until year one and only Stage 1 essential protection works are included. Before this (i.e. for the first 12-months), works adopted for Option 3b (Section 3.5) were assumed to be implemented.

A summary of the key inputs and assumptions for each variant is provided in Table 4. The costs for Option 1a and 1c have been based on those outlined in RHDHV (RHDHV, 2020). For Option 1b and 1d the nourishment costs were based on the rational and estimates provided in **Appendix B**, noting the assumptions of:

- Native Stockton Beach sand with grain size D50 = 0.35 - 0.40mm.
- Nourishment sand source is assumed to be within 5NM of the nearshore placement zone.
- Assumed placement is all nearshore but as close as possible to the shore for:
  - 75% rainbowed (see example in Figure 4).
  - 25% is bottom dumped.
- 5 or 10 yearly repeated nourishments in the order of 1.0M m^3.
- Budgetary estimates provided by potential contractors based on limited information available and subject to confirmation by a tendering process.

Figure 4: A TSHD rainbowing sand onto the nearshore area of the beach as part of beach nourishment works (source: City of Gold Coast).

Table 4: Option 1 key inputs and assumptions for each variant.

Parameter	Option 1a	Option 1b	Option 1c	Option 1d
Initial nourishment campaign				
Total initial nourishment volume – native	1.8M m^3	2.4M m^3	1.8 M m^3	2.4M m^3
Source	Terrestrial	Marine (offshore)	Hunter River (South Arm)	Marine (offshore)
Method (transport and placement)	Trucks, back passing pipeline and earthmoving equipment	Dredge (e.g. TSHD with rainbowing capability)	Dredge (e.g. CSD with pumping ashore capability)	Dredge (e.g. TSHD with rainbowing capability)
Placement area (cross shore & alongshore)	Upper beach (sub aerial)	Surf zone and lower profile	Upper beach	Surf zone and lower profile
Year of works	1	1	1	2
Average increase in beach width – year of works completion	36	48	36	48
Maintenance nourishment campaign				
Annual nourishment volume	112,000m^3/yr	112,000m^3/yr	112,000m^3/yr	112,000m^3/yr

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Parameter	Option 1a	Option 1b	Option 1c	Option 1d
Renourishment period (years)	5 years	10 years	5 years	10 years
Nourishment volume*	560,000 m^3	1.12 M m^3	560,000 m^3	1.12 M m^3
Indicative increase in beach width – average over nourishment period	30	42	30	42
Structures				
Stage 1 vertical seawalls	Original	Original	Original	Revised
Maintenance of seawalls	Reduced relative to base case	Reduced relative to base case	Reduced relative to base case	Reduced relative to base case

*where terrestrial sources are used a 2.5 overfill adjustment factor is required to be applied to the reported values (RHDHV (2020)

3.3.1 Protection of assets

The risks associated with beach nourishment for the purpose of providing coastal erosion protection to backshore assets at Stockton Beach are discussed in detail in **Appendix C**. Broadly, two sand placement quantities and renourishment periods have been considered in the CBA. A simplistic analysis comparing the two strategies is outlined in Table 5. Based on the simplified analysis the risk profile for backshore assets at Stockton Beach is expected to be lower for the higher initial quantity and longer renourishment period. This scenario is also more economical in terms of sand delivery due to the lower mobilisation/demobilisation costs. An even lower risk profile could be realised if a higher initial quantity is provided with regular annual increments delivered thereafter. This would be feasible if a local vessel were utilised to source and place the sand.

Table 5: Mass nourishment risk profile comparison for Option 1.

Parameter	Lower initial quantity	Higher initial quantity
Initial nourishment volume (m^3)	1,800,000	2,400,000
Renourishment period (years)	5	10
Alongshore length (m) along 0m AHD contour plus an additional 200m based on RHDHV (2020a)	2,200	2,200
Length (m) along the -8m AHD contour plus 200m	2,000	2,000
Protection benefits (i.e. above base case) provided by the nourishment immediately following the works		
Nourishment volume per linear meter of nearshore compartment (i.e. full coastal profile) in year 0 (m^3/m)	857	1,143
Effective nourishment volume above AHD (i.e. sub-aerial storm demand) available in year 0 (m^3/m)[1]	286	381
Additional effective Average Recurrence Interval (ARI) storm demand provided in year 0[4]	>500-year (photogrammetry Block A)	>500-year (photogrammetry Block A)

Parameter	Lower initial quantity	Higher initial quantity
	~80-year (photogrammetry Block C)	>100-year (photogrammetry Block C)
Protection benefits (i.e. above base case) provided by the nourishment at the end of the renourishment period		
Long term (full coastal profile) sand loss rate ($m^3/m/yr$) [2]	46.2	46.2
Nourishment volume per linear meter of nearshore compartment (i.e. full coastal profile) at the end of the nourishment period (m^3/m)[3]	626	681
Effective nourishment volume above AHD (i.e. sub aerial storm demand) available in the last year of the nourishment period (m^3/m)[1]	209	227
Additional effective ARI storm demand provided in the last year of the nourishment period[4]	>200-year (photogrammetry Block A) ~45-year (photogrammetry Block C)	>200-year (photogrammetry Block A) ~50-year (photogrammetry Block C)

Notes:
1. This is based on the typical proportion of 33% of the total nourishment volume being the effective volume above AHD (Carley and Cox, 2017).
2. This is based on the long-term volumetric rate of sand loss over the full profile of 112,000m^3/yr between the northern breakwater and the Hunter Water site. An additional allowance for loss due to sea level rise has been included to account for the flattening of the profile due to Bruun rule-based slope re-adjustment.
3. Nourishment sand is also assumed to be lost at the long-term historic rate with an additional allowance for sea level rise. Accelerated losses because of the nourishment sand itself have not been included.
4. This is the additional sub-aerial sandy buffer provided by the beach nourishment works. The existing sub-aerial beach, in unprotected areas of the shoreline, would also provide some coastal protection function. Storm demands are based on the values provided in Bluecoast (2020) with consideration of seawall end effects after Carley et al. (2010).

Sand placed in the surf zone by rainbowing and bottom dumping is assumed to provide an immediate positive coastal protection benefit based on the increased volume in the coastal profile. Referring to the nourishment boxes in Figure 2 it can be seen that sand can be directly rainbowed to the inner surf zone and/or sub-aerial beach along most of the CMP area. This will result in an immediate beach widening and associated benefits being delivered. In the southern corner, the shallower coastal profile means rainbowing is not effective at delivering sand to the sub-aerial beach. Along this southern corner it has been assumed that sand will redistribute across the profile with a proportion of the sand move moving onto the sub-aerial beach and widening the beach in a relatively short period (i.e. less than 3 months).

3.4 Option 2 – Beach amenity sand nourishment and protection (staged)

This option includes construction of terminal protection structures at currently unprotected areas along the entire stretch north of the training wall to Meredith Street, a total length of 1,453m. Given the requirement to maintain a useable beach, a total beach nourishment volume of 375,000m^3/ year of terrestrial sand is proposed to be placed on the upper beach. Sand placement would occur at the

Holiday Park as well as Dalby Oval frontage. A summary of the key inputs and assumptions for this option is presented in Table 6.

Table 6: Option 2 key inputs and assumptions.

Parameter	Option 2
Nourishment campaign	
Total initial nourishment volume – native beach material	210,000 m^{3**}
Source	Terrestrial
Method (transport and placement)	Trucks, back passing pipeline and earthmoving equipment
Placement area (cross shore & alongshore)	Upper beach (sub aerial), Holiday Park & Dalby Oval frontage
Approximate ARI protection afforded based on storm demand	1-year ARI
Maintenance nourishment campaign	
Annual nourishment volume – native beach material	112,000 m^3 **
Renourishment period (years)	1 year
Structures	
Stage 1 vertical seawalls	Included (original)
Stage 2 Vertical seawalls^^	Included (original)
Maintenance of seawalls	Reduced relative to base case

**Nourishment volumes converted to native sand volumes using the specified overfill factor of 2.5 in RHDHV (2020).
^^Stage 2 was assumed to be developed from 2027

3.5 Option 3 – Available sand nourishment and protection (staged)

As per Option 2, this option includes construction of terminal protection structures at currently unprotected areas along the entire stretch north of the training wall to Meredith Street, a total length of 1,453m. Given the requirement to maintain a useable beach and the logistically feasible sand volumes, a total beach nourishment volume of 200,000m^3/ year of terrestrial sand is proposed to be placed on the upper beach. Sand placement would occur at the Holiday Park and Dalby Oval frontages. An additional sensitivity case (Option 3b) was also undertaken which consisted of the revised Stage 1 structures and a reduced nourishment quantity. A summary of the key inputs and assumptions for Option 3 is presented in Table 7.

Table 7: Option 3 key inputs and assumptions.

Parameter	Option 3	Option 3b
Nourishment campaign		
Total initial nourishment volume – native	80,000 m^3**	20,000 m^3**
Source	Terrestrial	Terrestrial
Method (transport and placement)	Trucks and earthmoving equipment	Trucks and earthmoving equipment
Placement area (cross shore & alongshore)	Upper beach (sub aerial), Holiday Park frontage	Upper beach (sub aerial), Holiday Park frontage
Approximate ARI protection afforded based on storm demand	1-year ARI	Not calculated
Maintenance nourishment campaign		
Annual nourishment volume – native beach material	80,000 m^3**	20,000 m^3**
Renourishment period (years)	1 year	1 year
Structures		
Stage 1 vertical seawalls	Original	Revised
Stage 2 Vertical seawalls^^	Original	Revised
Maintenance of seawalls	Reduced relative to base case	Reduced relative to base case

**Nourishment volumes were converted to native sand volumes using the specified overfill factor of 2.5 in RHDHV (2020).
^^Stage 2 was assumed to be developed from 2027

4. CBA METHODOLOGY

4.1 Approach

The economic assessment considers the comparative costs and benefits of each of the three management options (and variations therein) against the base case scenario as outlined in Section 3.

The economic merit of each option was determined by comparing the present value of the change in net economic benefits (compared with the base case) less the change in capital and operational and maintenance costs (compared with the base case). The key benefits incorporated within this cost benefit analysis (CBA) assessment were in the form of:

- Maintained beach area and associated non-use and use values.
- Reduced loss or property and land to both private landowners and CN.

4.1.1 Model assumptions

For the purposes of this assessment several assumptions have been made to facilitate evaluation of project performance, these include:

- A discount rate of seven per cent per annum has been applied.
- The initial nourishment works for all options has been assumed to be undertaken in 2021 with 2022 representing the first full year of operation and benefits.
- Stage 2 structural works were assumed to be completed by 2028, with 2029 representing the first year of associated benefits.
- A benefit evaluation period of 50 years from the first full year of operation was adopted.
- The base year of assessment was assumed to be 2020 and all values are in 2020 dollars.

4.1.2 Shoreline recession and erosion

In conjunction with the CBA a probabilistic erosion hazard assessment is being undertaken by Bluecoast. The approach and adopted input parameters to the probabilistic modelling are discussed in Bluecoast (2020). In summary, appropriate ranges of long-term recession, sea level rise and beach profiles were adopted to produce probability density curves that fed into a Monte-Carlo simulation of over one million scenarios.

Storm erosion was assessed for beach profiles along DPIE's NSW photogrammetry locations (Figure 5) using the Wedge Failure Plan Model described in Nielsen et al. (1992) which provides setbacks for a series of foundation stability zones. For the purpose of this study, the Zone of Reduced Foundation Capacity (ZRFC) was adopted as the erosion hazard extent, which is the estimated unstable zone of a dune following a coastal erosion event in which it is not acceptable to locate foundations for coastal buildings and infrastructure. The results from the probabilistic hazard modelling provide probabilities of exceedance (PoE) for shoreline recession and erosion setbacks for every year in a 100-year planning horizon. As an example, the calculated 1% PoE (or Annual Exceedance Probability - AEP) erosion hazard lines for the base case (Option 1) are presented in Figure 5.

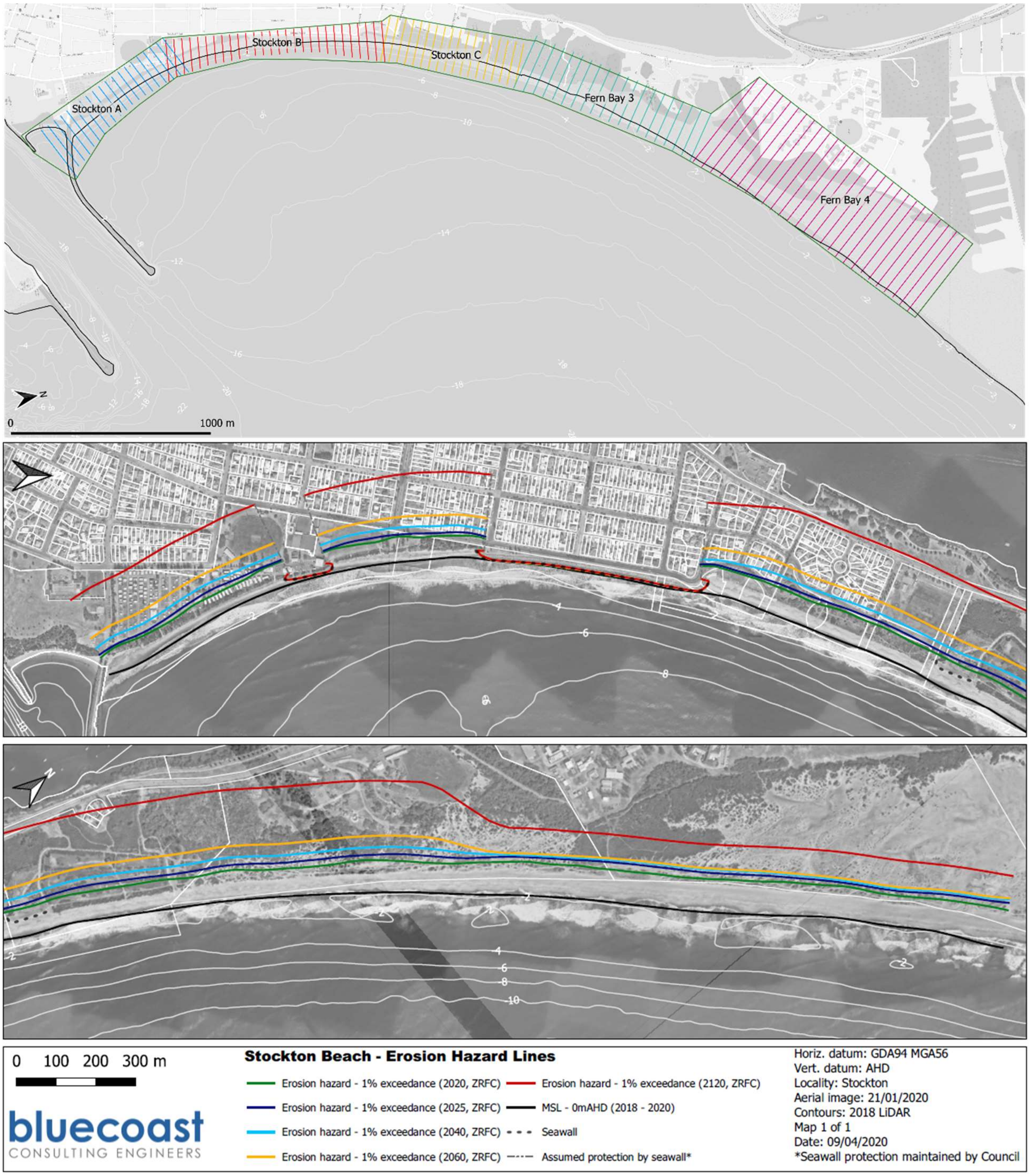

Figure 5: (top) NSW photogrammtery profile locations and (bottom) hazard lines for the 1% AEP erosion hazard for various years in the planning period.

Recession extents for four forecast years were evaluated for each of the options assessed. Within each forecast year, three PoE of erosion setback scenarios were assessed. The erosion setback was assumed to be the calculated ZRFC. The scenarios assessed are summarised in Table 8.

Table 8: Erosion scenarios assessed.

Year	ZRFC PoE Scenarios	Source
2020	50%	Hazard Mapping
	10%	Hazard Mapping
	1%	Hazard Mapping
	100%	*Linear extrapolation*
2040	50%	Hazard Mapping
	10%	Hazard Mapping
	1%	Hazard Mapping
	100%	*Linear extrapolation*
2060	50%	Hazard Mapping
	10%	Hazard Mapping
	1%	Hazard Mapping
	100%	*Linear extrapolation*
2120	50%	Hazard Mapping
	10%	Hazard Mapping
	1%	Hazard Mapping
	100%	*Linear extrapolation*

It is seen in Table 8 the 50% PoE represents the most likely occurring scenario assessed. In the absence of analysis of a more certain extent (e.g. a 100% PoE), linear extrapolation of the three PoE data points was adopted as a conservative (i.e. likely to underestimate the extent) method of estimating these more frequent events and allowing for a fuller probabilistic evaluation of potential impacts over time. Figure 6 provides an example of the estimated scenarios and associated linear extrapolation function adopted.

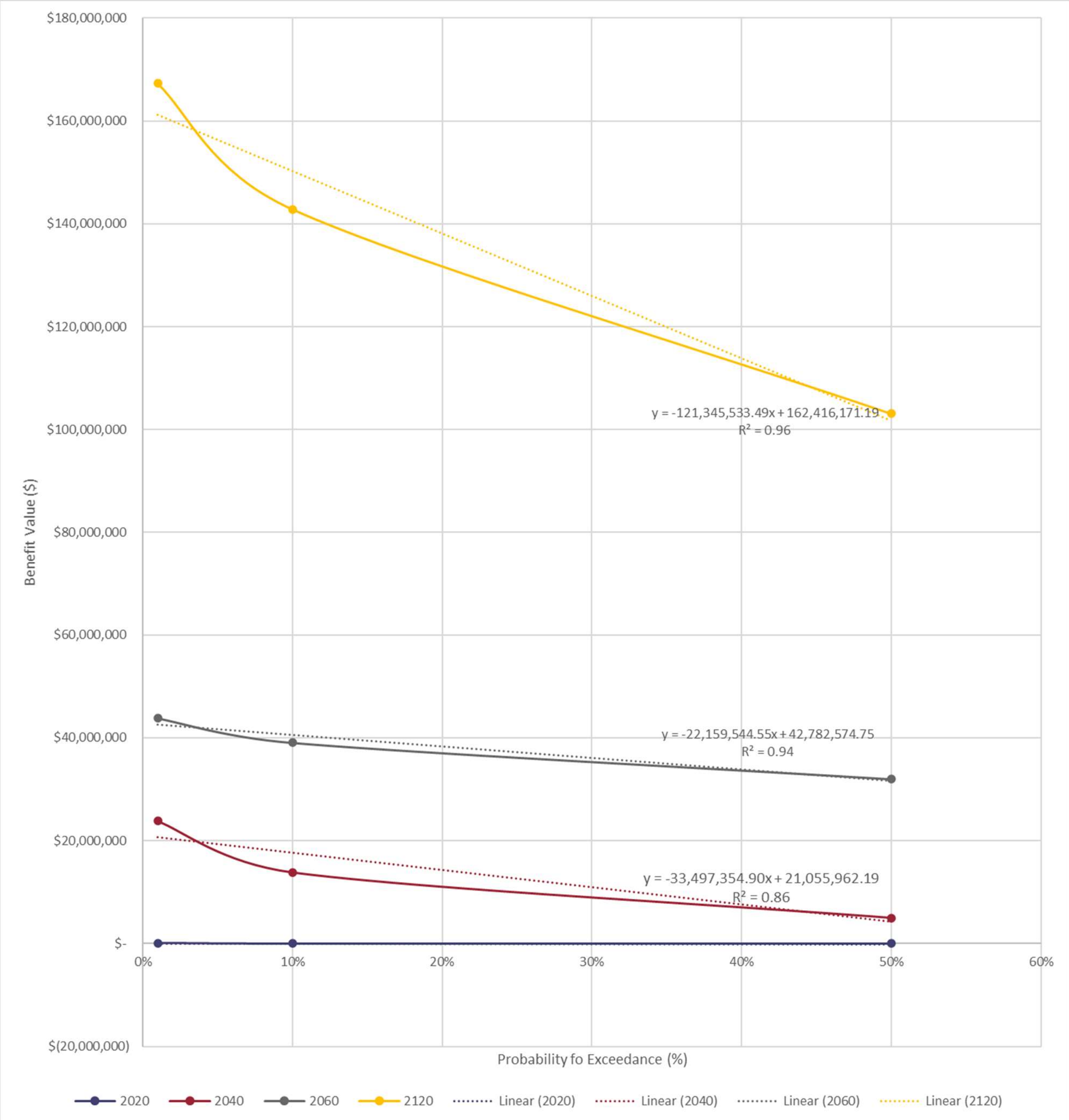

Figure 6: Value of properties affected by year and PoE.

Within each of the 16 scenarios, the following impact or erosion setback to a range of aspects were considered. Table 9 summarises the categories considered, and key units and assumptions utilised in quantifying the impacts. The GIS asset databases provided by CN and hazard mapping extents were utilised as the basis of identification and evaluation.

Table 9: Categories of assets affected by erosion setback.

Asset Category	Metric / Unit	Assumptions / Rules
Private Property (Buildings)	No. of Buildings Affected	Where the scenario ZRFC was seen to intersect with the known main structure on a property it was assumed the building would be lost. Secondary structures (e.g. shed) were not considered independently of the main building per lot.
Private Property (Land)	m^2	The proportion of affected land within individual lots was evaluated.
Council owned land and other non-private lands	m^2	The proportion of affected land within individual lots was evaluated.
Council owned assets (Buildings)	No. of buildings Affected	Where the scenario ZRFC was seen to intersect with the known main structure on a property it was assumed the building would be lost. For the Holiday Park, multiple structures were counted and evaluated independently although falling within a single lot.
Council owned assets (Roads and Paved Areas)	m^2	The proportion of affected land within individual lots was evaluated.
Council owned assets (Shelters)	No. of Buildings Shelters	Where the scenario ZRFC was seen to intersect with a shelter it was assumed the shelter would be lost.
Council owned assets (Stormwater Drainage Infrastructure)	m	The length of affected land within individual lots was evaluated
Council owned assets (Public Artworks)	No. of Artworks Affected	No artworks fell within any of the scenarios assessed.
Council owned assets (Public Furniture)	No. of Furniture Affected	No furniture fell within any of the scenarios assessed.
Council owned assets (Public Playgrounds)	No. of Playgrounds Affected	No furniture fell within any of the scenarios assessed.

Table 10 summarises the resulting assets at risk identified within each category, for each scenario under the base case. There is a marked increase in the extent of affected private assets between 2040 and 2060. In contrast, affected council assets are seen to increase significantly between 2020 and 2040.

Table 10: Base case assets affected.

Year	PoE	Private Property		Council and Non-Private Property				
		Buildings (no.)	Land (m^2)	Buildings (no.)	Land (m^2)	Pavement (m^2)	Shelter (no.)	Drainage (m)
2020	50%	-	-	-	-	132	-	-
	10%	-	-	16	15,279	1,622	-	-
	1%	1	2,694	18	28,023	4,866	-	-
2040	50%	4	2,213	24	70,588	6,004	3	-
	10%	12	4,427	28	76,635	8,592	4	-
	1%	24	6,640	31	83,028	11,131	4	4
2060	50%	26	389,141	33	87,227	12,218	4	13
	10%	37	445,684	34	94,520	14,579	5	29
	1%	44	496,447	34	100,990	16,293	5	43
2120	50%	114	687,003	36	129,710	28,381	6	371
	10%	167	797,980	37	139,250	35,254	6	505
	1%	202	879,902	37	145,530	47,189	7	840

Under each of the project case scenarios it was assumed that all these losses would be avoided through either the maintenance of the beach or the provision of seawall protection structures. However, under Option 2 and Option 3, while retaining some beach amenity, the beach will effectively still recede back to the proposed seawalls and be maintained at the location. As such the construction of the seawall will require both the demolition of assets along its alignment as well as the gradual recession and loss of council land as the beach moves to the seawalls. For the purposes of this assessment it is assumed that this will occur at the same rate as would occur under the base case scenario. However, it is recognised that studies indicated the presence of seawall structures may accelerate the rate of recession. For both Option 2 and Option 3, land areas affected under the 2040 50% PoE will be lost. Beyond 2040, no further loss would occur. In terms of assets, other than assets required for removal in construction of the seawall, no assets will be lost within the area landward of the seawall. Construction will require some Holiday Park assets to be relocated or demolished. For the purposes of this CBA it was assumed that all such losses would occur in 2027 (Table 11). None of the options resulted in the loss of private property.

Table 11: Project case assests affected for Options 2 and 3.

Year	PoE	Council	
		Buildings (no.)	Land
2027	-	23 Holiday Park structures and 2 shelters	2.8 ha
2040	50%	-	8.3 ha

4.1.3 Beach areas

The current and forecast beach areas were estimated into the future, considering the:

- Historic variation in beach widths (Figure 7) based on photogrammetry.
- Variation between sections in terms of landward infrastructure (e.g. seawalls), see Figure 8.
- Projected impacts of climate change to sea levels and storm erosion.

The current dry beach area was considered adopting RHDHV's definition (i.e. 1.5m AHD to scarp). Historic dry beach widths were calculated based on available survey data between June 1994 and February 2020 and average occurrence frequencies were determined for representative beach zones, see Figure 8. These zones follow the management zones defined in the 2018 Newcastle CZMP but also include the SLSC revetment as a separate zone. Applying the estimated combined underlying and sea level rise recession (Bluecoast, 2020) to the distribution of historic beach widths provided the projected future beach width for each representative zone.

This was based on assumptions in RHDHV (2020a) that any future beach recession would result in a reduction in available (dry) beach widths and associated amenity values where seawalls are in place while unprotected areas would recede without a change in the beach area. Recession of the unprotected areas without a change in beach area assumes that the landward area is composed of sand. This is considered a reasonable assumption given Stockton is a sand spit/coastal barrier. The geotechnical data required to confirm this assumption does not exist. Any storm erosion hazard is excluded from this part of the assessment because it is assumed that the beach naturally recovers from episodic storm-driven erosion. In general, it was assumed that as the shoreline recedes the beach width would not change. Estimated recession rates included both long term shoreline recession and recession due to sea level rise and varied between the 1.31 m/year for photogrammetry Block A and 1.62 m/year for Block B (see photogrammetry locations in Figure 5).

In addition, dry beach areas have been calculated based on the 1.5m AHD contour and scarp (or structure) position in the 2018 LiDAR topography data. The future beach areas over the planning period were estimated by applying the representative beach width reduction over the alongshore distance of each section. Based on five yearly increments from 2020 to 2120, probabilistic estimates of exceedance for beach area were estimated for the base case as well as for each of the project case scenarios. Based on the modelled probabilities of exceedance (100%, 99%, 98% 95%, 90%, 75%, 50%, 25%, 10%, 5%, 2%, 1%, 0.1% and 0.0001%) an expected average annual beach width was determined for each year. An example sub-set for the adopted beach areas is presented in Table 12.

The resultant areas for each project case are summarised in Table 13. The mass nourishment options, significantly expand the available average beach areas, whereas Option 2 provides a constant minor addition, and Option 3 leads to a gradual decay as the beach retreats to the seawalls.

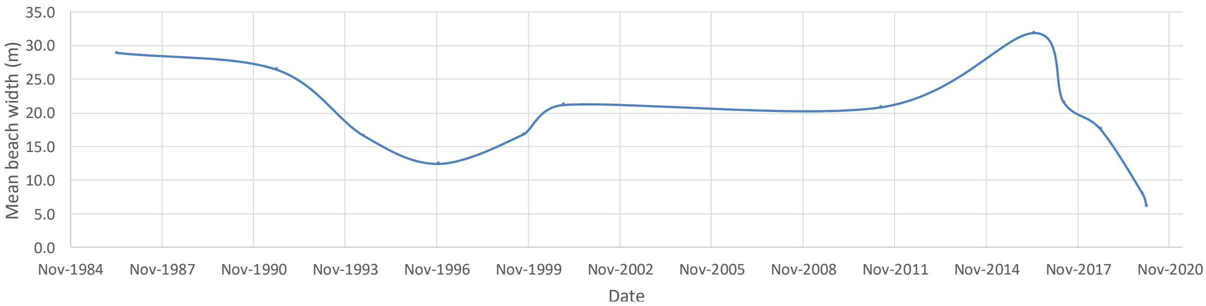

Figure 7: Historic photogrametry-based beach widths averaged over Block A.

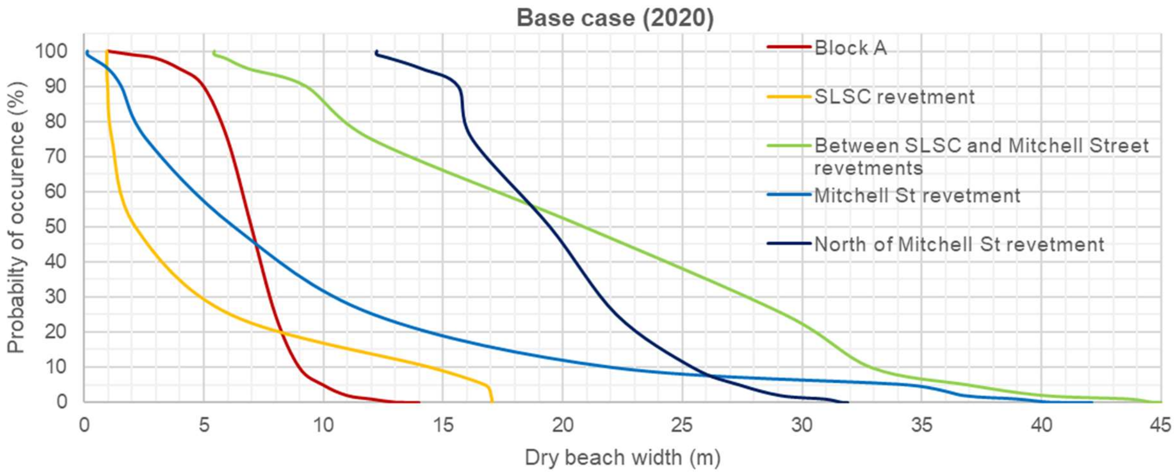

Figure 8: Distribution of beach width occurrences for representative sections along Stockton Beach comparing periods when a rock revetment was in place.

Note: the periods represented in this figure vary depending on the construction date of the rock revetments. For the Block A and SLSC revetment sections the period presented is from August 2018 to February 2020. For all other sections, the periods presented in from June 1994 to February 2020.

Table 12: Example summary of the distribution of adopted dry beach areas in square metres for the base case scenario for Block A.

	Probability of occurrence (%) of beach areas (m^2)								
Year	**100**	**90**	**75**	**50**	**25**	**10**	**5**	**1**	**0.1**
2020	916	2,278	2,460	3,072	6,667	9,887	11,120	14,018	14,036
2025	916	2,278	2,460	3,072	6,667	9,887	11,120	14,018	14,036
2040	916	2,278	2,460	3,072	6,667	9,887	11,120	14,018	14,036
2060	916	2,278	2,460	3,072	6,667	9,887	11,120	14,018	14,036
2120	916	2,278	2,460	3,072	6,667	9,887	11,120	14,018	14,036

Table 13: Forecast average annual beach areas.

Year	Expected Beach Area (m^2)					
	Base Case	Option 1a & 1c	Option 1b & 1d	Option 2	Option 3	Option 3b
2020	23,146	89,646	95,104 *(23,146 for 1b)*	29,844	28,988	28,988
2025	19,279	85,779	95,104	29,844	23,479	21,702
2040	19,279	85,779	95,104	29,844	21,279	14,127
2060	19,279	85,779	95,104	29,844	13,888	500
2120	19,279	85,779	95,104	29,844	0	0

4.2 Costs

4.2.1 Capital costs

The capital costs for each option were provided in RHDHV (2020) and are summarised in Table 14. It is seen that the forecast costs for Option 1 and 2 greatly exceed other components due to the high cost of terrestrial sand acquisition for nourishment.

Table 14: Project option capital costs.

Project case	Component				TOTAL COSTS
	Nourishment		Vertical structures (seawalls, rock toe etc.)		
	Volume (m^3)	Costs ($M)	Length (m)	Costs ($M)	
Option 1a	4,500,000**	364.5	458	12.2	376.7
Option 1b	2,400,000	21.4	458	12.2	33.6
Option 1c	1,800,000	45.0	458	12.2	57.2
Option 1d*	2,400,000	25.4	225	5.8	31.2
Option 2a	525,000**	46.5	1,453	39.8	86.3
Option 2b	610,000	11.6	1,453	39.8	51.4
Option 2c	610,000	18.3	1,453	39.8	58.1
Option 3	200,000**	16.0	1,453	39.9	55.9
Option 3b	50,000**	4.0	1,411	36.0	40.0

*includes nourishment costs associated with Option 3b for the first year.

** These quantities are based on the quantities required from the source rather than the effective beach nourishment volume (as presented in Table 2). Due to grain size compatibility the quantity required from the source is 2.5 times the effective beach nourishment volume.

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The expenditure profile for each of the option is shown in Table 15. Due to the logistics constraints associated with terrestrial transport of sand and volume of nourishment required under Option 1a, its costs have been extended over a five-year period. For options involving the development of one or more seawall components, this was assumed to be undertaken over a two-year period from 2025-2030.

Table 15: Capital cost expenditure profile.

Year	Expenditure ($M, 2020)								
	Option 1a	**Option 1b**	**Option 1c**	**Option 1d**	**Option 2a**	**Option 2b**	**Option 2c**	**Option 3a**	**Option 3b**
2020	-	-			-	-	-	-	
2021	376.7	27.2	50.8	9.8	609	26.0	32.6	28.2	9.8
2022	-	-	-	24.4	-	-	-	-	-
2023	-	-	-	-	-	-	-	-	-
2024	-	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-	15.1
2026	-	-	-	-	-	-	-	-	15.1
2027	-	-	-	-	12.7	-	-	13.9	-
2028	-	-	-	-	12.7	-	-	13.9	
2029						12.7	12.7		
2030	-	-	-	-		12.7	12.7		-
TOTAL	**376.7**	**27.2**	**50.8**	**31.2**	**86.3**	**51.4**	**58.1**	**55.9**	**40.0**
NPV (7% discount rate)	**352.0**	**25.4**	**47.5**	**27.8**	**72.2**	**37.6**	**43.9**	**43.0**	**30.0**

4.2.2 Operational and maintenance costs

The proposed beach nourishment works for each of the options will require on-going periodic maintenance nourishment in order to maintain the average estimated beach width under each option and protect assets from recession. In addition, the proposed vertical structures will require on-going periodic maintenance to ensure functionality and protection. The assumed maintenance works, frequencies and associated costs are summarised in Table 16 as well as the associated Net Present Value of future maintenance works under each option. Full details are provided in RHDHV (2020), including a figure showing the CZMP zones referred to in the table. All costs are additional over the base case scenario. As noted in Section 3, the base case includes $200,000 per annum of emergency works (present value - $2.6M) which will be avoided under each project scenario.

Table 16: Operational and maitenance cost expenditure profile.

Activity	Frequency	Cost	Stage
Option 1a			
Terrestrial Beach Nourishment	5	112,000,000	1
Corroba Oval Nourishment Storage	1	2,500,000	1
Diesel pump	1	1,200,000	1
Zone 1 Pile wall	5	56,000	1
Zone 1 Rock toe	5	14,000	1
Zone 1 Waste disposal	5	-	1
Zone 2 Pile wall	5	224,000	1
Zone 2 Rock toe	5	56,000	1
Zone 2 Waste disposal	5	25,000	1
Zone 4 Pile wall	5	178,000	1
Zone 4 Rock toe	5	44,500	1
Zone 4 Beach access	5	22,500	1
Zone 4 Road and Footpath	5	21,250	1
NPV (7% Discount Rate)	**$297.8M**		
Option 2a			
Beach Nourishment	1	22,400,000	1
Corroba Oval Nourishment	1	2,500,000	1
Diesel pump	1	1,200,000	1
Zone 1 Pile wall (s1)	5	56,000	1
Zone 1 Rock toe (s1)	5	14,000	1
Zone 2 Pile wall (s1)	5	224,000	1
Zone 2 Rock toe (s1)	5	56,000	1
Zone 4 Pile wall (s1)	5	178,000	1
Zone 4 Rock toe (s1)	5	44,500	1
Zone 4 Barrie Cres	5	21,250	1
Zone 4 Griffiths	5	225,000	1
Zone 4 Beach access	5	10,000	1
Zone 1 Pile wall (s2)	5	420,000	2
Zone 1 Rock toe (s2)	5	1,050,000	2
Zone 1 Waste disposal (s2)	5	-	2
Zone 1 Accessways (s2)	5	7,500	2

Activity	Frequency	Cost	Stage
Zone 1 SLSC (s2)	4	144,000	2
Zone 2 Pile wall (s2)	5	223,000	2
Zone 2 Rock toe (s2)	5	55,750	2
Zone 2 Waste disposal (s2)	5	7,500	2
Zone 2 Accessways (s2)	5	25,000	2
Zone 4 Stg 2 Griffiths	5	352,000	2
Zone 4 stg 2 Rock Toe	5	88,000	2
Zone 4 Accessways	5	7,500	2
NPV (7% Discount Rate)	**$339.2M**		
Option 2b			
As with Option 2a except:			
Beach Nourishment	5	10,640,000	1
NPV (7% Discount Rate)	**$26.0M**		
Option 2c			
As with Option 2a except:			
Beach Nourishment	5	16,800,000	1
NPV (7% Discount Rate)	**$39.8M**		
Option 3			
Beach Nourishment	1	16,000,000	1
Corroba Oval Nourishment	0	-	1
Diesel pump	0	-	1
Zone 1 Pile wall (s1)	5	56,000	1
Zone 1 Rock toe (s1)	5	14,000	1
Zone 2 Pile wall (s1)	5	224,000	1
Zone 2 Rock toe (s1)	5	56,000	1
Zone 4 Pile wall (s1)	5	44,500	1
Zone 4 Rock toe (s1)	5	25,000	1
Zone 4 Barrie Cres	5	21,250	1
Zone 4 Griffiths	5	178,000	1
Zone 4 Beach access	0	-	1
Zone 1 Pile wall (s2)	5	420,000	2
Zone 1 Rock toe (s2)	5	105,000	2

Activity	Frequency	Cost	Stage
Zone 1 Waste disposal (s2)	0	-	2
Zone 1 Accessways (s2)	5	7,500	2
Zone 1 SLSC (s2)	4	144,000	2
Zone 2 Pile wall (s2)	5	223,000	2
Zone 2 Rock toe (s2)	5	55,750	2
Zone 2 Waste disposal (s2)	5	25,000	2
Zone 2 Accessways (s2)	5	7,500	2
Zone 4 Stg 2 Griffiths	5	352,000	2
Zone 4 stg 2 Rock Toe	5	88,000	2
Zone 4 Accessways	5	7,500	2
NPV (7% Discount Rate)	**$207.6M**		
Option 1b			
Beach Nourishment	10	12,400,000	1
Corroba Oval Nourishment	1	-	1
Diesel pump	1	-	1
Zone 1 Pile wall	5	56,000	1
Zone 1 Rock toe	5	14,000	1
Zone 1 Waste disposal	5	-	1
Zone 2 Pile wall	5	224,000	1
Zone 2 Rock toe	5	56,000	1
Zone 2 Waste disposal	5	25,000	1
Zone 4 Pile wall	5	178,000	1
Zone 4 Rock toe	5	44,500	1
Zone 4 Bleachers	5	22,500	1
Zone 4 Road and Footpath	5	21,250	1
NPV (7% Discount Rate)	**$10.4M**		
Option 1c			
Beach Nourishment	5	16,800000	1
Corroba Oval Nourishment	1	-	1
Diesel pump	1	-	1
Zone 1 Pile wall	5	56,000	1
Zone 1 Rock toe	5	14,000	1

Activity	Frequency	Cost	Stage
Zone 1 Waste disposal	5	-	1
Zone 2 Pile wall	5	224,000	1
Zone 2 Rock toe	5	56,000	1
Zone 2 Waste disposal	5	25,000	1
Zone 4 Pile wall	5	178,000	1
Zone 4 Rock toe	5	44,500	1
Zone 4 Bleachers	5	22,500	1
Zone 4 Road and Footpath	5	21,250	1
NPV (7% Discount Rate)	**$14.5M**		
Option 1d			
Option 3b Costs for 1 year	-		-
Option 1b costs from year 2	-		-
NPV (7% Discount Rate)	**$13.9M**		
Option 3b			
Beach Nourishment	1	4,000,000	1
Zone 1 Pile wall	5	35,000	1
Zone 1 Rock toe	5	8,750	1
Zone 2 Pile wall	5	150,000	1
Zone 2 Rock toe	5	37,500	1
Zone 4 Pile wall (s1)	5	40,000	1
Zone 4 Rock toe (s1)	5	10,000	1
Zone 4 Barrie Cres	5	10,000	1
Zone 4 Accessways	5	2,500	1
Zone 1 Pile wall (s2)	5	441,000	2
Zone 1 Rock toe (s2)	5	110,250	2
Zone 1 Accessways (s2)	5	7,500	2
Zone 1 SLSC (s2)	4	144,000	2
Zone 2 Pile wall (s2)	5	295,000	2
Zone 2 Rock toe (s2)	5	73,750	2
Zone 2 Waste disposal (s2)	5	25,000	2
Zone 2 Accessways (s2)	5	7,500	2
Zone 4 Stg 2 Griffiths	5	450,000	2

Activity	Frequency	Cost	Stage
Zone 4 stg 2 Rock Toe	5	112,500	2
Zone 4 Accessways	5	7,500	2
NPV (7% Discount Rate)	**$52.7M**		

4.2.3 Other unquantified aspects

A summary of other non-quantified aspects not included in the CBA are:

- Approvals risks for obtaining the required sand volumes from any of the sources.
- There are existing approvals for relatively modest quantities of beach nourishment material to be placed at Stockton Beach. They do not allow for the larger quantities required for mass nourishment. The existing approvals are associated with maintenance dredging in an area referred to as Area E, located at the entrance to the navigation channel of the Port of Newcastle. This area has a high sand content. The existing approvals are described further in WorleyParsons, 2012.
- The results of the 2019 beach nourishment trial showed that sand delivered by terrestrial sources does not match the colour of native beach material at Stockton. This is often poorly received by the community and has been raised as a concern in the CLG. However, the effect of this negative perception has not been factored into the amenity value of the beach. It is noted that sand delivered to the inner surf zone would be expected to naturally mix with native sand and not show marked colour differences.
- The high cost of the terrestrial sand along with the overfill ratio means that this represents extremely poor value for money and is unlikely to be a widely acceptable expenditure of public money.
- Wave overtopping and coastal inundation from storm surge, large storm waves and sea level rise as they relate to Stage 1 and Stage 2 structures have not been included herein. While not expected to be significant in the short term, by 2040 and beyond, in the case nourishment is not maintained at the desired levels and when the structures start to serve their intended erosion protection function, wave overtopping and inundation risks is considered likely to become significant offsetting the erosion protection benefits.
- The completion of Stage 1 and Stage 2 coastal structures, when combined with the existing rock revetments, would see the armouring of a total of 2,200m of coastline that is known to be undergoing long term recession. Should nourishment not compensate for the long-term sand losses and losses due to sea level rise, downdrift (i.e. northern) areas will be at an increased risk of erosion and shoreline recession. It is recommended that the future Newcastle CMP consider a sediment compartment wide strategic approach when developing feasible options.
- Trucking of terrestrial sand and placement on the subaerial beach would require four works campaigns a year, each taking 7-weeks at three project sites spread across the CMP area (RHDHV, 2020). Heavy machinery occupying the beach for up to 28-weeks a year is a high level of disruption to amenity value of the beach but has not been factored into the CBA. The public safety risks, damage to public roads and/or the local traffic disruption associated with truck movements have not been factored into the CBA.

4.3 Benefits

For the purposes of the CBA and given the magnitude of the costs identified the analysis has focussed upon quantification of the major benefit streams. The following benefits were estimated:

- Beach amenity (i.e. use and non-use values)
- Avoided private property loss
- Avoided public land loss
- Avoided public infrastructure loss
- Avoided loss of producer surplus
- Residual value

The following sections details the derivation of the each of the benefits identified. Table 17 provides a summary of the contribution of each benefit to the economic performance of each project. It is seen that beach amenity represents the major benefit for several project cases. Avoided impacts to private land and property remains relatively constant across all options as all options provide a similar level of protection in this regard.

Table 17: Summary of estimated benefits ($2018/20 constant dollars).

	O1a		O2a-c		O3		O1b		O1c		O1d		O3b	
	$M	%	$M	%	$M	%	$M	%	$M	%	$M	%	$M	%
Beach amenity	40.5	76.5	15.0	63.2	8.1	48	42.7	77.3	40.5	76.4	40.6	76.6	2.3	20.5
Property loss	7.2	13.5	7.2	30.1	7.2	42.5	7.2	12.9	7.2	13.5	7.2	13.5	7.2	65.1
Council asset loss	2.5	4.8	0.4	1.7	0.4	2.4	2.5	4.6	2.5	4.8	2.5	4.8	0.4	3.5
Council land loss	1.3	2.4	0.4	1.7	0.4	2.4	1.3	2.3	1.3	2.4	1.2	2.8	0.4	3.7
Producer Surplus	1.5	2.8	0.4	1.5	0.4	2.4	1.5	2.7	1.5	2.8	1.5	2.3	0.2	2.0
Residual value	0.0	-	0.4	1.7	0.4	2.4	0.1	0.2	0.1	0.2	0.1	0.1	0.6	5.2
TOTAL	**52.9**	**100**	**23.8**	**100**	**16.8**	**100**	**55.2**	**100**	**53.0**	**100**	**53.0**	**100**	**11.0**	**100**

It is noted that there are number of additional benefits that have not been able to be captured within the CBA given its timing and scope. These are discussed in Section 4.3.7.

4.3.1 Beach amenity

Beach amenity is a broad term that can capture a wide range of beach values to both active and non-active beach users. For the purposes of this economic assessment, beach amenity is defined to be the collective use and non-use values ascribed to the presence and extent of Stockton Beach. In the absence of site specific information regarding usage of the beach and associated foreshore areas for the CBA and literature review was undertaken to identify potential benefit transfer values that could be taken to be representative of the Stockton Beach use and non-use value of the beach. Numerous studies have been undertaken regarding beach valuation, however in general many relate to high usage or high tourism value beaches (e.g. Gold Coast, Manly, Bondi) and rely upon travel-cost / willingness to pay valuations for users wanting to utilise the beach and broader impacts into surrounding economies. Given that Stockton Beach is not of a similar tourism scale to many such studies (although the Holiday Park does attract regional visitors), the economic analysis does not directly consider tourism values, but rather focuses on estimate recreational and non-use values for beach areas.

A number of studies have been completed recently which attempt to place high level order of magnitude values to both beach use values (i.e. the values humans derive from the beach through some form of interaction with it; this may be direct (e.g. visitation) or indirect (e.g. ecosystem services provide by the beach that support fisheries) or non-use values (the intrinsic value assigned by individuals to the beach that it should continue to exist, independent of personal use). Table 18 summarises a series of recent valuation estimates for use and non-use values for beaches within Sydney and across NSW. In particular, the Pascoe et al. (2017) study represents a state-wide (considering both Sydney and regional locations) to estimate use and non-use values per hectare of beach area. The methodology within combines a range of techniques (choice experiments and analytic hierarchy process), based on a single survey. While the resultant valuations are highly influenced by LGA populations, for the purposes of this CBA the valuations are potentially representative of a lower valuation range.

Table 18: Use and non-use valuations.

Source	Non-Use	Unit	Use	Unit
Pascoe et al 2017	$1.19	per household per quarter per hectare	$11.70	per person per visit
Deloitte 2016	$28.50	per person per year	$40.12	per person per visit
Sydney Coastal Councils 2013	$141.76	per person	$16.13	per person per visit

Based on the estimated current annual beach visitation rates, population and household size within the Stockton and surrounding suburbs and LGA, and the current beach area, these literature values were converted to $/m^2 of Stockton Beach and a conservative weighted[2] estimate derived:

- Use value: $57.31 per m^2 per year
- Non-use value: $19.0 per m^2 per year

It is recognised that the local community have strongly expressed their concern for protection of the beach and the preservation of connectivity, supporting an elevated level of beach value. However, a limitation of the utilisation of per square meter metrics is that it does not recognise the variation that may arise in valuation between circumstances in which there is little or a lot of additional beach area and how this may vary over time. In response to these elements the following assumptions were adopted:

- Diminishing marginal returns of sand provision - A diminishing rate of return per additional square meter of beach area (over the existing beach area) was applied to use values, reaching a floor of $1 per m^2 per year.

[2] For use values 80%:10%:10% was applied to Pascoe et al (2017), Deloitte (2016) and Sydney Coastal Council (2013). For non-use values 90%:10% was applied to Pascoe et al (2017), Deloitte (2016).

- Connectivity losses – Where recession and erosion led to segmentation of the beach through separation of lengths of sea wall (in either the base case or project case) a series of reduction in use and non-use rates was applied: 15% for the first division, 20% for the second and a floor of 50% for further segmentation.

Based on the forecast expected beach areas under each year (Table 13), an estimate of the change in beach amenity relative to the base case was derived. The resultant present values are summarised in Table 19. It is seen that Options 1a-d generate significant amenity benefit through the more than five-fold increase in average beach area sustained into the future.

Table 19: PV of beach amenity benefits.

	Base Case	Project Case	Difference
Option 1a	18.1	58.5	40.5
Option 2a-c	18.1	33.1	15.0
Option 3	18.1	26.1	8.0
Option 1b	18.1	60.7	42.7
Option 1c	18.1	58.5	40.4
Option 1d	18.1	58.7	40.6
Option 3b	18.1	20.3	2.3

As way as comparison, the current base case present value of Stockton Beach ($18M), consists of $13.5M in use value and $4.5M in non-use value. This non-use value is equivalent to approximately $1.6M (present value) per hectare of beach. This is at the lower end of estimate values for sandy beaches estimated by Pascoe et al 2017 for non-Sydney Beaches. Given the strongly expressed community values for protection of the beach (within the immediate community) this may be a conservative estimate of value. It also demonstrates the high dependency of the result upon forecast beach visitation. As noted previously, the lack of beach visitation and utilisation data is a constraint to this analysis and ratification of the assumptions therein should be undertaken.

4.3.2 Private property

City of Newcastle (CN) provided a database of current land values and sale prices for all private properties within the affect hazard extents. Where cadastral blocks land values and/or sale prices were unavailable, an estimated land value and sale price was based on the average multiplied between land values and sale prices and, where required, the cadastral lot size. To account for variation in land and sale prices with proximity to beach frontage, the estimated valuations were applied incrementally within each of the 16 probability of exceedance scenarios. The average land value per cadastral block was seen to be approximately $545,000 and the average sale price $800,000 (the average sale price for properties in closest proximity to the beach were seen to be $1.39M). Using the criteria outlined in Table 9, each affected building and land parcel under each scenario was estimated using the following assumptions:

- If the erosion extent intruded within a cadastral block but did not affect the main structure, the value of impact was the proportionate land value of area affected.

- If the erosion extent intruded within the footprint of the main structure, the value of impact was the sale price for the property.
- For strata properties, it was assumed all property values would be lost where the main structure was affected. To avoid duplication, strata properties with non-structural erosion, were only applied to one of the listed properties.

Based on the three PoE scenarios assessed (and linear extrapolation of 100% scenario) an average annual private property estimate was determined for the base case scenario (Table 20). There is a significant difference in the magnitude of properties affected between 2040 and 2060, and between 2060 and 2120. For the project case, none of the private properties identified were forecast to be affected under any of the options (i.e. all potential impacts are avoided). The resultant present value of each property loss benefit is shown in Table 21.

Table 20: Base case affected property values over time.

	2020	2040	2060	2120
100%	$ -	$ -	$ 20,623,030	$41,070,637
50%	$ -	$5,011,471	$ 31,981,724	$103,110,659
10%	$ -	$13,872,320	$ 39,048,047	$142,837,673
1%	$66,277	$23,850,707	$ 43,800,630	$167,279,405
Annual Value	**$2,982**	**$ 6,727,162**	**$ 31,085,333**	**$ 99,190,259**

Table 21: PV of avoided private property loss.

	Base Case	Project Case	Difference
Option 1a	7.15	0.00	7.15
Option 2a-c	7.15	0.00	7.15
Option 3	7.15	0.00	7.15
Option 1b	7.15	0.00	7.15
Option 1c	7.15	0.00	7.15
Option 1d	7.15	0.00	7.15
Option 3b	7.15	0.00	7.15

4.3.3 Council lands

Due to the range of assets potentially affected, the estimation of impact to Council property was calculated separately: Council owned land and associated land values, council owned assets and associated asset values. CN provided estimates of current land values associated with CN owned land parcels. Where a land parcel was not assigned a current land value, an estimate was derived based on the average per square metre value of land. Within some cadastral blocks, Council maintains sub-lots; it was not possible to confirm the extent of valuation boundaries (i.e. whether they applied to specific sub-lots or the parcel as a whole). Where this occurred, a conservative approach was adopted, and the cumulative total of estimate land value applied to the whole cadastral block area extent to derive a per square meter value. The value of council owned land was seen to vary from approximately $31 per square meter near the foreshore, to $23 per square meter at the 2120 erosion extent.

As with private property land valuation, the proportion affected within a cadastral block under each assess scenario was used to estimate the base case expected annual average cost of erosion within each year into the future (Table 22). This was linearly interpolated between years to estimate the growth rate per year. It is seen that, in contrast to private property, a lot of council land at risk is affected within the next 40 years and diminishes thereafter.

Table 22: Base Case affected council land values over time.

	2020	2040	2060	2120
100%	$-	$-	$3,594,536.59	$3,247,247.00
50%	$168,744.66	$3,496,601.13	$3,839,284.28	$4,641,428.00
10%	$932,018.14	$3,639,668.69	$3,976,710.84	$4,822,377.22
1%	$1,397,798.24	$3,760,159.90	$4,098,994.11	$4,947,497.38
Annual Value	$367,180.46	$2,634,396.53	$3,785,060.96	$4,304,574.15

*due to linear extrapolation of growth rates the 2120 100% PoE value is lower than that of the corresponding 2060 value

Under the project case scenario, Option 1a, 1b and 1c were assumed to effectively remove all potential impacts to Council Assets as the nourishment programs are of sufficient magnitude to retain the current average shoreline (NB. It is recognised that under 5- or ten-year maintenance nourishment regimes there may be small short-term local erosion impacts to Council land which would need to be addressed, however, this element has not been captured within the current CBA). In contrast, Options 2, 3 (and 1d as it performs as Option 3b for the first year) while retaining some beach amenity, will effectively recede back to the seawall and be maintained at this location. Therefore, the construction of the seawalls will require both the demolition of assets along its alignment (Section 4.3.4) as well as the gradual recession and loss of Council land as the beach moves to the seawall. For the purposes of this assessment it is assumed that this will occur at the same rate as would occur under the base case scenario. However, it is recognised that studies indicated that the presence of seawall structures may accelerate the rate of recession. For both Option 2 and Option 3, land areas affected under the 2040 50% PoE will be lost. Beyond 2040, no further loss would occur (Table 16). Option 3b, includes additional areas around Barrie Crescent and the Griffith Street car park that will be lost at a time that accords with the recession in the hazard lines (Bluecoast, 2020). Table 17 summarises the present value savings of each option in comparison to the base case.

Table 23: Project case affected Council land values over time Option 2 and 3.*

	2020	2040	2060	2120
100%	$-	$- ($ 30,431)	$ 3,496,601.13 ($ 3,527,033)	$ 3,496,601.13 ($ 3,527,033)
50%	$168,744 ($168,745)	$3,496,601 ($ 3,527,033)	$ -	$ -
10%	$932,018 ($ 942,765)	$ -	$ -	$ -
1%	$1,397,798 ($1,428,231)	$-	$ -	$ -
Annual Value	$367,180.46 ($ 371,183)	$1,573,470.51 ($ 1,594,773)	$ 3,496,601.13 ($ 3,527,033)	$ 3,496,601.13 ($ 3,527,033)

*figures in brackets represent corresponding 3b costs with additional impacts

Table 24: PV of avoided Council land loss ($M).

	Base Case	Project Case	Difference
Option 1a	1.3	0	1.3
Option 2a-c	1.3	0.85	0.4
Option 3	1.3	0.85	0.4
Option 1b	1.3	0	1.3
Option 1c	1.3	0	1.3
Option 1d	1.3	0.1	1.2
Option 3b	1.3	0.9	0.4

4.3.4 Council assets

For each of the Council Assets identified (Table 9), Council provided an estimate of current replacement value for the asset in question. For assets in which it was possible for partial replacement to be undertaken (e.g. road pavement areas, car parks areas, stormwater drainage lengths etc.) an estimate of the value of asset at risk under each PoE scenario was determined based on the proportionate extent of the area/length of impact relative to the overall asset and asset value. For structural or non-separable assets identified (e.g. buildings, shelters), whether the hazard modelling identified an impact to the structure it was assumed the whole asset value would be lost. Table 25 summarises the forecast value of each of the asset types at risk under each of the modelled scenarios. The buildings and structures represent the greatest magnitude of assets at risk. This is predominantly comprised of the facilities at the Holiday Park, Lynn Oval and tennis club, and the Surf Life Saving Club facilities. Road pavement areas and carparking represent a significant value by 2120 but are not significantly impacted within the next 40 years.

Table 25: Estimated value of Council assets at risk.

Council Buildings and Structures

Council Buildings and Structures	2020	2040	2060	2120
50%	$121,950	$5,145,694	$6,849,500	$7,777,971
10%	$2,881,800	$6,087,993	$7,534,851	$7,846,999
1%	$4,535,943	$ 6,889,041	$7,534,851	$9,326,999
Paved Areas	2020	2040	2060	2120
50%	$8,059	$277,356	$468,085	$1,194,056
10%	$90,323	$345,263	$536,784	$1,481,975
1%	$224,239	$435,907	$593,655	$2,038,054
Stormwater Pipe	2020	2040	2060	2120
50%	$-	$-	$7,922	$162,679
10%	$-	$-	$17,672	$209,297
1%	$-	$2,438	$26,204	$306,306
Public Shelter	2020	2040	2060	2120
50%	$-	$157,000	$164,500	$208,500
10%	$-	$164,500	$196,500	$208,500
1%	$-	$164,500.00	$196,500	$213,000

Under the project case scenario, the construction of the seawalls under Options 2 and 3 will necessitate the removal of a number of assets within the Stockton Beach Holiday Park. These assets are at risk from erosion by 2040. However, for the purposes of this CBA it is assumed that the loss of these assets will be incurred as part of the construction of the seawall in 2027 (approximately $3.4M). In addition, Option 3b (and subsequently Option 1d) will lose the car park area and associated road infrastructure at this location (approximately $100K to be lost by 2120). Table 26 summarises the associated present value savings of each option.

Table 26: PV of avoided Council asset loss ($M).

	Base Case	Project Case	Difference
Option 1a	2.51	0.0	2.51
Option 2a-c	2.51	2.1	0.4
Option 3	2.51	2.1	0.4
Option 1b	2.51	0.0	2.51
Option 1c	2.51	0.0	2.51
Option 1d	2.51	0.01	2.5
Option 3b	2.51	2.1	0.4

4.3.5 Producer surplus

While there are a number of businesses and economic activities that are undertaken within proximity to and are partially dependent upon Stockton Beach, for the purposes of this CBA the assessment of foregone producer focused on the Holiday Park operations. The Holiday Park would be most directly affected by both the base case shoreline recession as well as the proposed infrastructure. In absence of detailed operational information regarding the Holiday Park the potential impacts to the facility were assessed through the following assumptions:

- Assumed average direct expenditure within the LGA associated with the park is $4M per year. This was determined based on reported average annual operational revenue to the park ($3.25M) and a factor for additional expenditure (e.g. local food and beverage expenditure).
- In accordance with the OEH manual recommendations, in the absence of more specific data, a conversion factor of 0.3 was applied to the estimated direct expenditure to provide an estimated annual producer surplus of $1.2M.
- It is considered that with the forecast level of erosion, the Holiday Park is likely to become financial unviable in advance of physical impacts (i.e. loss of operational space and facilities). For the purposes of the assessment, it is assumed that 50% of producer surplus will be lost by 2027 under the base case and for those Options requiring construction of a seawall within park areas. It is assumed that under the base case 100% of the producer surplus would be lost by 2040 based on the forecast rate of recession. Project case option 1a – d will afford protection such that 100% of producer surplus will be maintained into the future. The proposed seawalls under Options 2 and 3 will permit 50% producer surplus generation onwards from 2027.
- Where a forecast loss in produced surplus is identified in the base case and project case it was assumed that:
    - 80% of this value would be redistributed within the LGA (e.g. to other accommodation venues) and is not considered and economic cost for inclusion within the CBA.

- 20% of this value is assumed to be lost from the economy and is considered a cost of recession.

Ground truthing and surveys would need to be undertaken to validate these desktop assumptions. Table 25 summarises the present value of producer surplus values able to be retained under each of the options.

Table 27: PV of Producer Surplus ($M).

	Base Case	Project Case	Difference
Option 1a	1.6	3.1	1.5
Option 2a-c	1.6	2.0	0.4
Option 3	1.6	2.0	0.4
Option 1b	1.6	3.1	1.5
Option 1c	1.6	3.1	1.5
Option 1d	1.6	3.1	1.5
Option 3b	1.6	1.8	0.2

4.3.6 Residual value

The maintenance requirements of beach nourishment are such that the works are considered to have a negligible service life beyond the 50-year evaluation period. However, the proposed seawalls are likely to have a design service life of in excess of 100 years. For the purposes of this CBA, it was assumed that at the end of the 50 year economic assessment period, the seawalls would have a further 50 years of service life and their residual value was estimated to be 50% of their capital cost (approximately $12M). Table 28 summarises the associated present value of option residual values.

Table 28: PV of avoided Council asset loss.

	Base Case	Project Case	Difference
Option 1a	0.00	0.00	0.00
Option 2a-c	0.00	0.4	0.4
Option 3	0.00	0.4	0.4
Option 1b	0.00	0.1	0.1
Option 1c	0.00	0.1	0.4
Option 1d	0.00	0.1	0.1
Option 3b	0.00	0.6	0.6

4.3.7 Unquantified benefits

There are a range of other intangible benefits and non-quantified benefits that were not assessed as part of the economic assessment. As such, the economic evaluation for this project should be a conservative appraisal. Other benefits arising from the project are likely to include:

- Benefits associated with reduced frequency of storm related inundation and associated damages.
- Avoided costs of periodic emergency response works following storm surge events.
- Impacts to areas beyond the northern extent of the study area.
- Usage values for Council parkland / reserve area adjacent to the beach.
- Avoided commercial and recreational fishing activity loses.
- Avoided loss of Holiday Park and local business revenue that is not captured elsewhere within the LGA.
- Loss of tourist and tourism expenditure due to Holiday Park impacts.
- Loss of recreational space associated with Lynn Oval, tennis club and bowls club.
- Environmental values.
- Any sand that moves from the CMP area in a northerly direction will have a benefit in slowing the erosion observed to the north.
- A shoreline control structure (e.g. a longer groyne or artificial headland) aimed at reducing the rate of sand loss in the CMP area has not been considered as an option. If successful, this would have the benefit of reducing maintenance nourishment costs while delivering equivalent beach amenity outcomes updrift of the control structure. DHI's (2009) study indicated that such a structure would serve this purpose but would create downdrift impacts. As the location is outside the defined CMP, such an option has not been considered as part of this CMP but may be considered as part of a future Newcastle CMP.
- Mass nourishment of the profile would be expected to achieve lasting surf amenity benefits at Stockton Beach. These benefits have been included within the use-value assigned to the beach amenity. If they had been separated a higher amenity benefit may have been found but would be unlikely to change the outcomes. Again, however, it highlights the conservative approach to valuing beach amenity adopted herein.

5. CBA RESULTS

5.1 Results

The relative costs and benefits of the Project Case for each option in comparison to a Base Case, as outlined above, were compared through a Cost Benefit Analysis (CBA). The results of the economic assessment for each of the project options are provided in Table 29 to Table 35. Of the seven options, only Options 1b and 1d are seen to have a BCR greater than one at a 7 per cent discount rate. For Option 1b, at 7 percent discount rate the BCR is 1.5, implying for every $1 spent on the project, $1.5 is expected to be returned in economic benefits. The net benefit under this option is $19.4M. For Option 1d at 7 percent discount rate the BCR is 1.3, implying for every $1 spent on the project, $1.30 is expected to be returned in economic benefits. The net benefit under this option is $11.3M. Option 1b is the economically preferred option. However, as noted previously, there may be a range of legislative and environmental issues associated with this option that would prevent its implementation at present. Both Options 1b and 1d depend upon access to a cheaper nourishment sand source to be available upon commencement of mass nourishment activities. Provided this is obtainable both options are likely to be viable.

It is noted that Options 1b and 1d are similar, with the exception for the first years of operation in which Option 1d includes the nourishment profile and protection works associated with Option 3b. None of the other options are feasible at a 7% discount rate, although Option 1c is seen to be viable at a 3% discount rate.

Option 2, 3 and 3b do not generate positive results as they provide little to no (even negative in the case of 3b for some years) amenity benefit in comparison to the base case, while incurring high upfront costs. While these options do provide protection of private assets, the risk of damage and loss of these assets is too far into the future to economically support investment in these options which rely upon physical infrastructure for asset protection. It is considered that seawall options are likely to improve in their economic feasibility over time (i.e. by 2040).

Table 29: Economic Appraisal Results for Option 1a.

	3%	***7%***	***10%***
PV COST	$983,184,531	$649,861,672	$540,331,071
PV BENEFIT	$109,563,722	$52,908,176	$35,581,032
NPV	-$873,620,809	-$596,953,496	-$504,750,039
BCR	**0.1**	**0.1**	**0.1**
NPVI	-2.4	-1.7	-1.5
FYRR	1%	1%	1%
IRR	-	-	-

Table 30: Economic Appraisal Results for Option 2a

	3%	***7%***	***10%***
PV COST	$738,680,424	$411,390,278	$304,277,300
PV BENEFIT	$56,411,570	$23,769,741	$14,811,643
NPV	-$682,268,854	-$387,620,536	-$289,465,657
BCR	**0.1**	**0.1**	**0.0**
NPVI	-8.6	-5.4	-4.3
FYRR	2%	2%	2%
IRR	-	-	-

Table 31: Economic Appraisal Results for Option 3a.

	3%	***7%***	***10%***
PV COST	$453,186,216	$250,641,117	$183,909,981
PV BENEFIT	$39,498,485	$16,836,521	$10,526,005
NPV	-$413,687,732	-$233,804,597	-$173,383,976
BCR	**0.1**	**0.1**	**0.1**
NPVI	-8.4	-5.4	-4.4
FYRR	2%	2%	3%
IRR	-	-	-

Table 32: Economic Appraisal Results for Option 1b.

	3%	7%	10%
PV COST	$51,424,817	$35,831,443	$30,861,447
PV BENEFIT	$114,771,668	$55,231,092	$37,104,439
NPV	$63,346,851	$19,399,649	$6,242,991
BCR	2.2	1.5	1.2
NPVI	2.4	0.8	0.3
FYRR	13%	12%	12%
IRR	13%	13%	13%

Table 33: Economic Appraisal Results for Option 1c.

	3%	7%	10%
PV COST	$83,925,253	$61,994,994	$54,804,428
PV BENEFIT	$110,203,197	$52,999,787	$35,603,393
NPV	$26,277,944	-$8,995,207	-$19,201,035
BCR	1.3	0.9	0.6
NPVI	0.5	-0.2	-0.4
FYRR	7%	6%	6%
IRR	5%	5%	5%

Table 34: Economic Appraisal Results for Option 3b.

	3%	7%	10%
PV COST	$138,504,145	$82,743,592	$63,378,309
PV BENEFIT	$24,149,701	$10,983,131	$7,312,100
NPV	-$114,354,445	-$71,760,461	-$56,066,209
BCR	0.2	0.1	0.1
NPVI	-3.3	-2.4	-2.1
FYRR	3%	3%	4%
IRR	-	-	-

Table 35: Economic Appraisal Results for Option 1d.

	3%	7%	10%
PV COST	$58,473,549	$41,755,105	$36,035,001
PV BENEFIT	$112,197,643	$53,060,612	$35,078,300
NPV	$53,724,094	$11,305,507	-$956,701
BCR	1.9	1.3	1.0
NPVI	1.8	0.4	0.0
FYRR	4%	4%	4%
IRR	10%	10%	10%

5.2 Sensitivity testing

It is recognised that the results of the assessment presented in Table 29 to Table 35 are dependent upon a range of assumptions made as part of the economic analysis. Both in terms of financial parameters (i.e. discount rates) as well as cost and benefit assessments (e.g. beach valuations, construction costs). Consequently, to assess the robustness of the observed results, detailed sensitivity analysis of the CBA was undertaken on the three best performing options: Options 1b, 1c and 1d. The results are shown in Table 36 and Table 38. **Appendix D** provides a summary of key sensitivity testing results for all options.

Table 36: Sensitiviy testing for Option 1b.

	BCR	NPV ($M)	IRR	NPVI
Original	1.5	$19,399,649	12.6%	0.8
Cost Estimate +40%	1.1	$5,067,072	8.1%	0.3
Cost Estimate +20%	1.3	$12,233,360	10.0%	0.6
Cost Estimate – 20%	1.9	$26,565,938	16.3%	0.8
PV Benefits +20%	1.8	$30,445,867	15.6%	1.2
PV Benefits – 20%	1.2	$8,353,431	9.5%	0.3
PV Benefits –40%	0.9	-$2,692,788	6.1%	-0.1
Delay by 1 Year	1.4	$15,150,049	11.1%	0.6
Delay by 3 years	1.3	$10,771,369	9.6%	0.4
50% increase in assumed beach use and non-use value per m^2	2.1	$40,757,087	18.5%	1.6
50% reduction in assumed beach use and non-use value per m^2	0.9	-$1,957,789	6.4%	-0.1

Table 37: Sensitivity testing for Option 1c.

	BCR	NPV ($M)	IRR	NPVI
Original	0.9	-$8,995,207	5.5%	-0.2
Cost Estimate +40%	0.6	-$33,793,205	2.4%	-1.0
Cost Estimate +20%	0.7	-$21,394,206	3.8%	-0.5
Cost Estimate – 20%	1.1	$3,403,792	7.7%	0.1
PV Benefits +20%	1.0	$1,604,751	7.3%	0.0
PV Benefits – 20%	0.7	-$19,595,164	3.4%	-0.4
PV Benefits – 40%	0.5	-$30,195,122	0.7%	-0.6
Delay by 1 Year	0.8	-$12,857,271	4.8%	-0.3
Delay by 3 years	0.7	-$16,415,609	4.4%	-0.3
50% increase in assumed beach	1.2	$11,246,578	8.8%	0.2

use and non-use value per m^2				
50% reduction in assumed beach use and non-use value per m^2	0.5	-$29,236,992	1.3%	-0.6

Table 38: Sensitiviy Testing for Option 1d.

	BCR	*NPV ($M)*	*IRR*	*NPVI*
Original	1.3	$11,305,507	9.7%	1.3
Cost Estimate +40%	0.9	-$5,396,534	6.0%	0.9
Cost Estimate +20%	1.1	$2,954,487	7.6%	1.1
Cost Estimate – 20%	1.6	$19,656,528	12.6%	1.6
PV Benefits +20%	1.5	$21,917,630	12.0%	1.5
PV Benefits – 20%	1.0	$693,385	7.2%	1.0
PV Benefits –40%	0.8	-$9,918,737	4.3%	0.8
Delay by 1 Year	1.3	$10,575,324	9.6%	1.3
Delay by 3 years	1.2	$6,131,432	8.4%	1.2
50% increase in assumed beach use and non-use value per m^2	1.8	$31,624,594	14.2%	1.1
50% reduction in assumed beach use and non-use value per m^2	0.8	-$9,013,579	4.7%	-0.3

For those options which enhance beach amenity the key challenge to feasibility is the relative benefit per square meter of **additional** sand in comparison to the per square meter cost of maintenance nourishment requirement. For most scenarios tested the quantity and cost of nourishment activities outweighs the benefit generated. Given the dependency of the CBA results upon the capital and maintenance costs of nourishment, a series of further cost sensitivity scenarios were undertaken on Option 1d, as described in the following paragraphs.

Based on the assumed use of terrestrial sourced sand delivered by trucks and the like, the high capital and maintenance costs were considered to have already been assessed and the sensitivity tests focused on the low to moderate costs sources and methods, as:

- **Low capital cost:** adopted a combined sand placement rate of $1.83/$m^3$ assuming that the sand would be sourced from material that is excess to the needs of another large infrastructure project and delivered to Stockton free of charge. The unit rate is the additional rate for rainbowing the sand to the surf zone.

- **Moderate capital cost:** adopted a combined sand placement rate of $21.50/m^3 assuming that the sand would be sourced from the North Arm of the Hunter River (between Welsh Point and Stockton Bridge). The rate is based on the value presented in RHDHV (2020) (for an 850mm CSD with one booster discharging sand to the upper beach).
- **Low maintenance cost:** adopted a combined sand placement rate assuming that the sand would be sourced from the entrance area of the Hunter River and could be delivered on an annual basis using a dredger based at the Port of Newcastle (i.e. a local vessel). This arrangement and any commercial rate would be subject to capability, willingness, capacity, and negotiations.
- **Moderate maintenance cost:** adopted a combined sand placement rate of $6.42/m^3 assuming a dredging contractor would use a small TSHD to rainbow and bottom dump up to 1.2M m^3 sand in a campaign every 10-years under a long-term contract. The rate was based on budgetary pricing provided by potential contractors.

The sensitivity tests then included a range of capital and maintenance cases including:

- Low capital cost, low maintenance costs.
- Low capital cost, moderate maintenance costs.
- Moderate capital cost, moderate maintenance costs.
- Moderate capital cost, low maintenance costs.

Table 39 to Table 42 demonstrate that there are a number of scenarios in which the economic performance of Option 1d will significantly improve through the identification and use of cost-effective nourishment sources.

Table 39: Economic Appraisal Results for Option 1d – Low : Low.

	3%	*7%*	*10%*
PV COST	$23,331,079	$19,283,798	$17,663,847
PV BENEFIT	$112,197,643	$53,060,612	$35,078,300
NPV	$88,866,564	$33,776,815	$17,414,453
BCR	**4.8**	**2.8**	**2.0**
NPVI	6.5	2.6	1.4
FYRR	8%	8%	8%
IRR	20%	20%	20%

Table 40: Economic Appraisal Results for Option 1d – Low : Moderate.

	3%	*7%*	*10%*
PV COST	$31,100,932	$22,044,888	$19,040,011
PV BENEFIT	$112,197,643	$53,060,612	$35,078,300
NPV	$81,096,711	$31,015,724	$16,038,289
BCR	**3.6**	**2.4**	**1.8**
NPVI	5.9	2.4	1.3
FYRR	8%	8%	8%
IRR	20%	20%	20%

Table 41: Economic Appraisal Results for Option 1d – Moderate : Moderate.

	3%	*7%*	*10%*
PV COST	$75,591,459	$63,271,196	$58,048,276
PV BENEFIT	$112,197,643	$53,060,612	$35,078,300
NPV	$36,606,184	-$10,210,584	-$22,969,975
BCR	**1.5**	**0.8**	**0.6**
NPVI	0.6	-0.2	-0.4
FYRR	2%	2%	2%
IRR	6%	6%	6%

Table 42: Economic Appraisal Results for Option 1d – Moderate : Low.

	3%	*7%*	*10%*
PV COST	$39,355,209	$34,132,256	$31,713,434
PV BENEFIT	$112,197,643	$53,060,612	$35,078,300
NPV	$72,842,434	$18,928,356	$3,364,867
BCR	**2.9**	**1.6**	**1.1**
NPVI	2.5	0.7	0.1
FYRR	4%	4%	4%
IRR	11%	11%	11%

The CBA results show that, in the absence of sand sourced from another large infrastructure project, offshore marine sand is the most viable source of sand for beach nourishment. There are several cost sensitivities associated with access and delivery of nourishment material. One of the assumptions underlying cost estimates for Option 1b and Option 1d is that suitable sand can be sourced within 5NM of the sand placement areas. Based on budgetary estimates provided by experienced dredging contractors an additional sailing distance of 2.5NM would incur an additional $0.60/m^3, which equates to an extra $1.44M or a 6.7% increase in capital costs of initial mass nourishment works. For the preferred option (Option 1d), the 6.7% increase in capital costs for nourishment would equate to a PV cost of approximately $43.2M, reducing the BCR to 1.2. It follows that the Option 1d would remain economically viable, if sand could be sourced from within a radius of 22.5NM.

Table 43 to Table 46 provide the results of further sensitivities tests carried out for Option 2a, 2b and 2c (see Table 2 and **Appendix A** for more detail on these cases). The results demonstrate the issue with both these options is that they are still too expensive and generate small beach amenity benefits in comparison to the cost of maintenance. The offset factor applied to terrestrial sand sources is seen to be a significant cost factor. However, even when reduced to 1, the costs of terrestrial access still outweigh the benefits and do not make the option viable in comparison to marine sources. The reduced cost per m^3 for Options 2b and 2c in comparison to 2a, while generating a notable improvement in costs, do not generate a real change on the benefit side. The figure below demonstrates this issue in regard to Option 2b: the discounted sum of the red bars above the line would need to exceed those below the line to be economically feasible, the five year maintenance costs clearly show this is not achievable at 5 yearly maintenance increments with a nourishment cost of $11M. Running 2b at 10-yearly maintenance increments is a big improvement, saving some $14M in cost (see Figure 9 below) but the capital cost is still $49M for the Stage 1 and Stage 2 works, plus initial nourishment. These costs alone outweigh the total estimated present value benefit of $24M.

Table 43: Economic Appraisal Results for Option 2a – Overfill Ratio of 1.

	3%	7%	10%
PV COST	$378,478,455	$214,491,184	$160,227,203
PV BENEFIT	$56,411,570	$23,769,741	$14,811,643
NPV	-$322,066,885	-$190,721,443	-$145,415,560
BCR	0.1	0.1	0.1
NPVI	-5.9	-3.9	-3.2
FYRR	2%	2%	3%

Table 44: Economic Appraisal Results for Option 2a – Overfill Ratio of 1 and cost of $50 per m^3

	3%	7%	10%
PV COST	$288,427,962	$165,266,411	$124,214,679
PV BENEFIT	$56,411,570	$23,769,741	$14,811,643
NPV	-$232,016,393	-$141,496,669	-$109,403,036
BCR	0.2	0.1	0.1
NPVI	-4.7	-3.3	-2.8
FYRR	3%	3%	3%

Table 45: Economic Appraisal Results for Option 2b.

	3%	7%	10%
PV COST	$101,215,438	$63,639,289	$50,520,600
PV BENEFIT	$56,411,570	$23,769,741	$14,811,643
NPV	-$44,803,868	-$39,869,548	-$35,708,958
BCR	0.6	0.4	0.3
NPVI	-1.0	-1.1	-1.1

Table 46: Economic Appraisal Results for Option 2b adjust to have a 10-year renousihment period for discussion purposes.

	3%	7%	10%
PV COST	$74,337,575	$49,708,269	$40,829,372
PV BENEFIT	$56,411,570	$23,769,741	$14,811,643
NPV	-$17,926,006	-$25,938,528	-$26,017,730
BCR	0.8	0.5	0.4
NPVI	-0.4	-0.7	-0.8
FYRR	3%	3%	3%

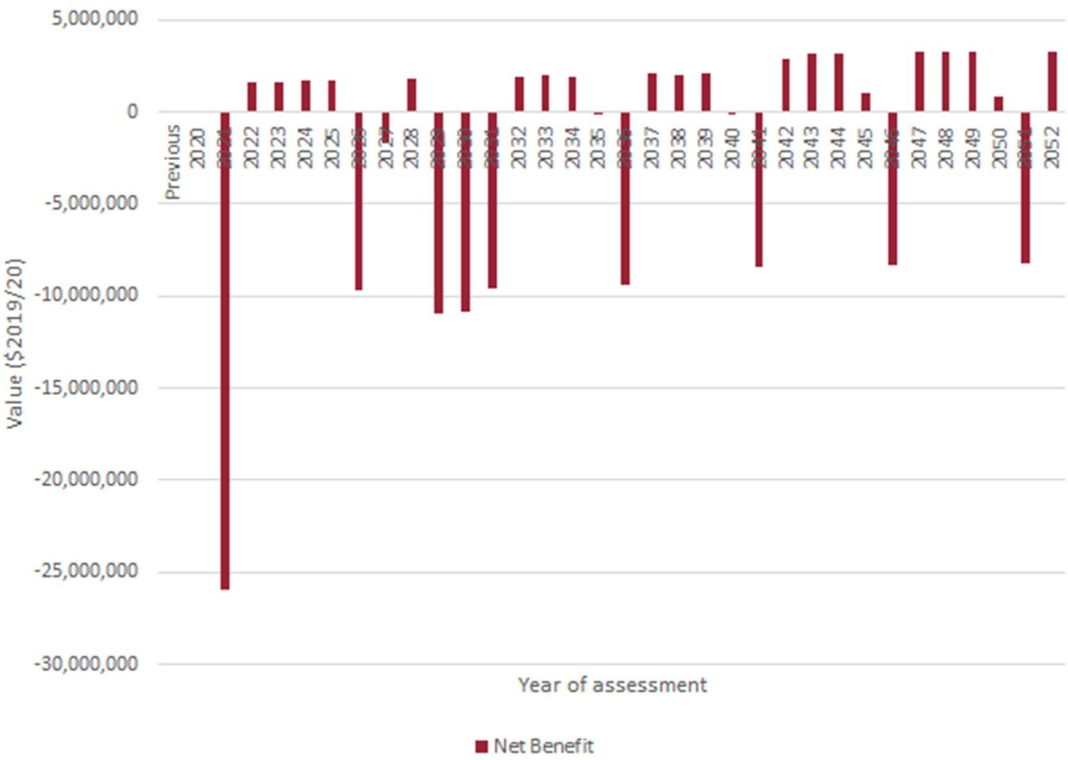

Figure 9: Annual net benefits for Option 2b.

5.3 Transfer of amenity benefits

The calculated amenity benefit provided by each of the options varies between 20% and 77% of total option benefit. Of this, the use values associated estimated with the amenity benefit represents approximately 65% - 75% of the overall amenity benefit for each of the options. Based on the per square meter benefit transfer approach as detailed above, the current beach is seen to have a use value of approximately $13.5M (present value), with the mass beach nourishment options generating an additional $23M (present value), while Options 2 and 3, generate smaller additional use values ($11M and $6M present value, respectively).

However, it is recognised that beach use values may be transferable to other beaches within the LGA, and the use values are thus maintained rather than lost. In the case of Stockton Beach, the estimated approximate 100,000 beach visits per year (in 2020) are unlikely to be readily transferred as:

- Most trips are understood to be undertaken either by residents within Stockton or from visitors associated with the Caravan Park. Stockton is relatively isolated from other town centres with one main access road (Fullerton Street) providing access to the community (Newcastle CBD is approximately a 20-minute drive). The proximity to an isolated beach is a strong residential location choice factor for many residents for both passive and active use of the beach.
- Stockton Beach provides a unique combination of relatively low-density patronage, commercial facilities, surf lifesaving club facilities (and patrols), as well as coastal conditions that make it attractive. There are few other beaches in proximity which provide the same combination of amenity factors. Nobby's Beach and Mereweather Beach in Newcastle are similar (although larger) and approximately 25 min travel time distance. To the north, One

Mile Beach, Port Stephens, provides a similar amenity range, although approximately 43km distant (35 minutes) away from Stockton.

It is recognised that some specific beach uses (e.g. surfing) may be able to be undertaken at suitable alternate locations within closer or further proximity to the few beaches identified that provide a similar overall amenity environment. Further details regarding beach use, purpose, demand and willingness to pay would enable a more detailed analysis of the likelihood of potential transfer of amenity.

However, while any such transfer may prevent the loss of use values, the change in beach use represents a reduction in consumer surplus (i.e. an existing beach user currently prefers to use Stockton Beach given the availability of alternate options). Alternate sites either provide a lower benefit (e.g. lesser surfing experience) or additional access costs (e.g. costs of travel), or a combination therein. As such, an alternate beach use valuation method is consideration of transport cost associated with accessing alternate locations to undertake the preferred use. Utilising Nobby's beach as representative of the nearest next best beach location (for all users), a preliminary travel cost analysis (considering travel time, vehicle operation cost, but not crash risk or externalities) was undertaken in accordance with the Transport for NSW Guidelines for Economic Appraisal (2019)[3]. Based on the estimate 100,000 trips (2 ways) an annual travel time value of $1.4M per year and vehicle operating costs of $1M per year were derived. Were the beach to be maintained in its current extent into the future, the use value of the beach, measured by avoided travel cost is approximately $35M. While it is recognised that not all current beach users would be willing (or need) to pay the associated cost, were the beach to be lost, the magnitude of use-value estimate is consistent with the order of magnitude estimates assessed within the benefit transfer methodology adopted within this assessment. For example, even if under the base case, loss of beach amenity through recession leads to only 50% of current beach users switch to an alternate beach, the associated additional travel cost would be in the order of $17.5M PV. This cost would be avoided under any option which preserves current beach usage at Stockton Beach (i.e. Options 1 and 2). In comparison the CBA estimates a use value of $23M for Option 1 and $11M for Option 2.

A more detailed understanding of beach use drivers and behaviour would be required to assess the potential more rigorously for beach usage to be transferred to alternate locations. However, the preliminary analysis undertaken indicates that the transport cost of access to alternate sites is relatively high, such that the extent of transfer is likely to be relatively low and that the order of magnitude valuations for beach usage adopted within the CBA are consistent with values determined through an next best alternative travel cost estimation approach.

It is also noted that the provision of additional beach area at Stockton Beach, has the potential to increase switching of beach usage currently undertaken at other beaches within the LGA to Stockton Beach (e.g. trips to a crowded beach (e.g. Merewether Beach) may be made to Stockton Beach instead due to enhanced amenity, although potentially incurring a greater travel cost to do so.

5.4 Preliminary distribution analysis

From a distributional perspective the affected and benefit parties varies over time. Under the base case scenario, it is Council and the users of the Stockton Beach Holiday Park that are likely to incur the greatest costs associated with the business as usual approach. The expected value of land and assets at risk to Council exceeds $8M dollars within the next 20 years. Other community members

[3] Assumptions included: All trips undertaken by car. Assumed persons per car = 1.7, Average travel time of 25 minutes, within a distance of 20km and travel speed of 48km/h (Google Maps). Value of average light vehicle with 1.7 occupancy – $29.21/h. Vehicle operating cost of light vehicle at 48 km/hr (43.2 c/km)

will not be directly affected through impacts to property in the short term, but are likely to experience the loss of Beach Amenity (although the beach width will likely remain relatively constant) as well as reduced associated foreshore amenity, loss of recreational spaces and sporting grounds. The short-term impacts to the Holiday Park are likely to be large and could ultimately lead to the closure of the Holiday Park. Tourists from outside the LGA will be required to choose alternate destinations for beach side camping (of which there are many within the areas to the north and south of Newcastle). Beyond 2040 it is likely that some landowners near the beach will experience property damage and Council will start to lose rate income.

Under all the options proposed private property damages are avoided into the future. However, the options differ in the broader impacts to the communities. The mass beach nourishment options retain and even enhance the value of the asset to the beach and are likely to add additional value to properties and the attractiveness of the Stockton Beach Holiday Park. This may also support increased economic activity through beach related commerce. In contrast, Options 2 and 3 will ultimately loose public space adjacent to the beach as recessions shifts back to the proposed seawalls. While a beach area will be retained, the reduced area will alter the utilisation and desirability of the beach. Moreover, the construction of the seawall will require the removal of a significant portion of facilities at the Stockton Beach Holiday Park. A financial analysis would need to be undertaken to assess whether the park would remain viable within the reduced land area and whether the reduced beach and foreshore area is considered suitable to continue to attract tourists to the community.

The benefit estimation methodology adopted within the economic assessment is based on a benefit transfer approach and does not readily allow for a detailed distributional analysis of costs and benefits to specific stakeholders. A preliminary analysis of the major stakeholder groups and their applicable costs and benefits is provided in Table 48 in relation to Option 1d. The benefit distribution is quantified over two time periods (2030 and 2060), to show the incremental shift towards private property owners over time. It is also noted that a financial and commercial analysis of beach front businesses (as well as sporting ground operatons) would need to be undertaken to better benefits to local economic activity

Table 48: Preliminary Distribution Analysis of Costs and Benefits

Stakeholder	Benefits	Net Present Value	Value – 2030	Value - 2060
COSTS				
Local Government	Capital investment costs for initial nourishment and physical protection	$28M	-	-
	Ongoing Beach Nourishment and Maintenance	$14M	$0.2M	$0.2M
Local Community – Residents in proximity to the beach	Construction noise and visual amenity impacts. This is likely to be associated predominantly with terrestrial protection works, rather than offshore nourishment and are likely to be temporary and minor	n/a	n/a	n/a
Tourists	Disruption and temporary closure of the Caravan park during construction of physical protection works. Impacts are likely to be temporary	n/a	n/a	n/a
BENEFITS				
Local Government	Avoided damage and loss of assets and property	$2.5M	$0.2M	$0.2M
	Avoided loss of Council owned lands	$1.2M	$0.1M	$0.05
	Revenues associated with the Caravan Park preserved and potentially enhanced	$1.5M	$0.1M	$0.2M
	Rate revenues preserved through mitigated hazard and loss of private land	n/a	n/a	n/a
State Government	Protection of beach environment values and coastal ecosystems	n/a	n/a	n/a

Stakeholder	Benefits	Net Present Value	Value – 2030	Value - 2060
Local Community – Beach Users	Protection and enhancement of beach amenity to support passive and active uses. While a detailed study has not been undertaken it is understood that most beach visitors are residents of Stockton and surrounding suburbs.	$22M	$1.7M	$2.1M
Local Community – Residents	Protection of property owner land values and assets, including associated repair through mitigated hazard.	$7.1M	$0.3M	$1.2M
	Protection and enhancement of beach amenity and associated non-use values	$19M	$1.5M	$1.7M
Local Community – Clubs and Sports	Community groups associated with the beach of recreations sports facilities immediately behind the foreshore (e.g. tennis and bowls club, swimming pool, oval) will not be disrupted by long term beach recession	n/a	n/a	n/a
Tourists	The Caravan park will remain viable for regional tourists	n/a	n/a	n/a
	Local tourists may take advantage of enhanced beach amenity	n/a	n/a	n/a
Businesses	Viability of businesses based upon the presence of the beach as a recreational and social gathering space will not be threatened by reduced beach amenity (e.g. Lexies on the Beach)	n/a	n/a	n/a

Most of the capital and maintenance costs are incurred by Council (indirectly ratepayers). Approximately 1/3 of all assets and land values at risk to coastal hazard, that are protected by Option 1d, are seen to belong to Council. However, the costs of development and maintenance to Council, significantly outweigh the avoided asset and property protection generated. Most of the benefit (approximately 70%) is received in terms of beach amenity, either to beach users directly or more broadly to the surrounding suburbs considered likely to place a non-use value upon Stockton Beach. As all beneficiaries are located within the LGA and not limited to a highly limited number of properties (see Table 10), there is reasonable justification for Council to seek funding. However, it is noted that Stockton Beach is a proportionately smaller beach within Newcastle (in terms of visitation), utilised predominantly by the Stockton local community and not all households within the LGA are likely to receive the use or non-use benefits generated through the project. Stockton represents approximately 2.6% of households within the City of Newcastle LGA. As the broader LGA population will contribute to the significant CAPEX and OPEX associated with the project, consideration of the magnitude of investment relative to Council rate revenues per household and other investment priorities should be recognised in project decision making.

6. SUMMARY

A cost benefit analysis (CBA) has been completed in support of the coastal management program (CMP) being prepared by the City of Newcastle (CN) for the area north of the Stockton Breakwater (northern training wall of the Hunter River) to Meredith Street, Stockton. The CBA has been prepared in accordance with the Coastal Management Act 2016 and the NSW Coastal Management Manual (the Manual) with consideration of the *Guidelines for using cost-benefit analysis to assess coastal management options* (OEH, 2018).

Three main coastal management options have been developed as part of the CMP. In addition to the three main options a total of nine project cases and an additional four cost sensitivities were assessed by the CBA. The options developed provide a comprehensive array of solutions to two key issues associated with forecast erosion and recession:

- Loss of beach area and amenity.
- Need for protection of Council assets, services and private property.

The CBA was undertaken over a 50-year period, utilising a 7% discount rate. The options assessed represent combinations of the two major management measures to address these issues: beach nourishment and physical coastal protection infrastructure. As both options achieve protection of property, due to the high values ascribed to the presence of a continuous beach, nourishment options were seen to generate higher benefits than options that focused on physical infrastructure. The benefits considered included: beach amenity, avoid losses to private property, Council lands and Council assets, producer surplus and residual value.

However, the nourishment options were also observed to be significantly more expensive than infrastructure options. Of the currently environmentally and legally permissible options, none of the options identified were seen to be economically feasible. It is likely that, overtime, the cheaper physical infrastructure options will become more viable as the value of property at risk increases (e.g. by 2040, Option 3b may become viable). However, the change to character of the Stockton Beach foreshore, the wave overtopping and coastal inundation risk and the high level of impacts on downdrift (northern) coastline require further consideration.

Option 1b was identified as the economically preferred option, with a benefit to cost ratio (BCR) of 1.5 and producing over $19M in net present value to society. However, the permits and approvals required for this option requires further investigation and resolution. Option 1d would give time for these issues to be resolved while still addressing the immediate issues associated with beach erosion and returning a positive BCR. As such it is recommended that further investigation of Option 1d be considered as a practical viable option. It is noted that all the nourishment options identified are highly sensitive to the cost assumptions associated with access and delivery of nourishment material. The sensitivity analysis undertaken indicates that should lower costs be realised, the economic performance of Option 1d will significantly improve. It is recommended that nearby any geophysical survey and geotechnical field investigation to identify suitable sand for nourishment be focused on areas as close to Stockton Beach as possible.

The lowest capital cost of mass nourishment would be realised if suitable nourishment material that is in excess to the needs of another large infrastructure project is delivered to Stockton free of charge. At present there are no existing approvals that would allow the placement of significant quantities of suitable nourishment material at Stockton Beach. It is therefore recommended that a concept level approval for additional sand placements be investigated as a priority action under the CMP. The next lowest capital cost is for sand sourced from offshore marine sources. This is an economically viable options that could be undertaken independent of other projects. It is recommended that investigations into obtaining approvals for sand extraction from the nearby seabed for the purposes of beneficial beach nourishment also be investigated as a priority action under the CMP.

Regarding maintenance nourishment, it is recommended that CN consult with the Port of Newcastle and relevant government agencies regarding the maintenance dredging sea dumping permit that is due for renewal in March 2022. This permit is issued by the Federal government and requires assessment under the National Assessment Guidelines for Dredging 2009 (Commonwealth of Australia, 2009). This includes assessing opportunities for beneficial reuse of dredged material in preference to sea disposal as well as the assessment of the impacts of the maintenance dredging activity (both loading and unloading) that lead to the “alternation of wave and current conditions affecting sediment regimes and leading to erosion of areas”.

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APPENDIX A – RHDHV'S CBA INPUTS

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Classification:	Open		

Technical Note: RHDHV input information for a Cost Benefit Analysis for Stockton Beach

1 Background

In line with the Coastal Management Act 2016 and the NSW Coastal Management Manual Part A (the Manual), a Cost Benefit Analysis (CBA) for Stockton Beach will be undertaken for the City of Newcastle (CN). The CBA is being undertaken by Bluecoast Pty Ltd (Bluecoast). The location under consideration is limited to the area north of the northern training wall of the Hunter River (Breakwater) as far as the northern boundary of Meredith Street. This technical note describes input parameters for potential coastal management actions to be considered within the CBA.

This revision has been undertaken in response to queries from the Department of Planning, Infrastructure and Environment (DPIE), to provide clarity regarding technical assumptions and detailing methods applied. This involves a further breakdown of calculations applied in estimating nourishment volumes and represents the final values applied in the CBA after what has been an iterative process involving management option development, coastal process/hazard investigations, CBA, and consultation with CN and DPIE.

A CN long-term sand nourishment plan is being developed and assessed in regard to its ability to meet the amenity desire of the community, considering:

- the results of beach monitoring;
- completion of a sediment transport study; and
- as sand sources for nourishment are identified, CN proposes to proceed with the investigation of three options for the CBA for comparison against a base case.

It is noted that whilst nourishment volumes have been estimated by RHDHV in this technical note, nourishment volumes should be refined by Bluecoast for input into the CBA, using models and outcomes of the Stage 2 Sediment Transport Study (also being undertaken by Bluecoast).

While acknowledging that marine sand sources are currently either; restricted by legislation, or not available, there may be potential future opportunities to access these sources. CN have requested RHDHV provide estimates of costs and recommendations as to potential methodology required to undertake provision of marine sands as a coastal management action. Accordingly, marine sand sources have been included for Options 1 and 2 outlined below to allow the CBA to undertake sensitivity analysis of benefit cost ratios for potential future use of offshore marine sand and/or Hunter River marine sand. Cost estimates of coastal management options are provided in **Appendix A, B, C** and **D**. Details of potential terrestrial sources, methodology and costs are provided in **Appendix E.** Details of potential marine sources, methodology and costs are provided in **Appendix F.**

Base Case – Business as Usual

General Description – The Base Case involves continued delivery of the actions within the Newcastle Coastal Zone Management Plan (CZMP) 2018 Part A. This certified CZMP provides a planning and approvals pathway to undertake a range of management actions and investigations, which are eligible to receive grant funding.

Option 1 - Mass sand nourishment for protection + amenity, limited terminal coastal protection works

General Description - Option 1 involves sand nourishment to a level that provides coastal protection to existing assets, and the construction of buried terminal coastal protection structures to protect assets at risk within the next 5 years (in accordance with established 2025 hazard lines[1]).

Option 2 - Sand nourishment for improved beach amenity + staged terminal coastal protection works

General Description - Option 2 involves beach nourishment to provide improved recreational access amenity. The beach amenity objective is a minimum annual average beach width of 5m at the narrowest point including volume to accommodate a 1 year Average Recurrence Interval (ARI) storm every year. This option also includes construction of buried terminal coastal protection structures, constructed in two stages, to address the current and future risk of potentially high consequence, low probability events that may affect the area (mandatory requirement 13, Coastal Management Manual Part A).

Option 3 – Nominal sand nourishment to reduce ongoing beach amenity loss + staged terminal coastal protection works

General Description - Option 3 involves beach nourishment of a logistically and economically feasible volume using available terrestrial sources of sand (i.e. less volume than considered in Option 2). This nourishment volume would reduce (but not prevent) future loss of beach width and amenity. As in Option 2, this option also includes construction of buried terminal coastal protection structures, constructed in two stages, to address the current and future risk of potentially high consequence, low probability events that may affect the area (mandatory requirement 13, Coastal Management Manual Part A). In Option 3,

[1] This approach allows a 5 years' time period for sufficient nourishment to be in place to provide ongoing protection to coastal assets further landward.

Stage 1 terminal coastal protection structures have been optimised (relative to Option 2) to reduce capital costs with comparatively more works delayed to Stage 2.

Sand Sources (all options)

Noting that terrestrial sand is currently the only readily available source, all Options have been developed using this supply source, with relevant methodology and cost estimates.

Recognising that various alternative marine sand sources may become available, RHDHV have developed a range of cost estimates based on vessel sizes, methodology, and volumes required for use in sensitivity analysis of some of the Options. A Technical Note regarding marine sources of sand is provided as **Appendix F.**

Sand Nourishment Volume Calculations

Initial nourishment volumes are calculated, assuming a re-nourishment every 'x' years, though the addition of the following three volumetric components:

1. volume requirement to *establish the amenity outcome objective or asset protection outcome objective*, based on current beach state (a critical section of beach may control this volume, e.g. 'pinch point' or specific asset, given the nourishment volume will be distributed along the coast); plus
2. 'x' years times projected underlying loss (based on historical record and any future adjustment of the historical value from a processes perspective); plus
3. 'x' years times projected sea level rise loss.

Underlying loss comes about due to the occurrence of storms over time of varying ARI and the absence of full beach recovery, so this is 'built in' to the calculation. At times, post storms, there may not be the minimum beach width for amenity or minimum beach volume for asset protection, but subsequent beach recovery occurs.

The last two components (2 and 3) of the above, typically comprise the ***maintenance re-nourishment volume*** component which will be required every 'x' years following the initial establishment of the desired coastal management outcome. This is equivalent to the what is referred to as the "Dutch Method" described in Section 2.6 of the Guidelines for Sand Nourishment (WRL, 2017), referred to by DPIE in their technical review queries.

For all calculations herein, the:

- projected underlying loss (based on historical record and any future adjustment of the historical value from a processes perspective) has been taken as **1m/yr** (Bluecoast, 2020); and
- projected sea level rise loss (based on an average future SLR allowance of 0.36m by 2070 (interpolated from 2050 and 2100 SLR data in Bluecoast, 2020), or 0.0072m years, and adopting a Bruun factor of 50 (average presented in (Bluecoast, 2020)) equates to **0.36m/yr** recession

Shape and Depth of the Active Profile

For first pass consideration, it is assumed that the borrow material is similar to the native material (or an overfill ratio will be applied, where it is not), and that therefore the shape of the active profile after nourishment would be similar to the natural profile. Further consideration of the shape of the active profile is not required at this time. It is necessary, however, to establish the likely depth to which the active profile will develop as this will govern the quantity of sand required for specific widening of the beach (i.e. to establish and maintain the desired coastal management outcome as discussed above).

Several approaches are commonly adopted (in combination) for estimating the depth of the active profile:

- wave climate based zonation approach (based on annual wave climate and statistics and local sand characteristics) developed at the US Army Corps of Engineering Research Centre (Hallermeier, 1981)
- examination of shore-normal seabed profiles (identification of a break in the bed slope);
- examination of variations in surface sediment characteristics along shore normal profiles (not considered here due to insufficient spatial data across the profile); and
- adoption of proven depth limits established for similar situations (commonly -8 to -12 m AHD for exposed NSW beaches).

The approach by Hallermeier is recommended in the Coastal Engineering Manual (CEM) (US Army Corp of Engineers) and is also the method advised in the Manual on Artificial Beach Nourishment produced in the Netherlands jointly by the Centre for Civil Engineering Research, Codes and Specification, the Netherlands Department of Public Works or Rijkswaterstaat, and the Delft Hydraulics Laboratory (Rijkswaterstaat, 1987).

Hallermeier (1981) divides the coastal profile into three zones as noted and shown in ***Figure 1*** below:

1. a littoral zone out to a water depth d_L (commonly referred to as the "depth of closure"). This depth is the seaward limit to extreme surf related effects, so that significant alongshore transport and intense onshore-offshore transport are restricted to depths less than d_L;

2. a shoal zone between d_L and a depth d_i. This latter depth defines the seaward limit of all onshore-offshore transport; and

3. an offshore zone seaward of d_i where the effects of surface waves on the bed are usually negligible.

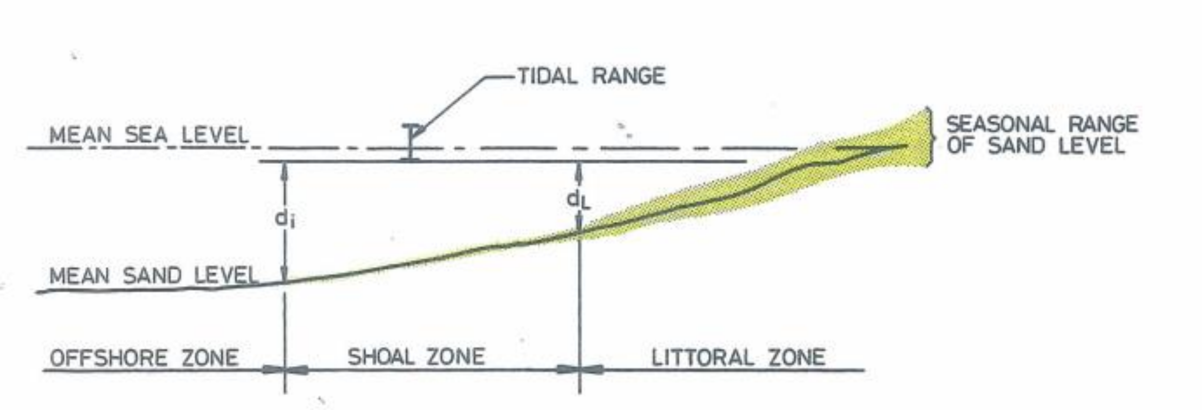

Figure 1 - Beach Zonation and Terminology (Source: Hallermeier, 1981)

RHDHV initially estimated d_L and d_i (closure depths), as 8m and 16m, respectively. These initial values are consistent with the statistical range developed in analysis of depth of closure subsequently undertaken in the Stockton Beach coastal erosion hazard study (Bluecoast, 2020). Accordingly, for the purposes of this revised memo, closure depths have not been adjusted from the initial values and the "full" profile is considered to develop to -16m AHD.

After Rijkswaterstaat (1987) see ***Figure* 2**, the sub-aqueous nourishment volume should consider a transition zone below the depth of closure out to a depth of twice the depth of closure where the thickness of the nourishment volume decrease linearly to zero (assuming the borrow sand is similar to the native sand).

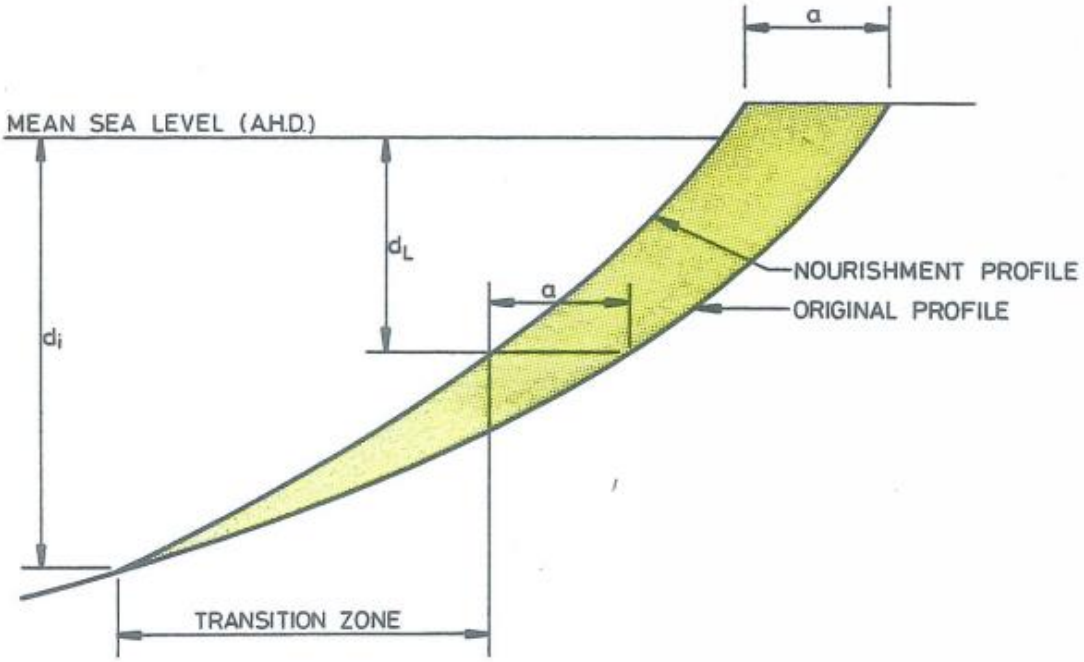

Figure 2 - Profile of Nourishment, Borrow Sand similar to Native Sand (Source: Rijkswaterstaat, 1987)

Accordingly, adopting a d_L value of the depth of closure of -8 m AHD and using the approach of Rijkswaterstaat (1987) gives a subaqueous nourishment requirement for a seaward advancement of the beach system of "a" m, of approximately 12 x a m^3/m i.e.:

Sub aqueous volume (m^3/m)	=	a x 8 + 0.5 x a x (16 - 8)
	=	**12 x a m^3/m**

Height of the Dune System

The existing dune heights along the beach are variable and have been modified by the presence of the numerous seawall constructions. It is considered likely that the nourishment exercise for Stockton Beach would only be able to practically achieve a dune height of 3m AHD. For the purposes of calculation of nourishment volumes, it is assumed that the average dune crest level would form (or be placed) at the design "profile" of 3.0 m AHD along the length of beach at threat.

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Length of Beach to be Nourished

Whilst the method adopted for any “massive” nourishment exercise would involve the majority of the sand being placed in a particular area of the stretch of beach at threat, the sand will redistribute over the beach length (primarily to the north) naturally over time as a result of alongshore transport rates.

For the purposes of calculation of nourishment volumes, it is assumed that it would be necessary in effect to provide sufficient sand to nourish the approximately 2200m between the Breakwater and the northern management area extent (a length of 200m north of the CMP area has been included as this area would realistically also need to be nourished to achieve the nourished profile at Meredith St), to achieve the desired management objectives.

Estimate of Sand Nourishment Volumes

Based on the above discussion, estimates have been prepared of the total sand nourishment to achieve the desired objective of each management option (which equates to a particular seaward advancement of the beach system “a”). This generic estimate is set out below. The total nourishment volume requirement is estimated to be approximately **33,000 x “a” m^3** and assumes the borrow sand is similar to the native sand.

Volume to achieve management objective:

(i) sub-aerial volume (i.e. above AHD)

3.0 m (dune height) x “a” m (width) x 2200 m (length)	6,600 x “a” m^3

(ii) sub-aqueous volume (i.e. below AHD)

(to 8 m depth)	
8 m x “a” m x 2200 m	17,600 x “a” m^3
(8 m to 16 m depth)	
0.5 x 8 m x “a” m x 2200 m	8,800 x “a” m^3
Total	**33,000 x “a” m^3**

The estimated volume above can be seen to be a factor of the desired objective of each management option. In this assessment the sub-aqueous volume has been estimated based on closure depths of d_L (adopted as -8 m AHD) and inclusion of a “wedge’ of material below this limit to a depth d_i at which the effects of surface waves are negligible (adopted as -16 m) in line with recommendations set out in the Manual on Artificial Beach Nourishment (Rijkswaterstaat, 1987).

The approach by Rijkswaterstaat provides an estimate of the “full” nourishment volume and follows from a comprehensive overview of available literature, design practices and performance of nourishment projects worldwide. Accordingly, it is considered a conservative estimate.

For NSW beaches historical surveys indicate that very limited movement of sediment occurs beyond d_L (adopted in this case as -8m AHD). Furthermore, for the local application, longshore movement dominates the sediment transport processes. Accordingly, the temporal scale associated with cross shore movement beyond the depth of closure is significantly greater than the processes occurring within the active profile. This would effectively limit any significant development of the “full” nourishment profile as described by Rijkswaterstaat.

It is therefore appropriate to consider estimate of the volumes which would be required based on the less conservative approach of Hallermeier (adopted by CEM) for which the total nourishment volume requirement to advance the average profile “a” m would be at least **24,200 x “a” m^3**. This estimate is set out below.

Volume to achieve management objective:

(i) sub-aerial volume (i.e. above AHD)

3.0 m (dune height) x “a” m (width) x 2200 m (length) 6,600 x “a” m^3

(ii) sub-aqueous volume (i.e. below AHD)

(to -8 m depth)

8 m x “a” m x 2200 m 17,600 x “a” m^3

Total (at least) 24,200 x “a” m^3

The qualification “at least” is believed to be recognition of a somewhat indeterminate volume of material below d_L in the area between the nourished profile and the natural profile. As discussed above, for development of a nourished profile at Stockton Beach this is not considered to be a significant volume.

However, in recognition of the uncertainty and variability in estimates of closure depths (Bluecoast, 2020), and to account for this uncertainty, it is considered prudent for this comparative, feasibility level investigation to adopt the more conservative values of the Rijkswaterstaat approach. This is the approach that has consistently been followed for all subsequent calculations herein, described for each management option in the following sections.

2 Base Case

In 2018, CN adopted the Newcastle CZMP 2018, which outlines a range of coastal management actions for the local government area. Part A – Stockton, is limited to the coastal zone north of the Hunter River while the remainder of the coastal zone within the Newcastle Local Government Area (LGA) is addressed in, Part B - Coastline South of the Harbour. The Base Case discussed herein, involves continued delivery of the actions within the Newcastle CZMP 2018 Part A (refer ***Figure 3***).

DRAWING No. PA2395-RHD-00-DR-MA-1011

DO NOT SCALE

FIGURE 3

BASE CASE (SOUTH)

1:2000 (A1)

LEGEND

- APPROX. CREST OF EROSION SCARP FROM 17 FEB 2020 UAV SURVEY (PROVIDED BY NEWCASTLE CITY COUNCIL)
- MAINTAIN EXISTING ROCK REVETMENT
- 2018-2020 MSL (0m AHD)
- 2020 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2025 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2040 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2060 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2120 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)

BASE CASE (NORTH)

1:2000 (A1)

DIAL BEFORE YOU DIG www.1100.com.au

AUSTRALIAN HEIGHT DATUM

40 0 40 80 120 160 200m

1:4000 (A3) 1:2000 (A1)

REV	DATE	DESCRIPTION	BY	CHK	APP
B	14.04.2020	RE- ISSUED FOR REVIEW	BR	NP	AT
A	07.04.2020	ISSUED FOR REVIEW	BR	NP	AT

REVISIONS

CLIENT: City of Newcastle

PROJECT: STOCKTON CMP

TITLE: COASTAL MANAGEMENT BASE CASE

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DRAWN	COORD. SYSTEM	DATUM	DATE
	MGA ZONE 56	AHD	09.04.2020

SCALE AT A1: AS SHOWN

REF: PA2395-RHD-00-M3-MA-1001

DRAWING No. PA2395-RHD-00-DR-MA-1011

REVISION B

C:\USERS\220068\BOX\PA2395 STOCKTON CMP\PA2395 STOCKTON CMP TEAM\PA2395 TECHNICAL DATA\E11 WORKING DRAWINGS\PA2395-RHD-00-M3-MA-1001

The Stockton study area has been divided into seven management action zones to enable identification of the location of management actions within the study area. The seven zones are located from south to north along the Stockton coastline as shown in ***Figure 4*** and comprise:

- Zone 1 - Little Beach, including Stockton Breakwater and the foreshore area north to the seawall east of the Stockton Surf Life Saving Club (SLSC);
- Zone 2 - Seawall east of Stockton SLSC and the foreshore area north to the Mitchell Street seawall;
- Zone 3 - Mitchell Street seawall extent;
- Zone 4 – Foreshore from the northern end of Mitchell Street seawall north to Meredith Street;
- Zone 5 – Foreshore from Meredith Street to the northern boundary of Corroba Oval;
- Zone 6 – Foreshore from the northern boundary of Corroba Oval north to the southern boundary of Fort Wallace (main land ownership by Hunter Water Corporation); and
- Zone 7 – Foreshore from the southern boundary of Fort Wallace to CN LGA boundary (main land ownership by Defence Housing Australia and Family and Community Services).

Figure 4: Management action zones for Stockton study area.

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Beach erosion and shoreline recession are identified as coastal hazards in the Stockton study area. Replenishment of sand to the Stockton study area was identified as a high priority by the community. Port of Newcastle (PoN) currently places suitable sand, from maintenance dredging activities undertaken for navigational safety at the harbour entrance, off Stockton Beach. This sand is bottom dumped in the nearshore zone at a designated location offshore of Mitchell St revetment.

Implementation of CZMP actions includes:

- maintenance to Mitchell Street seawall (as identified in the condition assessment report (RHDHV, 2019));
- beach management works such as beach scraping and beach grooming to increase dune volume in a number of locations;
- dune maintenance; and
- ongoing temporary emergency works, as required.

The CZMP authorised repairs to the northern end of the Mitchell Street seawall. The CZMP authorised temporary coastal protection works for the former landfill site at 310 Fullerton Street (Lot 202 DP 1150470) which are now complete.

The CZMP outlines the requirement for detailed investigations and other required studies, including a scoping study and assessment of sand replenishment sources, to be undertaken to facilitate certification of a Coastal Management Program (CMP) under the *Coastal Management Act 2016*. Costs for the full range of management actions are included within the Newcastle Coastal Zone Management Plan 2018.

3 Option 1 - Mass sand nourishment for protection + amenity, limited terminal coastal protection works

General Description

Option 1 involves sand nourishment to a level that provides coastal protection to existing assets and the construction of terminal coastal protection structures to protect those particular assets at risk within the next 5 years (in accordance with established 2025 hazard lines (Bluecoast, 2020)).

Option 1 comprises the following components:

- ongoing maintenance of existing rock revetment structures at the Surf Lifesaving Club (SLSC) and Mitchell St;
- buried terminal coastal protection structures to protect the following assets at risk within the next 5 years (refer established 2025 hazard line shown in ***Figure 5***):
    - the flanks of all of the existing rock structures;
    - roadways; and
    - residential assets,
- an initial mass sand nourishment for the full extent of the CMP area (northern breakwater to Meredith St) to provide coastal protection to existing foreshore alignment and all assets from a 50 year ARI storm event, with maintenance nourishment every 5 years (nourishment to provide coastal protection would by default also provide significant improvements in beach amenity).

Refer to; ***Figure 5*** for layout of Option 1, and **Appendix A** for breakdown of estimated costs and timing. The rationale behind this option and further detail of each component is provided below.

Rationale

The community of Stockton have indicated a desire to limit hard terminal structures, as much as possible in the provision of coastal protection, in preference for beach nourishment. This option aims to provide coastal protection from storm erosion and long term beach recession (including allowance for sea level rise (SLR)) through beach nourishment. Due to the immediate threat to some assets, it is proposed that the minimum extent of buried terminal coastal protection structures be built to protect these assets whilst beach nourishment works are in planning and progress. Timing of proposed works is provided in cost estimates in **Appendix A**.

Nourishment

In order to provide coastal protection from long term recession and a potential succession of storm events, the nourishment volume to achieve this objective has been derived for the most critical part of the beach. The combination of the most vulnerable, or most seaward, asset with the most exposed part of the beach occurs at Barrie Cres., and more specifically at the convergence with Griffiths Ave. The sand nourishment volume and frequency has been designed to protect this location, and by default other less exposed parts of the CMP coastline.

A permissible risk of ‘failure’ of the nourishment volume of 10% has been adopted for the 50 year ARI design storm event, implying a re-nourishment (maintenance) period of **5 years** (in accordance with the binomial distribution of event occurrence outlined in **Table 1).**

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DESIGN RETURN PERIOD T IN YEARS

PERMISSIBLE RISK OF FAILURE (R)	EXPECTED PROJECT LIFE IN YEARS (N)							
	1	2	5	10	20	25	50	100
0.99	1.01	1.11	1.66	2.71	4.86	5.95	11.40	22.20
0.95	1.05	1.29	2.22	3.86	7.18	8.85	17.20	33.90
0.90	1.11	1.46	2.71	4.86	9.19	11.40	22.20	43.90
0.75	1.33	2.00	4.13	7.73	14.90	18.60	36.60	72.60
0.50	2.00	3.41	7.73	14.90	29.40	36.60	72.60	145.00
0.33	3.00	5.45	12.90	25.20	49.90	62.10	124.00	247.00
0.25	4.00	7.46	17.90	35.30	70.00	87.30	174.00	348.00
0.20	5.00	9.47	22.90	45.30	90.10	113.00	225.00	449.00
0.10	10.00	19.50	48.00	95.40	190.00	238.00	475.00	950.00
0.05	20.00	39.50	98.00	195.00	390.00	488.00	975.00	1,950.00
0.02	50.00	99.00	248.00	495.00	990.00	1,238.00	2,476.00	4,951.00
0.01	100.00	199.50	498.00	995.00	1,990.00	2,488.00	4,977.00	9,953.00

Table 1: Binomial distribution of event occurrence

The following has also been considered when applying the adopted Rijkswaterstaat approach in developing the nourishment scheme design:

Initial nourishment volumes

- Allowing for a 50 year ARI storm at Barrie Cres., a 220m^3/m storm erosion demand has been adopted (interpolating between the 80m^3/m at the breakwater and 220m^3/m at the LGA boundary (Bluecoast, 2020) and allowing for end effects adjacent to the Mitchell St revetment[2]).

- For the current beach state, there is approximately 14m between the critical asset and the foreshore. Given the dune height in this location of approximately 5.5.m AHD, this equates to 77m^3/m of existing sediment in the subaerial profile to partially meet the 220m^3/m storm demand. The deficit is therefore 143m^3/m. Based on a 3m design nourishment profile this is approximately **47.5m** of beach width that needs to be provided.

[2] According to DECCW (2010b) additional erosion close to the ends of a seawall can be estimated in its cross-shore and alongshore extents. In assessing the additional erosion that may result from a seawall, the estimated design erosion volume should be increased by 80% near the wall and increased above the design value for a distance of up to 70% of the length of the seawall along the shore or 500 m, whichever is the lesser.

After Rijkswaterstaat (1987)

1. Volume to *establish the amenity outcome objective or asset protection outcome objective*, based on current beach state (47.5m increased width):

(i)	sub-aerial volume (i.e. above AHD)	
	3.0 m (dune height) x 47.5 m (width) x 2200 m (length)	313,500 m^3
(ii)	sub-aqueous volume (i.e. below AHD)	
	(to 8 m depth)	
	8 m x 47.5 m x 2200 m	836,000 m^3
	(8 m to 16 m depth)	
	0.5 x 8 m x 46 m x 2200 m	418,000m^3
	(sub)Total	**1,567,500 m^3**

2. Volume for five years times projected underlying loss (1m/yr). i.e. 5m beach width

(i)	sub-aerial volume (i.e. above AHD)	
	3.0 m (dune height) x 5 m (width) x 2200 m (length)	33,000 m^3
(ii)	sub-aqueous volume (i.e. below AHD)	
	(to 8 m depth)	
	8 m x 5 m x 2200 m	88,000 m^3
	(8 m to 16 m depth)	
	0.5 x 8 m x 5 m x 2200 m	44,000m^3
	(sub) Total	**165,000 m^3**

3. Volume for five years times projected sea level rise loss (0.36m/yr) i.e. 1.8m beach width

(i)	sub-aerial volume (i.e. above AHD)	
	3.0 m (dune height) x 1.8 m (width) x 2200 m (length)	11,880 m^3
(ii)	sub-aqueous volume (i.e. below AHD)	
	(to 8 m depth)	
	8 m x 1.8 m x 2200 m	31,680 m^3
	(8 m to 16 m depth)	
	0.5 x 8 m x 1.8 m x 2200 m	15,840m^3
	(sub) Total	**59,400 m^3**
Totalling 1, 2 and 3	**Total**	**1.8 million m^3**

Previous assessments of terrestrial sand sources found that the median grain size available in large quantities was generally finer than the native sand, requiring 1.8 to 5 times as much sand to retain 1m^3 on the beach (known as the overfill ratio, as outlined in Supporting Document E – Potential Sand Sources). An overfill ratio of approximately 2.5 has therefore been included for terrestrial sand sources. The total nourishment volume required would therefore be approximately **4.5 million m^3 for the initial nourishment campaign (for the terrestrial source). It is recommended that a sensitivity analysis be undertaken to assess an overfill ratio of 1, should a perfectly compatible sand source become available.**

Maintenance nourishment volumes

As discussed in Section 1, the last two components (2 and 3) of the above calculation, typically comprise the maintenance re-nourishment volume. i.e. approximately 225,000 m^3 every 5 years.

However, the findings of the Stage 2 investigation (Bluecoast, 2020a) note that the combined rate of long-term sand loss from the Stockton CMP area is 112,000m^3/yr, which is based on the historical observations of:

- 100,000m^3/yr of sand loss from the sub-aqueous part of the coastal profile in the southern Stockton embayment between the northern breakwater and Fort Wallace (inshore of 20m depth contour) between 1988 and 2018.
- 12,000m^3/yr of sand loss from sub-aerial part of the coastal profile in Block A, Block B and Block C between 1985 and 2020.

On this basis it is proposed that the maintenance nourishment volume be **560,000 m^3 every 5 years**. This recognises the uncertainty in the coastal processes understanding and an acknowledgment of the indication from data that the beach profile at the site is not only receding but changing in shape (deepening).

Applying the overfill ratio factor, the **maintenance nourishment becomes 1.4 million m^3 every 5 years (for the terrestrial source).** For the placement of sand from a terrestrial source the following is noted:

- Due to logistical constraints and the subsequent limited rate of placement of sand from terrestrial sources, the sand would need to be placed constantly rather than at 5 yearly intervals. To achieve the initial nourishment campaign of 4.5 million m^3 would require 234,375 truck and dog loads (32t or 19.2m^3 per truck and dog). As outlined below sand would need to be transported and placed on the subaerial beach constantly throughout the year.

- The recent sand placement Pilot Study undertaken in front of the Holiday Park involved placement of 5564t (approximately 3340m^3) of sand transported in 173 truck-and-dog loads (32t) over 4 days i.e. 44 loads/day. This rate of trucking was generally considered acceptable in the community for a short time frame. At this rate it would take approximately 21 years to place the initial amount of sand transported by truck. To place this amount within the first 5 years would require more than 4 times the rate of trucking as previously experienced during the Pilot Study sand placement campaign. Community willingness to accept this rate of truck movements has not been assessed.

- To reduce truck movements through residential streets, an alternative sand placement methodology could be undertaken simultaneously. In addition to having trucks transporting sand directly onto the beach via the King St access (as per the Pilot Study methodology) it is also proposed that trucks transport sand to a sand pumping station established near Corroba Oval (on western side of Fullerton Rd). The sand would be pumped as a slurry via a buried pipeline to outlets at Dalby Oval frontage and Barrie Cres frontage. A trial diesel pumping station and pipeline with a 100,000m^3/year capacity could be established with a 5 year operational contract. However, this is only a small proportion of the 4.5 million m^3 and would provide negligible reduction in truck movements/costs overall for Option 1.

- Protection of assets for the design storm would not be established until the beach nourishment volume equalled the storm erosion demand (220m^3/m). This would require in the order of 484,000 m^3, or 1.2 million m^3 considering the overfill ratio. This would take around 6 years at the same trucking rate as the recent pilot study and including the establishment of the sand pumping station and pipeline.

- **It is noted that based on existing demand for quarry sand locally, it is currently considered unlikely that the required nourishment volume could be sourced from local quarries within the existing licensing arrangements. This issue would need to be addressed to make this option feasible, otherwise alternative sources would be required. It is also noted that the quantity of sand could not logistically be placed on the current sub aerial beach width.**

Option 1 - Sensitivity Analysis

While acknowledging that marine sand sources are currently either; restricted by legislation, or not available, there are potential future opportunities to access these sources. Accordingly, it is recommended that a sensitivity analysis be undertaken in the CBA to examine the benefit cost ratio (BCR) for Option 1 – mass sand nourishment for coastal protection, using marine sourced sand from offshore sources (Option 1b), or Hunter River sources (Option 1c). The nourishment volumes would be:

- **1.8 million m^3 initial**, and **560,000 m^3** maintenance for a 5 year re-nourishment period; or
- 2.1 million m^3 initial (or **2.4 million m^3** after Bluecoast (2020a)) with **1.12 million m^3** maintenance for a 10 year re-nourishment period.

It should be noted that values adopted have been updated following Bluecoast's further refinement with modelling and data from the Stage 2 Sediment Transport Study. A detailed outline of the development of refined volumes and the residual risks is requested in the CBA. Stage 1 terminal coastal protection works would still be required in Option 1b and Option 1c.

Risks

It is important to note that Option 1 – Mass sand nourishment for coastal protection, is a relatively high risk option in terms of protection of assets. When beach nourishment is intended for asset protection, a different risk approach needs to be taken compared to use of sand nourishment for amenity purposes.

This approach needs to include the following considerations:

- What safety factor should be applied (or risk level is deemed acceptable) to the sand volume on the beach? E.g. In the case of amenity considerations, a succession of more severe storms than average may be acceptable because the outcome is a level of inconvenience. Whereas, if it means the loss of an asset, the consequences may not be acceptable. The need to design for a lower risk profile becomes apparent.
- Will a dredger be available when you want it at a future time? What will mobilisation/ demobilisation costs be if you need it in a hurry?

- Will funds be available at a future time?

Under any variant of Option 1 – mass sand nourishment for coastal protection strategy, assets would potentially be at risk if any of the following occurred:

- more than one design storm occurs within the re-nourishment period, or a series of storms with a cumulative impact exceeding the design storm;
- a storm larger than the design storm occurs;
- beach recession exceeds estimated values;
- SLR exceeds estimated values;
- sufficient sand supply cannot be sourced; or
- the placement rate cannot be achieved, e.g. inclement weather.

It is noted that this risk can be significantly reduced through more frequent, smaller re-nourishment campaigns to avoid the beach becoming depleted at the end of a long re-nourishment period. Smaller scale more frequent re-nourishment campaigns from marine sources are generally not economically viable due to mobilisation/demobilisation costs. However, if a strategic alliance with other existing dredging operations can be created these costs can potentially be offset.

Option 1 poses minimal risk of negatively impacting downdrift beaches (to the north), as the proposed nourishment volume exceeds the estimated long term losses determined in the Stage 2 Sediment Transport Study (Bluecoast, 2020a). Downdrift beach are likely to benefit from additional sediment.

DRAWING No. PA2395-RHD-00-DR-MA-1012

DO NOT SCALE

FIGURE 5

OPTION 1 (SOUTH)
1:2000 (A1)

OPTION 1 (NORTH)
1:2000 (A1)

LEGEND

- STAGE 1 - BURIED TERMINAL PROTECTION STRUCTURE
- APPROX. CREST OF EROSION SCARP FROM 17 FEB 2020 UAV SURVEY (PROVIDED BY NEWCASTLE CITY COUNCIL)
- POTENTIAL WASTE THAT NEEDS TO BE MANAGED
- MAINTAIN EXISTING ROCK REVETMENT
- BEACH NOURISHMENT FOR COASTAL PROTECTION
- POSSIBLE VEHICLE BEACH ACCESS RAMP
- 2018-2020 MSL (0m AHD)
- 2020 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2025 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2040 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2060 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2120 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)

REV	DATE	DESCRIPTION	BY	CHK	APP
C	14.04.2020	RE-ISSUED FOR REVIEW	BR	NP	AT
B	07.04.2020	RE-ISSUED FOR REVIEW	BR	NP	AT
A	03.04.2020	ISSUED FOR REVIEW	BR	NP	AT

REVISIONS

CLIENT
City of Newcastle

PROJECT
STOCKTON CMP

TITLE
COASTAL MANAGEMENT OPTION 1

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DRAWN	COORD. SYSTEM	DATUM	DATE
-	MGA ZONE 56	AHD	14.04.2020
SCALE AT A1 AS SHOWN	REF. PA2395-RHD-00-M3-MA-1001		

DRAWING No. PA2395-RHD-00-DR-MA-1012
REVISION C

40 0 40 80 120 160 200m
1:4000 (A3) 1:2000 (A1)

AUSTRALIAN HEIGHT DATUM

4 Option 2 - Sand nourishment for improved beach amenity + coastal terminal protection works

General Description

Option 2 involves beach nourishment to provide improved recreational beach access amenity and construction of buried terminal coastal protection structures, in two stages, to address the current and future risk of potentially high consequence, low probability events that may affect the area (mandatory requirement 13 of the Coastal Management Manual Part A).

Option 2 comprises the following components:

- ongoing maintenance of existing rock revetment structures at the Stockton SLSC and Mitchell St;
- Stage 1 buried terminal coastal protection structures are to be built in the short term to protect the following assets at risk within the next 5 years (in accordance with established 2025 hazard lines):
  - the flanks of all of the existing rock structures,
  - roadways; and
  - residential assets,
- Stage 2 buried terminal coastal protection structures set back at the established hazard lines to be constructed if/when minimum foreshore width triggers are reached;
- Stage 2 small rock headland at the end of Griffiths Ave to protect the road head and create a stable embayment within the Barrie Cres frontage to be constructed if/when minimum foreshore width triggers are reached;
- sand nourishment for the full extent of the CMP area (Breakwater to Meredith St) to provide ongoing beach amenity, with the specific objective of a minimum annual average beach width of 5m at the narrowest point along the CMP area (revetment structures) measured at 1.5m AHD (approximately 1m above MHW to account for wave runup) accommodating a volume for a 1 year ARI storm each year; and
- aspirational goals of sand nourishment include:
  - a wide beach width at popular locations to enable the continuation of established recreational uses of the beach (such as nippers);
  - minimum dry beach width provides reasonable space at the narrowest point for two people walking along the beach in opposite directions to comfortably pass one another; and
  - minimum dry beach width provides adequate operational space to undertake nourishment.

Refer to; ***Figure 6*** for layout of Option 2, and **Appendix B** for breakdown of estimated costs and timing. The rationale behind this option and further detail of each component is provided below.

Rationale

The objective of Option 2 is to improve beach amenity through sand nourishment whilst ensuring assets at immediate risk are protected by buried terminal coastal protection structures (refer immediate hazard lines). The rationale behind Option 2 is to improve the beach's resilience and capacity to accommodate coastal processes and avoid loss of beach amenity.

This resilience is achieved by creating a foreshore zone for adaptive land use that effectively creates a buffer for the natural coastal processes of short term erosion and recovery to occur. If/when the beach recedes back such that the erosion scarp is within the minimum threshold distance of the Stage 2 alignment, this would trigger the need for Stage 2 buried terminal coastal protection to be constructed, connecting the two Stage 1 seawalls (refer ***Figure 6***).

Having the Stage 2 structures set back at this alignment and a sand buffer in front of it, reduces the likelihood of the interaction between the structure and wave action. Accordingly, the potential for; reflective wave energy, toe scour and exacerbated beach erosion, ultimately causing a loss of the sandy beach, are also reduced. The buffer width (to the point of the trigger) provides a minimum volume equivalent to the storm erosion demand of a 10 year ARI event.

Assuming it would take a maximum of 5 years from triggering the need for the terminal coastal protection works to completing them, there would be about a 40% chance of the 10 year ARI event occurring in that period. During this time, assets would be at risk, prior to completion of the terminal coastal protection structures. If the structures can be completed within a shorter timeframe, the probability of the storm event occurring and assets being at risk reduces. E.g. there is a 20% chance of the 10 year ARI event occurring in a 2 year period. For this reason, it is recommended that preparations be made to allow this protection to be implemented with expediency once triggers are reached. CN has acknowledged and accepted this level of risk.

In Stage 1, buried terminal coastal protection structures would be constructed to protect assets seaward of the 2025 Zone of Reduced Foundation Capacity (ZRFC) 1% Annual Exceedance Probability (AEP) hazard line (Bluecoast, 2020), i.e. there is a 1% risk that the ZRFC will reach this shoreline position in the next 5 years. This is typically at the flanks of the existing revetment structures and the Barrie Cres roadway including the end of Griffiths Ave as shown in ***Figure 6***.

The timing of the trigger for the Stage 2 buried terminal protection structures will be dependent on a number of factors including:

- the performance of the beach nourishment;
- the rate of beach recession;
- ambient conditions (whether it has been a stormy period or not); and
- sea level rise.

If some or all of these factors are favourable, the construction of the buried terminal coastal protection structures could be delayed, or may not be triggered, offsetting the capital cost of this Option. For the purpose of undertaking the CBA it assumed that **the buried terminal coastal protection structures would be triggered in year 7 with the full economic cost realised in year 9**.

The Stage 2 buried structures would provide terminal coastal protection to the foreshore areas including:

- a portion of the Holiday Park;
- Dalby Oval; and
- the roadway and residential assets behind these areas.

In each zone, the alignment of the proposed Stage 2 structures allows for terminal coastal protection of a portion of the existing foreshore land. Any built assets should be behind this alignment. The land seaward of this alignment can still be utilized for adaptive environmental and recreational activities. However, as it is within the proposed buffer zone it will be subject to coastal processes over time. Appropriate and adaptive land use in these areas might include grassed areas for casual recreation, or camp sites etc.

In Zone 1, the alignment of the proposed Stage 2 buried terminal coastal protection structures allows for protection of the majority of the Holiday Park. Accordingly, the area landward of the structures could be used for the built assets such as amenities and cabins. The area seaward of the proposed buried structures could still be utilized for Holiday Park functions such as caravans and camping, allowing flexibility to adapt these sites as required. A Holiday Park upgrade would be required to rebuild amenities blocks etc. and rearrange the layout, but current revenue could be maintained in the future.

In Zone 2, the alignment of the proposed Stage 2 buried terminal coastal protection structure allows for protection of the majority of Dalby Oval. Accordingly, the land seaward of this alignment can still be utilized for environmental and recreational activities. However, as it is within the proposed buffer zone it will be subject to coastal processes over time. Appropriate and adaptive land use in these areas might include grassed areas for casual recreation.

In Zone 4, most of Barrie Cres and the seaward end of Griffiths Ave are within the 2025 ZRFC. Accordingly, terminal coastal protection structures are proposed as shown in ***Figure 6*****.**

The proposed buried terminal coastal protection structure is a vertical seawall with rock scour protection at the toe, as demonstrated in **Attachment A**. A vertical seawall is more costly than a rock revetment (typically in the order of 1.5 times the cost/lineal m). However, the reasons for selecting this style of structure over a rock revetment (like existing protective structures at Stockton) are as follows:

- increasing difficulty in sourcing local rock of a suitable size and integrity for rock armour is a factor (as evidenced by the issues with the rock armour splitting and fracturing in the existing Stockton SLSC revetment);
- narrower footprint of the vertical seawall option is of benefit in reducing the encroachment on the sandy beach amenity area; and
- the vertical seawall can be constructed using secant piles which can be installed without the need for complete excavation which has the following advantages:
  - avoids excavation which is difficult, costly (due to groundwater) and high risk due to the exposure to wave action; and
  - can incorporate a concrete capping beam and upstand at the top of the wall which provides a visually appealing wall as it becomes exposed when beach levels lower (e.g. towards the end of a beach nourishment period).

Timing of works is provided in cost estimates in **Appendix B.**

<u>Nourishment</u>

The objective of the beach nourishment in this option is to provide improved beach amenity. The design of the nourishment has been based on a minimum beach width of 5m measured at 1.5m AHD[3], approximately 1m above mean high water (MHW) (including the effects of typical wave runup, which approximately delineates the “permanently dry” portion of the sandy beach). This width would be monitored at the existing rock revetment structures as they are the most prominent areas on the beach. This will equate to significantly wider beaches in the adjacent areas. The premise is that a 5m beach width is considered to provide reasonable space for two people walking along the beach in opposite directions to comfortably pass one another.

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[3] The MHW level is located at approximately RL 0.5. A 1 m allowance for typical wave runup has been included, which was calculated based on methods described in Hanslow and Nielsen (1995). Therefore, the amenity objective is measured at RL 1.5 for the purposes of this study.

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When the annual average beach width adjacent to the either the Stockton SLSC or Mitchell St revetment reduces to 8m, this serves as a trigger for Council to commence investigations for a nourishment project which is implemented within a period of two years. Based on February 2020 UAV data, the existing nominal beach width in the CBA Study Area is assessed to range approximately between 0 m (at the existing revetments) to 20 m (near Meredith St).

The sand placements would be designed to accommodate recession such that the minimum beach width is in place at the commencement of successive nourishment campaigns. In practice, the exact timing of nourishment campaigns would vary according to beach conditions, available sand sources and the like.

For the purposes of the CBA, it has been assumed that an improved amenity sand nourishment exercise would conceptually involve adding **5 m beach width** to the length of the CBA Study Area and maintenance nourishment would effectively occur **annually**.

Depending on the quantities required, nourishment material could be supplied by truck and dog haulage from Port Stephens quarries and/or through back passing (trucked or pumped via land-based pipeline) from the northern end of the beach, or a combination of these options. An alternative to reduce truck movements in residential streets would be to truck sand to the Corroba Oval foreshore where it is mixed into a slurry and pumped via a land-based pipeline to the southern end of the beach.

The following has also been considered when applying the adopted <u>Rijkswaterstaat approach</u> in developing the nourishment scheme design:

Initial nourishment volumes

After Rijkswaterstaat (1987)

1. Volume to <u>*establish the amenity outcome objective or asset protection outcome objective*</u>, based on current beach state (5m increased width):

(i) sub-aerial volume (i.e. above AHD) + (ii) sub-aqueous volume (i.e. below AHD)

33,000 x 5 m (from Section 1 and detailed in Option 1 above) <u>165,000m^3</u>

(sub)Total 165,000 m^3

2. Volume for one year times projected underlying loss (1m/yr). i.e. 1m beach width

(i) sub-aerial volume (i.e. above AHD) + (ii) sub-aqueous volume (i.e. below AHD)

33,000 x 1 m <u>33,000m^3</u>

(sub) Total 33,000 m^3

3. Volume for one year times projected sea level rise loss (0.36m/yr) i.e. 0.36m beach width

(i) sub-aerial volume (i.e. above AHD) + (ii) sub-aqueous volume (i.e. below AHD)

33,000 x 0.36 m <u>12,000m^3</u>

<u>**(sub) Total 12,000 m^3**</u>

Totalling 1, 2 and 3 **Total 210,000 m^3**

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Maintenance nourishment volumes

As discussed in Section 1, the last two components (2 and 3) of the above calculation, typically comprise the maintenance re-nourishment volume. i.e. approximately 45,000 m^3 annually.

However, as previously discussed, the findings of the Stage 2 investigation note that the sediment deficit, over the full active profile between the 1980's and 2018 has been in the order of 112,000m^3/year (Bluecoast, 2020a). On this basis it is proposed that the maintenance nourishment volume be **112,000 m^3 as an annual maintenance regime**.

Previous assessments of terrestrial sand sources found that the median grain size available in large quantities was generally finer than the native sand, requiring 1.8 to 5 times as much sand to retain 1m^3 on the beach (known as the overfill ratio, as outlined in Supporting Document E – Potential Sand Sources). An overfill ratio of approximately 2.5 has therefore been included for terrestrial sand sources. The total nourishment volume required would therefore be approximately **525,000m^3 in the first year and 280,000m^3 placed annually thereafter (for the terrestrial source).** For the placement of sand from a terrestrial source the following is noted:

- Due to logistics constraints and the subsequent limitations on the rate of placement of sand from terrestrial sources, the sand would need to be placed continually at a rate of 14,300m^3/day or 75 truck and dog loads/day. This is almost twice the truck movements involved in the recent 4 day Sand Placement Pilot Study undertaken in front of the Holiday Park where 5564t was placed in 173 truck and dog loads over 4 days. This is likely to cause an unacceptable level of traffic/environmental/social impacts on the local community and it is therefore proposed that the nourishment be approached in two ways.
    - trucks transporting sand directly onto the beach via the King St access (as per the Pilot Study methodology); and
    - trucks transporting sand to a sand pumping station established near Corroba Oval (on western side of Fullerton Rd) which would then be pumped as a slurry via a buried pipeline to the outlets at Dalby Oval frontage and Barrie Cres. frontage. This would reduce truck movements within residential streets. A trial diesel pumping station and pipeline could be established with a 5 year operational contract.
- **It is noted that based on existing demand for quarry sand locally, it is currently considered unlikely that the required nourishment could be sourced from local quarries within the existing licensing arrangements. This issue would need to be addressed to make this option feasible, otherwise alternative sources would be required.**

<u>Option 2 - Sensitivity Analysis</u>

As for Option 1, while acknowledging that marine sand sources are currently either; restricted by legislation, or not available, there are potential future opportunities to access these sources. Accordingly, it is recommended that a sensitivity analysis be undertaken in the CBA to examine the benefit cost ratio (BCR) for Option 2 – sand nourishment for improved amenity coastal protection. The management option object is therefore, accommodate a 1 year ARI storm event with demand of 20m^3/m, (i.e. provide a buffer of 6.7m considering a 3m design dune height) and achieve the minimum annual average beach width of 5m at the narrowest point, using marine sourced sand from offshore sources (Option 2b), or Hunter River sources (Option 2c). The nourishment volumes for a **5 year** re-nourishment frequency would be:

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Initial nourishment volumes

After Rijkswaterstaat (1987)

1. Volume to *establish the amenity outcome objective or asset protection outcome objective*, based on current beach state (6.7m + 5m = 11.7m increased width):

(i) sub-aerial volume (i.e. above AHD) + (ii) sub-aqueous volume (i.e. below AHD)

33,000 x 11.7 m		386,100m^3
	(sub)Total	**386,100 m^3**

2. Volume for five years times projected underlying loss (1m/yr). i.e. 5m beach width

(i) sub-aerial volume (i.e. above AHD) + (ii) sub-aqueous volume (i.e. below AHD)

33,000 x 5 m		165,000m^3
	(sub) Total	**165,000 m^3**

3. Volume for five years times projected sea level rise loss (0.36m/yr) i.e. 1.8m beach width

(i) sub-aerial volume (i.e. above AHD) + (ii) sub-aqueous volume (i.e. below AHD)

33,000 x 1.8 m		59,400m^3
	(sub) Total	**59,400 m^3**
Totalling 1, 2 and 3	**Total**	**610,000 m^3**

Maintenance nourishment volumes

As discussed in Section 1, the last two components (2 and 3) of the above calculation, typically comprise the maintenance re-nourishment volume. i.e. approximately 225,000 m^3 every five years.

However, as previously discussed, the findings of the Stage 2 investigation note that the sediment deficit, over the full active profile between the 1980's and 2018 has been in the order of 112,000m^3/year (Bluecoast, 2020a). On this basis it is proposed that the maintenance nourishment volume be **560,000 m^3 every five years**. For the placement of sand from a marine source the following is noted:

- It is assumed a marine source would typically be compatible with the native sand and as such an overfill ratio has not been included. The total nourishment volume required would therefore be approximately **610,000 m^3 initially and 560,000 m^3 every 5 years thereafter (for the marine source).**

Risks

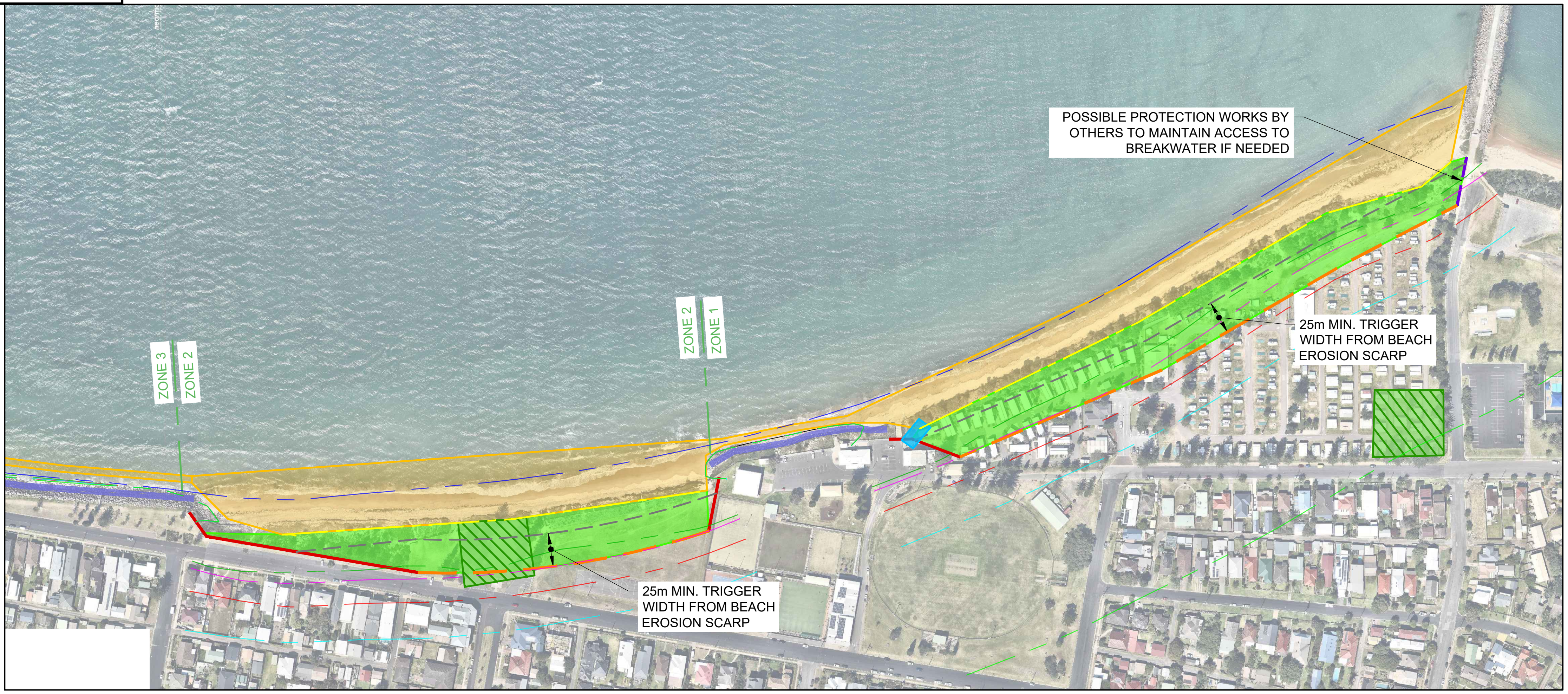
Option 2 - Sand nourishment for improved beach amenity + coastal terminal protection works, presents a lower risk than Option 1. The risks associated with this option include:

- If more than one design storm occurs within the re-nourishment period, or a storm larger than the design storm occurs, the Stage 2 buried terminal structure would need to be constructed sooner than predicted.
- If sufficient sand supply cannot be sourced when required, beach amenity would not be maintained.
- If the placement rate cannot be achieved, e.g. inclement weather, beach erosion limits access for trucks and plant on beach, etc then beach amenity would not be maintained.
- This option poses minimal risk of impacting downdrift beaches as the proposed nourishment volume approximate the long term losses determined in the Stage 2 Sediment Transport Study (Bluecoast, 2020a).
- Potential Acid Sulphate Soils being exposed through erosion. The Department of Land and Water Conservation Acid Sulfate Soil Risk Map for Newcastle (DLWC, 1997) indicates that the Holiday Park Site is located an area of low probability of occurrence of ASS, 1 to 3 m below ground surface (GHD, 2017). Further soil investigations are required to assess these areas. The Newcastle Local Environmental Plan (LEP) 2012 identifies the site as a Class 3 Acid Sulfate Soil region. The plan stipulates that a development consent is required for the carrying out of works more than 1 meter below the natural ground surface and/or works by which the water table is likely to be lowered more than 1 meter below the natural ground surface.
- Potential contamination seaward of the proposed alignment of the proposed terminal coastal protection structures requiring removal and disposal with associated costs and environmental/social impacts. There is thought to be waste material beneath the carpark at the Monument, directly east of Hereford St in Zone 2. There is also building waste in the form of brickwork and concrete in other parts of Zone 2, which has been exposed in the erosion scarp and on the beach after erosion events. Based on the findings of investigations undertaken to date this risk is considered low in Zone 1 as the only waste material identified was well behind the proposed alignment of the buried terminal structures.

DRAWING No. PA2395-RHD-00-DR-MA-1013

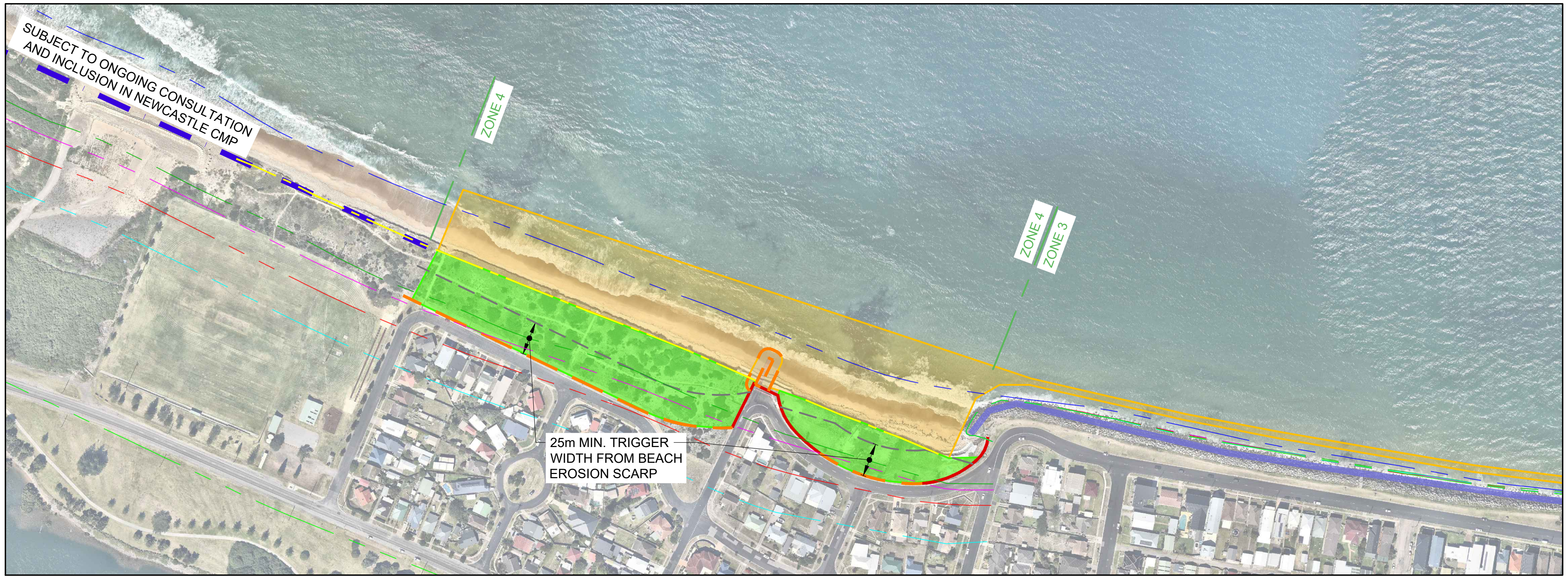
DO NOT SCALE

FIGURE 6



OPTION 2 (SOUTH)

1:2000 (A1)



OPTION 2 (NORTH)

1:2000 (A1)

AUSTRALIAN HEIGHT DATUM

DIAL BEFORE YOU DIG www.1100.com.au

LEGEND

- STAGE 1 - BURIED TERMINAL PROTECTION STRUCTURE
- STAGE 2 - BURIED TERMINAL PROTECTION STRUCTURE AND HEADLAND
- APPROX. CREST OF EROSION SCARP FROM 17 FEB 2020 UAV SURVEY (PROVIDED BY NEWCASTLE CITY COUNCIL)
- POTENTIAL WASTE THAT NEEDS TO BE MANAGED
- MAINTAIN EXISTING ROCK REVETMENT
- BEACH NOURISHMENT FOR AMENITY
- POSSIBLE VEHICLE BEACH ACCESS RAMP
- ADAPTIVE ENVIRONMENTAL AND RECREATIONAL LAND USE AREA
- 2018-2020 MSL (0m AHD)
- 2020 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2025 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020))
- 2040 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2060 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2120 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)

REV	DATE	DESCRIPTION	BY	CHK	APP
C	14.04.2020	RE-ISSUED FOR REVIEW	BR	NP	AT
B	07.04.2020	RE-ISSUED FOR REVIEW	BR	NP	AT
A	03.04.2020	ISSUED FOR REVIEW	BR	NP	AT

REVISIONS

CLIENT

City of Newcastle

PROJECT

STOCKTON CMP

TITLE

COASTAL MANAGEMENT OPTION 2

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Enhancing Society Together
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DRAWN	COORD. SYSTEM	DATUM	DATE
-	MGA ZONE 56	AHD	14.04.2020
SCALE AT A1 AS SHOWN	REF. PA2395-RHD-00-M3-MA-1001		

40 0 40 80 120 160 200m

1:4000 (A3) 1:2000 (A1)

DRAWING No. PA2395-RHD-00-DR-MA-1013 REVISION C

5 Option 3 – Sand nourishment to maintain beach amenity + terminal coastal protection works

General Description

Option 3a involves beach nourishment of a volume limited to what is logistically feasible using terrestrial sources of sand (i.e. less volume than considered in Option 2 using terrestrial sources), to reduce (but not prevent) future loss of beach amenity. As in Option 2, this option also includes construction of buried terminal protection structures, constructed in two stages, to address the current and future risk of potentially high consequence, low probability events that may affect the area (mandatory requirement 13, Coastal Management Manual Part A).

Option 3a comprises the following components:

- ongoing maintenance of existing rock revetment structures at the Stockton SLSC and Mitchell St;
- Stage 1 buried terminal coastal protection structures are to be built in the short term to protect the following assets at risk within the next 5 years (in accordance with established 2025 hazard lines):
    - the flanks of all of the existing rock structures,
    - roadways; and
    - residential assets,
- Stage 2 buried terminal coastal protection structures set back at the established hazard lines to be constructed if/when minimum foreshore width triggers are reached;
- Stage 2 small rock headland at the end of Griffiths Ave to protect the road head and create a stable embayment within the Barrie Cres. frontage to be constructed if/when minimum foreshore width triggers are reached; and
- sand nourishment for the full extent of the CMP area (Breakwater to Meredith St) to reduce future loss of beach amenity which, rather than target a specific beach width objective (as in Option 2), is an annual volume that has been calculated to be the realistic, logistically feasible quantity of sand that can be placed on the beach from terrestrial sources using trucks and dozers.

Refer to ***Figure 7*** for layout of Option 3a, and **Appendix C** for breakdown of estimated costs and timing. The rationale behind this option and further detail of each component is provided below.

Rationale

The objective of Option 3a is to provide as much beach nourishment as physically and logistically possible from terrestrial sources (as the only currently permissible source) whilst ensuring assets at risk by 2025 are protected by buried terminal coastal protection structures (refer 2025 hazard lines). The amount of sand nourishment in Option 3a is less than that in Option 2 (or 1) as it aims to eliminate constraints for terrestrial sand sources identified in the previous options, such as:

- availability of sand from local quarry sources;
- community acceptance of social/environmental/noise/traffic impacts of trucking movements and disruption of beach use during placement operations;
- cost; and
- physical and logistical constraints on the amount of additional sand that can be placed on the beach at any one time without creating public safety issues.

The rationale behind the combination of buried terminal coastal protection and beach nourishment in Option 3a is to maintain the beach's current levels of resilience and capacity to accommodate coastal processes and avoid loss of beach amenity whilst ensuring assets are protected.

The total sand volume that could be physically accommodated on the beach each year is approximately 200,000 m^3. However, based on the adopted overfill ratio of 2.5, the quantity of terrestrial sand effectively retained for nourishment on Stockton Beach is around 80,000 m^3 per year. This volume has been derived on the basis of the following key assumptions:

- CN could secure 20% of the licensed extraction limits from each of the local quarries;
- quarry material from each site is 'compatible', with an average overfill factor of 2.5;
- shoreline length that could accommodate truck movements = 1,500 m (i.e. revetment shorelines excluded due to insufficient beach width for safe plant access);
- max. depth of placement in a single campaign = 1 m to avoid excessively high vertical scarps forming in newly placed sand and ensuring public safety;
- average beach width = 30 to 35 m, therefore, max. volume that could be physically accommodated on the beach in a single campaign = 50,000 m^3;
- three project sites would operate alternately to distribute trucking movements and manage amenity impacts, as follow:
    - Holiday Park frontage with access via existing King St ramp,
    - Dalby Oval via newly constructed beach access from Dalby oval, and
    - Stone St to Meredith St frontage via newly constructed beach access from Meredith St,
- each of the three project sites would have four campaigns per year of 50,000 m^3 per campaign, which is (on average) ~17,000 m^3 per project site per campaign;
- each 17,000 m^3 'sub-campaign' could be completed in 4 weeks, working at the same trucking rate as per December 2019 Pilot Study; and
- works could be scheduled to avoid school holidays.

It is noted that these values are consistent with the sand quantities available from local quarries.

Further background information and detail regarding the development of the feasible terrestrial based nourishment can be found in **Appendix E.**

For the CBA Option 3 involves placement of **200,000m^3 on the subaerial beach each year.** Timing of works is provided in cost estimates in **Appendix C.**

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Case 3b – Nominal sand nourishment to reduce ongoing loss of beach amenity + terminal protection

General Description

Option 3b involves beach nourishment of a volume limited to what is logistically and economically feasible using terrestrial sources of sand (i.e. less volume than considered in Option 2 using terrestrial sources), to reduce (but not prevent) future loss of beach amenity. As in Option 2, this option also includes construction of buried terminal coastal protection structures, constructed in two stages, to address the current and future risk of potentially high consequence, low probability events that may affect the area (mandatory requirement 13, Coastal Management Manual Part A).

Relative to Option 3a, the extent of the Stage 1 coastal protection works has been reduced with more works delayed until Stage 2 to reduce initial capital costs. This also has the benefit of providing time for alternative coastal management strategies to potentially become feasible, such as larger nourishment campaigns using marine sand sources, which could eliminate the need for the Stage 2 terminal protection works.

Option 3b comprises the following components:

- ongoing maintenance of existing rock revetment structures at the Stockton SLSC and Mitchell St;
- reduced Stage 1 buried terminal coastal protection structures are to be built in the short term to provide a degree of protection to assets including (refer ***Figure 8*** for extent of protected assets):
    - the flanks of all of the existing rock structures;
    - roadways; and
    - residential assets.
- Stage 2 buried terminal coastal protection structures set back at the established hazard lines to be constructed if/when minimum foreshore width triggers are reached, with trigger widths optimised relative to Option 3a to further delay Stage 2 works;
- sand nourishment for the full extent of the CMP area (northern breakwater to Meredith St) to reduce future loss of beach amenity, which, rather than a specific beach width objective (as in Option 2), is an annual volume that has been calculated to be the logistically and economically feasible quantity of sand that can be placed on the beach from terrestrial sources using trucks and dozers.

Refer to ***Figure 8*** for layout of Option 3b, and **Appendix D** for breakdown of estimated costs and timing. The rationale behind this option and further detail of each component is provided below.

Rationale

The objective of Option 3b is to provide as much beach nourishment as logistically and economically possible from terrestrial sources (as the only currently permissible source) whilst providing terminal coastal protection to assets seaward of the Zone of Slope Adjustment (ZSA) for a 5% Annual Exceedance Probability (AEP) within the next 5 years (in accordance with established 2025 hazard lines (Bluecoast, 2020)):

However, the cost of terrestrial sourced sand would require a $16 million p.a. commitment to implement and sustain the 200,000m^3 p.a. volume proposed in Option 3a. This is understood to be beyond CN

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funding capacity. Accordingly, the nourishment volume considered for the **CBA Option 3b involves an initial placement of 50,000m^3** on the subaerial beach in year 1 at a cost of **$4 million**. Based on the adopted overfill ratio for terrestrial sand sources of 2.5, the 50,000m^3 p.a. would effectively provide the equivalent of 20,000m^3 of native sand on the beach.

The extent of the Stage 1 terminal coastal protection works in Option 3b has been reduced relative to Option 3a. The rationale behind this reduction is to reduce (or delay) capital cost to make this option more economically feasible and to broaden the window of opportunity for an alternative coastal management option to become feasible, such as, marine sourced sand nourishment, that would eliminate the need for the Stage 2 terminal protection works to be constructed.

The reduced Stage 1 works provide coastal protection to assets seaward of the Zone of Slope Adjustment (ZSA) for a 5% Annual Exceedance Probability (AEP) within the next 5 years (rather than assets seaward of the Zone of Reduced Foundation Capacity for the 1% AEP in the next 5 years (in accordance with the 2025 hazard lines in (Bluecoast, 2020)).

CN have advised that under Option 3b they would not provide protection to the Barrie Cres./Griffiths Ave intersection road head, but rather create cul-de-sacs at the northern end of Barrie Cres and the eastern end of Griffiths Ave to maintain access to all residences. Stage 2 works would include a terminal coastal protection structure protecting a 4m wide pedestrian pathway adjacent to the residential property boundary in this location (refer ***Figure 8***).

CN have advised acceptance of a reduction in the trigger widths for implementation of the Stage 2 terminal coastal protection works in Option 3b from 25m (in Option 3a) to 20m, and the subsequent increase in risk. Accordingly, the trigger width for the Stage 2 works has been reduced to 20m and provides a minimum sand volume seaward of assets, approximately equivalent to the storm erosion demand of an 8 year ARI event. Assuming it would take a maximum of 3 years from triggering the need for the terminal protection works to completing them, there would be about a 33% chance of an 8 year ARI event occurring in the 3 year construction period putting assets at risk prior to completion of the coastal protection structures.

If the structures can be completed within a shorter timeframe, the probability of the storm event occurring and assets being at risk reduces, e.g. there is a 24% chance of the 8 year ARI event occurring in a 2 year period. For this reason, it is recommended that preparations be undertaken to allow this protection to be implemented with expediency once triggers are reached. CN has acknowledged and accepted this level of risk.

The estimated annual long-term sand deficit (for the full sub aerial and sub aqueous profile) noted in the Stage 2 Sediment Transport Study (Bluecoast, 2020) for this portion of the Stockton embayment was approx. 112,000m^3/year in the three decades. The effective volume of 20,000m^3 placed annually on the aerial beach does not match these losses and may therefore only produce short term maintenance of beach width but would not be sufficient nourishment to counter the ongoing losses. Option 3b would therefore result in loss of amenity and potentially lead to impacts on the downdrift coastline in the long term . Accordingly, it is recommended that this option be considered a short-term option only, with a view to **upgrading to Option 2 (or Option 1 if sufficient sand and funding are available)** when a more cost-effective marine source of sand becomes available. This is explored further in the sensitivity analysis outlined below.

Option 3 - Sensitivity Analysis

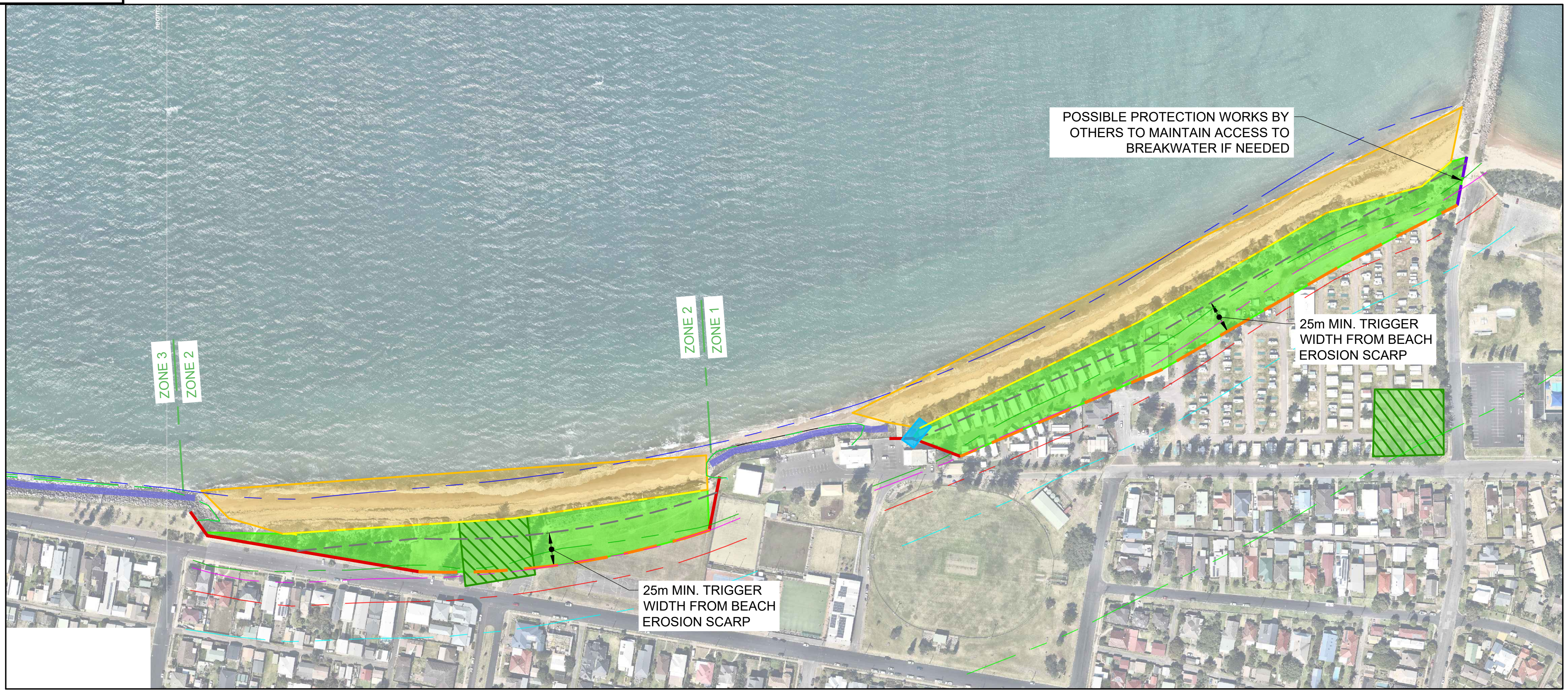
As noted previously, the amount of nourishment that is economically viable from terrestrial sources is not sufficient to offset ongoing losses of sand. As a result, there is likely to be continued loss of beach amenity and eventual impacts on the adjacent coastline to the north if Option 3 were implemented beyond the short term. Accordingly, it is recommended that the CBA assess a combined approach comprising Option 3b for the first year followed by a mass nourishment strategy from marine sources (Option 1b) in year 2 and for the remaining 49 years of the project life. In this scenario only the reduced Stage 1 terminal coastal protection works would be implemented and the Stage 2 terminal coastal protection works are assumed to be eliminated. This may identify a potential strategy that is technically and economically feasible in the short and longer term that would also be acceptable to the local community.

This option is termed **Option 1d.**

DRAWING No.
PA2395-RHD-00-DR-MA-1014

DO NOT SCALE

FIGURE 7



OPTION 3 (SOUTH)
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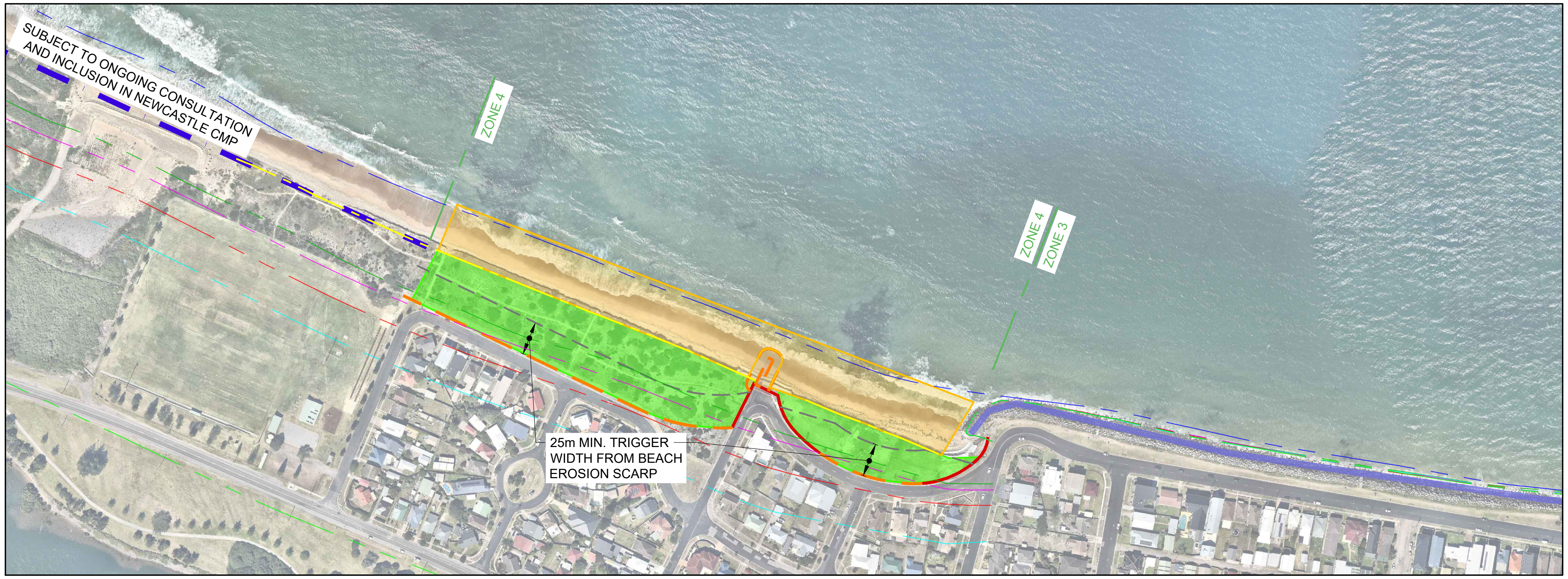

OPTION 3 (NORTH)
1:2000 (A1)

AUSTRALIAN HEIGHT DATUM

LEGEND

- STAGE 1 - BURIED TERMINAL PROTECTION STRUCTURE
- STAGE 2 - BURIED TERMINAL PROTECTION STRUCTURE AND HEADLAND
- APPROX. CREST OF EROSION SCARP FROM 17 FEB 2020 UAV SURVEY (PROVIDED BY NEWCASTLE CITY COUNCIL)
- POTENTIAL WASTE THAT NEEDS TO BE MANAGED
- MAINTAIN EXISTING ROCK REVETMENT
- BEACH NOURISHMENT FOR AMENITY
- POSSIBLE VEHICLE BEACH ACCESS RAMP
- ADAPTIVE ENVIRONMENTAL AND RECREATIONAL LAND USE AREA
- 2018-2020 MSL (0m AHD)
- 2020 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2025 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2040 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2060 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2120 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)

REV	DATE	DESCRIPTION	BY	CHK	APP
B	14.04.2020	RE- ISSUED FOR REVIEW	BR	NP	AT
A	08.04.2020	ISSUED FOR REVIEW	BR	NP	AT

REVISIONS

CLIENT
City of Newcastle

PROJECT
STOCKTON CMP

TITLE
COASTAL MANAGEMENT OPTION 3 a

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DRAWN	COORD. SYSTEM	DATUM	DATE
-	MGA ZONE 56	AHD	14.04.2020
SCALE AT A1 AS SHOWN	REF. PA2395-RHD-00-M3-MA-1001		

DRAWING No. PA2395-RHD-00-DR-MA-1014
REVISION B

40 0 40 80 120 160 200m
1:4000 (A3) 1:2000 (A1)

C:\USERS\220068\BOX\PA2395 STOCKTON CMP\PA2395 STOCKTON CMP TEAM\PA2395 TECHNICAL DATA\E11 WORKING DRAWINGS\PA2395-RHD-00-M3-MA-1001

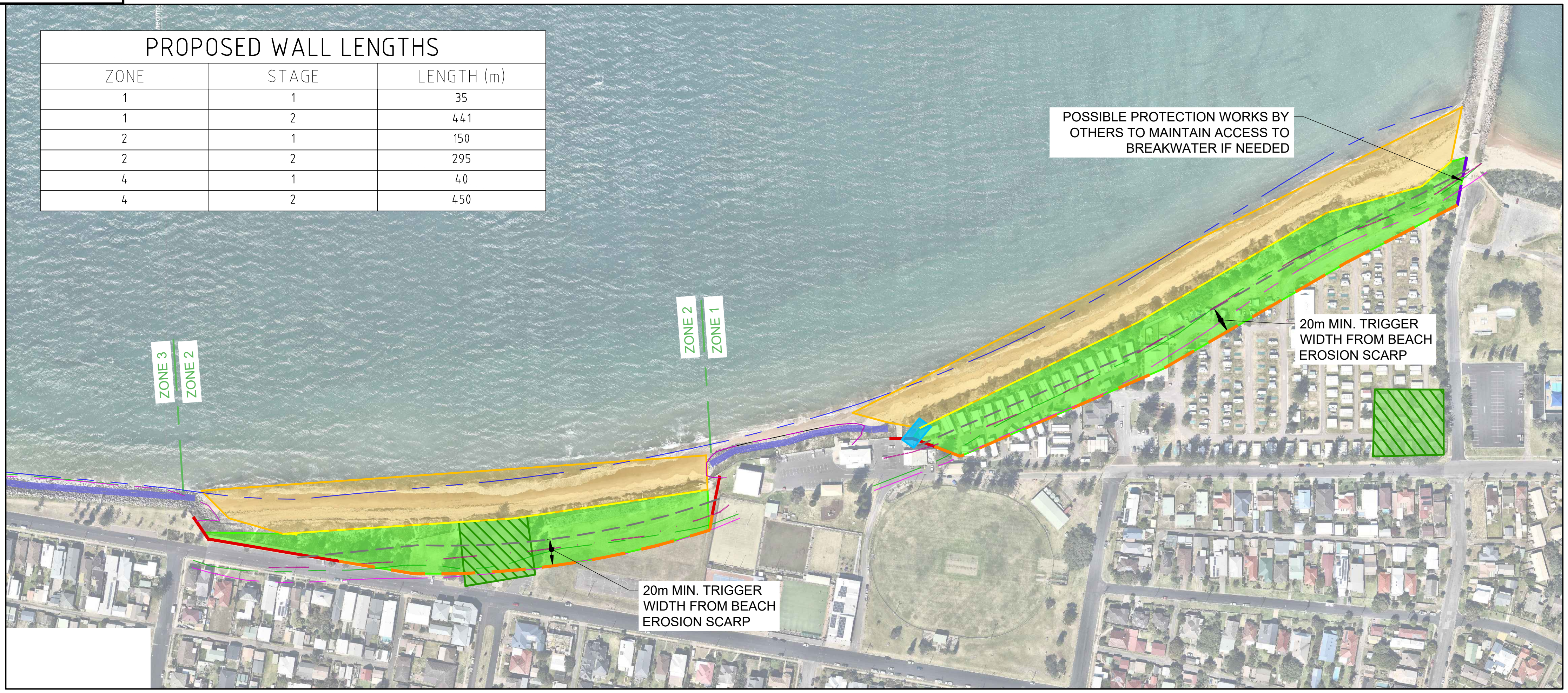
DRAWING No. PA2395-RHD-00-DR-MA-1014

DO NOT SCALE

FIGURE 8

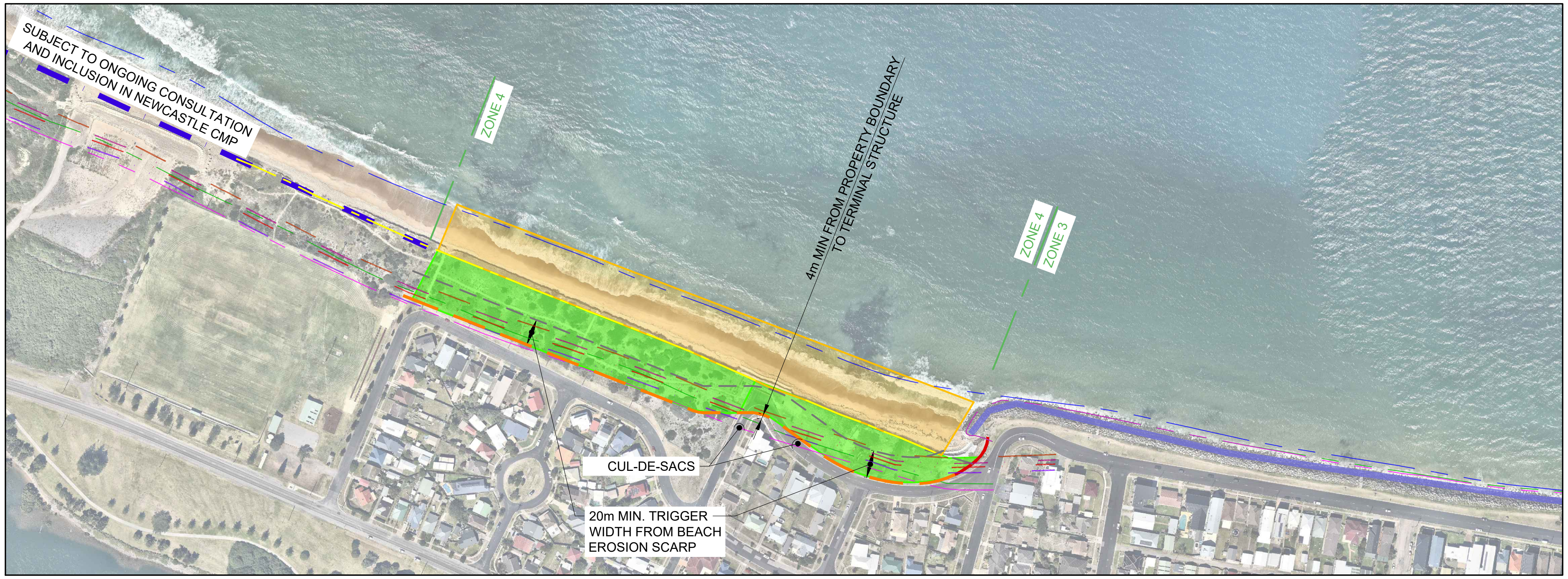
PROPOSED WALL LENGTHS

ZONE	STAGE	LENGTH (m)
1	1	35
1	2	441
2	1	150
2	2	295
4	1	40
4	2	450



OPTION 3 (SOUTH)

1:2000 (A1)



OPTION 3 (NORTH)

1:2000 (A1)

LEGEND

- STAGE 1 - BURIED TERMINAL PROTECTION STRUCTURE
- STAGE 2 - BURIED TERMINAL PROTECTION STRUCTURE AND HEADLAND
- APPROX. CREST OF EROSION SCARP FROM 17 FEB 2020 UAV SURVEY (PROVIDED BY NEWCASTLE CITY COUNCIL)
- POTENTIAL WASTE THAT NEEDS TO BE MANAGED
- MAINTAIN EXISTING ROCK REVETMENT
- BEACH NOURISHMENT FOR AMENITY
- POSSIBLE VEHICLE BEACH ACCESS RAMP
- ADAPTIVE ENVIRONMENTAL AND RECREATIONAL LAND USE AREA
- 2018-2020 MSL (0m AHD)
- 2020 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2025 ZONE OF REDUCED FOUNDATION CAPACITY HAZARD LINE (BLUECOAST 2020)
- 2025 ZONE OF SLOPE ADJUSTMENT HAZARD LINE 5% (AEP)

DIAL BEFORE YOU DIG www.1100.com.au

AUSTRALIAN HEIGHT DATUM

40 0 40 80 120 160 200m

1:4000 (A3) 1:2000 (A1)

REV	DATE	DESCRIPTION	BY	CHK	APP
C	21.04.2020	RE- ISSUED FOR REVIEW	BR	NP	AT
B	14.04.2020	RE- ISSUED FOR REVIEW	BR	NP	AT
A	08.04.2020	ISSUED FOR REVIEW	BR	NP	AT

REVISIONS

CLIENT: City of Newcastle

PROJECT: STOCKTON CMP

TITLE: COASTAL MANAGEMENT OPTION 3b

Royal HaskoningDHV
Enhancing Society Together

DRAWN	COORD. SYSTEM	DATUM	DATE
-	MGA ZONE 56	AHD	21.04.2020

SCALE AT A1: AS SHOWN

REF: PA2395-RHD-00-M3-MA-1001

DRAWING No. PA2395-RHD-00-DR-MA-1014 REVISION C

Royal HaskoningDHV

Summary

A summary of the Options and nourishment quantities is provided below.

Option	Sub-option	Description	Sand Source	Initial nourishment vol (m^3)	Maintenance nourishment vol (m^3)	Maintenance nourishment frequency (years)
1	1a	Mass nourishment for protection + amenity, limited coastal protection works	Terrestrial**	4.5 million*	1.4 million*	5 years
	1b		Marine offshore	2.4 million	1.12 million	10 years
	1c		Hunter River	1.8 million	560,000	5 years
	1d	Option 3b for year 1 followed by Option 1b in year 2	Terrestrial** and marine	50,000 2.4 million	1.12 million	10 years
2	2a	Sand nourishment for improved beach amenity (5m width) + staged terminal protection	Terrestrial**	525,000*	280,000*	annual
	2b	Sand nourishment for improved beach amenity (5m width +1 yr ARI storm) + staged terminal protection	Marine offshore	610,000	560,000	5 years
	2c		Hunter River	610,000	560,000	5 years
3	3a	Sand nourishment to maintain beach amenity (feasible terrestrial volume) + staged terminal protection	Terrestrial**	200,000	200,000	annual
	3b	Sand nourishment to maintain beach amenity (affordable terrestrial volume) + staged terminal protection	Terrestrial**	50,000	50,000	annual

* exceeds volume from terrestrial sources that can feasibly be placed on the subaerial beach by trucking.

** an overfill factor of 2.5 has been adopted based on quarry investigations and a sensitivity analysis is recommended to assess an overfill factor of 1.

Sensitivity Analysis

The supply and place cost rate for terrestrial quarry sourced sand for the small (5,664 m^3) Pilot Study beach nourishment campaign at the Holiday Park in December 2019 was $100/$m^3$. This rate has been adopted with a 20% discount for the CBA cost estimates to account for economies of scale i.e. $80/$m^3$. A sensitivity analysis is recommended to assess the impact on CBA outcomes of the following:

- a further reduction of the sand cost rate to $50/$m^3$; and
- elimination of the overfill factor (i.e. overfill factor of 1).

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References

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WRL, 2017, Guidelines for Sand Nourishment. WRL Research Report 263. J T Carley and R J Cox.

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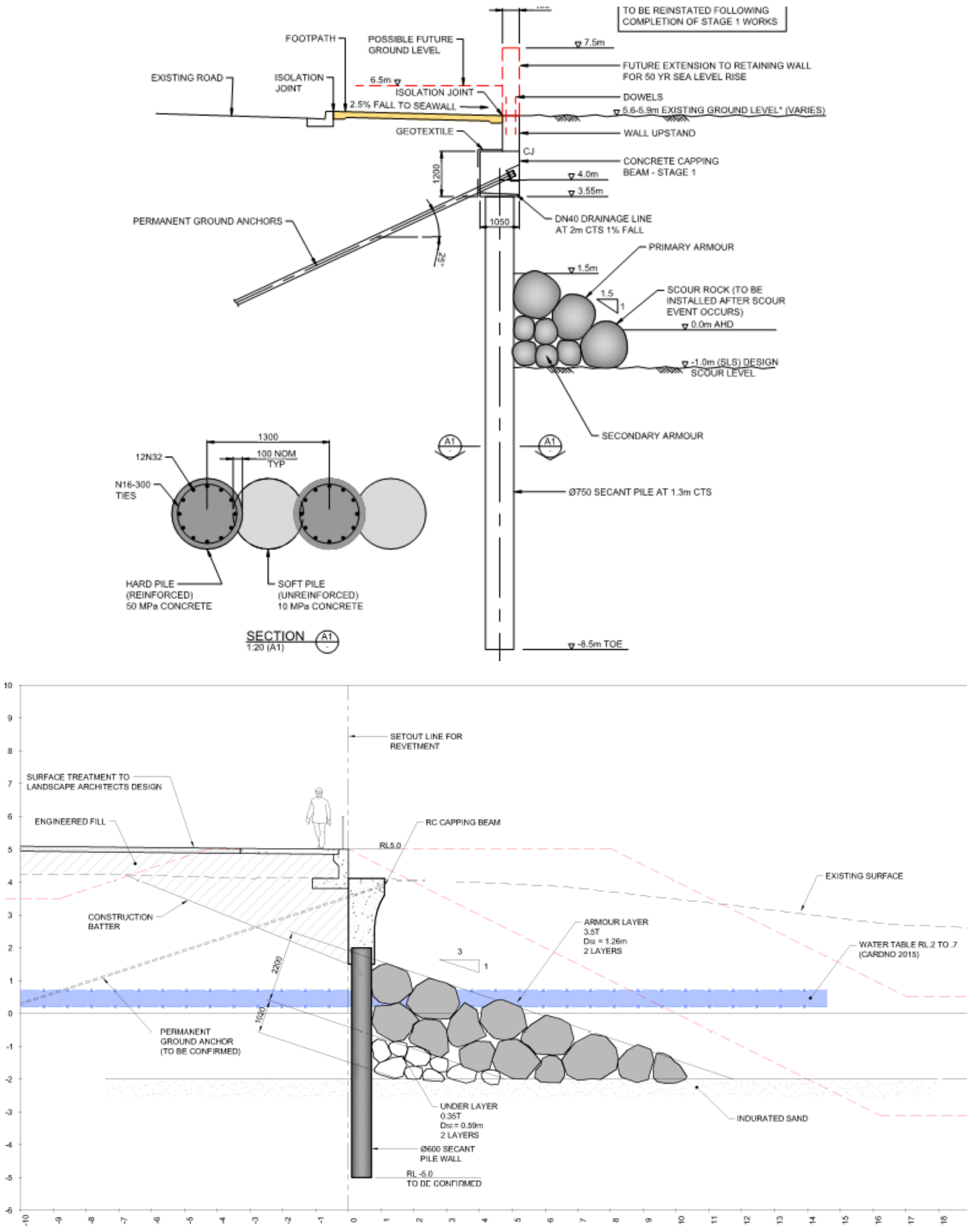
ATTACHMENT A

-



***Figures A1**: Typical concept design cross section showing combination of vertical secant pile and rock structures.*

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Appendix A – Cost Estimates for Option 1

Royal HaskoningDHV
Enhancing Society Together

Stockton CMP

Cost Estimate for CBA
Option 1 - Beach Nourishment for coastal protection

Prepared By: N Patterson
Checked By: G Blumberg

Date Issued: 16/06/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE SAND VOLUME (m3)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment (based on terrestrial source)**						**356,500,000**				
1.1a	Beach nourishment with sand from terrestrial sources placed constantly throughout year on subaerial beach	Based on costs from sand placement pilot study (Dec 2019) undertaken by SCS, as provided by Council, reduced by 20% for economies of scale	m3	4,400,000	80	352,000,000		1	1,400,000	112,000,000	every 5 years
	Beach nourishment with sand from commercial terrestrial sources transported to pumping station near Corroba Oval (20 x 30m area) and pumped via buried pipeline onto subaerial beach to Dalby Oval beach frontage constantly throughout year	Trial diesel system set up for 5 year contract with 100,000m3/year capacity (RH, 2018). Ongoing cost reduced as sand shifter not required.	capital cost item	1	2,000,000	2,000,000		1		1,200,000	yearly
		Sand from commercial terrestrial source delivered to Corroba Oval (based on pilot study)	m3	100,000	25	2,500,000		1	100,000	2,500,000	yearly
1.1b	**Alternative (b) for sensitivity testing**						**30,600,000**				
	Beach nourishment with sand sourced from offshore dredging within 7.5 nautical miles over 5 year period (with initial campaign then 5 year frequency)	1.8 million m3 initial campign and 1 million m3 maintenance nourishment every 5 years. Based on Trailing Suction Hopper Dredge (TSHD) . Rate of $19/m3 used for maintenance campaign (conservatively estimated between rates for 500,000m3 and 2,000,000m3 rates).	m3	1,800,000	17	30,600,000		1	560,000	19,000,000	every 5 years
1.1c	**Alternative (c) for sensitvity testing**						**45,000,000**				
	Beach nourishment with sand sourced from dredging within Hunter River eg. potential Gasdock project (with initial campaign then 5 year frequency)	1.8 million m3 initial campign and 1 million m3 maintenance nourishment every 5 years. Based on cutter suction dredge. Rate of $30/m3 used for maintenance campaign (conservatively estimated between rates for 500,000m3 and 2,000,000m3 rates).	m3	1,800,000	25	45,000,000		1	560,000	30,000,000	every 5 years

Disclaimer

The reader should note that cost estimate presented here is based on Royal HaskoningDHV's experience and judgement as a firm of practising professional engineers familiar with the coastal and maritime construction industry. It includes construction costs only and no allowance is made for contingencies. It would be reasonable to apply an average contingency of up to 40% for design development uncertainty and unforseen and uncontrollable items, such as those relating to ground and weather conditions.

The quantities used to develop the cost estimate have been gauged from typical concept arrangements and planform measurements made using available mapping and high level aerial photography.

The construction cost estimate can NOT be guaranteed as RHDHV have no control over Contractor's prices, market forces and competitive bids from tenderers. The cost estimate is for CONSTRUCTION ONLY and excludes items which should be considered in a cost plan such as site investigation fees, environmental assessment fees, design and tendering fees, project management fees, authority approval and permitting fees, and construction site supervision, works certification and administration fees.

Stockton CMP

Cost Estimate for CBA
Option 1 - Zone 1

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 16/06/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT ($)	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment - refer serarate spreadsheet for whole project area nourishment cost estimate**									
2	**Vertical Structures**						**1,400,000**			
2.1	Secant pile wall (including capping beam and ground anchors)	Based on construction cost for Kingscliff Project and Rawlinsons	m	56	20,000	1,120,000		1	56,000	every 5 years
2.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for limited profile)	m	56	5,000	280,000		1	14,000	every 5 years
3	**Maintenance of SLSC revetment**	Current proposed repair works are included in Base Case and therefore not included here.	m	140	2,000	0	**0**		170,000	every 4 years

Stockton CMP

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 16/06/2020

Cost Estimate for CBA
Option 1 - Zone 2

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment - refer serarate spreadsheet for whole project area nourishment cost estimate**									
2	**Vertical Structures**						**5,600,000**			
2.1	Secant pile wall (including capping beam and ground anchors)	Based on construction cost for Kingscliff Project and Rawlinsons	**m**	224	20,000	4,480,000		1	224,000	every 5 years
2.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for dry construction)	m	224	5,000	1,120,000		3	56,000	every 5 years
3	**Removal and Disposal of Waste**	Provisional sum in case of discovery of General Solid Waste. No information available on quantities. Progressive removal would be required as it is exposed.	t	100	250	25,000	**25,000**	1	25,000	every 5 years
4	**Removal and disposal of carpark at the Monument**	Rawlinsons	m2	200	90	18,000	**18,000**	3	NA	

Stockton CMP

Cost Estimate for CBA
Option 1 - Zone 3

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 16/06/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment - refer serarate spreadsheet for whole project area nourishment cost estimate**									
2	**Maintenance of Mitchell St revetment**									
	Current planned maintenance works	Current proposed repair works are included in Base Case and therefore not included here.	item	1	5,000,000		**0**		480,000	every 2 years

Royal HaskoningDHV
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Stockton CMP

Cost Estimate for CBA
Option 1 - Zone 4

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 16/06/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Footpaths and roadworks**						**212,500**			
1.1	Close roadway lane and create one way road on Barrie Cres with new kerb		m	200	500	100,000		1	10,000	every 5 years
1.2	New footpath Barrie Cres		m3	150	750	112,500		1	11,250	every 5 years
2	**Vertical Structures**									
							4,900,000			
2.1	Barrie Crescent/Stone/Griffiths Ave secant pile wall and and rock wedge at Mitchell St flank	Based on construction cost for Kingscliff Project/Rawlinsons	**m**	178	20,000	3,560,000		1	178,000	every 5 years
2.2.	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	178	5,000	890,000		3	44,500	every 5 years
2.3	Beach access - Concrete bleachers on piles	Based on construction cost for Kingscliff Project	m	10	45,000	450,000		5	22,500	every 5 years
3	**Remove temporary emergency geocontainer structures**						**75,000**			
3.1	Stone St structure	Sand from geocontainers to be placed on the beach	m	30	1,000	30,000		1	NA	
3.2	Griffiths Ave structure	Sand from geocontainers to be placed on the beach	m	45	1,000	45,000		1	NA	

Royal HaskoningDHV

Appendix B – Cost Estimates for Option 2

Stockton CMP

Prepared By: N Patterson
Checked By: G Blumberg

Cost Estimate for CBA
Option 2 - Beach Nourishment for coastal amenity

Date Issued: 16/06/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE SAND VOLUME (m3)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment for amenity (based on terrestrial source)**						**38,500,000**			**18,100,000**	yearly
1.1a	Beach nourishment with sand from commercial terrestrial sources placed by trucks/dozers on subaerial beach at Holiday Park frontage via King St, constantly throughout year.	Based on costs from sand placement pilot study (Dec 2019) undertaken by SCS, as provided by Council, reduced by 20% for economies of scale	m3	425,000	80	34,000,000		1	180,000	14,400,000	yearly
	Beach nourishment with sand from commercial terrestrial sources transported to pumping station near Corroba Oval (20 x 30m area) and pumped via buried pipeline onto subaerial beach to Dalby Oval beach frontage constantly throughout year	Trial diesel system set up for 5 year contract with 100,000m3/year capacity (RH, 2018). Ongoing cost reduced as sand shifter not required.	capital cost item	1	2,000,000	2,000,000		1		1,200,000	yearly
		Sand from commercial terrestrial source delivered to Corroba Oval (based on pilot study)	m3	100,000	25	2,500,000		1	100,000	2,500,000	yearly
1.1b	**Alternative (c) for sensitivity testing (incl. 1 yr ARI storm)**						**11,590,000**				
	Beach nourishment with sand sourced from offshore dredging of sand lobe off Nobbys over 5 year period (with initial campaign then 5 year frequency)	750,000 m3 initial campaign and 1 million m3 maintenance nourishment every 5 years. Based on Trailing Suction Hopper Dredge (TSHD) . Rate of $19/m3 used (conservatively estimated between rates for 500,000m3 and 2,000,000m3 rates).	m3	610,000	19	11,590,000		1	560,000	19,000,000	every 5 years
1.1c	**Alternative (d) for sensitivity testing (incl. 1 yr ARI storm)**						**18,300,000**				
	Beach nourishment with sand sourced from dredging of shipping channel in the south-arm of the Hunter River as part of the potential Gasdock project (with initial campaign then 5 year frequency)	750,000 m3 initial campaign and 1 million m3 maintenance nourishment every 5 years. Based on cutter suction dredge. Rate of $30/m3 used for maintenance campaign (conservatively estimated between rates for 500,000m3 and 2,000,000m3 rates).	m3	610,000	30	18,300,000		1	560,000	30,000,000	every 5 years

Disclaimer

The reader should note that cost estimate presented here is based on Royal HaskoningDHV's experience and judgement as a firm of practising professional engineers familiar with the coastal and maritime construction industry. It includes construction costs only and no allowance is made for contingencies. It would be reasonable to apply an average contingency of up to 40% for design development uncertainty and unforseen and uncontrollable items, such as those relating to ground and weather conditions.
The quantities used to develop the cost estimate have been gauged from typical concept arrangements and planform measurements made using available mapping and high level aerial photography.
The construction cost estimate can NOT be guaranteed as RHDHV have no control over Contractor's prices, market forces and competitive bids from tenderers. The cost estimate is for CONSTRUCTION ONLY and excludes items which should be considered in a cost plan such as site investigation fees, environmental assessment fees, design and tendering fees, project management fees, authority approval and permitting fees, and construction site supervision, works certification and administration fees.

Stockton CMP

Cost Estimate for CBA
Option 2 - Zone 1

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 16/06/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT ($)	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment - refer serarate spreadsheet for whole project area nourishment cost estimate**									
2	**Vertical Structures**									
2.1	**Stage 1**						**1,400,000**			
3.1.1	Secant pile wall (including capping beam and ground anchors)	Based on construction cost for Kingscliff Project and Rawlinsons	**m**	56	20,000	1,120,000		1	56,000	every 5 years
3.1.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for dry construction)	m	56	5,000	280,000		1	14,000	every 5 years
3.2	**Stage 2**						**10,650,000**			
3.2.1	Secant pile wall	Based on construction cost for Kingscliff Project and Rawlinsons	m	420	20,000	8,400,000		9	420,000	every 5 years
3.2.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	420	5,000	2,100,000		10	105,000	every 5 years
3.2.3	Accessways on piles (3 accessways 2m wide)	FRP superstructure on concrete piles. Once full length of seawall is in place this access may be needed (earliest timing)	item	3	50,000	150,000		10	7,500	every 5 years
4	**Relocation of Holiday Park Assets behind seawall**	New amenities block timing will depend on conditions and nourishment behaviour	item	1	500,000	500,000	**500,000**	3	NA	NA
5	**Maintenance of SLSC revetment**	Based on current estimates for maintenance works	m	140	2,000		**0**	1	144,000	every 4 years

Stockton CMP

Cost Estimate for CBA
Option 2 - Zone 2

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 16/06/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment - refer serarate spreadsheet for whole project area nourishment cost estimate**									
2	**Vertical Structures**									
2.1	**Stage 1**						**5,600,000**			
3.1.1	Secant pile wall (including capping beam and ground anchors)	Based on construction cost for Kingscliff Project and Rawlinsons	**m**	224	20,000	4,480,000		1	224,000	every 5 years
3.1.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for dry construction)	m	224	5,000	1,120,000		1	56,000	every 5 years
3.2	**Stage 2**						**5,725,000**			
3.2.1	Secant pile wall	Based on construction cost for Kingscliff Project and Rawlinsons	m	223	20,000	4,460,000		9	223,000	every 5 years
3.2.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	223	5,000	1,115,000		10	55,750	every 5 years
3.2.3	Accessways on piles (3 accessways 2m wide)	FRP superstructure on concrete piles. Once full length of seawall is in place this access may be needed (earliest timing)	item	3	50,000	150,000		10	7,500	every 5 years
4	**Removal and Disposal of Waste**	Provisional sum in case of discovery of General Solid Waste. No information available on quantities. Progressive removal would be required as it is exposed.	t	100	250	25,000	**25,000**	1	25,000	every 5 years
5	**Removal and disposal of carpark at the Monument**	Rawlinsons	m2	200	90	18,000	**18,000**	3	NA	

Royal HaskoningDHV
Enhancing Society Together

Stockton CMP

Cost Estimate for CBA
Option 2 - Zone 3

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 16/06/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING (YEARS)
1	**Nourishment - refer serarate spreadsheet for whole project area nourishment cost estimate**									
2	**Maintenance of SLSC revetment**									
	Current planned maintenance works	Current planned works. Based on current estimates for maintenance works	item					1	$500,000	every 2 years

Royal HaskoningDHV
Enhancing Society Together

Stockton CMP

Cost Estimate for CBA
Option 2 - Zone 4

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 16/06/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Footpaths and roadworks**						**212,500**			
1.1	Close roadway lane and create one way road on Barrie Cres with new kerb		m	200	500	100,000		1	**10,000**	every 5 years
1.2	New footpath Barrie Cres		m3	150	750	112,500		1	**11,250**	every 5 years
2	**Stage 2- Headland Structure**						**2,250,000**			
2.1	**Griffiths Avenue**	Based on Contructed cost of Stockton SLSC seawall (factored for wet construction)	**m**	75	30,000	2,250,000		5	**225,000**	every 5 years
3	**Vertical Structures**									
	Stage 1						**4,900,000**			
3.1	Barrie Crescent/Stone St/Griffiths Ave secant pile wall and and rock wedge at Mitchell St flank	Based on construction cost for Kingscliff Project/Rawlinsons	**m**	178	20,000	3,560,000		1	**178,000**	every 5 years
3.1.1	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	178	5,000	890,000		3	**44,500**	every 5 years
3.1.2	Beach access - Concrete bleachers on piles	Based on construction cost for Kingscliff Project	m	10	45,000	450,000		5	**22,500**	every 5 years
	Stage 2						**8,950,000**			
3.2	Griffiths Ave/Eames Avenue secant pile wall	Based on construction cost for Kingscliff Project	**m**	352	20,000	7,040,000		5	**352,000**	every 5 years
3.2.1	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	352	5,000	1,760,000		8	**88,000**	every 5 years
3.1.2	Accessways on piles (3 accessways 2m wide)	FRP superstructure on concrete piles. Once full length of seawall is in place this access may be needed (earliest timing)	item	3	50,000	150,000		10	**7,500**	every 5 years
4	**Remove temporary emergency geocontainer structures**						**75,000**			
4.1	Stone St structure	Sand from geocontainers to be placed on the beach	m	30	1,000	30,000				
4.2	Griffiths Ave structure	Sand from geocontainers to be placed on the beach	m	45	1,000	45,000				

Appendix C – Option 3a Cost Estimate

Stockton CMP

Cost Estimate for CBA
Option 3a - Beach Nourishment for coastal amenity

Prepared By: N Patterson
Checked By: G Blumberg

Date Issued: 01/05/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment (based on terrestrial source)**						**16,000,000**			
1.1a	Beach nourishment with sand from commercial terrestrial sources placed by trucks/dozers on subaerial beach at Holiday Park frontage via King St, constantly throughout year.	Based on costs from sand placement pilot study (Dec 2019) undertaken by SCS, as provided by Council, reduced by 20% for economies of scale	m3	200,000	80	16,000,000		1	16,000,000	yearly
	Disclaimer									

The reader should note that cost estimate presented here is based on Royal HaskoningDHV's experience and judgement as a firm of practising professional engineers familiar with the coastal and maritime construction industry. It includes construction costs only and no allowance is made for contingencies. It would be reasonable to apply an average contingency of up to 40% for design development uncertainty and unforseen and uncontrollable items, such as those relating to ground and weather conditions.
The quantities used to develop the cost estimate have been gauged from typical concept arrangements and planform measurements made using available mapping and high level aerial photography.
The construction cost estimate can NOT be guaranteed as RHDHV have no control over Contractor's prices, market forces and competitive bids from tenderers. The cost estimate is for CONSTRUCTION ONLY and excludes items which should be considered in a cost plan such as site investigation fees, environmental assessment fees, design and tendering fees, project management fees, authority approval and permitting fees, and construction site supervision, works certification and administration fees.

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Stockton CMP

Cost Estimate for CBA
Option 3a - Zone 1

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 01/05/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT ($)	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment - refer serarate spreadsheet for whole project area nourishment cost estimate**									
2	**Vertical Structures**									
2.1	**Stage 1**						**1,400,000**			
3.1.1	Secant pile wall (including capping beam and ground anchors)	Based on construction cost for Kingscliff Project and Rawlinsons	**m**	56	20,000	1,120,000		1	56,000	every 5 years
3.1.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for dry construction)	m	56	5,000	280,000		1	14,000	every 5 years
3.2	**Stage 2**						**10,650,000**			
3.2.1	Secant pile wall	Based on construction cost for Kingscliff Project and Rawlinsons	m	420	20,000	8,400,000		7	420,000	every 5 years
3.2.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	420	5,000	2,100,000		9	105,000	every 5 years
3.2.3	Accessways on piles (3 accessways 2m wide)	FRP superstructure on concrete piles. Once full length of seawall is in place this access may be needed (earliest timing)	item	3	50,000	150,000		9	7,500	every 5 years
4	**Relocation of Holiday Park Assets behind seawall**	New amenities block timing will depend on conditions and nourishment behaviour	item	1	500,000	500,000	**500,000**	3	NA	NA
5	**Maintenance of SLSC revetment**	Based on current estimates for maintenance works	m				**0**	1	144,000	every 4 years

Stockton CMP

Cost Estimate for CBA
Option 3a - Zone 2

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 01/05/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment - refer serarate spreadsheet for whole project area nourishment cost estimate**									
2	**Vertical Structures**									
2.1	**Stage 1**						**5,600,000**			
3.1.1	Secant pile wall (including capping beam and ground anchors)	Based on construction cost for Kingscliff Project and Rawlinsons	**m**	224	20,000	4,480,000		1	224,000	every 5 years
3.1.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for dry construction)	m	224	5,000	1,120,000		1	56,000	every 5 years
3.2	**Stage 2**						**5,725,000**			
3.2.1	Secant pile wall	Based on construction cost for Kingscliff Project and Rawlinsons	m	223	20,000	4,460,000		7	223,000	every 5 years
3.2.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	223	5,000	1,115,000		9	55,750	every 5 years
3.2.3	Accessways on piles (3 accessways 2m wide)	FRP superstructure on concrete piles. Once full length of seawall is in place this access may be needed (earliest timing)	item	3	50,000	150,000		9	7,500	every 5 years
4	**Removal and Disposal of Waste**	Provisional sum in case of discovery of General Solid Waste. No information available on quantities. Progressive removal would be required as it is exposed.	t	100	250	25,000		1	25,000	every 5 years
5	**Removal and disposal of carpark at the Monument**	Rawlinsons	m2	200	90	18,000		3	NA	

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Stockton CMP

Cost Estimate for CBA
Option 3a - Zone 3

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 01/05/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST AND TIMING	MAINTENANCE TIMING
1	**Nourishment - refer serarate spreadsheet for whole project area nourishment cost estimate**									
2	**Maintenance of SLSC revetment**									
	Current planned maintenance works	Current planned works. Based on current estimates for maintenance works	item					1	$500,000	every 2 years

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Stockton CMP

Cost Estimate for CBA
Option 3a - Zone 4

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 01/05/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Footpaths and roadworks**						**212,500**			
1.1	Close roadway lane and create one way road on Barrie Cres with new kerb		m	200	500	100,000		1	**10,000**	every 5 years
1.2	New footpath Barrie Cres		m3	150	750	112,500		1	**11,250**	every 5 years
2	**Stage 2 - Headland Structure**						**2,250,000**			
2.1	**Griffiths Avenue**	Based on Contructed cost of Stockton SLSC seawall (factored for wet construction)	**m**	75	30,000	2,250,000		4	**225,000**	every 5 years
3	**Vertical Structures**									
	Stage 1						**4,950,000**			
3.1	Barrie Crescent/Stone St/Griffiths Ave secant pile wall and and rock wedge at Mitchell St flank	Based on construction cost for Kingscliff Project/Rawlinsons	**m**	178	20,000	3,560,000		1	**178,000**	every 5 years
3.1.1	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	178	5,000	890,000		3	**44,500**	every 5 years
3.1.2	Beach access - Concrete bleachers on piles	Based on construction cost for Kingscliff Project	m	10	50,000	500,000		5	**25,000**	every 5 years
	Stage 2						**8,950,000**			
3.2	Barrie Cres/Griffiths Ave/Eames Avenue secant pile wall	Based on construction cost for Kingscliff Project	**m**	352	20,000	7,040,000		4	**352,000**	every 5 years
3.2.1	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	352	5,000	1,760,000		6	**88,000**	every 5 years
3.1.2	Accessways on piles (3 accessways 2m wide)	FRP superstructure on concrete piles. Once full length of seawall is in place this access may be needed (earliest timing)	item	3	50,000	150,000		6	**7,500**	every 5 years
4	**Remove temporary emergency geocontainer structures**						**75,000**			
4.1	Stone St structure	Sand from geocontainers to be placed on the beach	m	30	1,000	30,000				
4.2	Griffiths Ave structure	Sand from geocontainers to be placed on the beach	m	45	1,000	45,000				

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Appendix D – Option 3b Cost Estimate

Stockton CMP

Cost Estimate for CBA
Option 3b - Beach Nourishment

Prepared By: N Patterson
Checked By: G Blumberg

Date Issued: 16/06/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment (based on terrestrial source)**						**4,000,000**			
1.1a	Beach nourishment with sand from commercial terrestrial sources placed by trucks/dozers on subaerial beach at Holiday Park frontage via King St, constantly throughout year.	Based on costs from sand placement pilot study (Dec 2019) undertaken by SCS, as provided by Council, reduced by 20% for economies of scale	m3	50,000	80	4,000,000		1	4,000,000	yearly
	Disclaimer									

The reader should note that cost estimate presented here is based on Royal HaskoningDHV's experience and judgement as a firm of practising professional engineers familiar with the coastal and maritime construction industry. It includes construction costs only and no allowance is made for contingencies. It would be reasonable to apply an average contingency of up to 40% for design development uncertainty and unforseen and uncontrollable items, such as those relating to ground and weather conditions.
The quantities used to develop the cost estimate have been gauged from typical concept arrangements and planform measurements made using available mapping and high level aerial photography.
The construction cost estimate can NOT be guaranteed as RHDHV have no control over Contractor's prices, market forces and competitive bids from tenderers. The cost estimate is for CONSTRUCTION ONLY and excludes items which should be considered in a cost plan such as site investigation fees, environmental assessment fees, design and tendering fees, project management fees, authority approval and permitting fees, and construction site supervision, works certification and administration fees.

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Stockton CMP

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 16/06/2020

Cost Estimate for CBA
Option 3b - Zone 1

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT ($)	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment - refer serarate spreadsheet for whole project area nourishment cost estimate**									
2	**Vertical Structures**									
2.1	**Stage 1**						**875,000**			
3.1.1	Secant pile wall (including capping beam and ground anchors)	Based on construction cost for Kingscliff Project and Rawlinsons	**m**	35	20,000	700,000		1	35,000	every 5 years
3.1.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for dry construction)	m	35	5,000	175,000		1	8,750	every 5 years
3.2	**Stage 2**						**11,175,000**			
3.2.1	Secant pile wall	Based on construction cost for Kingscliff Project and Rawlinsons	m	441	20,000	8,820,000		5	441,000	every 5 years
3.2.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	441	5,000	2,205,000		6	110,250	every 5 years
3.2.3	Accessways on piles (3 accessways 2m wide)	FRP superstructure on concrete piles. Once full length of seawall is in place this access may be needed (earliest timing)	item	3	50,000	150,000		6	7,500	every 5 years
4	**Relocation of Holiday Park Assets behind seawall**	New amenities block timing will depend on conditions and nourishment behaviour	item	1	500,000	500,000	**500,000**	3	NA	NA
5	**Maintenance of SLSC revetment**	Based on current estimates for maintenance works	m				**0**	1	144,000	every 4 years

Stockton CMP

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 16/06/2020

Cost Estimate for CBA
Option 3b - Zone 2

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Nourishment - refer serarate spreadsheet for whole project area nourishment cost estimate**									
2	**Vertical Structures**									
2.1	**Stage 1**						**3,750,000**			
3.1.1	Secant pile wall (including capping beam and ground anchors)	Based on construction cost for Kingscliff Project and Rawlinsons	**m**	150	20,000	3,000,000		1	150,000	every 5 years
3.1.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for dry construction)	m	150	5,000	750,000		1	37,500	every 5 years
3.2	**Stage 2**						**7,525,000**			
3.2.1	Secant pile wall	Based on construction cost for Kingscliff Project and Rawlinsons	m	295	20,000	5,900,000		5	295,000	every 5 years
3.2.2	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	295	5,000	1,475,000		6	73,750	every 5 years
3.2.3	Accessways on piles (3 accessways 2m wide)	FRP superstructure on concrete piles. Once full length of seawall is in place this access may be needed (earliest timing)	item	3	50,000	150,000		6	7,500	every 5 years
4	**Removal and Disposal of Waste**	Provisional sum in case of discovery of General Solid Waste. No information available on quantities. Progressive removal would be required as it is exposed.	t	100	250	25,000		1	25,000	every 5 years
5	**Removal and disposal of carpark at the Monument**	Rawlinsons	m2	200	90	18,000		3	NA	

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Stockton CMP

Cost Estimate for CBA
Option 3b - Zone 3

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 16/06/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST AND TIMING	MAINTENANCE TIMING
1	**Nourishment - refer serarate spreadsheet for whole project area nourishment cost estimate**									
2	**Maintenance of SLSC revetment**									
	Current planned maintenance works	Current planned works. Based on current estimates for maintenance works	item					1	$500,000	every 2 years

Stockton CMP

Cost Estimate for CBA
Option 3b - Zone 4

Prepared By: N Patterson
Checked By: G Blumberg
Date Issued: 16/06/2020

ITEM NO.	DESCRIPTION OF WORK INCLUDED	DETAILS	UNIT	QUANTITY	RATE	SUB TOTAL AMOUNT (Sub items x.x)	TOTAL AMOUNT	TIMING FOR CAPITAL PROJECT (YEAR)	MAINTENANCE COST	MAINTENANCE TIMING
1	**Footpaths and roadworks**						**100,000**			
1.1	Create culdesac at end of Barrie and Griffiths roadways		m	200	500	100,000		1	**10,000**	every 5 years
2	**Vertical Structures**									
	Stage 1						**1,050,000**			
2.1	Barrie Crescent/Stone St/Griffiths Ave secant pile wall and and rock wedge at Mitchell St flank	Based on construction cost for Kingscliff Project/Rawlinsons	**m**	40	20,000	800,000		1	**40,000**	every 5 years
2.1.1	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	40	5,000	200,000		3	**10,000**	every 5 years
2.2	Accessways on piles (3 accessways 2m wide)	FRP superstructure on concrete piles. Once full length of seawall is in place this access may be needed (earliest timing)	item	1	50,000	50,000		6	2,500	every 5 years
	Stage 2						**11,400,000**			
3.2	Barrie Cres/Griffiths Ave/Eames Avenue secant pile wall	Based on construction cost for Kingscliff Project	**m**	450	20,000	9,000,000		4	**450,000**	every 5 years
3.2.1	Rock Toe Protection	Based on Contructed cost of Stockton SLSC seawall (factored for reduced profile)	m	450	5,000	2,250,000		6	**112,500**	every 5 years
3.1.2	Accessways on piles (3 accessways 2m wide)	FRP superstructure on concrete piles. Once full length of seawall is in place this access may be needed (earliest timing)	item	3	50,000	150,000		6	**7,500**	every 5 years
4	**Remove temporary emergency geocontainer structures**						**75,000**			
4.1	Stone St structure	Sand from geocontainers to be placed on the beach	m	30	1,000	30,000				
4.2	Griffiths Ave structure	Sand from geocontainers to be placed on the beach	m	45	1,000	45,000				

Appendix E – Terrestrial Sand Source Methodology and Costs

Memo

HASKONING AUSTRALIA PTY LTD
MARITIME & AVIATION.

To	:	City of Newcastle
From	:	RHDHV
Date	:	17/06/20
Copy	:	
Our reference	:	PA2395_StocktonCMP_TerrestrialNourishment_Option3_Final001
Subject	**:**	**STOCKTON CMP FEASIBILITY ASSESSMENT OF OPTION 3 BEACH NOURISHMENT FROM TERRESTRIAL SOURCES**

1. General

'Option 3' of the CMP includes sand nourishment from terrestrial sources, with the objective of providing the maximum sand volumes that can be reasonably sourced and placed based on current knowledge and recent experience.

This memo provides an assessment of terrestrial sand nourishment opportunities and constraints, with a view to establishing a nominal annual nourishment volume that would apply under Option 3.

2. Sand Sources

The suitability of sand for beach nourishment purposes is primarily dependent on the physical and chemical characteristics of both the native beach and source (or borrow) sand. In investigating the compatibility of potential terrestrial sand sources, RHDHV have undertaken a number of tasks as summarised below:

- assessment of the characteristics of native beach sand at Stockton Beach (based on previous investigations);
- identification of permissible criteria for the source sand;
- assessment of the potential sand sources from local quarry suppliers:
- calculation of Overfill Factors associated with the above terrestrial sand sources which have been identified as compatible.

Each of the above listed tasks is discussed in the following sections.

2.1 Characteristics of the Native Beach Material

In April 2011, WorleyParsons (2012) collected several samples of native beach sand along three transect profiles at Stockton Beach, with the transects located 900 m, 1700 m and 2500 m north of the breakwater. Median grain sizes (D_{50}) ranged from 0.27 to 0.47 mm, with finer sand generally found at the southern end. The average grain size (D_{50}) from these samples was 0.37 mm (excluding a gravelly sample collected in the nearshore zone at the northernmost transect), as shown in Figure 1.

The beach and nearshore sands extending to a depth of approximately 15 m at the southern end of Stockton Beach were described by Roy and Crawford (1980) as well to very well sorted fine to medium grained sands with grain sizes ranging from 0.18 to 0.35 mm. A uniform mean grain size of 0.25 mm was determined for beach and nearshore sands at the southern end of Stockton Beach (Roy & Crawford 1980). This grain size was used as a constant in the most recent coastal processes modelling undertaken by DHI (2006). MHL (1977) similarly found finer sands in the southern few kilometres closest to the breakwater, with many samples finer than 0.3 mm.

2.2 Nourishment Sand Criteria

Based on the characteristics of the native beach sand, assumed to be consistent in the proposed placement area with transects immediately to the north previously analysed (WorleyParsons 2012), criteria have been developed for compatible source sand for nourishment purposes. These criteria are outlined below.

The physical properties of the source material are required to meet the following technical specification criteria:

- Median Grain Size (D_{n50})
  The median grain size shall be 0.30 mm to 0.40 mm. This criterion accounts for the range of grain sizes found along the length of the beach, with progressively coarser material occurring with distance north of the breakwater. This criterion also has regard to the Coastal Engineering Manual (CERC 2006) which notes that the D_{50} of the borrow material should be within plus or minus 0.02 mm of the native sand D_{50}.
  -

- Fines Content
  - No discrete grab sample of surface or subsurface sand greater than 5 kg shall, following thorough mixing, exhibit a fines fraction greater than 5% by weight. Fine sized sediments shall be defined as being smaller than 75 microns in diameter.

- Excessively Coarse Material
  - No discrete grab sample of surface or subsurface sand greater than 50kg shall, following thorough mixing, contain a fraction greater than very coarse sand size which exceeds 2% by weight. The minimum size of very coarse sand shall be defined as 2 mm. Very coarse material may include shell.

- Colour and Composition
  - The beach nourishment material shall be comprised of carbonate and silica particles and shall not contain organic matter, demolition material or other debris.
  - The beach nourishment material shall have a colour, following placement and exposure to the elements, similar to the existing beach sand in the placement area.

2.3 Local Quarry Sand Suppliers

2.3.1 Material Properties (Previous Assessment)

Consultation with several local sand quarries was undertaken to assess the suitability of available products against material acceptance criteria. Sand products from the following local quarries were assessed:

- Macka's Sand and Soil Supplies;
- Boral Stockton Sand Quarry;
- Redisands (Salt Ash);
- Newcastle Sand (Williamtown); and
- Sibelco Sand Quarry in Salt Ash (Note: Sibelco only carry a maximum of 2,500 tonnes of their 3060 product at any one time, and orders greater than this will incur longer lead times).

Material data sheets relating to available products were provided by each of the quarries and assessed by RHDHV engineers.

Considering that all locally sourced terrestrial sands are quarried from the windblown dunes of Stockton Bight and are further processed (i.e. washed and screened), it is unlikely that these terrestrial sands would contain any contaminants, organic matter, excessive fines or excessive coarse material, or significant colour incompatibilities following placement. Therefore, the key criterion determining the compatibility of these quarried sands is the Particle Size Distribution (PSD) of the available sand products.

PSD curves for a range of sand products available from local quarries are plotted in Figure 1. It is evident that the majority of these products are characterised by a median grain size (D_{50}) ranging between around 0.30 and 0.40 mm, while two of the products comprise relatively fine sand with D_{50} values below 0.25 mm.

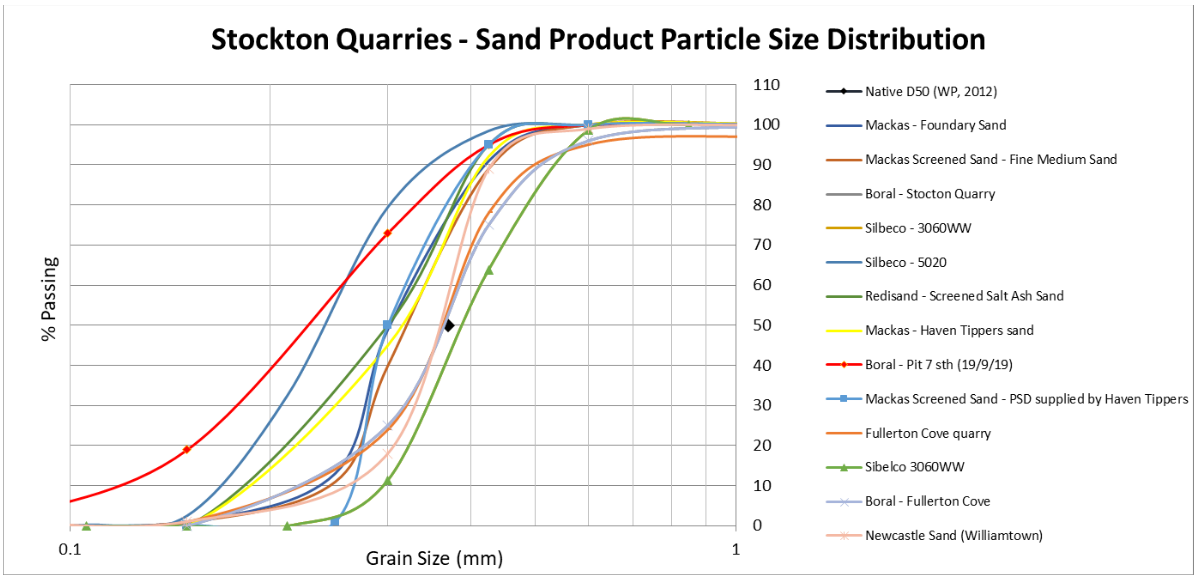

Figure 1: Stockton quarries - sand product PSDs

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Using the criterion outlined in **Section 2.2**, it is evident that the majority of sand products available from local quarries would likely be compatible for nourishment purposes at Stockton Beach (refer Figure 1).

2.3.2 Overfill Factors

The Overfill Factor or Overfill Ratio (R_A) is the ratio of fill (nourishment) material required from a given borrow site compared to that required using the existing (native) beach sediments (CERC 2006). The Overfill Factor is based on differences in the mean grain size and sorting characteristics of both the native and nourishment (borrowed) sands.

Whilst the Overfill Factors provide an indication of compatibility between borrow and native sediment, more detailed assessment of the compatibility is recommended to inform detailed project design. For example, CERC (2006) notes that:

- Recent research and beach nourishment experiences have questioned the continued use of grain-size based factors, such as R_A and the renourishment factor (R_J), to estimate beach-fill performance (Dean 2000).
- Present guidance recommends that design be based on equilibrium beach profile concepts, an assessment of storm-induced erosion, and an assessment of wave-driven longshore transport losses; and that these methods be used to replace or complement the overfill and renourishment factor approaches (National Research Council (NRC) 1995).

Nevertheless, the Overfill Factor can be used to provide a useful indication of sand volume requirements for a nourishment project, particularly in the early stages of project design. As such, this approach has been adopted for the purpose of undertaking a high-level assessment of sand volume requirements associated with the placement of local quarry sand sources at Stockton Beach.

CERC (2006) recommends that for a sand nourishment project, ideally a nourishment (borrow) sand should have an overfill ratio of 1 to 1.05 relative to the native sand. However, CERC (2006) also notes that this may not always be possible and as a rule of thumb if the median grain size of the borrow sand is within 0.02 mm of the native sand median grain size it is considered compatible.

Overfill Factors were calculated for several of the potential quarry sand sources using methods outlined in the Shore Protection Manual (CERC 1984). The WorleyParsons (2012) grain size data was used to characterise the native beach sands for these calculations (mean grain size, D_{50} = 0.37 mm or 1.43 phi units). Overfill Factors typically ranged from 1.8 to 5 for quarries carrying larger quantities of sand (suitable for a nourishment campaign at Stockton). This indicates that the median grain size of quarry sand sources is generally finer than the native sand requiring 1.8 to 5 times as much sand to retain each 1 m^3 on the beach. It should be noted that some products were in the unstable range (R_A > 10).

Based on the above, an Overfill Factor of approximately 2.5 is recommended for adoption in the CMP for the purpose of assessing terrestrial sand nourishment at Stockton Beach using quarry sand sources. It is also recommended that a sensitivity analysis be carried out in the CBA using an Overfill Factor of 1. The Overfill Factor would need to be reviewed on a case by case basis during any future nourishment works in consideration of the material properties of proposed sand nourishment material.

2.3.4 Licensed Extractive Capacity

The extractive capacity of local quarries is stipulated in the Environment Protection Licences (EPLs) issued to each facility. For example, EPL 10132 for Boral Quarries Stockton (Fullerton Cove) authorises an annual sand extraction of 100,000 to 500,000 tonnes. The current annual extractive capacities licensed for each of the local quarries considered herein are listed in **Table 1**.

Table 1: Local Quarry Licensed Extractive Capacity

Quarry Sand Source	EPL Number	Annual Extractive Capacity (tonnes)[1]	Annual Extractive Capacity (m^3)[1]
Boral Stockton (Fullerton Cove)	10132	500,000	300,000
Macka's Sand and Soil (Salt Ash)	12108	50,000	30,000
Sibelco (Oyster Cove)	11633	150,000	90,000
Newcastle Sand (Williamtown)	21264	500,000	300,000
Redisand (Salt Ash)	13406	500,000	300,000
TOTAL	**-**	**1.7 M tonnes**	**1,020,000 (sourced) 408,000 (effective)[2]**
Assumed availability for nourishment of Stockton Beach	**20% of total licensed quantities**	**340,000 tonnes**	**200,000 (sourced) 80,000 (effective)[2]**

[1] Maximum quantity that can be extracted, processed or stored annually.

[2] Effective in situ volume of quarry sand following placement, based on adopted overfill ratio of 2.5.

Based on preliminary enquiries made with Boral Stockton (Fullerton Cove), it is understood that annual extractive operations are typically within around 15,000 tonnes of the upper licensed limit of 500,000 tonnes. For the purpose of the assessment undertaken herein, it has been assumed that up to around 20% of the current annual combined extractive capacity of 1.7 million tonnes could be secured for terrestrial sand nourishment at Stockton Beach (refer **Table 1**). This would require detailed negotiations with each quarry to secure such a substantial portion of their licensed quantities, confirmation that suitable products can be made available, and (potentially) modifications to the existing EPLs.

Therefore, it has been assumed that local quarry sources are currently capable of supplying 340,000 tonnes annually for the purpose of nourishing Stockton Beach, which is equivalent to a supplied volume of around 200,000 m^3. Based on the adopted overfill ratio of 2.5, the effective quantity of nourishment sand that could be placed on Stockton Beach is around 80,000 m^3 per year.

3. Methodology

3.1 General

The amount of nourishment sand placed in a single trucking campaign will be limited by budgetary constraints, environmental impacts of the trucking operations and how much sand can practically be accommodated on the sub-aerial beach.

The following is considered the most effective placement methodology given the current site constraints and opportunities. This approach was adopted for the December 2019 pilot exercise.

- nourishment sand trucked to the relevant project site (refer **Section 3.3**) and stockpiled in designated areas;
- an excavator loads sand into 40T site dump trucks for haulage on the beach;
- sand placed on the beach within the placement zone; and
- sand shaped using an excavator and/or D6 dozer to achieve the design beach profiles.

It should be noted that any lowering of the dune during the placement activities would need to be reinstated and revegetated at the conclusion of the works.

The finished sand profile will extend from the erosion scarp at the back of the beach down to the low water mark (or as close as practically possible) – refer to design profiles in **Section 3.1.2**. Within a 9-hour workday a high and a low tide will be encountered (~6 hrs apart). Strategic placement should therefore be undertaken by placing sand in the upper beach during higher tides and the lower beach during low tides. Material should also be initially placed on the upper beach area if access to the lower beach is problematic, then later redistributed by dozer/excavator when conditions are favourable.

When water levels are extreme (due to king tides or storm surge) or wave conditions are severe and wave runup prevents safe access onto the beach for trucks, construction downtime will occur. It is difficult to predict how the construction period will be affected by these factors.

Typically, in the summer months conditions are generally calmer though king tides do occur. The state of the beach will also affect the accessibility i.e. if the beach is particularly eroded and low level, the window of opportunity will be reduced, whereas if the beach has accreted and built up to some extent, the impact of tides and waves will be reduced.

3.2 December 2019 Pilot Exercise

A small pilot nourishment campaign was undertaken by Soil Conservation Services (SCS) in December 2019 using trucks and bulldozers in front of the Holiday Park. The nourishment exercise comprised:

- 5564 tonnes sand delivered to site. (equivalent to 3500 m^3 placed volume);
- Cost $389,753.10 GST inclusive. (approximately $100/m^3 ex GST);
- 173 loads to site – 32 T per truck and dog;
- approximately 346 truck movements.

The works were completed within a four (4) day period. Photographs taken during and immediately following the December 2019 nourishment exercise are provided in **Figure 2** and Figure 3.

Figure 2: December 2019 nourishment activity in progress (date: 10/12/19)

Figure 3: December 2019 nourishment activity upon completion (date: 12/12/19)

3.3 Project Sites

It should be noted that the existing narrow beach widths in locations such as the Mitchell St and SLSC revetments would make it very difficult for machinery to access the full length of the study area. It may be necessary to end tip in other locations where access is limited. Sand placement may be required updrift of these narrow locations, with coastal processes relied on to subsequently distribute nourishment sand to these areas. Eventually, these sections may become wide enough to accommodate access for plant and machinery.

Based on the above, it has been assumed that machinery would not be able to access the sections of beach immediately seaward of the existing protective structures (SLSC and Mitchell St). Therefore, it would be necessary to provide project sites either side of these structures. This would also allow for truck movements and other construction activities to be more evenly distributed within the study area, which would lead to a more favourable amenity outcome. For example, the King St and Dalby Oval sites could operate on an alternate basis to ensure that significant sections of beach are available for recreational purposes at any given time.

Proposed project sites are summarised in **Table 2**. The lengths of shoreline that machinery could access from each project site are also listed in **Table 2**. The total length of shoreline that could be accessed by machinery is around 1,500 m (Note: the total shoreline length that requires nourishment sand is around 2,200 m, which extends from the breakwater to just north of Meredith St).

Table 2: Nourishment Project Sites

Project Site	CMP Zone	Accessible shoreline length	Comment
King St	Zone 1	500 m	Project site utilised during December 2019 Pilot Exercise (refer **Figure 4**). Could operate on an alternate basis with Dalby Oval site.
Dalby Oval	Zone 2	350 m	Construction of beach access thoroughfare through the dune would be required. Could operate on an alternate basis with King St site.
Corroba Oval	Zone 4	650 m	Construction of beach access thoroughfare through the dune would be required. Possibility of establishing sand pumping system at this location (refer **Section 3.6**).
TOTAL		**1,500 m**	Excludes sections of beach seaward of existing revetments (SLSC, Mitchell St). Entire length of study area shoreline is 2,200 m.

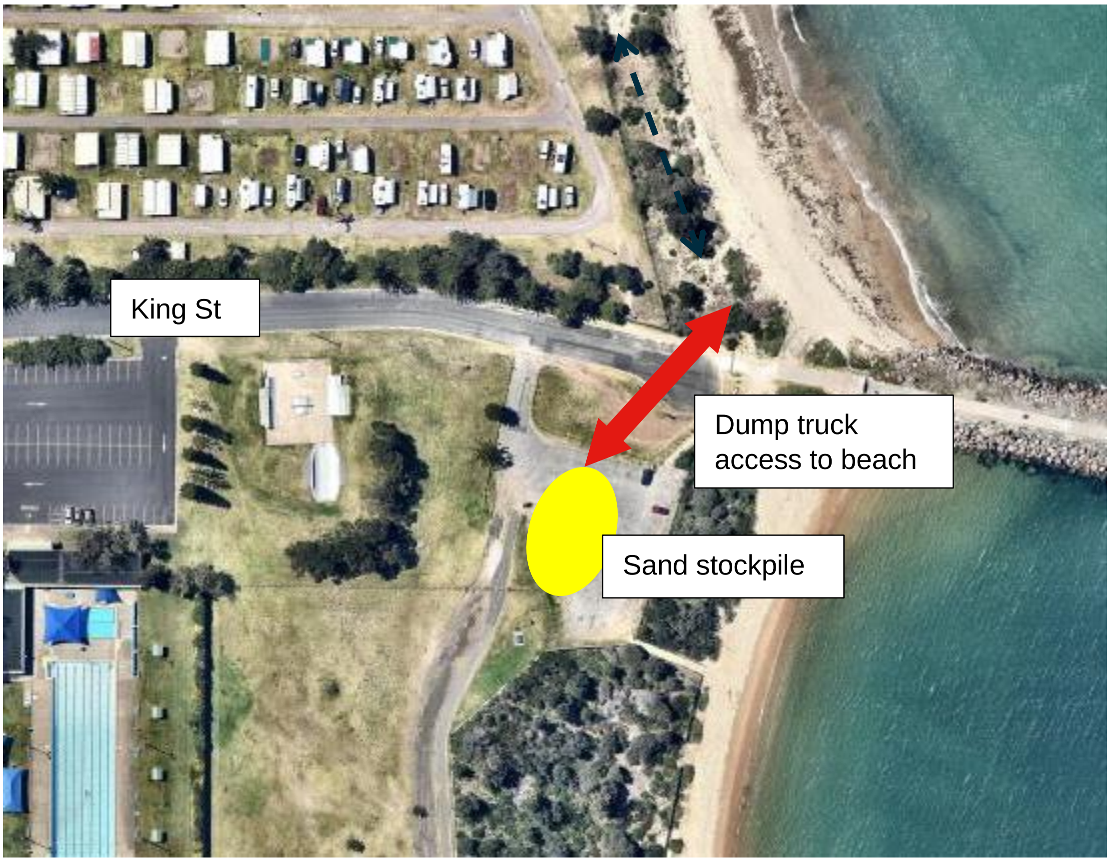

Figure 4: King St Site Plan (December 2019 Pilot Exercise)

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3.4 Design Profiles

Terrestrial nourishment using land-based plant would be limited to the sub-aerial beach above 0m AHD. The objective of the design profile would be to nourish the full sub-aerial beach width while limiting the potential erosion scarp height formed as the new material was eroded. In practical terms, the design profile would also aim to build up sand volumes at the back of the beach where it has the best chance of being retained for a longer duration on the beach and providing a buffer to mitigate coastal erosion hazard (storm demand).

An example of a typical design profile for the sand placement is shown in **Figure 5**.

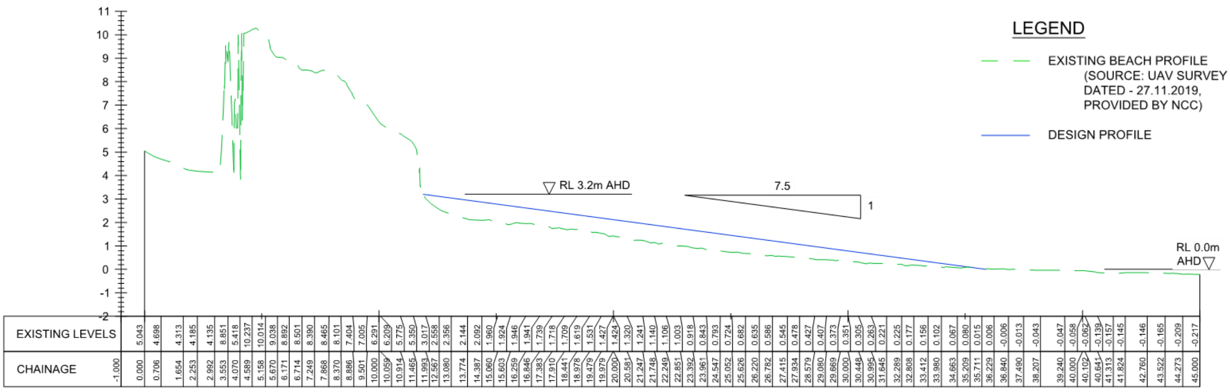

Figure 5: Example of a typical design beach profile (December 2019 campaign)

Based on an assessment of current beach widths (measured from the base of the dune to the RL 0 shoreline position), an average beach width of around 30 m is estimated for the sections of shoreline that are accessible to machinery (refer **Table 2**). RHDHV estimate that the volume of sand that can be practically accommodated on the sub-aerial portion of Stockton Beach in a single campaign is approximately 30 m^3/m, based on a maximum placement depth of 1 m. Higher placement rates would result in the formation of steep scarps that may result in public safety issues. Over the entire 1,500 m length of accessible shoreline, this equates to a total maximum nourishment volume of 45,000 m^3 for a single nourishment campaign.

Additional sand could be subsequently placed at intervals once coastal processes have redistributed the sand down the beach profile and alongshore. The capacity of subsequent nourishment campaigns would be expected to increase as more sand begins to ‘fill in’ the active beach profile and the beach widens compared to present conditions. Based on an assumed beach widening of up to around 5 m, and a typical placement depth of 1 m, it is estimated that an additional 5 m/m^3 could be placed on the beach at this time.

Based on the above, RHDHV estimate that, under a future widened beach condition, the maximum volume of sand that can be practically accommodated on the sub-aerial portion of Stockton Beach in a single campaign is approximately 35 m^3/m. Over the entire 1,500 m length of accessible shoreline, this equates to a total maximum nourishment volume of around 50,000 m^3 for a single nourishment campaign.

The timing between nourishment campaigns would depend on the rate of sand redistribution from the sub-aerial beach and across the overall beach profile. Following the December 2019 nourishment exercise undertaken in front of the Holiday Park, it was observed that the nourishment material was largely lost from the subaerial beach (with the exception of a small proportion of material at the very back of the beach) within the six-week period. During this period, conditions were moderate with no significant swell events (H_s typically less than 1.5 m).

These observations suggest that the rate of redistribution of subaerial nourishment placements is quite rapid (i.e. in the order of weeks to months), and that subsequent nourishment campaigns could be carried out in reasonably quick succession. However, it is expected that the rate of redistribution would decline with each nourishment campaign as more sand begins to 'fill in' the active beach profile.

In summary:

- **It is considered reasonable to assume that a maximum of one terrestrial nourishment campaign comprising 50,000 m^3 could be physically accommodated on the beach every three months.**
- **In practical terms, this would be expected to comprise multiple 'sub-campaigns' carried out from the three project sites at different times within each three-month period.**
- **A total of four (4) nourishment campaigns could be undertaken in a single year.**
- **Therefore, the total nourishment volume that could be physically accommodated on the beach each year is approximately 200,000 m^3.**
- **However, based on the adopted overfill ratio of 2.5, the effective quantity of nourishment sand that could be placed on Stockton Beach is around 80,000 m^3 per year.**
- **It is noted that these values are consistent with the sand quantities available from local quarries (refer Section 2.2.4).**

3.5 Logistical Constraints

As noted above, the maximum volume of terrestrial nourishment that could be physically accommodated on the beach in a single campaign is estimated to be around 50,000 m^3. Four (4) campaigns per year could be undertaken (i.e. approximately one campaign every three months). For the purpose of this assessment, it has been assumed that each nourishment campaign would be evenly spread across the three (3) project sites, i.e. approximately 17,000 m^3 at each site per campaign.

As noted in **Section 3.1.2**, the December 2019 campaign involved the placement of around 3,500 m^3 over a 4-day period. Assuming a five-day working week to avoid the need to undertake placement works on the weekend when public usage is highest, a weekly placement rate of around 4,400 m^3 is considered to be feasible. It is understood that the level of truck activity during the December 2019 operations was generally acceptable, although the short duration of this activity must be acknowledged.

The required project duration to place 17,000 m^3 of sand from each project site at a rate of 4,400 m^3/week is around four (4) weeks. This would be expected to provide sufficient flexibility for CN to manage trucking operations within each three (3) month campaign period without needing to

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increase the level of truck activity above the December 2019 levels. Example scenarios include (but are not limited to):

1. each project site could operate on a standalone basis of one (1) month each during each three (3) month campaign period; or,
2. the Corroba Oval site could operate concurrently with either of the other sites, which would permit project operations to be completed within a two (2) month period.

Council have stated that nourishment activities should not be undertaken during the school holiday periods, as well as public holidays and weekends. In each year, the available time to undertake nourishment activities is up to nine (9) months. Scenario 2 listed above involves trucking operations two out of every three months, or eight (8) months per year. This approach would be consistent with Council's stated objective.

Overall, it is considered that the level of truck activity required to place the available volumes of nourishment sand would not exceed the December 2019 conditions. Furthermore, operational scenarios are possible that would enable nourishment activities to cease during school holiday periods. As such, the proposed level of truck activity is not considered to be a significant constraint from a technical feasibility perspective, however the long-term nature of the works and associated impacts should be investigated further.

3.6 Alternative Sand Delivery Mechanism (Corroba Oval)

It may be worthwhile considering the option of delivering sand from the Corroba Oval project site via a slurry pumping system as an alternative to trucking along the beach. It is envisaged that the other project sites (King St and Dalby Oval) would operate concurrently as trucking sites as described above. Several potential advantages are associated with this option, including (but not limited to):

- pumping facilities may offer economies of scale benefits (subject to further assessment);
- avoids the need to truck sand along the beach and the associated safety and amenity impacts;
- increased flexibility around timing and rate of nourishment activities because the physical space constraints outlined in **Section 3.4** would not apply.

In addition to having trucks transporting sand directly onto the beach via the King St and/or Dalby Oval project sites, trucks would transport sand to a sand pumping station established near Corroba Oval. The sand would be pumped as a slurry via a buried pipeline to outlets at Dalby Oval frontage and Barrie Cres frontage.

A trial diesel pumping station and pipeline with a 100,000 m^3/year capacity could be established with a 5-year operational contract. RHDHV estimate the costs set out below for this option (based on 85,000 to 100,000 m^3 per year, with the remaining 100,000 to 115,000 m^3 delivered via trucking from the other two project sites).

3.6.1 Backpassing Costs

The estimated costs are set out below for this backpassing option.

For a trial diesel system (100,000 m^3/year capacity over a 5-year contract):

Capital Cost:

Mobilisation	$ 1.6M
Demobilisation	$ 0.35M
Total	**$ 1.95M**

Recurring Costs

Operating costs	$390,000/year ($32,500/month)
Unit rate for sand	$750,000/year ($7.5/m^3 for 100,000 m^3/year)
Power	$220,000 ($2.2/m^3)
Total	**$1.36M**/year for 5 years

For a permanent electrical system (85,000 m^3/year capacity):

Capital Cost:	**$4.5M**
Recurring Costs:	**$8/m^3** (operating costs including maintenance, power and unit rate for sand)

<u>Summary</u>

For the purpose of the present assessment to inform the Stockton CMP, it has been assumed that a trial diesel system (100,000 m^3/year capacity over a 5-year contract) would initially operate as per the details set out above. This would deliver 500,000 m^3 of nourishment over the first five years at an average cost rate of around $17.50/m^3.

A permanent system with an appropriate pumping capacity would then be installed, based on annual pumping requirements. A capital cost of around $4.5 million plus an ongoing rate of around $8/m^3 would apply for this option. However, further investigations would be required to assess the feasibility of pumping systems able to keep pace with the Bluecoast (2020) high estimated recession rates of 112,000 m^3/year.

These volumes would inevitably lead to adverse impacts at the borrow site, which would require further investigations.

As such, it is considered that this backpassing option may be constrained by:

- the maximum quantity of material that can be sourced from the borrow area without yielding adverse impacts;
- existing land zoning and regulatory provisions, although noting that sand would be sourced within the Newcastle LGA which would be expected to simplify the approvals process; and,
- pumping capacity of the permanent system, which may struggle to achieve maximum required rates of 112,000 m^3/year, subject to further investigations.

4. References

CEM (2006), *Coastal Engineering Manual*, U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, MS.

CERC (1984), *Shore Protection Manual*, Coastal Engineering Research Center. Waterways Experiment Station, US Army Corps of Engineers, Vicksburg, Mississippi.

WorleyParsons (2012), Stockton Beach Sand Scoping and Funding Feasibility Study, prepared for City of Newcastle. Report No. 301015-02514, April.

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Appendix F – Marine Sand Source Methodology and Costs

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Addendum to Technical Note: RHDHV input information for a Cost Benefit Analysis for Stockton Beach (marine sand sources)

1 Background

In line with the Coastal Management Act 2016 and the NSW Coastal Management Manual Part A (the Manual), a Cost Benefit Analysis (CBA) will be undertaken in order to inform a Coastal Management Program (CMP) for Stockton Beach. The location under consideration is limited to between the area north of the Stockton Breakwater (northern training wall of the Hunter River), and the northern boundary of Meredith Street. This technical note describes input parameters for potential coastal management actions that include access to subaqueous marine sources of sand to be considered within the Cost Benefit Analysis.

While noting that marine sand sources are not currently available, there may be opportunities to access these sources into the future. City of Newcastle (CN) have requested that RHDHV provide estimates of costs and recommendations as to the potential methodology required to undertake provision of marine sands as a coastal management action. It is recommended that the cost estimates provided within this report are considered within the CBA, in order to quantify the alternative approaches to beach nourishment should such sources become available.

2 General Information

There are two basic approaches being considered for the supply of marine sand that will be described in further detail:

1. Offshore marine source accessed by a Trailing Suction Hopper Dredger (TSHD) method.
2. Inshore ‘Marine’ source in the South Arm of the Hunter River accessed by a Cutter Suction Dredger (CSD) method.

A TSHD is a self-propelled ship which is mainly used for dredging loose and soft soils such as sand, gravel, silt or clay. TSHDs have a hull in the shape of a conventional ship and are both highly seaworthy and able to operate without any form of mooring or spud. They are equipped with either single or twin (one on each side) trailing suction pipes. A pump system sucks up a mixture of sand or soil and water and discharges it into the ‘hopper’ or hold of the vessel.

The hopper can be emptied in a nearshore location by opening the doors or valves in the hopper bottom (“bottom dumping”), by using the dredging pump to deliver material to shore through a floating pipeline, or by projecting material towards the shore using a special bow jet. This latter method of placement is commonly referred to as “rainbowing”, whereby sand is sprayed in a high arc towards the deposition location, resembling a sand-coloured rainbow.

The measure of size of a TSHD is the hopper capacity, which may range from a few hundred cubic metres to over 40,000 m³. Through consideration of the site conditions and industry knowledge, four vessels ranging in size from 1,850 m³ to 20,000 m³ have been selected to undertake comparative analysis of scale, placement methods and cost.

A CSD is a stationary dredger which makes use of a rotating cutter head at the suction inlet to loosen the material to be dredged. The dredged material is usually sucked up by a wear-resistant centrifugal pump and discharged either through a pipeline to the shore (more typical) or into barges.

A CSD operates by swinging about a central working spud using two fore sideline wires leading from the lower end of the ladder to anchors. By pulling on alternate sides the dredger clears an arc of cut, and then moves forward by pushing against the working spud using a spud carriage. A generally smooth bottom can be achieved, and accurate profiles and side slopes are able to be dredged.

The size of a CSD is measured by the diameter of the suction pipe and by the installed machinery power. Pipe diameters generally range from 100 mm to 1,500 mm, and booster stations are utilised to improve productivity over longer pumping distances. Through consideration of site conditions and industry knowledge, four pipe diameters ranging from 500 mm to 900 mm and use of between one and three boosters have been selected to undertake comparative analysis of efficiency and cost.

3 Assumptions for TSHD

The following assumptions are made for offshore sand sources.

1. Adequate and appropriate offshore sand sources (borrow areas):
   - are available within 7.5 nautical mile sailing distance of the site
   - comprise areas where no rock or wrecks are shown on Admiralty Charts
   - contain minimal amount of fines[1] (<2%), noting that grainsize at the borrow area would need to be established by sampling.
   - are to be dredged by Trailing Hopper Suction Dredge (TSHD) methodology, with comparison of potential plant shown in **Table 1**
   - overflowing from the hopper to be allowed during dredging to maximise solids (sand) content in the hopper.

TSHD Sub-Options - Distances to Stockton Beach

- Bottom Dumping– suggested vessel including capacity and closest distance to the low water line at Stockton Beach
  - TSHD Albatros - 1,850 m³ capacity, 250-350 m

[1] Fines is the collective term given to particle sizes less than 0.075mm (75 microns) and comprise silts and clays.

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- TSHD Balder R - 6,000 m³ capacity, 500-600 m
- TSHD Volvox Asia - 10,000 m³ capacity, 1000-1150 m
- TSHD Rotterdam - 20,000 m³ capacity, 1200-1400 m

- Rainbowing – suggested vessel including capacity and closest distance to the low water line at Stockton Beach
  - TSHD Albatros - 1,850 m³ capacity, 200 m
  - TSHD Balder R - 6,000 m³ capacity, 450 m
  - TSHD Volvox Asia - 10,000 m³ capacity, 950 m
  - TSHD Rotterdam - 20,000 m³ capacity, 1150 m

Table 1 – Comparison of potential plant

Reference / Example Vessel	Rotterdam	Volvox Asia	Balder R	Albatros
TSHD Hopper Capacity m³	20,000	10,000	6,000	1,860
Installer Power kW	27,500	12,500	11,000	2,500
Loaded Draft m	11	10	7	4
Max Dredging Depth m	40-70-100	35	65	30
Distance: Pipeline along beach m	1300	1300	1300	1300
Distance: Pump-out to Stockton Beach m	1600	1250	900	500
Suitability of plant option	Y	Y	Y	Y NOTE: Marginal suitability due to potential water depth at sand source

2. Nourishment volumes of 500,000, 2,000,000 and 3,500,000 m³ have been used as input figures.

3. All Options Costs based on:
   - Working hours 24x7
   - No GST included
   - All costs are in 2019-dollar rates
   - Mobilisation/demobilisation costs are shared with one other proponent/project (e.g. Collaroy, Gold Coast.)

4. For direct placement and delivery of sand on the beach, there are 2 options:
   - Offshore connection in Stockton Bight by floating hose, submerged line to shore connection and Y-pieces on shore for spreading (all pump-out TSHDs), or;
   - An Inshore connection along the bank of the Steelworks Channel off Stockton Ferry Wharf (for large TSHD unit) or along the Hunter River near Stockton Boat Harbour (for TSHD of Albatros size) with floating line to the foreshore and landlines to the section of beach to be nourished (possibly bridge over road or trenching under the road or along foreshore)

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4 Considerations

There are a number of variable factors that require consideration before providing recommendations for inclusion within a CBA. It is recognised that the objective of the nourishment program is a key factor, as this will guide design of sand placement, selection of methodology and plant, as shown in **Table 2**.

Table 2: Relative methodologies for sand placement

Method / benefit & cost	Placement	Constraint	Cost
THSD - Bottom Dumping	Nearshore	Vessel draft	Lowest
TSHD - Rainbowing	Nearshore	Vessel draft	Moderate
TSHD – Pumping	Onshore		High
CSD - Pumping	Onshore		Highest

It is understood that the desired beach state following works would be a combination of subaerial sand and subaqueous sand, requiring placement of sand in onshore and nearshore locations. It is considered likely that a combination of placement methods would be utilised to achieve the desired beach profile.

As a general guide, utilization of larger capacity plant will result in decreased costs per m^3 of sand, however larger vessels may be constrained by laden draft when seeking to place sand by bottom dumping and rainbowing, limiting how close they can safely approach the beach. The southern section of Stockton Beach is relatively shallow as shown in **Figure 1**, restricting the ability of deeper draft vessels (e.g. Volvox Asia and Rotterdam) to bottom dump in nearshore areas closer to the beach and therefore also requiring the use of more expensive placement methods.

Smaller vessels such as the Albatros provide the greatest flexibility for nearshore placement due to their shallow laden draft of 4m, however their smaller capacity requires significantly more vessel movements to the borrow area, adding to cost. In addition, this size vessel also has limitations in terms of maximum dredging depth to access marine sands (maximum dredging depth of 30 m – refer **Table 1**). Due to this combination of factors, it is considered that a mid-size TSHD such as the Balder R with a fully laden draft of 7 m would provide the widest range of benefits for nourishment of Stockton Beach.

Figure 1: 2018 AHD depth contours (Source: Bluecoast 2020)

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5 Cost Estimates for TSHD

Based on the discussion above, cost estimates and durations have been developed for a TSHD vessel of 6,000m³ capacity, for three modes of placement (bottom dumping, rainbowing, and pumping onshore) across three nominal quantities (500,000, 2,000,000 and 3,500,000 m³) as shown in **Table 3**.

Table 3: Cost estimates by placement mode and quantity

OPTIONS	Hopper capacity m³	Destination	Quantity m³	Rate $/m³	Cost for Dredging $	Mob/Demob $	All Incl rate $/m³	Total cost per campaign $	Duration (weeks)
TSHD - Bottom Dumping	6,000	Nearshore	**500,000**	7.13	3,562,500	5,100,000	17.33	**7,800,000**	2.5
TSHD - Rainbowing	6,000	Nearshore	**500,000**	10.50	5,250,000	5,100,000	20.70	**10,350,000**	3.5
TSHD - Pumping	6,000	Onshore	**500,000**	14.25	7,125,000	6,200,000	26.65	**13,325,000**	5.0
TSHD - Bottom Dumping	6,000	Nearshore	**2,000,000**	7.13	14,250,000	5,100,000	9.68	**19,350,000**	9.5
TSHD - Rainbowing	6,000	Nearshore	**2,000,000**	10.50	21,000,000	5,100,000	13.05	**26,100,000**	14.0
TSHD - Pumping	6,000	Onshore	**2,000,000**	14.25	28,500,000	6,200,000	17.35	**34,700,000**	17.5
TSHD - Bottom Dumping	6,000	Nearshore	**3,500,000**	7.13	24,937,500	5,100,000	8.59	**30,037,500**	16.5
TSHD - Rainbowing	6,000	Nearshore	**3,500,000**	10.50	36,750,000	5,100,000	11.96	**41,650,000**	24.0
TSHD - Pumping	6,000	Onshore	**3,500,000**	14.25	49,875,000	6,200,000	16.02	**56,075,000**	30.5

As noted previously, during a large scale offshore sand nourishment campaign it is likely that a suite of placement methods would be used to create the desired beach profile. This is termed ‘profile nourishment’ and seeks to create the natural beach profile from the outset so as to minimise cross shore redistribution of the placed sand.

For a nominal campaign of 3,500,000 m³, it is considered likely that approximately 55% of material may be able to be placed in the subaqueous zone by bottom dumping, a further 30% by rainbowing, and the remaining 15% by pumping to the subaerial onshore zone. **Table 4** provides an estimated total cost of a combined method profile nourishment campaign from an offshore sand source using a 6,000 m³ hopper capacity TSHD.

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Table 4: Cost estimates for nominal 3,500,000 m^3 sand nourishment campaign using 6,000 m^3 TSHD

OPTIONS	Hopper capacity m^3	Destination	Quantity m^3	Rate $/$m^3$	Total cost per campaign $	Duration (weeks)
TSHD - Bottom Dumping	6,000	Nearshore	2,000,000	7.13	14,250,000	9.5
TSHD - Rainbowing	6,000	Nearshore	1,000,000	10.50	10,500,000	7
TSHD - Pumping	6,000	Onshore	500,000	14.25	7,125,000	5.0
Mobilisation / Demobilisation					6,200,000	
Total:			**3,500,000**		**38,075,000**	**21.5**

6 Assumptions for CSD

The following assumptions are made for the inshore sand source.

1. Adequate and appropriate inshore sand source:
   - is available within the South Arm of the Hunter River below the Tourle Street Bridge
   - control of fines (<75 microns) and grainsize will be subject to the levels in available Soil Reports, with limited options to search for cleaner sand
   - are to be dredged by Cutter Suction Dredge (CSD) methodology.

2. Nourishment volumes of 500,000, 2,000,000 and 3,500,000 m^3 have been used as input figures.

3. All Options Costs based on:
   - Working hours 24x7
   - No GST included
   - All costs are in 2019-dollar rates
   - Mobilisation/demobilisation costs are shared with one other proponent/project (e.g. a commercial/port development project in the South Arm)
   - No cost or time has been included for removing contaminated or clean silts at existing surface levels in the river, i.e. silts which overly the sand to be accessed for nourishment

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7 Cost Estimates for CSD

It is noted that the CSD option is recommended for consideration if inshore (Hunter River South Arm) sources become available. Dredging utilising a CSD would be a more costly exercise, if all mobilisation / demobilisation costs are included, although the option offers some benefits in terms of duration, as shown in **Table 5**. Mob/demob costs are relatively high due to the long pumping distance involved (pipework and boosters).

In practice, the sand in the South Arm of the Hunter River would likely only be sourced on an opportunistic basis in concert with a major commercial development in the South Arm, in which case the mob/demob costs would be defrayed. In addition, as the CSD supplies sand to the onshore beach (and inner nearshore through relatively rapid redistribution), it may best form a part of a hybrid approach to nourishment.

Table 5: Cost estimates for Hunter River sourced sands by CSD (Two most cost effective options for each nominal dredge volume)

Options - CSD incl Boosters	Diameter pipe	Destination	Quantity m^3	Rate $\$/m^3$	Cost for Dredging $	Mob/Demob $	All Inclusive rate $\$/m^3$	Total cost per campaign $	Duration (weeks)
2-3 Boosters	500	Onshore	500,000	21.50	10,750,000	6,500,000	34.50	17,250,000	7.5
2 Boosters	600	Onshore	500,000	17.50	8,750,000	8,250,000	34.00	17,000,000	4.5
1 Booster	850	Onshore	2,000,000	14.50	29,000,000	14,000,000	21.50	43,000,000	8.8
1 Booster	900	Onshore	2,000,000	10.50	21,000,000	18,000,000	19.50	39,000,000	5.0
1 Booster	850	Onshore	3,500,000	14.50	50,750,000	14,000,000	18.50	64,750,000	22
1 Booster	900	Onshore	3,500,000	10.50	36,750,000	18,000,000	15.64	54,750,000	12.5

APPENDIX B – MASS NOURISHMENT BUDGETARY ESTIMATES

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Technical Note

To: City of Newcastle
From: Evan Watterson
Copy:
Reference: P19028_NourishmentRates_TN0.0
Date: 18 June 2020
Subject: Nourishment costs from offshore marine sand sources

---

1 Introduction

In line with the Coastal Management Act 2016 and the NSW Coastal Management Manual Part A (the Manual), the City of Newcastle (CN) are preparing a Coastal Management Program (CMP) for Stockton Beach. This technical note describes the nourishment costs from non-terrestrial sources used in the cost benefit analysis (CBA) for the Stockton CMP. It supplements the information in Royal HaskoningDHV's *Addendum to Technical Note: RHDHV input information for a Cost Benefit Analysis for Stockton Beach (marine sand sources)*, dated 15 April 2020, referred to herein as RHDHV's memo.

2 Background information

RHDHV's memo outlines two basic approaches including the dredging methods that can be used for beach nourishment from non-terrestrial sand sources as offshore marine sand sources and estuarine (Hunter River) sources and the reader is referred to this document for further information. Based on the assumptions and consideration outlined in the memo, RHDHV developed cost estimates.

To supplement this information Bluecoast Consulting Engineers (Bluecoast) consulted dredging contractors who operate the types of Trailer Hopper Suction Dredgers that could potentially undertake the initial and on-going mass nourishment works at Stockton using offshore marine sand sources. Noting that, at present, there is a range of legislative issues associated with this sand source that would prevent its implementation.

Based on the assumption outlined below the experienced dredging contractors provided budgetary estimates which were then used as supplementary inputs to inform cost sensitivity to capital and maintenance nourishment programs in the CBA.

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3 Assumptions

The assumptions used to inform budgetary estimates were:

1. Native Stockton Beach sand is D50 = 0.35 to 0.40mm.
2. Nourishment sand source was assumed to be nearby (within 5NM) and offshore in depth less than 28m.
3. Placement is all nearshore but as close as possible to the shore, adopting:
    - 75% rainbowed
    - 25% is bottom dumped.
4. Total quantities ranging across:
    - 1.8M m^3 – as one-off mass nourishment; or
    - 2.4M m^3 – as one-off mass nourishment; or
    - 3.0M m^3 – as one-off mass nourishment; and
5. Optional – 5-10-yearly repeated nourishments of between 120,000m^3 and 1.0M m^3.

4 Nourishment rates

The budgetary rates provided in Table 1 are believed to represent realistic costs for the delivery of beach nourishment sand to Stockton Beach from potentially available offshore marine sand sources. The cost estimate cannot be guaranteed as Bluecoast have no control over tender prices, market forces and competitive bids from tenderers.

Table 1: Nourishment rates for CBA cost sensitivity analysis

Initial or maintenance nourishment campaign (2020)					
Nourishment volume (m^3)	0.12M m^3	1.0M m^3	1.8M m^3	2.4M m^3	3.0M m^3**
Mobilisation and demobilisation costs*	\$0.6M-\$4M	\$0.6M-\$4M	\$0.6M-\$4M	\$0.6M-\$4M	\$0.6M-\$4M
Rainbow rate (\$/m^3)	\$6.50	\$7.00 - \$8.00	\$7.00 - \$8.00	\$7.00 - \$7.50	\$7.00 - \$8.00
Bottom dumping rate (\$/m^3)	\$6.00	\$6.00 - \$7.00	\$6.00 - \$7.00	\$6.50	\$6.00

* Mobilisation and demobilisation costs can vary substantially depending on the location of the dredgers at the time of tendering the works.

** As a comparison the 2017 Gold Coast Mass Nourishment project delivered just over 3M m^3 of sand for a total cost of \$13.9M, or a combined rate of \$4.63/m^3. Most of the sand was rainbowed to the surf zone.

APPENDIX C – ASSET PROTECTION RISK AND BEACH NOURISHMENT

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Technical Note

To:	City of Newcastle
From:	Evan Watterson and Heiko Loehr
Copy:	
Reference:	P19028_NourishmentRisks_TN1.0
Date:	18 June 2020
Subject:	Risks associated with the use of mass nourishment for coastal protection at Stockton Beach

1 Introduction

In line with the Coastal Management Act 2016 and the NSW Coastal Management Manual Part A (the Manual), the City of Newcastle (CN) are preparing a Coastal Management Program (CMP) for Stockton Beach. This technical note sets out a review of the risks associated with beach nourishment for the purpose of providing coastal erosion protection to backshore assets at Stockton Beach. It informs the cost benefit analysis (CBA) for the Stockton CMP. It supplements the information in Royal HaskoningDHV's technical note titled *Technical Note: RHDHV input information for a Cost Benefit Analysis for Stockton Beach – Revised 23/4/20*, dated 15 April 2020, referred to herein as RHDHV's technical note.

2 Mass nourishment scenarios and initial assessment

Broadly, two sand placement quantities and renourishment periods have been considered in the CBA. A simple analysis comparing the two strategies is outlined in Table 1. Based on this initial assessment, the risk profile for backshore assets at Stockton Beach is expected to be lower for the scenario with the higher initial quantity and longer renourishment period. This scenario is also more economical in terms of sand delivery due to the lower mobilisation/demobilisation costs. An even lower risk profile could be realised if the nourished profile is maintained by regular annual increments equivalent to the annual sand loss rate delivered thereafter.

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Table 1: A simple risk profile comparison for two mass nourishment scenarios

Parameter	Lower initial quantity	Higher initial quantity
Initial nourishment volume (m^3)	1,800,000	2,400,000
Renourishment period (years)	5	10
Alongshore length (m) along 0m AHD contour plus an additional 200m based on RHDHV (2020a)	2,200	2,200
Length (m) along the -8m AHD contour plus 200m	2,000	2,000
Protection benefits (i.e. above base case) provided by the nourishment immediately following the works		
Nourishment volume per linear meter of nearshore compartment (i.e. full coastal profile) in year 0 (m^3/m)	857	1,143
Effective nourishment volume above AHD (i.e. sub-aerial storm demand) available in year 0 (m^3/m)[1]	286	381
Additional effective Average Recurrence Interval (ARI) storm demand provided in year 0[4]	>500-year (photogrammetry Block A) ~80-year (photogrammetry Block C)	>500-year (photogrammetry Block A) >100-year (photogrammetry Block C)
Protection benefits (i.e. above base case) provided by the nourishment at the end of the renourishment period		
Long term (full coastal profile) sand loss rate ($m^3/m/yr$) [2]	46.2	46.2
Nourishment volume per linear meter of nearshore compartment (i.e. full coastal profile) at the end of the nourishment period (m^3/m)[3]	626	681
Effective nourishment volume above AHD (i.e. sub aerial storm demand) available in the last year of the nourishment period (m^3/m)[1]	209	227
Additional effective ARI storm demand provided in the last year of the nourishment period[4]	>200-year (photogrammetry Block A) ~45-year (photogrammetry Block C)	>200-year (photogrammetry Block A) ~50-year (photogrammetry Block C)

Notes:

1. This is based on the typical proportion of 33% of the total nourishment volume being the effective volume above AHD (Carley and Cox, 2017).

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2. This is based on the long-term volumetric rate of sand loss over the full profile of 112,000m^3/yr between the northern breakwater and the Hunter Water site. An additional allowance for loss due to sea level rise has been included to account for the flattening of the profile due to Bruun rule-based slope re-adjustment.
3. Nourishment sand is also assumed to be lost at the long-term historic rate with an additional allowance for sea level rise. Accelerated losses because of the nourishment sand itself have not been included.
4. This is the additional sub-aerial sandy buffer provided by the beach nourishment works. The existing sub-aerial beach, in unprotected areas of the shoreline, would also provide some coastal protection function. Storm demands are based on the values provided in Bluecoast (2020) with consideration of seawall end effects after Carley et al. (2010).

3 Immediate erosion hazard for a pre- and post-nourishment beach

An assessment of the immediate coastal erosion hazards for pre- and post-nourishment was undertaken using the NSW beach profile photogrammetry data (DPIE, 2020), which provide coverage of the sub-aerial part of the beach. The 2.4M m^3 initial mass nourishment campaign delivered by rainbowing to the beach face and surf zone and bottom dumping was adopted along with the lowest risk profile of delivery of a yearly increment equivalent to the long-term annual sand loss rate. The long-term rate of sand loss within the beach compartment considered for nourishment (i.e. the CMP area) is in the order of 110,000m^3/yr (Bluecoast, 2020). In effect, placement of 2.4M m^3 of sand to the compartment will revert the coastal profile back in time around 22-years. If 2020 is selected as the pre-nourishment beach then around 1998 is representative of a post-nourishment beach. Using this assumption, a probabilistic coastal hazard assessment was completed for a post-nourishment beach using a representative profile in the NSW photogrammetry data (DPIE, 2020).

The results are presented in Figure 1. They show that if 2.4M m^3 of sand was placed in the CMP area then the extent of the 1% Annual Exceedance Probability (or 100-year Average Recurrence Interval) coastal erosion as defined by the zone of reduced foundation capacity (ZRFC) would not reach any assets. The post-nourishment erosion extents are in a similar position to today's mean sea level (MSL) shoreline. In contrast, the pre-nourishment (2020) erosion extents would impact numerous backshore assets.

The post-nourishment probabilistic erosion hazard results aligns with the greater than 100-year (or more) of additional effective ARI storm demand protection calculated for year zero following the works in Table 1. By regularly placing the required annual sand volumes in the coastal profile this level of asset protection would be maintained.

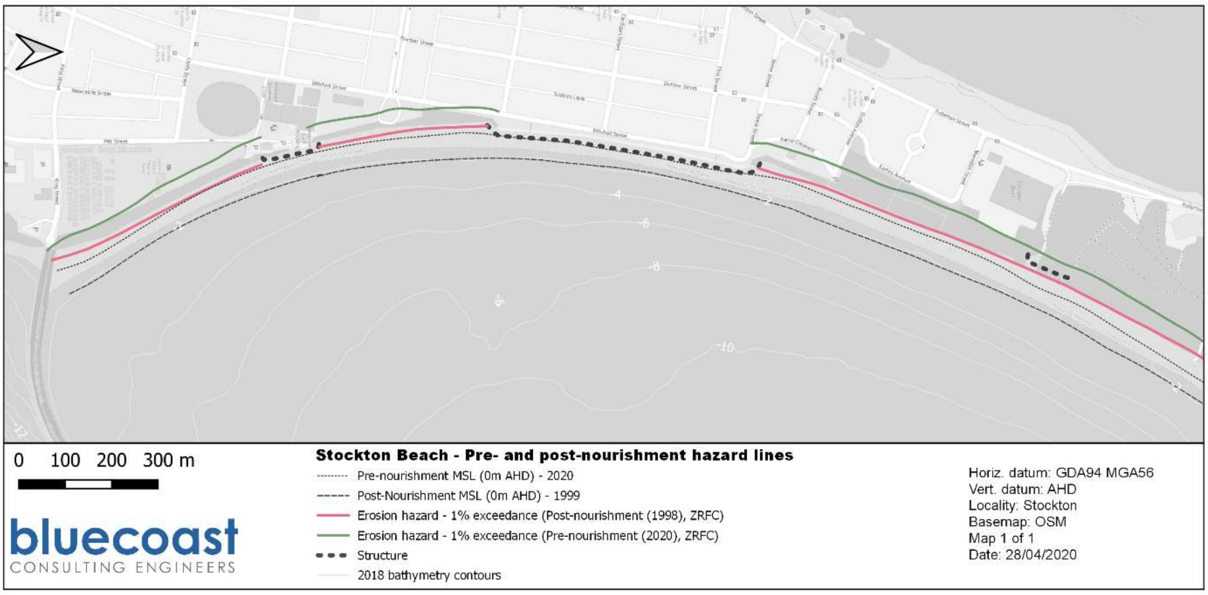

Figure 1: Pre- and post-nourishment 1%AEP immediate erosion hazard lines for Stockton Beach.

4 The nourished coastal profile

The immediate erosion hazard assessment for pre- and post-nourishment presented above considered only the sub-aerial beach (i.e. above 0m AHD). Shortly following the completion of beach nourishment works the nourished profile would be expected to readjust to an equilibrium shape with additional sand volume mostly in the sub-aqueous profile. Like the nourishment in the upper beach, the additional sand in the lower would provide a protective buffer against storm erosion.

Consideration has been given to the full nourished coastal profile down to the depth of closure. The assumption of the 2.4M m^3 of sand nourishment reverting the coastal profile back in time was applied to present a comparison of the pre-nourishment (2018 bathymetry) and post-nourishment (1995 bathymetry) in Figure 2. During a storm, sand that is eroded from the sub-aerial beach moves offshore into a storm bar causing waves to break further offshore dissipating their energy and protecting the beach against further erosion. It is noted that the post-nourishment profile has a 35m[1] wider surf zone and a milder slope of 1V:29H compare to the steeper 1V:24V slope in the pre-nourishment profile.

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[1] The surf zone has been assumed to be between 0m AHD and -5m AHD.

The storm response of the post-nourishment (1995) profile is therefore expected to be more resilient, particularly in the case of successive storm, resulting in reduced erosion at the beach when compared to the pre-nourishment (2018) profile. This would be expected to improve the relative level of asset protection afforded by the nourished profile compared to that presented in the immediate hazard lines.

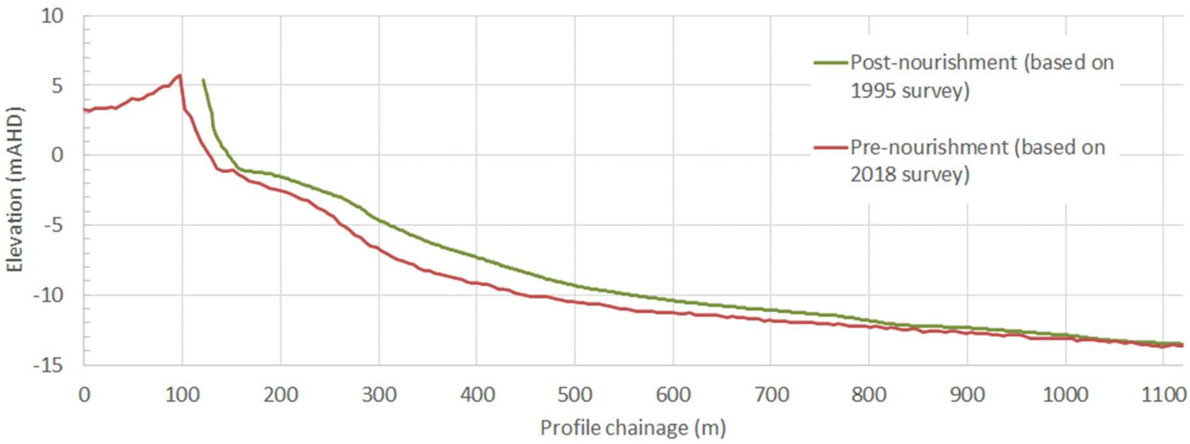

Figure 2: Adopted pre- and post-nourishment coastal profile for Stockton Beach.

This assessment of risk is considered adequate for the purposes of the CBA. However, it is recommended that storm response modelling be undertaken to quantify the storm response of the nourished profile using an appropriately calibrated and validated model during the planning and design stages of mass nourishment works.

5 References

Bluecoast (2020). *Stockton Beach coastal hazard assessment - Part B*. Report prepared for the City of Newcastle.

Carley, J.T. and Cox, R.J. (2017). *Guidelines for Sand Nourishment.* NSW Office of Environment and Heritage's Coastal Processes and Responses Node - Technical Report.

Carley J.T., Shand T.D., Mariani A., Shand R.D. and Cox, R.J. (2010). *Technical advice to support guidelines for assessing and managing the impacts of long-term coastal protection works (draft)*, Water Research Laboratory Technical Report 2010/32.

DPIE (2020). *NSW Beach Profile Database* online at: http://www.nswbpd.wrl.unsw.edu.au/photogrammetry/about/

RHDHV (2020). *Addendum to Technical Note: RHDHV input information for a Cost Benefit Analysis for Stockton Beach (marine sand sources)*. Dated 15 April 2020.

APPENDIX D – SUMMARY OF KEY SENSITIVITY RESULTS

Option 1a

Original	**0.1**	**-$596,953,496**	**N/A**	**-1.7**
Cost Estimate +40%	0.1	-$856,898,165	N/A	-3.4
Cost Estimate +20%	0.1	-$726,925,831	N/A	-2.5
Cost Estimate – 20%	0.1	-$466,981,162	N/A	-1.1
PV Benefits +20%	0.1	-$586,371,861	N/A	-1.7
PV Benefits –20%	0.1	-$607,535,131	N/A	-1.7
PV Benefits –40%	0.0	-$618,116,767	N/A	-1.8
Delay by 1 Year	0.1	-$582,375,975	N/A	-1.7
Delay by 3 years	0.1	-$552,934,479	N/A	-1.6

Option 1b

Original	**1.5**	**$19,399,649**	**12.6%**	**0.8**
Cost Estimate +40%	1.1	$5,067,072	8.1%	0.3
Cost Estimate +20%	1.3	$12,233,360	10.0%	0.6
Cost Estimate – 20%	1.9	$26,565,938	16.3%	0.8
PV Benefits +20%	1.8	$30,445,867	15.6%	1.2
PV Benefits –20%	1.2	$8,353,431	9.5%	0.3
PV Benefits –40%	0.9	-$2,692,788	6.1%	-0.1
Delay by 1 Year	1.4	$15,150,049	11.1%	0.6
Delay by 3 years	1.3	$10,771,369	9.6%	0.4

Option 1c

Original	**0.9**	**-$8,995,207**	**5.5%**	**-0.2**
Cost Estimate +40%	0.6	-$33,793,205	2.4%	-1.0
Cost Estimate +20%	0.7	-$21,394,206	3.8%	-0.5
Cost Estimate – 20%	1.1	$3,403,792	7.7%	0.1
PV Benefits +20%	1.0	$1,604,751	7.3%	0.0
PV Benefits –20%	0.7	-$19,595,164	3.4%	-0.4
PV Benefits –40%	0.5	-$30,195,122	0.7%	-0.6
Delay by 1 Year	0.8	-$12,857,271	4.8%	-0.3
Delay by 3 years	0.7	-$16,415,609	4.4%	-0.3

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Option 1d

Original	**1.3**	**$11,305,507**	**9.7%**	**0.4**
Cost Estimate +40%	0.9	-$5,396,534	6.0%	-0.3
Cost Estimate +20%	1.1	$2,954,487	7.6%	0.1
Cost Estimate – 20%	1.6	$19,656,528	12.6%	0.6
PV Benefits +20%	1.5	$21,917,630	12.0%	0.8
PV Benefits –20%	1.0	$693,385	7.2%	0.0
PV Benefits –40%	0.8	-$9,918,737	4.3%	-0.4
Delay by 1 Year	1.3	$10,575,324	9.6%	0.4
Delay by 3 years	1.2	$6,131,432	8.4%	0.2

Option 2a

Original	**0.1**	**-$387,620,536**	**N/A**	**-5.4**
Cost Estimate +40%	0.0	-$552,176,647	N/A	-10.7
Cost Estimate +20%	0.0	-$469,898,592	N/A	-7.8
Cost Estimate – 20%	0.1	-$305,342,481	N/A	-3.4
PV Benefits +20%	0.1	-$382,866,588	N/A	-5.3
PV Benefits –20%	0.0	-$392,374,485	N/A	-5.4
PV Benefits –40%	0.0	-$397,128,433	N/A	-5.5
Delay by 1 Year	0.1	-$367,901,389	N/A	-5.1
Delay by 3 years	0.1	-$330,690,326	N/A	-4.6

Option 2b

Original	**0.4**	**-$39,869,548**	**-3.1%**	**-1.1**
Cost Estimate +40%	0.3	-$65,325,263	N/A	-2.4
Cost Estimate +20%	0.3	-$52,597,405	-6.5%	-1.7
Cost Estimate – 20%	0.5	-$27,141,690	-0.5%	-0.6
PV Benefits +20%	0.4	-$35,115,599	-0.9%	-0.9
PV Benefits –20%	0.3	-$44,623,496	-7.7%	-1.2
PV Benefits –40%	0.2	-$49,377,444	N/A	-1.3
Delay by 1 Year	0.4	-$39,905,276	-5.2%	-1.1
Delay by 3 years	0.3	-$39,203,113	N/A	-1.0

Option 2c

Original	**0.3**	**-$59,956,370**	**N/A**	**-1.4**
Cost Estimate +40%	0.2	-$93,446,814	N/A	-3.0
Cost Estimate +20%	0.2	-$76,701,592	N/A	-2.1
Cost Estimate – 20%	0.4	-$43,211,147	-5.8%	-0.8
PV Benefits +20%	0.3	-$55,202,421	-6.9%	-1.3
PV Benefits –20%	0.2	-$64,710,318	N/A	-1.5
PV Benefits –40%	0.2	-$69,464,266	N/A	-1.6
Delay by 1 Year	0.3	-$59,088,261	N/A	-1.3
Delay by 3 years	0.3	-$56,751,944	N/A	-1.3

Option 3a

Original	**0.1**	**-$233,804,597**	**N/A**	**-5.4**
Cost Estimate +40%	0.0	-$334,061,044	N/A	-10.9
Cost Estimate +20%	0.1	-$283,932,820	N/A	-7.9
Cost Estimate – 20%	0.1	-$183,676,373	N/A	-3.4
PV Benefits +20%	0.1	-$230,437,293	N/A	-5.4
PV Benefits –20%	0.1	-$237,171,901	N/A	-5.5
PV Benefits –40%	0.0	-$240,539,205	N/A	-5.6
Delay by 1 Year	0.1	-$222,092,441	N/A	-5.2
Delay by 3 years	0.1	-$199,679,775	N/A	-4.6

Option 3b

Original	**0.1**	**-$71,760,461**	**N/A**	**-2.4**
Cost Estimate +40%	0.1	-$104,857,897	N/A	-4.9
Cost Estimate +20%	0.1	-$88,309,179	N/A	-3.5
Cost Estimate – 20%	0.2	-$55,211,742	N/A	-1.5
PV Benefits +20%	0.2	-$69,563,834	N/A	-2.3
PV Benefits –20%	0.1	-$73,957,087	N/A	-2.5
PV Benefits –40%	0.1	-$76,153,713	N/A	-2.5
Delay by 1 Year	0.1	-$69,553,966	N/A	-2.3
Delay by 3 years	0.1	-$65,040,041	N/A	-2.2

City of Newcastle

ATTACHMENTS DISTRIBUTED UNDER SEPARATE COVER

CCL 23/06/2020 - ENDORSEMENT OF THE DRAFT STOCKTON COASTAL MANAGEMENT PROGRAM

ITEM-30	**Attachment H:**	Options Evaluation (Royal HaskoningDHV, 2020) – Stockton CMP Supporting Document D.

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Supporting Documentation D.

Options Evaluation (RHDHV, 2020a)

City of Newcastle

REPORT

Stockton Coastal Management Program

Options Evaluation – Supporting Document D

Client: City of Newcastle

Reference: PA2395-RHDHV-CN-SDD-0008

Status: S1/P01

Date: 17/06/2020

Open

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Author(s):	N Patterson
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Checked by:	D Messiter
Date / initials:	DM 16/6/2020
Approved by:	D Messiter
Date / initials:	DM 16/6/2020

Classification
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MANAGEMENT SYSTEM CERTIFICATION
DNV·GL
ISO 9001 = ISO 14001
ISO 45001

Table of Contents

Table of Tables

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1 Introduction

This Supporting Document to the Stockton Coastal Management Plan (CMP) developed for CN provides the following:

- review and discussion of the alternative coastal engineering and management options that have been considered during the CMP process;
- comparative ‘coarse filter’ evaluation of the options and the reasons for either; selection of options for further consideration and development, or rejection or not progressing options further; and
- brief description of the options short listed for further development and economic assessment in a Cost Benefit Analysis (CBA) in line with the *Coastal Management Act 2016* and the NSW Coastal Management Manual Part A (the Manual).
- reasoning and justification as to what options have been considered and the basis of how the proposed preferred management regime was developed.

This report draws upon numerous reports and studies that have been undertaken previously considering the management options that are available to address coastal hazards in Stockton. The reader is referred to the main Stockton CMP report for further detail on the proposed preferred option.

This document will further inform the development of the Newcastle CMP.

2 Previous Studies

2.1 Introduction

A number of previous studies and reports have been undertaken to investigate coastal processes and the potential management options to be used along the Stockton frontage. These reports include:

- Newcastle Coastal Zone Hazards Study (WBM, 1998)
- Shifting Sands at Stockton Beach (Umwelt, 2002)
- Newcastle Coastal Zone Management Plan (Umwelt, 2003)
- Stockton Beach Coastal Processes Study (DHI, 2006)
- Stockton Coastline Management Study Report (DHI, 2009)
- Stockton Beach Coastal Processes Study Addendum – Revised Coastal Erosion Hazard Lines 2011 (DHI, 2011)
- Stockton Beach Sand Scoping and Funding Feasibility Study (Worley Parsons, 2012)
- Newcastle Coastal Zone Hazards Study (BMT WBM, 2014)
- Newcastle Coastal Zone Management Study (BMT WBM, 2014)
- Newcastle Coastal Zone Management Plan (BMT WBM, 2016)

This section briefly summarises the previous coastal management recommendations that were made in the three Management Study/Plan documents from the above list (DHI, 2009; BMT WBM 2014; BMT WBM, 2016), which drew on information from the other investigations. This summary provides context as to how options have been identified, considered and selected in the past. The next three sections then build on this by providing detail on how this information has been utilised by CN and its consultants to consider, evaluate and select options for coastal management.

3 Stockton Coastline Management Study (DHI, 2009)

3.1 Options Considered

The Stage 2 Coastal Zone Management Study undertaken by DHI in 2009 assessed the following options:

1. Planned retreat (coupled with voluntary purchase)
2. Beach nourishment (onshore placement for capital nourishment)
3. Seawall (rubble mound construction)
4. Offshore breakwater (emergent, straight, shore parallel)
5. Offshore breakwater (multi-functional artificial reef)
6. Groynes (emergent)
7. Artificial headland
8. Seawall (rubble mound construction) with nourishment
9. Offshore breakwater (emergent, straight, shore parallel) with beach nourishment
10. Offshore breakwater (artificial surf reef) with beach nourishment
11. Groynes (emergent) with beach nourishment
12. Artificial headland with beach nourishment

Table 1 summarises the options that were eliminated (and the reasons for elimination) following initial screening on the basis of reliability, practicality, and community acceptance.

Table 1 Options eliminated via the initial screening process in 2009 Study

Option Description	Reasons for elimination
Do Nothing	Loss of residential and roadway assets. Lack of community support.
Development Control Conditions	Would limit damage to new development and redevelopment but would not address ongoing erosion problems and would therefore fail the reliability test. May be implemented as secondary measures.
Dune Management	Insufficient to protect beach from further erosion, particularly during storm events. To be used in conjunction with another management option.
Sand bypassing across channel from Nobbys Beach lobe	Lack of community support to potentially impact Nobbys Beach as it is highest utilised beach in Newcastle area (Umwelt, 2003b). Available quantities likely to only be suitable for maintenance nourishment not capital nourishment and cost of bypassing system therefore not justified.
Configuration Dredging	Not practical on an open coastline particularly in view of complex wave patterns.
Beach Drainage	Not considered a reliable option due to unproven nature of these schemes.

Following further analysis, the following five options were short listed and assessed in greater detail:

1. Beach nourishment
2. Seawall with beach nourishment
3. Artificial headland with beach nourishment
4. Offshore breakwater with beach nourishment
5. Multi-function artificial reef with beach nourishment

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3.1.1 Options Assessment Results

Computational modelling was used to predict the performance of the proposed options.

For Option 1, the beach nourishment was predicted to have a small effect on sediment transport processes and, as such, the ongoing recession would continue. This meant that periodic maintenance nourishment would be required to replace the sand that would be lost.

The modelling predicted that the seawall in Option 2 would only act as a passive coastal protection measure because the width of the beach provided by the nourishment scheme was sufficient to account for both long term recession and short-term erosion. This meant that the structure would remain covered, provided maintenance nourishment as for Option 1 was undertaken to maintain the beach.

Both Options 3 and 4 were predicted to effectively mitigate the long-term recession and lead to the formation of a stable beach planform. This meant that the maintenance nourishment requirements for each option would be minimal. Both options required additional capital maintenance nourishment volumes to provide sufficient sand for the predicted beach re-orientation. For Option 4, further sand was provided to allow for early sand bypassing of the end of the headland and to minimise downdrift erosion of the beach in this area. The modelling predicted that the generation of eddies in the vicinity of the offshore breakwaters in Option 3 could form rip currents, while the current profile along the beach for Option 4 was predicted to be uniform.

The Multi-Functional Artificial Reed (MFAR) in Option 5 was predicted to have a small effect on the overall wave and current patterns on the beach and would have a limited effect on littoral transport. The current patterns in the vicinity of the reef were predicted to be extremely complex, with the possibility of offshore sand transport on one side of the reef. Overall, the MFAR option did not mitigate the ongoing recession and it was expected that maintenance nourishment would be required.

The selection of the preferred option was based on the qualitative weighing up of the following considerations:

- performance as a coastal protection measure;
- environmental effects;
- social factors; and
- economic factors.

The assessment resulted in the selection of Option 3 – Artificial Headland with Beach Nourishment, as the preferred option for the following reasons:

- effectively mitigated the ongoing long-term recession of Stockton Beach and it was predicted there would be minimal maintenance nourishment requirements - unlike Options 1, 2 and 5 where there was predicted to be ongoing recession;
- did not cause adverse current effects, which was the case for Option 4;
- received broad support at the community workshop, which was not the case for Option 4;
- provided opportunity for increased amenity value, and
- although the capital costs would be high at an estimated cost of $31.2 M (only Option 2 was higher), the increased coastal protection, reduced maintenance costs, increased amenity value and broad community support were considered sufficient to justify the additional cost.

4 Newcastle Coastal Zone Management Study (BMT WBM, 2014)

4.1 Options Considered

Options considered within the 2014 Coastal Zone Management Study included the following:

- Sand Borrowing
- Dune Rehabilitation
- Seawalls
- Beach Nourishment
- Artificial Breakwaters
- Groynes
- Artificial Headlands
- Sacrifice Land or Assets
- Relocate Assets
- Acquisition
- Buy Back / Lease Back
- Redesign or Retrofit
- LEP Clauses and Rezoning
- Coastal Hazard Development Controls
- Integration of Coastal Zone Management Planning within Council
- Asset Management Planning
- Audit of Existing Assets
- Infrastructure Design Elements
- Public Safety Policy
- Monitoring
- Community Education

4.1.1 Options Assessment Results and Recommendations

A 'coarse' filter was initially applied to the above options. The results are reproduced below in **Table 2.**

Table 2 Coarse Filtering of Management Options (BMT WBM, 2014)

Option	Treats Erosion	Treats Recession	Treats Wave Overtopping	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 (G = 1, Sl = 0, St = -1)	Overall Analysis	Comments
Sand Borrowing	✓		✓	GO	GO	GO	GO	GO	STOP	GO	GO	6	GO	
Dune Rehabilitation	✓	✓	✓	GO	GO	GO	GO	GO	STOP	GO	GO	6	GO	
Seawalls	✓	✓	✓	STOP	SLOW	STOP	SLOW	SLOW	SLOW	SLOW	SLOW	-2	SLOW	
Beach Nourishment	✓	✓	✓	STOP	STOP	GO	GO	GO	SLOW	SLOW	STOP	0	SLOW	
Artificial Breakwaters	✓		✓	STOP	SLOW	SLOW	STOP	STOP	SLOW	STOP	STOP	-5	STOP	
Groynes	✓			STOP	SLOW	STOP	SLOW	STOP	STOP	STOP	STOP	-6	STOP	
Artificial Headlands				STOP	SLOW	SLOW	GO	STOP	STOP	SLOW	STOP	-3	STOP	Noting that the preferred version of this option in DHI (2009) involved nourishment.
Sacrifice Land or Assets	✓	✓	✓	GO	GO	GO	SLOW	STOP	GO	SLOW	GO	4	SLOW	Costs not based on lost land because beach is retained = higher value
Relocate Assets	✓	✓	✓	STOP	GO	GO	SLOW	GO	GO	GO	SLOW	4	SLOW	
Acquisition	✓	✓	✓	STOP	GO	GO	SLOW	SLOW	GO	GO	SLOW	3	SLOW	
Buy Back / Lease Back	✓	✓	✓	SLOW	SLOW	GO	SLOW	GO	GO	SLOW	STOP	2	SLOW	
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	
Integration of CZM Planning Within CoN	✓	✓	✓	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 CoN Assets	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	GO	
Infrastructure Design Elements	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	GO	
Public Safety Policy			✓	GO	GO	GO	GO	GO	SLOW	GO	GO	7	GO	
Monitoring	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	GO	
Community Education	✓	✓	✓	GO	GO	GO	GO	GO	SLOW	GO	GO	7	GO	

For the purpose of determining management options, Stockton Beach was separated into three areas:

- Southern Stockton Beach, south of the Mitchell Street Seawall;
- Mitchell Street Seawall at Stockton Beach, and
- Northern Stockton Beach, north of Mitchell Street Seawall to Fern Bay.

The recommended management options for each of the three areas are described below.

Stockton Beach South of Mitchell Street Seawall

The recommended approach for the southern part of Stockton Beach was to maintain the current shoreline where possible over the short to medium term through management and opportunistic supplements (nourishment) to sand reserves. Over the long-term, the approach would be to facilitate beach retreat that would preserve the sandy beach amenity, by relocating public assets further landward (onto adjacent public lands). Specific recommended management options made in the 2014 report are outlined below.

- **Sand Borrowing and Dune Rehabilitation** were recommended when there are good sand reserves on the beach to prolong the retention of sand within this section of beach.
- **Formal Agreement for use of dredge material from Newcastle Harbour as beach nourishment material** - it was recommended that CN be added to an existing agreement between the Port of Newcastle (PoN) and the (then) Office of Environmental and Heritage (OEH) to strengthen the commitment for this arrangement to continue on a regular basis.
- **Opportunistic beach nourishment** – to use sand from any large scale capital dredging projects as part of port expansion developments planned within the PoN as beach nourishment.
- **Planned retreat** - Over the long term, retreat involving both a relocation of assets and sacrifice of land immediately behind the beach was recommended as it was considered to offer the most financially and technically feasible option for retaining the sandy beach amenity. The majority of land behind southern Stockton Beach is public land. The consequences to the general public from loss of public open space were considered to be less than the consequences from loss of beach amenity in this location. Public land is in government control and typically does not demand the same compensation; therefore, retreat was considered more easily implemented.
- **Beach nourishment** - Given the planned retreat intent for this section of Stockton Beach, an ongoing nourishment program was proposed to assist in prolonging the current state requiring approximately 30,000m^3/year[1] to replicate the stated natural sediment supply (DHI, 2009). The primary focus area for targeted nourishment would be Stockton Beach (i.e. south of the seawall) as this was the major focus area for recreation. In addition, the beach to the north of the seawall would be targeted in years when the southern beach had accreted and built up. The ideal sediment source would be dredged material from the channel entrance with funding contribution made by State Government and/or PoN. Alternatively, large scale beach scraping along the beach to the north of the Fort Wallace Royal Australian Navy (RAN) facility was suggested for consideration.

Mitchell Street Seawall at Stockton Beach

The key recommendation was to undertake the minor maintenance works identified within the BMT WBM (2014) seawall condition assessment, including repairing the rusted gabion baskets used to bed the concrete lined stormwater drainage pipe in the seawall.

[1] *This volume has been recalculated as approximately 112,000m^3/yr in preparation of the Stockton CMP 2020 (Bluecoast 2020)*

Stockton Beach North of Mitchell Street Seawall

The recommended management option involved facilitation of an agreement between key landholders and governing bodies regarding the future management intent for Stockton Beach. A preliminary management approach for Stockton Early Learning Centre was also developed.

There were two option suites that were recommended:

- Options Suite 1: construct protection works along current and future beach alignments
- Options Suite 2: construct protection works along future beach alignment combined with relocation of the childcare centre and setbacks for future development.

5 Newcastle Coastal Zone Management Plan (BMT WBM, 2016)

In 2016, the Newcastle Coastal Zone Management Plan (CZMP) was produced by BMT WBM. This, however, was not certified by the NSW State Government and, as such, was never gazetted.

Of relevance to this Appendix, it had the following coastal management plan for the Stockton area:

“Council's preferred option for protection works is to construct an artificial headland/groyne with beach nourishment. This option has the benefit of stopping the northerly drift of sand, which means that the sand would become trapped between the northern breakwater and the artificial headland/groyne (and would protect the southern end of Stockton), and is the communities preferred option.

The DHI (2009) report indicated that an artificial headland with beach nourishment would cost in the order of $31.2M, $13.7M to construct the structure and $17.5M for beach nourishment. The NSW Government has previously indicated that this amount of funding would not be made available for the headland. However, it is possible that the structure could be redesigned to reduce costs. As Council does not have the capacity to fund this option on its own, it is proposing to advocate the NSW Government and other stakeholders to fund the preferred management option.

In the absence of funding being made available for the artificial headland/groyne, Council is proposing to investigate and construct a rock seawall with beach nourishment to protect public assets. The benefit of this option is that Council can afford to stage the construction over a number of years, and is therefore able to fund the project. Construction of a 165m section of the rock seawall between the Surf Life Saving Club (SLSC) and Lexies Café will commence in 2016. Council is also currently preparing a beach scraping program to ensure the rock seawall remains buried by sand (except during storm events), and has committed ongoing annual funding for beach scraping activities. Council held a community presentation and drop in session in August 2016 to discuss the proposed seawall. The community highlighted the importance of maintaining a sandy beach, that is why Council has committed to annual beach scraping.

Further potential stages of the seawall are under investigation, with future stages of the seawall being subject to the findings from the investigations, funding and resource availability. Council will monitor the seawall and undertake maintenance works as required. End effects will be managed through the annual beach scraping/ nourishment program.

Council will also continue to investigate other beach nourishment options including a sand bypassing system and offshore dredging. Offshore dredging for the purposes of beach nourishment is currently prohibited, and Council will advocate the NSW Government to allow offshore dredging for beach nourishment. Council will also advocate for the NSW Government to purchase (or contract) an offshore dredge, which could provide beach nourishment activities up and down the NSW coastline.”

The preferred option of the artificial headland was rejected by the Coastal Panel on the basis of a lack of detail concerning:

- availability of material to facilitate the strategy;
- details of its proposed location or impacts;
- Cost-Benefit Analysis to justify the extent of financial investment proposed, and
- any feasible or identified funding source.

The Coastal Panel also noted that there was a lack of evidence of consultation with affected landowners, including and notably Crown Lands.

6 Stockton Coastal Zone Management Plan (2018)

6.1 Introduction

The Newcastle Coastal Zone Management Plan including Part A - Stockton, was submitted to the Minister for Environment for certification under the savings provisions of the Coastal Protection Act 1979 (now repealed) to address coastal management actions for the short (1-2 year) and medium (1-5 years) term. Certification under the Coastal Protection Act 1979 was required to be undertaken by 3 October 2018 due to legislative reform. Under provisions of the Coastal Management Act 2016, this plan will cease on 31 December 2021.

CN's elected Council adopted the Newcastle Coastal Zone Management Plan 2018 on the 24th July 2018 and the plan was certified by the Minister for the Environment on 24 August 2018. The Newcastle CZMP 2018 provides the current management framework for the Newcastle coastline and guides actions and projects to be undertaken by CN and other stakeholders. Management actions relate to coastal hazards along with recreational and environmental issues.

The 2018 CZMP was limited to short to medium-term coastal management actions, given that updated coastal processes investigations had not yet been completed to inform a longer term coastal management strategy. It is worth noting though that the 2018 CZMP recognised that the Stockton Community Liaison Group (CLG) has identified that the preferred long-term solution was sand replenishment or nourishment.

Under the CZMP, 7 coastal zones were introduced in order that coastal management options could be considered both holistically (e.g. beach nourishment, offshore breakwaters etc.) and site-specifically (i.e. options considered only appropriate to certain sections of the coastline).

- Zone 1 – Breakwater to Surf Life Saving Club (SLSC) revetment
- Zone 2 – SLSC to Mitchell Street revetment
- Zone 3 – Mitchell Street revetment
- Zone 4 – Barrie Crescent and Eames Avenue frontage (Stone Street to Meredith Street)
- Zone 5 – Griffiths Avenue to Corroba Oval (northern boundary)
- Zone 6 – Hunter Water
- Zone 7 – Hunter Water (northern boundary) to LGA boundary

Figure 1: Proposed Zones for Stockton Coastal Management Strategy

7 Coastal Management Actions

The CZMP developed a number of management actions for the seven zones with regard to coastal hazards. These are outlined below in **Table 3** as short (1-2 year) and medium (1-5 year) actions. The management actions are listed in priority order. Long-term management actions were identified as being part of a future Coastal Management Program submitted under the Coastal Management Act 2016. The 2018 CZMP also identified a series of short and medium-term management actions for a number of other aspects of the Stockton Coastline as identified below in **Table 3.**

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Table 3 Coastal Hazards Management Actions from the 2016 CZMP

#	Approach	Zone	Management Action	Primary responsibility	Supporting partners[1]	Cost estimate (Funding source)	Evaluation method	Timeframe
CH1	Risk assessment	4	Lease for the operation of a childcare centre at the former North Stockton Surf Life Saving Club not to be renewed once expired.	Mission Australia	Council	Minimal	Operation of childcare centre in building ceases.	Short-medium
CH2	On-ground works	4	Former North Stockton Surf Life Saving Club building demolished.	Council		$50,000 (Council)	Demolition of building.	Medium
CH3	Planning, on-ground works	6	Appropriate temporary coastal protection works undertaken at former landfill at 310 Fullerton Street (Lot 202 DP 1150470). Temporary coastal protection works will include geofabric container wall/structure designed by appropriately qualified coastal engineer with duration of 5-7 years.	Hunter Water Corporation	Department of Industry - Lands and Water (Crown Lands) Council	$1,500,000 (To be determined)	Temporary coastal protection works completed.	Short-medium
CH4	Planning, on-ground works	6	Investigate the extent of the former landfill to the south of 310 Fullerton Street (Lot 202 DP 1150470) on to part of Crown reserve 79066 Appropriate works on the Crown reserve will be subject to further negotiation between Department of Industry - Lands and Water (Crown Lands), Council and Hunter Water Corporation	Department of Industry - Lands and Water (Crown Lands) Council	Hunter Water Corporation	To be determined based on extent of landfill	Extent of former landfill on Crown reserve identified. Identified agreed works implemented	Short
CH5	Planning	3,4	Identify appropriate coastal protection works or repairs at northern end of Mitchell Street seawall. Planning to include how works will connect with future coastal protection works to the north.	Council	Department of Industry - Lands and Water (Crown Lands)	$40,000 (Council)	Appropriate design/repairs for northern end of Mitchell Street seawall completed.	Short
CH6	On-ground works	3,4	Identified coastal protection works or repairs at northern end of Mitchell Street constructed.	Council	Department of Industry - Lands and Water (Crown Lands)	$200,000 - $700,000 $20,000-$70,000/ annum maintenance (Council, State Government)	Identified works/repairs to northern end of Mitchell Street seawall completed.	Short-medium
CH7	On-ground works		Port of Newcastle to place suitable sand from maintenance dredging activities from harbour entrance offshore of Stockton Beach in accordance with concurrence issued by Office of Environment and Heritage.	Port of Newcastle	Office of Environment and Heritage Roads and Maritime Services Department of Industry - Lands and Water (Crown Lands)	Minimal. Maintenance dredging for navigational safety currently conducted by Port of Newcastle.	Placement of sand after dredging campaigns.	Short, medium
CH8	Planning		Coastal Management Program process for certification under the *Coastal Management Act 2016* commenced. Scoping study under Coastal Management Program process will include actions contained in Part A - Stockton.	Council	Office of Environment and Heritage	Minimal	Coastal Management Program process commenced.	Short
CH9	Planning	1-7	Undertake detailed investigations and other required studies, including scoping study and assessment of sand replenishment sources, to be undertaken to facilitate certification of a Coastal Management Program under the *Coastal Management Act 2016*.	Council		$250,000 (Council, State Government)	Detailed studies completed and Coastal Management Program prepared and certified.	Short -medium
CH10	Planning		Establish a working group to identify required investigations or studies, including potential studies to progress sand replenishment option, for development of Coastal Management Program. Working group will include Councils, key government stakeholders, community and interest groups.	Council		Minimal	Working group established	Short
CH11	Planning	1-7	Assess potential options for long-term management of coastal hazards in the Stockton study area through the development of a Coastal Management Program in accordance with the *Coastal Management Act 2016* and the NSW Coastal Management Manual.	Council		$100 000 (Council, State Government)	Coastal Management Program prepared and certified.	Medium
CH12	Monitoring		Monitor opportunities under grant programs and ensure grant applications are best positioned to deliver funding for Stockton study area projects.	Council		Internal Council resources	Funding applications submitted.	Short-medium
CH13	Monitoring		Alternative funding methods to be investigated and considered for Stockton study area projects. Funding methods to be advocated for in consultation with key stakeholders.	Council		Minimal	Alternative funding sources investigated and advocated for.	Short, medium
CH14	Monitoring	3	Undertake condition assessment/scope of works for maintenance to Mitchell Street seawall.	Council		$10,000 (Council)	Condition assessment/scope of works completed.	Short-medium
CH15	On-ground works	3	Undertake maintenance to Mitchell Street seawall identified in condition assessment report	Council	Department of Industry - Lands and Water (Crown Lands)	$2,750,000 capital. $200 000 per annum maintenance. (Council, State Government)	Identified repairs to Mitchell Street seawall completed.	Short-medium
CH16	On-ground works	1,2	Conduct beach management works, such as beach scraping and beach grooming, in areas south of the Mitchell Street seawall to increase dune volume. Required approvals for beach scraping will be obtained.	Council	Department of Industry - Lands and Water (Crown Lands)	$50,000 per annum (Council, State Government)	Identified beach scraping activities completed as conditions permit.	Short, medium
CH17	On-ground works	4,5	Conduct beach management works, such as beach scraping and beach grooming, in areas north of the Mitchell Street seawall to increase dune volume. Required approvals for beach scraping will be obtained.	Council	Department of Industry - Lands and Water (Crown Lands)	$75,000 per annum (Council, State Government)	Identified beach scraping activities completed as conditions permit.	Short, medium

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Table 3: Continued

#	Approach	Zone	Management Action	Primary responsibility	Supporting partners¹	Cost estimate (Funding source)	Evaluation method	Timeframe
CH18	On-ground works	1,2	Continue dune maintenance in areas south of the Mitchell Street seawall.	Council	Department of Industry - Lands and Water (Crown Lands) Landcare	$15,000 (Council, State Government)	Dune maintenance in identified areas undertaken.	Short, medium
CH19	On-ground works	4,5	Continue dune maintenance in areas north of the Mitchell Street seawall.	Council	Department of Industry - Lands and Water (Crown Lands) Landcare	$15,000 (Council, State Government)	Dune maintenance in identified areas undertaken.	Short, medium
CH20	Planning	1	Undertake annual inspection of Stockton breakwall and assess potential issues from coastal hazards	Port of Newcastle	Roads and Maritime Services	As required (Port of Newcastle)	Visual inspection of rock armour, public pathway and ancillary infrastructure	Short (annual basis)
CH21	Planning, on-ground works	1-5	Continue beach and seawall monitoring program with cross section sites within the Stockton study area.	Council		$10,000- $15,000 per annum (Council)	Beach and seawall monitoring program, cross sections completed. Innovation in methodology undertaken.	Short-medium
CH22	Planning	7	Identify coastal hazards at Stockton Centre (342 Fullerton Street) as part of Fern Bay and North Stockton Land Use Strategy.	Council	Port Stephens Council Family and Community Services	Minimal	Coastal hazards identified as part of Fern Bay and North Stockton Land Use Strategy.	Short
CH23	Planning	7	Identify coastal hazards at Defence Housing Australia site (338 Fullerton Street) as part of Fern Bay and North Stockton Land Use Strategy and rezoning proposal.	Council	Port Stephens Council Defence Housing Australia	Minimal	Coastal hazards identified as part of Fern Bay and North Stockton Land Use Strategy.	Short
CH24	Development controls		Review planning certificates to ensure properties potentially affected by coastal hazards contain an appropriate notation and reflect ability (or not) for complying development to be carried out on the land.	Council		Minimal	Planning certificate notification reviewed.	Short
CH25	Development controls		New subdivisions or greenfield development to be located landward of coastal hazards 2100 unlikely line.	Council		Minimal	Design of subdivisions or development landward of 2100 unlikely coastal hazard line.	Short-medium
CH26	Planning	1-3	When the opportunity arises, Plans of Management, public domain plans and other master plan documents within the Stockton study area will be prepared or amended in consideration of the coastal hazards outlined in the Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)).	Council	As required	Minimal	Coastal hazards incorporated into relevant plans	Short-medium
CH27	Planning	1-5	Consider impacts of coastal hazards when renewing or constructing public assets within the Stockton study area. The design of assets should consider the coastal hazards outlined in the Newcastle Coastal Zone Hazards Study (BMT WBM, 2014(a)). Asset life, purpose/service and location are to be considered along with the potential impacts from climate change.	Council		Varied due to project undertaken, costing within project budget (Council)	Incorporation of coastal hazards into project design documents.	Short-medium
CH28	Planning, on-ground works		Incorporation of coastal hazards into Council's service asset plans and implement service asset plans.	Council		$20,000 (Council)	Coastal hazard analysis included in service asset plans.	Short-medium
CH29	On-ground works	1-5	Undertake emergency works, if appropriate, to manage beach erosion during storm events in accordance with the Emergency Action Subplan contained in **Appendix D.**	Council		Varied based on extent of emergency works (Council, State Government, Federal Government)	Emergency works in accordance with Subplan completed as required.	Short-medium
CH30	Planning, monitoring, on-ground works	6	Undertake a monitoring and response procedure for the former landfill at 310 Fullerton Street ((Lot 202 DP 1150470) and part of Crown reserve 79066. Procedure will include management of former waste material in erosion events.	Hunter Water Corporation Council	Department of Industry - Lands and Water (Crown Lands)	Minimal	Monitoring of former landfill after erosion events completed	Short, medium
CH31	Partnerships		Continue to consult with Port of Newcastle and capital dredging proponents to request excess suitable sand from capital dredging projects is placed offshore of Stockton Beach.	Council	Port of Newcastle Roads and Maritime Services	Minimal	Excess suitable sand from capital dredging placed offshore of Stockton Beach.	Short-medium (project based)
CH32	Engagement		Conduct community engagement and education programs focusing on the Stockton study area environment and coastal processes.	Council		$5,000 per annum for coastal education program (Council)	Education programs developed and presented to community.	Short-medium
CH33	Engagement		Update and enhance Council's website with information about coastal processes, man-agement of the coastal environment. Provide more information about coastal activities.	Council		Minimal	Council website updated.	Short-medium
CH34	Planning, on-ground works	1-5	Prepare and implement post storm asset condition monitoring plan	Council		$5,000 per annum (Council)	Post storm asset monitoring plan developed and implemented.	Short-medium

Table 4: Coastal Environment Management Actions from the 2018 CZMP

#	Approach	Zone	Management Action	Primary responsibility	Supporting partners[1]	Cost estimate (Funding source)	Evaluation method	Timeframe
CE1	Monitoring	1-5	Continue to monitor coastal habitat and implement recommendations of monitoring program.	Council	Department of Industry - Lands and Water (Crown Lands)	$5,000 (Council)	Monitoring program undertaken.	Short, medium
CE2	On-ground works	1-5	Undertake coastal revegetation works as outlined in Coast and Estuary Vegetation Management Plan (Umwelt, 2014). Options to control Bitou Bush and other invasive plant species included in revegetation works.	Council	Department of Industry - Lands and Water (Crown Lands)	$10,000 per annum (Council)	Coastal revegetation works completed.	Medium
CE3	Planning	1-3	Public domain works along the coastal section of the Stockton study area to include landscaping with native provenance species	Council		$10,000 (Council)	Public domain plan completed.	Short, medium
CE4	On-ground works	1-5	Implement beach stormwater outlet maintenance program to manage dunes and remove stormwater ponding, particularly after rain events	Council		$10 000-$15 000 per annum (Council)	Stormwater outlet areas on beach maintained.	Short, medium
CE5	Planning	1-5	Water Sensitive Urban Design (WSUD) principles to be included in Public Domain Plans (or other masterplan documents) within the Stockton study area	Council	Department of Industry - Lands and Water (Crown Lands)	Minimal		Short, medium
CE6	On-ground works	1-7	Provide support and assistance to Landcare/volunteers when revegetation activities are undertaken in Stockton study area	Council		Minimal	Assistance to Landcare provided.	On-going
CE7	Monitoring, Partnerships		Build capacity for community volunteers to undertake citizen science environmental monitoring	Council		Minimal	Community environmental program established.	Medium

Table 5: Beach Access Management Actions from the 2018 CZMP

#	Approach	Zone	Management Action	Primary responsibility	Supporting partners[1]	Cost estimate (Funding source)	Evaluation method	Timeframe
BA1	Risk assessment	1-5	Undertake an audit of beach access points to assess public safety issues and erosion potential. Access point data to be available in Council GIS program.	Council	Department of Industry - Lands and Water (Crown Lands)	$5,000 (Council)	Audit undertaken.	Short
BA2	Monitoring	1-5	Identify beach access points for closure and/or replacement in consultation relevant stakeholders and the community.	Council	Department of Industry - Lands and Water (Crown Lands)	Minimal	Access points identified for closure and/or replacement.	Short
BA3	Planning	1-5	Design of new fencing and beach access points are undertaken in accordance with the Coastal Dune Management Manual (Department of Land and Water Conservation, 2001). Design will need to include maintenance plan for beach access points.	Council	Department of Industry - Lands and Water (Crown Lands)	$10,000 (Council)	Design drawings completed with reference to Coastal Dune Management Manual.	Short, medium

Table 6: Beach Amenity Management Actions from the 2018 CZMP

#	Approach	Zone	Management Action	Primary responsibility	Supporting partners[1]	Cost estimate (Funding source)	Evaluation method	Timeframe
B1	Planning	1-3	Investigate opportunities for landscaping within the Stockton study area as part of public domain plans.	Council	Department of Industry - Lands and Water (Crown Lands)	Minimal	Appropriate landscaping included within public domain plan.	Medium
B2	On-ground works	1-5	Undertake beach maintenance program and continue dune rehabilitation works. This includes dune fencing, access controls, invasive species control and replanting native colonising species.	Council	Department of Industry - Lands and Water (Crown Lands)	$150,000 per annum (Council)	Beach maintenance program undertaken.	Short
B3	Planning, risk assessment	1-5	Undertake audit of stormwater discharge points onto Stockton coastline and assess water quality and erosion potential	Council	Department of Industry - Lands and Water (Crown Lands)	Minimal	Stormwater audit undertaken.	Short-medium
B4	On-ground works	1-5	Undertake beach maintenance at stormwater discharge points on Stockton coastline after storm events to prevent additional erosion.	Council		$5,000 per annum (Council)	Beach maintenance at stormwater discharge points undertaken where required.	Short-medium

Table 7: Recreational Use Management Actions from the 2018 CZMP

#	Approach	Zone	Management Action	Primary responsibility	Supporting partners[1]	Cost estimate (Funding source)	Evaluation method	Timeframe
RU1	Planning	1-3	Prepare public domain plan for the Stockton coastal zone study area in consultation with relevant land managers and stakeholders. Public domain plan will build upon the adopted Newcastle Revitalisation Strategy Master Plan.	Council	Department of Industry - Lands and Water (Crown Lands)	Minimal	Public domain plan prepared.	Medium
RU2	Planning	1-5	Enhance opportunities for recreational fishing and identify areas for facilities such as fish cleaning tables.	Council	NSW Fisheries	TBA (Council, State Government)	Opportunities identified in public domain plan.	Medium
RU3	Planning	1-5	Public domain plan for Stockton coastal zone study area will consider footpath/cycleway along Mitchell Street.	Council		Minimal	Footpath/cycleway investigated in public domain plan.	Medium

Table 8: Culture and Heritage Management Actions from the 2018 CZMP

#	Approach	Zone	Management Action	Primary responsibility	Supporting partners[1]	Cost estimate (Funding source)	Evaluation method	Timeframe
H1	Planning	1-5	Incorporate Aboriginal cultural information into Council projects and works within the Stockton study area.	Council	Guraki Committee Worimi Aboriginal Land Council	Minimal	Aboriginal cultural information incorporated into Council projects	Short, medium
H2	Planning		Implement dual naming of sites within the Stockton study area where appropriate	Council	Guraki Committee Worimi Aboriginal Land Council	Minimal	Dual naming sites determined	Short, medium
H3	Planning	1-5	Ensure high quality interpretive treatments of heritage items or places that increase understanding of the heritage significance of these items or places in Council projects and works within the Stockton study area.	Council		Cost to be determined as part of individual project	Heritage treatment incorporated into Council projects	Short, medium
H4	Planning		Prepare Aboriginal Heritage Management Strategy to ensure due diligence processes are followed for Council projects and assessment of development applications	Council	Guraki Committee Worimi Aboriginal Land Council	$30 000 (Council)	Aboriginal Heritage Management Strategy completed	Medium
H5	Planning	1-3	Interpretation of the history and heritage within the Stockton area is to be integrated into Public Domain Plans.	Council		Minimal	Heritage considerations included in Public Domain Plan.	Medium
H6	Planning	1-7	Investigate protection of heritage listed items on public lands from coastal hazards	Council		Minimal		Short, medium

8 Stockton CMP Options Evaluation

8.1 Background

Since the 2016 Newcastle CZMP CN have undertaken consultation with the local Stockton community through the Stockton CLG and other general community meetings. This has provided CN with a good understanding of the community's values and desires for their coastline.

Since 2016 CN have also been in consultation with DPIE who have provided technical and financial advice to assist in the development of the CMP for this coastline.

On 3 April 2018, the Coastal Protection Act 1979 was replaced by the Coastal Management Act 2016. The Coastal Management Act 2016 includes the requirement for local councils to prepare a Coastal Management Program in accordance with the NSW Coastal Management Manual (2019) to address long-term management of the coastal zone. With erosion continuing at Stockton and growing community concern and interest the NSW Government issued CN a directive under section 13 of the *Coastal Management Act 2016*, to complete the CMP for Stockton Beach by 30 June 2020. The Stockton CMP would build on the short and medium term coastal management actions outlined in the 2016 CZMP, developing a long term coastal management strategy for the Stockton coastline.

Investigation and assessment of long-term coastal management actions to address coastal hazards within the Stockton CMP area has been undertaken in accordance with the NSW Coastal Management Manual to facilitate the preparation of a Coastal Management Program. Investigation of the feasibility of management actions such as sand nourishment or engineered structures to address beach erosion and shoreline recession has been conducted.

The Stockton CLG has identified sand replenishment or nourishment as a preferred long-term option to address coastal hazards and improve beach amenity. It is understood that the recently established NSW State Government Deputy Premier's Task Force will be investigating all options for sand nourishment sources, including offshore dredging which is currently not permissible under NSW legislation. The Stockton CMP has been prepared to include consideration of offshore dredging (or other potential sand sources) coming on-line in the future via a sensitivity analysis in the Cost Benefit Analysis (CBA) (Bluecoast, 2020a).

In developing the shortlisted options for appraisal in the Stockton CMP, the above factors have all been considered. Due to the extremely tight time frame available to develop and prepare the 2020 Stockton CMP, CN in consultation with DPIE, elected to limit the spatial extent of the Stockton CMP to the frontage from the Breakwater to Meredith St. This allowed efforts to be focussed on the southern portion of Stockton that could realistically be completed, allowing for the more complex stakeholder consultation required for the coastal area north of Meredith St to be undertaken at a later date under less time pressure. The remainder of the Stockton coastline (within the Newcastle LGA) will be addressed in the full Newcastle CMP to be completed in 2021.

In making this decision it was understood that any actions proposed in the south need to consider the potential impacts on stakeholders to the north and ensure that these are acceptable.

8.2 Coarse Filter Assessment

A coarse filter for the overall frontage was initially applied to rule out options deemed not feasible. The filter identified feasible options ('Go' options), options suitable to specific sites but which required further assessment ('Slow' options) and non-feasible options ('Stop' options). The Go, Slow, Stop assessment was also used to assess whether each option addressed short-term storm erosion, long term recession and beach amenity.

The assessment criteria used in the filter are summarised in **Table 9** outlines the coarse filter for the options relevant to the whole Stockton CMP area.

Only options with a Go or Slow assessment were considered further in the development of the Stockton CMP. **Table 10, Table 11**, **Table 12 and Table 13** outline more specifically the coarse filter for options for Zones 1, 2, 3 and 4, respectively (which constitute the spatial extent of the Stockton CMP).

Table 9: Coarse Filter Assessment Criteria

	Addresses Storm Erosion	Addresses Long Term Recession	Addresses Beach Amenity	Capital Costs	Recurrent Costs	Environmental or Social Impact	Likely Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Ease of implementation
STOP	Does not provide protection to assets in short term i.e.. can not accommodate design storm demand	Does not accommodate long term recession i.e.. Shoreline position moves landward	Does not provide a sandy beach i.e.. beach amenity is lost	Very Expensive (> $8 million)	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 alternative options in future	Option does not provide a solution over the period of time required.	Will require an EIS to implement and / or new Government Program to implement. There is a residual risk that approval will not be able to be obtained for the proposed work/strategy	Requires Substantial engineering investigations and capabilities; financial finding mechanisms etc. to be implemented.
SLOW	Provides protection to some assets in short term i.e.. can accommodate design storm demand in short term	Does not accommodate long term recession in all areas i.e.. Shoreline position moves landward and some assets at risk	Provides a sandy beach part of the time or in the medium term	Moderately expensive (e.g. $1 million - $8 million)	Moderately expensive (e.g. $30 000 - $300,000)	No net impact	Would be palatable to some, not to others (50/0 response) Briefing by 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 required further resources /changes to be effective over the long term	Will require government approvals to be implemented, or require assistance through an existing government program. Generally these approvals /assistance are likely to be granted assuming requirements are met	Requires further engineering designs, financial assistance (which is likely to be available) etc. to be implemented.
GO	Provides protection to all assets in short term i.e.. can accommodate design storm demand	Accommodates long term recession i.e.. Shoreline position stable and assets protected	Maintains a sandy beach in the long term	Low cost (< $1 million)	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 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 solutions	No or minimal government approvals required to implement.	Requires little to no further investigations and / or funding assistance to be implemented.

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Table 10: Traffic light coarse filtering of Options – general overview for whole Stockton CMP frontage

Option	Addresses Storm Erosion	Addresses Long Term Recession	Addresses Beach Amenity	Capital Cost	Recurring Costs	Environmental or Social Impact	Likely Community Acceptability	Adaptable into Future	Long Term Effectiveness	Approval Risk	Ease of Implementation	Score (G = 1, Sl = 0, St = -1)	Overall Analysis	Comments
Nourishment Options														
Beach Nourishment (Sand Backpassing from north)	SLOW	SLOW	GO	SLOW	SLOW	GO	GO	GO	GO	STOP	GO	5	STOP	A semi-permanent piped backpassing system or wheeled tractor scraper transport from Stockton Bight to Mitchell St could be investigated in the Newcastle CMP however this is outside of the spatial extent of the Stockton CMP.
Beach Scraping	STOP	STOP	SLOW	GO	GO	GO	GO	GO	STOP	GO	GO	4	STOP	Dependent on beach condition so sand may not be available when needed. Does not add any sand to the system, just redistributes it therefore beach scraping is not a coastal protection strategy and is therefore not considered further in the assessment, though it is recommended as a beach management tool where appropriate (refer previous report on beach scraping (RHDHV, 2016)).
Beach Nourishment (from dredging)	SLOW	SLOW	GO	SLOW	SLOW	GO	GO	GO	GO	SLOW	SLOW	5	GO	New offshore sand extraction is currently restricted by legislation in NSW, therefore only potentially feasible source is capital dredging for PoN or other developments. Costs could be low if aligned with capital dredging operations, however timing of sand availability is unknown and therefore not a reliable source. Concept based approval to be sought from NSW Gov. that provides an opportunity for any beneficial reuse of dredged material at Stockton should dredged material become available.
Beach nourishment from terrestrial sources	SLOW	SLOW	SLOW	STOP	STOP	SLOW	GO	GO	SLOW	SLOW	SLOW	0	SLOW	Sand sourced from local quarries and trucked to site and placed with trucks/dozers on sub aerial beach. Constrained by sand quantities available, logistics of placement and community acceptance of trucking movements, beach disruption, noise and traffic impacts. Would be limited to 5 days/week for 6 mths of the year. Also dependent on beach, weather and surf conditions.
Beach Nourishment (bypassing from Nobbys beach)	SLOW	SLOW	GO	STOP	STOP	SLOW	SLOW	SLOW	GO	STOP	STOP	-2	STOP	Cost prohibitive and unacceptable level of risk. High cost and high risk construction methodology to lay pipe beneath fully operational shipping channel. Risk of impacts to Port operations. Risk of damage to pipeline infrastructure in channel due to regular maintenance dredging.
Structural Solutions (all require beach nourishment to maintain beach amenity)														
Seawalls	GO	GO	SLOW	SLOW	GO	SLOW	SLOW	GO	GO	GO	GO	7	GO	Roadway and building assets are currently at immediate risk from storm erosion and seawalls are the only way to provide terminal protection to these assets. Appropriate alignment (as far landward as possible) required to ensure long term effectiveness and reduce likelihood of loss of beach amenity. Without nourishment will result in eventual loss of beach amenity. Recent quarry assessment indicates that sourcing local rock for extensive revetment structures would be very difficult. Alternative structure type therefore recommended.
Artificial Reef Breakwaters	SLOW	SLOW	SLOW	STOP	SLOW	SLOW	GO	GO	SLOW	STOP	STOP	-1	STOP	Cost prohibitive and technical performance unreliable (DHI, 2009). Would potentially reduce risk of storm erosion and long term recession but would not provide terminal protection to assets.
Groyne Field	STOP	STOP	STOP	STOP	SLOW	STOP	STOP	GO	SLOW	SLOW	SLOW	-4	STOP	High cost due to construction in high wave energy environment making cost prohibitive. Would potentially reduce risk of storm erosion and long term recession but would not provide terminal protection to assets. Lack of community acceptance due to intrusive nature as noted in (DHI, 2009).
Large Single Artificial Headland	SLOW	SLOW	GO	STOP	STOP	STOP	GO	SLOW	SLOW	STOP	STOP	-3	STOP	The Coastal Panel noted that this option was cost prohibitive with no funding mechanism, as reasons for not certifying the 2016 CZMP. Would potentially improve retention of beach nourishment sand, reduce risk of storm erosion and long term recession but would not provide terminal protection to assets. Not suitable within the 2020 Stockton CMP area as the downdrift erosion impacts would affect Hunter Water significantly. Potentially viable further north and should be investigated as part of broader Newcastle CMP.
Multiple Small(er) Artificial Headlands	SLOW	SLOW	GO	SLOW	SLOW	SLOW	SLOW	GO	GO	SLOW	SLOW	3	GO	May be feasible option north of Mitchell St revetment. Would potentially improve retention of beach nourishment thereby improving beach amenity, reduce risk of storm erosion and long term recession but would not provide terminal protection to assets.
Planned Retreat														
Relocate Assets	SLOW	GO	GO	SLOW	GO	GO	STOP	GO	GO	GO	GO	7	GO	Relocation of public assets is a feasible option in some zones. e.g Holiday Park
Land Acquisition	SLOW	SLOW	GO	SLOW	SLOW	SLOW	SLOW	GO	SLOW	SLOW	SLOW	2	SLOW	Potentially possible on a small scale in targeted locations.
Buy back/Lease scheme	STOP	GO	GO	STOP	SLOW	STOP	STOP	GO	SLOW	SLOW	SLOW	-1	STOP	Cost prohibitive, lack of community acceptance.
Sacrifice Land/Assets	GO	GO	GO	GO	GO	STOP	STOP	STOP	GO	SLOW	GO	4	GO	More appropriate in some zones where there is public land and limited assets.

Note: it is assumed that typical planning mechanisms such as LEP and DCP controls would also be adopted in combination with above options.

9 Options Consideration by Zone

The zones previously developed for the CZMP (2018), will be used to consider the options and evaluate feasible options more specifically for that area.

9.1 Zone 1 – Breakwater to Surf Life Saving Club (SLSC) revetment

Zone 1 is approximately 660m long and comprises the Stockton Holiday Park frontage, Lexie's Café, formalised carparking, SLSC amenities and storage facility, and the main SLSC building. Zone 1 is all CN owned land. Zone 1 is the most heavily utilised portion of Stockton Beach for recreation. Accordingly, beach amenity and access in this zone are highly valued.

Assets at immediate risk from storm erosion include (refer 2020 1% AEP hazard line):

- Lexie's café;
- northern end of Pitt St, and
- approx. 20-30m of Holiday Park frontage including amenities block.

A more specific coarse filter of options for Zone 1 was undertaken as shown in **Table 11.**

9.1.1 Zone 2 – SLSC to Mitchell Street revetment

Zone 2, extending approximately 400m from the SLSC revetment to the Mitchell Street revetment, is backed by predominantly public land including an informal grassed area and a pine tree lined loop road accessing the Memorial Monument at the end of Hereford Street.

Assets at immediate risk from storm erosion include (refer 2020 1% AEP hazard line):

- Mitchell St roadway at northern end of zone;
- Residential properties on Mitchell Street:
- Part of the Monument carpark:
- Tennis court behind SLSC: and
- SLSC building.

A more specific coarse filter of options for Zone 2 was undertaken as shown in **Table 12.**

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Table 11: Zone 1 – Coarse Filter Assessment of Options

Option	Addresses Storm Erosion	Addresses Long Term Recession	Addresses Beach Amenity	Capital Cost	Recurring Costs	Environmental or Social Impact	Likely Community Acceptability	Adaptable into Future	Long Term Effectiveness	Approval Risk	Ease of Implementation	Score (G = 1, Sl = 0, St = -1)	Overall Analysis	Comments
Nourishment Options														
Beach Nourishment (from dredging)	SLOW	SLOW	GO	SLOW	SLOW	GO	GO	GO	GO	SLOW	SLOW	4	GO	New offshore sand extraction is currently restricted by legislation in NSW, therefore only potentially feasible source is capital dredging from PoN. Costs could be low if aligned with PoN capital dredging operation, however timing of sand availability is unknown and therefore not a reliable source. Concept based approval to be sought from NSW Gov. that provides an opportunity for any beneficial reuse of dredged material should it become available.
Beach nourishment from terrestrial sources	SLOW	SLOW	SLOW	STOP	STOP	SLOW	GO	GO	SLOW	SLOW	SLOW	0	SLOW	Sand sourced from local quarries and trucked to site and placed with trucks/dozers on sub aerial beach. Constrained by sand quantities available, logistics of placement and community acceptance of trucking movements, beach disruption, noise and traffic impacts. Would be limited to 5 days/week for 6 mths of the year. Also dependent on beach, weather and surf conditions.
Structural Solutions (all require beach nourishment)														
Seawalls	GO	GO	SLOW	SLOW	GO	SLOW	SLOW	SLOW	GO	SLOW	GO	5	GO	Roadway and building assets are currently at immediate risk from storm erosion and seawalls are the only way to provide protection to these assets. Would provide terminal protection to assets at risk. Appropriate alignment (as far landward as possible) required to ensure long term effectiveness and reduce likelihood of loss of beach amenity. Without nourishment will result in eventual loss of beach amenity.
Multiple Small(er) Artificial Headlands	STOP	STOP	STOP	SLOW	SLOW	STOP	STOP	GO	STOP	SLOW	SLOW	-5	STOP	Due to complex sediment transport processes in this zone with both north and south movement of sediment it is not considered a technically suitable option to capture and retain sand transported alongshore. Loss of continuous alongshore beach access in this location is not likely to be acceptable to the community.
Planned Retreat														
Relocate Assets	SLOW	GO	GO	SLOW	GO	GO	SLOW	GO	GO	GO	GO	8	GO	Relocation of built assets (such as amenities in Holiday Park) further landward is a feasible option, with at-risk foreshore zone used for adaptive recreational and environmental land uses such as camp sites. Relocation of the SLSC revetment and assets behind it have not been considered as CN are committed to holding the line and protecting this area for as long as possible.
Sacrifice Land/Assets	GO	GO	GO	GO	GO	SLOW	SLOW	SLOW	GO	SLOW	GO	7	GO	Appropriate as there are limited non-relocatable assets .

Note: it is assumed that typical planning mechanisms such as LEP and DCP controls would also be adopted in combination with above options.

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Table 12: Zone 2 – Coarse Filter Assessment of Options

Option	Addresses Storm Erosion	Addresses Long Term Recession	Addresses Beach Amenity	Capital Cost	Recurring Costs	Environmental or Social Impact	Likely Community Acceptability	Adaptable into Future	Long Term Effectiveness	Approval Risk	Ease of Implementation	Score (G = 1, Sl = 0, St = -1)	Overall Analysis	Comments
Nourishment Options														
Beach Nourishment (from dredging)	SLOW	SLOW	GO	SLOW	SLOW	GO	GO	GO	GO	SLOW	SLOW	4	GO	New offshore sand extraction is currently restricted by legislation in NSW, therefore only potentially feasible source is capital dredging from PoN. Costs could be low if aligned with PoN capital dredging operation, however timing of sand availability is unknown and therefore not a reliable source. Concept based approval to be sought from NSW Gov. that provides an opportunity for any beneficial reuse of dredged material should it become available.
Beach nourishment from terrestrial sources	SLOW	SLOW	SLOW	STOP	STOP	SLOW	GO	GO	SLOW	SLOW	SLOW	0	SLOW	Sand sourced from local quarries and trucked to site and placed with trucks/dozers on sub aerial beach. Constrained by sand quantities available, logistics of placement and community acceptance of trucking movements, beach disruption, noise and traffic impacts. Would be limited to 5 days/week for 6 mths of the year. Also dependent on beach, weather and surf conditions.
Structural Solutions (all require beach nourishment)														
Seawalls	GO	GO	SLOW	SLOW	GO	SLOW	SLOW	SLOW	GO	SLOW	GO	5	GO	Roadway assets are currently at immediate risk from storm erosion and seawalls are the only way to provide protection to these assets. Appropriate alignment (as far landward as possible) required to ensure long term effectiveness and reduce liklihood of loss of beach amenity. Without nourishment will result in eventual loss of beach amenity. Minimal assets threatened in this zone, just road at northern end.
Multiple Small(er) Artificial Headlands	STOP	STOP	STOP	SLOW	SLOW	STOP	STOP	GO	STOP	SLOW	SLOW	-5	STOP	Due to complex sediment transport processes in this zone with both north and south movement of sediment it is not considered a technically suitable option in this zone to capture and retain sand transported alongshore.
Planned Retreat														
Relocate Assets	SLOW	GO	GO	SLOW	GO	GO	SLOW	GO	GO	GO	GO	8	GO	Relocation of the Memorial and carparking along Mitchell St are feasible.
Sacrifice Land/Assets	GO	GO	GO	GO	GO	SLOW	SLOW	SLOW	GO	SLOW	GO	7	GO	Appropriate as there are limited non-relocatable assets .

Note: it is assumed that typical planning mechanisms such as LEP and DCP controls would also be adopted in combination with above options.

9.1.2 Zone 3 – Mitchell Street revetment

Zone 3 comprises the entire Mitchell Street seawall (rock revetment) extends 550 m along Stockton Beach from Pembroke Street in the south to Stone Street in the north.

There are currently no assets at risk in Zone 3 assuming the Mitchell Street revetment continues to be maintained. The southern and northern flanks of the revetment have been considered with Zones 2 and 4, respectively. It is therefore proposed that the current CZMP action to maintain the Mitchell Street revetment structure be adopted as a long term action in the Stockton CMP, understanding that any beach nourishment adopted for the wider area will consider beach amenity value in this zone.

9.1.3 Zone 4 – Barrie Crescent and Eames Avenue frontage (Stone Street to Meredith Street)

Zone 4 is comprised of 200m fronting Barrie Crescent (between Stone Street and Griffiths Avenue) and 270m fronting Eames Avenue (between Griffiths Avenue and Meredith Street).

The assets at immediate risk in this zone (refer 2020 1% AEP hazard line) are:

- Barrie Cres roadway (north and south ends);
- residential dwellings on Stone Street and Griffiths Ave corners of Barrie Cres); and
- Griffiths Ave roadway.

The coarse filter of options 4 is summarised below in **Table 13.**

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Table 13: Zone 4 – Coarse Filter Assessment of Options

Option	Addresses Storm Erosion/ protects assets	Addresses Long Term Recession	Addresses Beach Amenity	Capital Cost	Recurring Costs	Environmental or Social Impact	Likely Community Acceptability	Adaptable into Future	Long Term Effectiveness	Approval Risk	Ease of Implementation	Score (G = 1, Sl = 0, St = -1)	Overall Analysis	Comments
Nourishment Options														
Beach Nourishment (from dredging)	SLOW	SLOW	GO	SLOW	SLOW	GO	GO	GO	GO	SLOW	SLOW	4	SLOW	NSW, therefore only potentially feasible source is capital dredging from PoN. Costs could be low if aligned with PoN capital dredging operation, however timing of sand availability is unknown and
Beach nourishment from terrestrial sources	SLOW	SLOW	SLOW	STOP	STOP	SLOW	GO	GO	SLOW	SLOW	SLOW	0	SLOW	Within the spatial extent of the Stockton CMP, trucking of sand from quarries is the only permissible option for nourishment. Other backpassing options from further north along Stockton Bight could be considered in the broader Newcastle CMP at a later date.
Structural Solutions (all require beach nourishment)														
Seawalls	GO	GO	SLOW	SLOW	GO	SLOW	SLOW	SLOW	GO	SLOW	GO	5	GO	Roadway assets are currently at immediate risk from storm erosion and seawalls are the only way to provide protection to these assets. Buried terminal seawall structure to protect roads and houses at risk by 2025
Multiple Small(er) Artificial Headlands	SLOW	SLOW	GO	SLOW	SLOW	SLOW	SLOW	GO	GO	SLOW	SLOW	3	GO	More predictably northerly net sediment transport in this zone therefore more suited to this type of structure than southerly zones. Would reduce alongshore losses and assist in retaining sand on beach. Small headland structures could be considered to the north of the Stockton CMP area in Newcastle CMP in consultation with stakeholders such as Hunter Water.
Planned Retreat														
Relocate Assets	SLOW	SLOW	SLOW	SLOW	GO	SLOW	STOP	SLOW	SLOW	GO	STOP	0	SLOW	Reconfiguration of Barrie Cres and Griffiths Ave roadways e.g one way system to provide additional natural buffer (sand volume) for storm demand to assist in maintaining beach amenity and reducing coastal inundation/overtopping.
Sacrifice Land/Assets	STOP	STOP	GO	STOP	SLOW	STOP	STOP	STOP	GO	SLOW	GO	-3	STOP	Numerous private residences would eventually need to be sacrificed as recession would continue. Likely to be cost prohibitive.
Land Acquisition	SLOW	SLOW	GO	SLOW	SLOW	SLOW	SLOW	GO	SLOW	SLOW	SLOW	2	SLOW	Potentially possible on a small scale in targeted locations where significant benefit can be gained from optimising beach planform.

Note: it is assumed that typical planning mechanisms such as LEP and DCP controls would also be adopted in combination with above options.

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9.1.4 Zones 5, 6 and 7

Whilst Zone 4 represents the northern most section of this Stockton CMP, the zones to the north have been considered in general terms to ensure a holistic view of the coastline and coastal processes in making decisions regarding the southern portion of the embayment.

The Zone 5 frontage extends from Meredith Street to the Hunter Water land and is approximately 200m long. It is comprised of vegetated dune fronting Corroba Oval. There are no built assets at risk in this zone, and it is considered likely that there would be no rationale to protect Zone 5 with engineered structures.

The Zone 6 Hunter Water frontage extends approximately 400m north from Corroba Oval. In 2019 a temporary coastal protection structure (5-7 year design life) in the form of geotextile container seawall was constructed in this zone. This structure's primary purpose is to temporarily contain the solid components of a legacy landfill waste located in the dune system and reduce the impact of oceanic storm conditions further exposing the waste, whilst a longer-term strategy is developed. Though not its original design purpose, this seawall will also function as a hard point controlling the beach planform of Zone 5 for the life of this temporary structure. The strategy for this zone needs to consider the outcomes of the assessment of long term options to treat/manage the landfill.

Zone 7 is approximately 2.3km long and extends from Hunter Water in the south to the Local Government Authority (LGA) boundary in the north. This coastline is generally undeveloped with most assets a minimum of 100m behind the beach. The back beach land use along the northern section of Stockton Beach from south to north comprises:

- Fort Wallace RAN Facility, owned by Defence Housing Australia (DHA);
- Stockton Centre, a major institutional heritage complex dating back to 1900, owned and managed by the State Government; and
- Fern Bay Rifle Range, considered to be outside of the scope of the Strategy.

This zone is relatively stable compared to the southern portion of the beach, with long term recession rates of 1m/year erosion at the southern end to approx. 1m/ year accretion at the northern end. There are currently no assets at risk in the short to medium term.

10 Selection of CM Options for CBA

In line with the Coastal Management Act 2016 and the NSW Coastal Management Manual Part A (the Manual), a Cost Benefit Analysis (CBA) for Stockton Beach is to be undertaken to provide an economic analysis of coastal management options (refer to **Supporting Document G** for CBA).

Due to the compressed Stockton CMP timeframe, a shortlist of potentially feasible management action options were selected for assessment in the CBA based on the 'Course Filter' Options Evaluation outlined in the previous sections. Three options were selected that are to be robustly examined in the CBA on the basis of the sometimes-competing considerations of:

- community values e.g. beach access and recreational amenity, coastal culture and environment;
- protection of assets from coastal hazards;
- cost and economic viability; and
- legal feasibility.

The options will be assessed relative to a Base Case of 'business as usual'. The base case and the three Options are outlined briefly below.

Base Case – Business as Usual
General Description – The Base Case involves continued delivery of the actions within the Newcastle Coastal Zone Management Plan (CZMP) 2018 Part A including ongoing retreat and relocation of assets e.g. the old SLSC building or Childcare Centre at Barrie Crescent. This certified CZMP provides a planning and approvals pathway to undertake a range of management actions and investigations, which are eligible to receive grant funding.

Option 1 - Mass sand nourishment for protection + amenity, limited coastal protection works
General Description - Mass sand nourishment to a level that provides coastal protection to existing assets and the construction of buried coastal protection structures to protect assets at risk within the next 5 years (in accordance with established 2025 hazard lines[2]).

Option 2 - Sand nourishment for improved beach amenity + staged buried terminal protection
General Description - Beach amenity sand nourishment to provide improved recreational access and use. The beach amenity objective is a minimum annual average beach width of 5m at the narrowest point. This option also includes construction of buried terminal protection structures, constructed in two stages, to address the current and future risk of potentially high consequence, low probability events that may affect the area (mandatory requirement 13, Coastal Management Manual Part A). Sub-options also include an additional nourishment volume to accommodate a 1 year ARI storm. Any future buried terminal protection structures would be set back from the current shoreline and construction of these structures would only be triggered if the foreshore reaches a threshold width. Built assets within the at-risk foreshore zone (such as amenities in Holiday Park) would be relocated further landward and at-risk foreshore zone used for adaptive recreational and environmental land uses.

Option 3 – Sand nourishment to maintain beach amenity + staged buried terminal protection
General Description - Beach amenity sand nourishment of a volume logistically feasible using available terrestrial sources of sand. This volume is likely to be able to maintain current beach widths, recreational access and use. As in **Option 2**, this also includes construction of buried terminal protection structures, constructed in two stages, to address the current and future risk of potentially high consequence, low

[2] *This approach allows a 5 years' time period for sufficient nourishment to be in place to provide ongoing protection to coastal assets further landward.*

probability events that may affect the area (mandatory requirement 13, Coastal Management Manual Part A). Any future buried terminal protection structures would be set back from the current shoreline and construction of these structures would only be triggered if the foreshore reaches a threshold width. As noted in Option 2, built assets within the at-risk foreshore zone (such as amenities in Holiday Park) would be relocated further landward and at-risk foreshore zone used for adaptive recreational and environmental land uses.

A sub-option (Option 3b) with optimised Stage 1 works, reduced nourishment volume and subsequent planned retreat and relocation of assets, was also assessed as described further below.

10.1 Sand Source Constraints and Opportunities

Noting that terrestrial sand is currently the only readily available source, all Options have been developed for the CBA using this supply source, with the relevant methodology and cost estimates. Existing extraction limits from licensed local sand quarries and practical limitations associated with transporting and placing sand on Stockton Beach using trucks and earth moving equipment have been acknowledged. Accordingly, it is understood that these actions are neither permissible (Carley & Cox 2017) nor technically feasible for the volumes of sand required for **Options 1** and **2** (refer **Supporting Document E** for a more detailed discussion of the constraints of availability and placement of terrestrially sourced sand). CN have advised that despite these not constituting certifiable actions within the Stockton CMP, they were to be assessed in the CBA due to the community preference for beach nourishment.

While acknowledging that marine sand sources are currently either; restricted by legislation, or not available, there are potential future opportunities to access these sources. Accordingly, marine sand sources have been included in a sensitivity analysis in the CBA to assess the benefit cost ratios of potential future use of offshore marine sand (**Option 1b**) and Hunter River marine sand (**Option 1c**). Details of potential marine sources, methodology and costs are provided in **Supporting Document F.**

As noted previously, **Option 3** was developed on the basis of a logistically feasible annual nourishment volume from terrestrial sources (200,000m^3/year) whilst providing terminal protection structures for any assets at risk by 2025 (seaward of ZRFC for 1% AEP storm) and future setback terminal protection (Stage 2) when trigger foreshore widths were reached. However, once developed to greater level of detail than the course filter assessment (**Section 8.2**), cost estimates for nourishment from terrestrial sources for the volumes required, indicated that Option 3 was not economically feasible (with nourishment costs from terrestrial sources at $16 million every year).

To reduce capital cost, a variant of Option 3 was developed (**Option 3b**), with a more affordable nourishment quantity and some of the initial buried terminal protection works delayed. Nourishment would be 50,000m^3/year which would reduce (but not prevent) future beach erosion and recession (as it is approx. 45% of the current annual volume of sand loss from this section of the coastline). The optimized initial buried terminal protection works would provide protection to assets seaward of the 2025 Zone of Slope Adjustment for a 5% AEP storm i.e. a higher risk profile than other options. This option would be viable in the medium term (2 to 5 years) but in the longer term it would result in significant loss of beach width and amenity within the Stockton CMP area and impact downdrift beaches to the north.

Furthermore, **Option 1d** was developed as a hybrid of **Option 1b** and **Option 3b** to provide an economic assessment of a practical path forward given current legislative and availability constraints on marine sand sources. **Option 1d** involves **Option 3b** for the first year i.e. nominal sand nourishment from terrestrial sources with optimized initial terminal protection structures, followed by **Option 1b** with a mass sand nourishment campaign in year 2 from offshore marine sources and ongoing maintenance nourishment campaigns every 10 years. The need for the Stage 2 structural works would be eliminated by the protection afforded by the mass sand nourishment.

A summary of all of the options and associated parameters assessed in the CBA are outlined in ***Table 14*****.**

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Table 14: Summary of Options and sub-options assessed in CBA

Option	Sub-option	Description	Sand Source	Initial nourishment vol (m3)	Maintenance nourishment vol (m3)**	Maintenance nourishment frequency (years)	Buried terminal Protection Structures (m)	
							Stage 1	Stage 2
1	1a	Mass nourishment for protection + amenity, stage 1coastal protection works	Terrestrial	4.5 million*	2.5 million*	5 years	458	0
	1b		Marine (offshore)	2.4 million**	1.12 million**	10 years		
	1c		Marine (Hunter River)	1.8 million	560,000	5 years		
	1d	Option 3b adopted for first year, then mass nourishment as per Option 1b, with optimised stage 1 coastal protection work	Terrestrial Marine (offshore)	50,000 2.4 million**	1.12 million**	10 years	225	0
2	2a	Sand nourishment for improved beach amenity + staged buried terminal protection	Terrestrial	525,000*	280,000*	5 years	458	995
	2b	Sand nourishment for improved beach amenity + 1 year ARI storm each year + staged buried terminal protection	Marine (offshore)	610,000*	560,000	5 years	458	995
	2c	Sand nourishment for improved beach amenity + 1 year ARI storm each year + staged buried terminal protection	Marine (Hunter River)	610,000*	560,000	5 years	458	995
3	3a	Sand nourishment to maintain beach amenity (logistically feasible terrestrial volume) + staged buried terminal protection	Terrestrial	200,000	200,000	annual	458	995
	3b	Reduced sand nourishment (economically feasible terrestrial volume) + optimised stage 1 and 2 buried terminal protection	Terrestrial	50,000	50,000	annual	225	1186

* exceeds volume from terrestrial sources that can feasibly be placed on the subaerial beach. Volumes include an overfill ratio of 2.5 though sensitivity analysis is also recommended to be undertaken for overfill ratio of 1.
** volumes determined by Bluecoast (2020) on basis of Stage 2 Sediment Transport Study findings

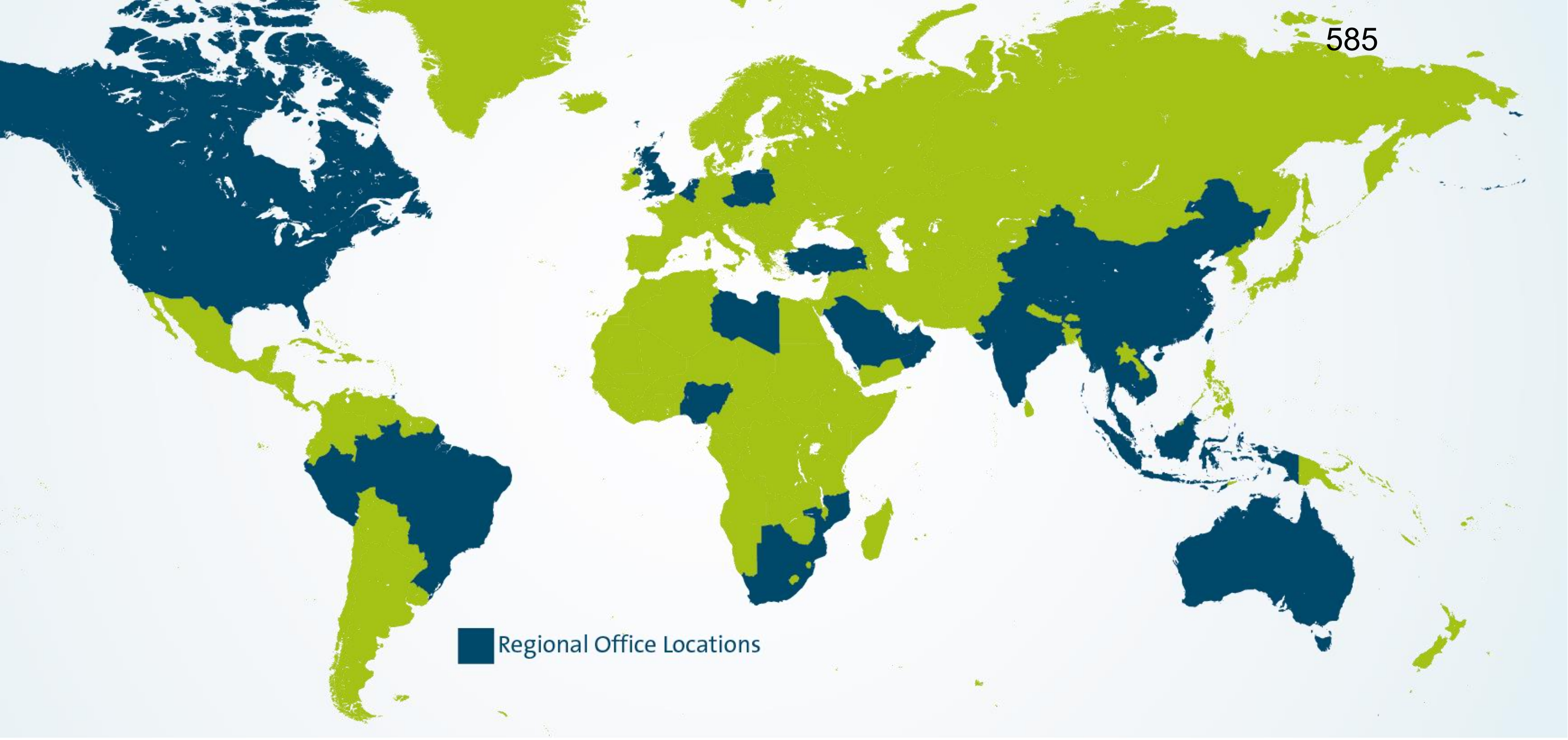
Nourishment volumes have been estimated by RHDHV for input into the CBA, with refinements made by Bluecoast based on models and outcomes of the Stage 2 Sediment Transport Study.

Further detail of the development, rationale and risks of each of the Options and sub-options is provided in **Appendix C** of the CBA report (refer **Supporting Document F**).

11 Reference list

Bluecoast (2020), Sediment Transport Study within Stockton Bight – Part A, Technical Note, prepared for City of Newcastle, 10 June 2020.

Bluecoast (2020a), Cost benefit analysis for Stockton Beach coastal management program, prepared for City of Newcastle. 23 April 2020.



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CCL 23/06/2020 - ENDORSEMENT OF THE DRAFT STOCKTON COASTAL MANAGEMENT PROGRAM

ITEM-30 **Attachment I:** Potential Nourishment Sources (Royal HaskoningDHV, 2020) – Stockton CMP Supporting Document E.

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Supporting Documentation E.

Potential Nourishment Sand Sources (RHDHV, 2020b)

City of Newcastle

REPORT

Stockton Coastal Management Program

Potential Nourishment Sand Sources
Supporting Document E

Client: City of Newcastle

Reference: PA2395-RHDHV-CN-SDE-0014

Status: S1/P01

Date: 17/06/2020

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Project name:	Stockton Coastal Management Program	
Project number:	PA2395	
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Date / initials:	NP 16/6/2020	
Approved by:	Greg Britton	D Messiter
Date / initials:	4/5/2020 GB	17/6/2020 DM

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ISO 45001

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1 Introduction

It is evident that one of the key drivers of the coastal risk at Stockton Beach is a long-term net sediment deficit (underlying recession). In addition, future shoreline recession is predicted to occur as a result of climate change sea level rise.

Beach nourishment has been considered in detail as a potential coastal management strategy to address the recession hazard. A wide range of potential sand sources have been considered as part of the Stockton CMP process, including:

- Terrestrial sources, including:
  - local quarries;
  - Sydney tunnelling spoil opportunities;
  - sand backpassing from Stockton Bight using beach scraping;
  - sand backpassing from Stockton Bight with Sand Shifter;
  - beach scraping within the Stockton CMP Area; and,
  - Swansea Channel dredged material;

- Marine sources, including:
  - offshore sand sources;
  - Port of Newcastle – Area E; and,
  - sand bypassing from Nobbys Beach;

- Hunter River sources, including:
  - South Arm; and,
  - North Arm.

An overview of each of the above potential sand sources is provided in **Sections 2, 3 & 4** below, including assessment of the feasibility, opportunities and constraints for each source. Details regarding a potential concept approval for the placement of nourishment material at Stockton Beach are provided in **Section 5** A 'traffic light' assessment of each sand source is provided in **Section 6.** References are provided in **Section 7.**

It should be noted that further details regarding potential sand sources will be provided in the Sand Management Guidelines (SMG), which is identified as an action within the Stockton CMP. The SMG will provide a summary document of information regarding sand for future beach nourishment at Stockton.

2 Terrestrial Sources

2.1 Local Quarries

Material Properties

Consultation with several local sand quarries was undertaken to assess the suitability of available products against material acceptance criteria. Sand products from the following local quarries were assessed:

- Macka's Sand and Soil Supplies;
- Boral Stockton Sand Quarry;
- Redisands (Salt Ash);
- Newcastle Sand (Williamtown); and
- Sibelco Sand Quarry in Salt Ash (Note: Sibelco only carry a maximum of 2,500 tonnes of their 3060 product at any one time, and orders greater than this will incur longer lead times).

Material data sheets relating to available products were provided by each of the quarries and assessed by RHDHV engineers.

Considering that all locally sourced terrestrial sands are quarried from the windblown dunes of Stockton Bight and are further processed (i.e. washed and screened), it is unlikely that these terrestrial sands would contain any contaminants, organic matter, excessive fines or excessive coarse material, or significant colour incompatibilities following placement. Therefore, the key criterion determining the compatibility of these quarried sands is the Particle Size Distribution (PSD) of the available sand products.

PSD curves for a range of sand products available from local quarries are plotted in **Figure 1**. It is evident that the majority of these products are characterised by a median grain size (D_{50}) ranging between around 0.30 and 0.40 mm, while two of the products comprise relatively fine sand with D_{50} values below 0.25 mm.

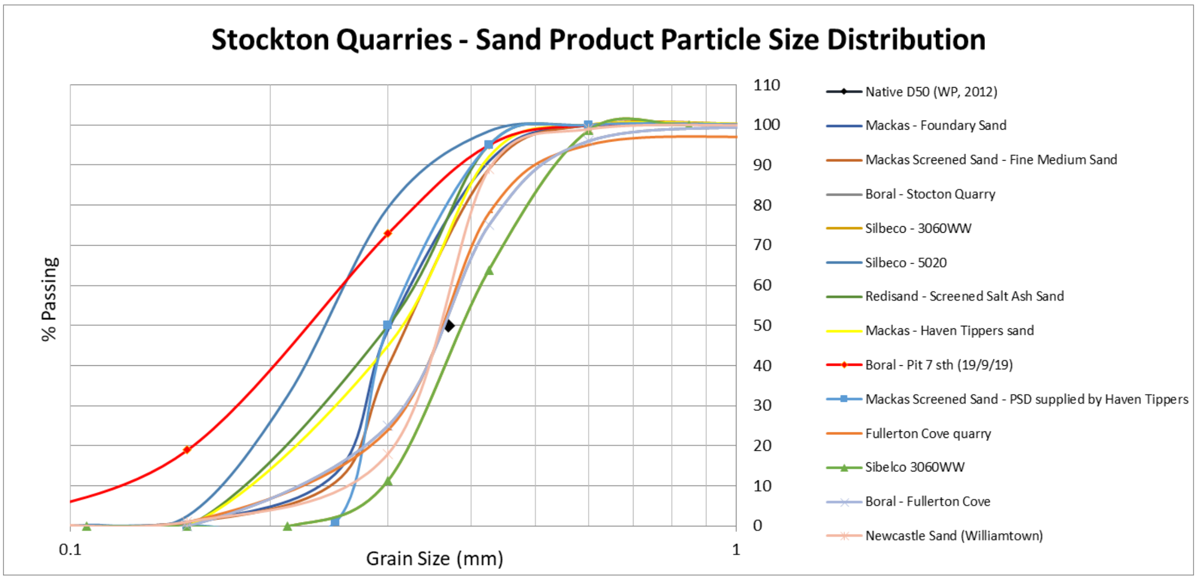

Figure 1: Stockton quarries - sand product PSDs

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In April 2011, WorleyParsons (2012) collected several samples of native beach sand along three transect profiles at Stockton Beach, with the transects located 900 m, 1700 m and 2500 m north of the Northern Breakwater of the Hunter River entrance (the Breakwater). Median grain sizes (D_{50}) ranged from 0.27 to 0.47 mm, with finer sand generally found at the southern end. The average grain size (D_{50}) from these samples was 0.37 mm (excluding a gravelly sample collected in the nearshore zone at the northernmost transect), as shown in **Figure 1**.

The beach and nearshore sands extending to a depth of approximately 15 m at the southern end of Stockton Beach were described by Roy and Crawford (1980) as well to very well sorted fine to medium grained sands with grain sizes ranging from 0.18 to 0.35 mm. A uniform mean grain size of 0.25 mm was determined for beach and nearshore sands at the southern end of Stockton Beach (Roy & Crawford 1980). This grain size was used as a constant in the most recent coastal processes modelling undertaken by DHI (2006). MHL (1977) similarly found finer sands in the southern few kilometres closest to the Breakwater, with many samples finer than 0.3 mm.

Based on the above information, it is considered that a compatible source sand for Stockton Beach should have a median grain size between 0.30 and 0.40 mm. This criterion accounts for the range of grain sizes found along the length of the beach, with progressively coarser material occurring with distance north of the Breakwater. This criterion also has regard to the Coastal Engineering Manual (CERC 2006) which notes that the D_{50} of the borrow material should be within plus or minus 0.02 mm of the native sand D_{50}.

Using this criterion, it is evident that the majority of sand products available from local quarries would likely be compatible for nourishment purposes at Stockton Beach (refer **Figure 1**).

Overfill Factors

The Overfill Factor or Overfill Ratio (R_A) is the ratio of fill (nourishment) material required from a given borrow site compared to that required using the existing (native) beach sediments (CERC 2006). The Overfill Factor is based on differences in the mean grain size and sorting characteristics of both the native and nourishment (borrowed) sands.

Whilst the Overfill Factors provide an indication of compatibility between borrow and native sediment, more detailed assessment of the compatibility is recommended to inform detailed project design. For example, CERC (2006) notes that:

- Recent research and beach nourishment experiences have questioned the continued use of grain-size based factors, such as R_A and the renourishment factor (R_J), to estimate beach-fill performance (Dean 2000).
- Present guidance recommends that design be based on equilibrium beach profile concepts, an assessment of storm-induced erosion, and an assessment of wave-driven longshore transport losses; and that these methods be used to replace or complement the overfill and renourishment factor approaches (National Research Council (NRC) 1995).

Nevertheless, the Overfill Factor can be used to provide a useful indication of sand volume requirements for a nourishment project, particularly in the early stages of project design. As such, this approach has been adopted for the purpose of undertaking a high-level assessment of sand volume requirements associated with the placement of local quarry sand sources at Stockton Beach.

CERC (2006) recommends that for a sand nourishment project, ideally a nourishment (borrow) sand should have an overfill ratio of 1 to 1.05 relative to the native sand. However, CERC (2006) also notes that this may not always be possible and as a rule of thumb if the median grain size of the borrow sand is within 0.02 mm of the native sand median grain size it is considered compatible.

Overfill Factors were calculated for several of the potential quarry sand sources using methods outlined in the Shore Protection Manual (CERC 1984). The WorleyParsons (2012) grain size data was used to characterise the native beach sands for these calculations (mean grain size, D_{50} = 0.37 mm or 1.43 phi units). Overfill Factors typically ranged from 1.8 to 5 for quarries carrying larger quantities of sand (suitable for a nourishment campaign at Stockton). This indicates that the median grain size of quarry sand sources is generally finer than the native sand requiring 1.8 to 5 times as much sand to retain each 1 m^3 on the beach. It should be noted that some products were in the unstable range (R_A > 10).

Based on the above, an Overfill Factor of approximately 2.5 has been adopted in the CMP for the purpose of assessing terrestrial sand nourishment at Stockton Beach using quarry sand sources. However, it should be noted that sensitivity testing was carried out in the CBA using an Overfill Factor of 1. The Overfill Factor would need to be reviewed on a case by case basis during any future nourishment works in consideration of the material properties of proposed sand nourishment material and the detailed project design.

Licensed Extractive Capacity

The extractive capacity of local quarries is stipulated in the Environment Protection Licence (EPL) issued to each facility. For example, EPL 10132 for Boral Quarries Stockton (Fullerton Cove) authorises an annual sand extraction of 100,000 to 500,000 tonnes. The current annual extractive capacities licensed for each of the local quarries considered herein are listed in **Table 1**.

Table 1: Local Quarry Licensed Extractive Capacity

Quarry Sand Source	EPL Number	Annual Extractive Capacity (tonnes)[1]	Annual Extractive Capacity (m^3)[1]
Boral Stockton (Fullerton Cove)	10132	500,000	300,000
Macka's Sand and Soil (Salt Ash)	12108	50,000	30,000
Sibelco (Oyster Cove)	11633	150,000	90,000
Newcastle Sand (Williamtown)	21264	500,000	300,000
Redisand (Salt Ash)	13406	500,000	300,000
TOTAL	**-**	**1.7 M tonnes**	**1,020,000 (sourced) 408,000 (effective)[2]**
Assumed availability for nourishment of Stockton Beach	**20% of total licensed quantities**	**340,000 tonnes**	**200,000 (sourced) 80,000 (effective)[2]**

[1] Maximum quantity that can be extracted, processed or stored annually.
[2] Effective in situ volume of quarry sand following placement at Stockton Beach, based on an adopted Overfill Factor of 2.5.

Based on preliminary enquiries made with Boral Stockton (Fullerton Cove), it is understood that annual extractive operations are typically within around 15,000 tonnes of the upper licensed limit of 500,000 tonnes. For the purpose of the assessment undertaken herein, it has been assumed that up to around 20% of the current annual combined extractive capacity of 1.7 million tonnes could be secured for terrestrial sand nourishment at Stockton Beach (refer **Table 1**). This would require detailed negotiations with each quarry to secure such a substantial portion of their licensed quantities, confirmation that suitable products can be made available, and (potentially) modifications to the existing EPLs.

Therefore, it has been assumed that local quarry sources are currently capable of supplying 340,000 tonnes annually for the purpose of nourishing Stockton Beach, which is equivalent to a supplied volume of around 200,000 m^3. Based on the adopted Overfill Factor of 2.5, the effective quantity of nourishment sand that could be placed on Stockton Beach is around 80,000 m^3 per year.

Costs

The cost to supply and place around 3,500 m^3 of quarry sand at Stockton Beach in December 2019 was around $\$100/m^3$. However, it is expected that lower cost rates would be available for large-scale nourishment campaigns due to economies of scale and competitive tendering. Therefore, for the purpose of costing in the CBA, a 20% reduction was applied to the December 2019 costs. That is, a cost rate of $80/m3 was adopted in the CBA for the supply and placement of quarry sands using land-based plant.

Sensitivity testing was carried out in the CBA using a lower bound cost rate of $\$50/m^3$, which incorporates a 50% reduction on the December 2019 project costs. This lower bound is to account for potentially even lower cost rates being available from local sand suppliers, depending on the scale of the project and a range of commercial factors.

2.2 Sydney Tunnelling Spoil Opportunities

Background

There is a potential to source tunnel spoil from the Western Harbour Tunnel (WHT) and other Sydney tunnel spoil projects for the purpose of beach nourishment.

It should be noted that sea disposal of terrestrially generated material is not common in Australia, with most material disposal occurring to land. Where this has involved material that is potentially suitable for beach nourishment purposes, such as Sydney Sandstone and Hawkesbury Sandstone, this could be considered as a series of missed opportunities. For example, future Sydney Metro and Cross-Harbour Tunnel projects are expected to generate several million m^3 of such material. While re-use of this material for nourishment purposes was briefly considered, it was not pursued further, likely due to the absence of a clearly defined, approved, alternative disposal pathway.

Concerns were raised in 2017 by the Sydney Coordination Office (SCO) regarding the cumulative impacts of proposed developments in and around White Bay and the Rozelle precinct, which included several tunnelling projects (WHT, Sydney Metro West and WestConnex Stage 3b). A Cumulative Traffic Working Group (CTWG) was established to jointly discuss management of all Sydney tunnel spoil, mostly around traffic implications related to land-based disposal of tunnel spoil. The working group comprised members of the following organisations:

- Transport for NSW;
- Urban Growth;
- Sydney Coordination Office;
- RMS (Network Sydney);
- RMS (Western Harbour Tunnel Project);
- RMS (WestConnex Stage 3b – Rozelle Interchange Project);
- Sydney Metro (Metro West); and,
- Port Authority of NSW.

The CTWG developed a shortlist of several potential mitigation options for the traffic implications, which included offshore disposal of terrestrially generated material.

Upcoming/Current Potential Opportunities

Some upcoming major tunnelling projects with the potential to generate significant quantities of material that would be suitable for nourishment at Stockton Beach include:

- Sydney Metro (Metro West), noting:
    - Tendering for construction of the 24 km Sydney Metro West metro line was launched on April 7 2020.
    - One of the tunnelling contracts associated with the tender is from Sydney Olympic Park to The Bays, with the ability to load tunnel boring machine (TBM) material at White Bay.
    - It is anticipated that tunnelling operations will commence around the end of 2022.
    - It is understood that the tunnelling works will generate around 2 million m^3 of Hawkesbury Sandstone.
    - The extra-over cost to transport this material to Newcastle is likely to be in the order of up to around \$10 per m^3, subject to commercial negotiations.

- Western Harbour Tunnel (WHT), noting:
  - Tunnel spoil from the WHT project is mostly going to land.
  - Following the work of the CTWG as outlined above, a sea dumping permit was obtained from the Commonwealth for the unconfined sea disposal of sandstone material from two of the WHT waterside construction sites, Yurulbin Point and Berrys Bay (**Figure 2**), from which material would already be on a barge.
  - A total of 600,000 m^3 of sandstone material requires removal from these sites.
  - The material would be disposed at Sydney Dredged Material Ground (DMG), similar to the method adopted for disposal of sandstone for approaches to the existing Sydney Harbour Tunnel in the late 1980s.

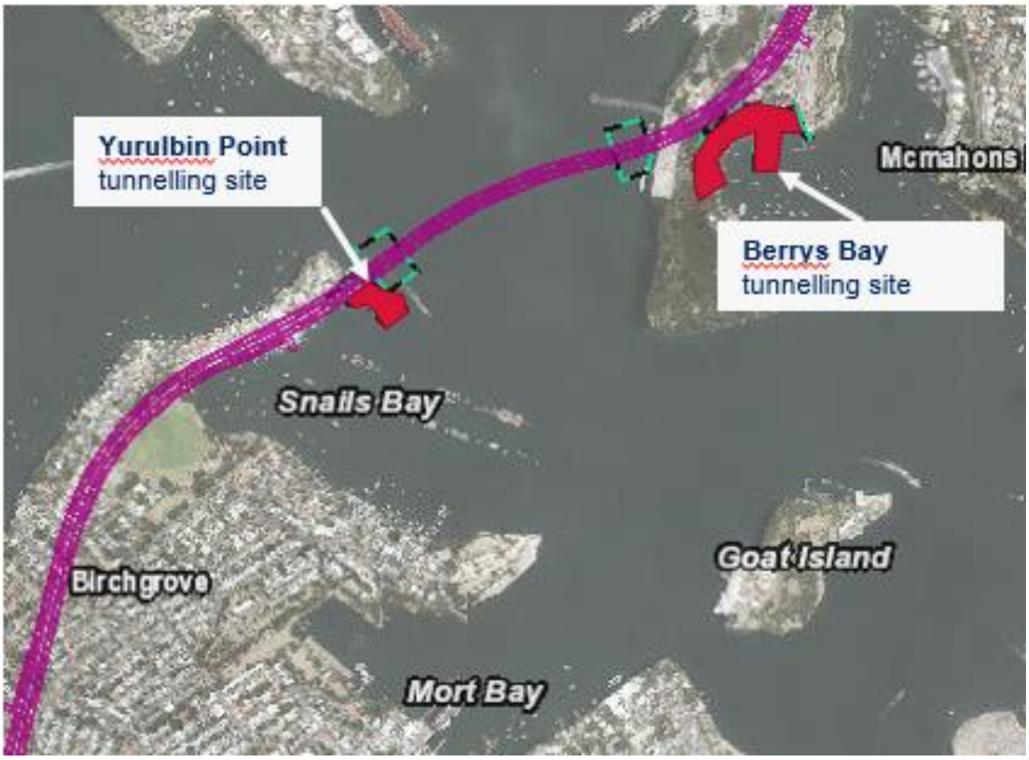

Figure 2: WHT tunneling sites nominated for unconfined sea disposal of terrestrial tunnel spoil

- WestConnex Stage 3b – Rozelle Interchange Project, noting:
  - tunnelling works commenced in early 2020;
  - the Rozelle Interchange tunnels are located mainly in Hawkesbury sandstone; and,
  - tunnelling is being largely carried out by roadheader machines that use a rotating head to slowly excavate the rock.

Tunnelling material is generated by either roadheader or TBM. Typically, TBM material is characterised by a narrower and 'finer' grading curve than roadheader material and may be generally better suited to beach nourishment applications. Furthermore, it is understood that tunnelling Contractors have the ability to adjust their machines to alter grading curves, which could enable tunnelling operations to be potentially optimised to generate the most suitable material for beach nourishment. However, Contractors would ideally be informed of this requirement prior to Tender because it can influence the types of machines used for the project and overall costs.

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In general, while further investigation would be necessary, it is considered that tunnel spoil would be suitable for nourishment of Stockton Beach provided it is placed in the nearshore, regardless of whether the material is generated by TBM or roadheader methods. Based on assessment of grading curves for roadheader material associated with Sydney tunnelling projects, typical roadheader material comprises around 10% fines (material less than 75 microns, i.e. silts and clays) and up to cobble size and greater. While this grading is not directly compatible with native material at Stockton Beach, it would not be financially justifiable to wash and screen the tunnel spoil prior to placement. In any case, this is not considered to be essential since if roadheader material, for example, was placed in the nearshore:

- fines would be transported out of the active coastal zone into deeper water, as they are not compatible with coastal processes (wave and current energy) in the nearshore;
- sand sized material would remain within the active coastal zone as required to satisfy nourishment objectives;
- larger fractions including cobbles would be expected to remain in the vicinity of the placement area over the medium to longer-term, noting that this material:
  - may provide some beneficial rocky reef function;
  - cannot become a navigation hazard (an issue for trawling) or significantly modify wave transformation unless by design;
  - would likely break down over time to form additional sand sized material.

Approvals Pathway

It must be noted that the proponents of these tunnelling projects, for certainty, have pursued other means of tunnel spoil disposal that are currently approvable. It is likely that the proponents would be generally open to the idea of the beneficial reuse of tunnel spoil for nourishment but only if it did not delay their project or incur additional cost.

It is likely the best opportunity for existing projects (such as WHT and WestConnex) may now lie with Contractors, but Contractors are unlikely to take on the risk of obtaining an approval for reuse of the material for beach nourishment.

It is considered that the most feasible and effective approvals pathway would involve a government agency obtaining a ‘concept approval’ for the placement of nourishment material at Stockton Beach. The following is noted:

- The concept approval would include a range of criteria that must be met for the nourishment project to proceed (e.g. properties of the proposed nourishment material).
- The concept approval would ideally apply to any future significant sand sourcing opportunities, including tunnelling projects, Hunter River dredging, Newcastle redevelopment sites, and any other potential sources.
- The Beach Nourishment Concept Approval Pathway is discussed further in **Section 5**.
- Having a concept approval for placement of suitable nourishment material at Stockton Beach is considered to be essential to ensure current and future opportunities to beneficially re-use tunnelling material or materials from other sources are not missed. Accordingly, it is recommended that the obtaining of a concept approval should be pursued as an immediate action. This could be progressed by any suitably resourced, tasked and funded Public Authority.

2.3 Sand backpassing from Stockton Bight using Beach Scraping

Overview

RHDHV, building on previous work by WorleyParsons (2012), have assessed the option of sand backpassing from the northern end of Stockton Bight using beach scraping techniques. WorleyParsons (2012) considered the use of sand from within the Newcastle LGA as well as sand from further north within the Port Stephens LGA. For beach scraping to be contained within the Newcastle LGA, the length of beach suitable for scraping is limited to approximately 1 km. This 1 km stretch of beach extending south from the LGA boundary (including part of Stockton Centre frontage) has been identified as the optimum location for beach scraping for the following reasons:

- the long-term beach behaviour in this area is stable to slightly prograding;
- the distance to transport the material is minimised therefore lowering costs;
- negotiations and approvals are minimised as the activities are contained within the Newcastle LGA; and,
- the wide dunes in this area mean that recession of the dune face due to scraping would not be expected to significantly impact the natural and built environments, with the narrowest dune width currently approximately 250 m (to the closest built assets within Stockton Centre) at the southern end of the 1km stretch of beach.

Further north, within the Port Stephens LGA, the beach and dune system of Stockton Bight is some 30 km long with a bare sand beach-dune width of around 600 m and dune elevations of 20 m. This area includes the Worimi Conservation Lands and National Park and Wildlife Service (NPWS) land, with further consultation required to negotiate use of this resource. The approvals process would be critical to the feasibility of this sand source. Relevant consents and approvals would need to be obtained to borrow sand from this area. This is discussed further below.

It is noted that the sand in the back dunes is likely to be less compatible due to the fineness of the sand as this is generally aeolian transported material. The proposed sand extraction is limited to scraping from within the tidal/wave runup zone which should be more compatible. This would likely lead to a level of recession of the dune face at the extraction site.

Methodology

The option involves land-based beach scraping equipment (Wheel Tractor Scrapers) excavating material from Stockton Bight and transporting it along the beach to the southern areas requiring nourishment. The Wheel Tractor Scrapers are self-loading machines with on-board storage (17 to 26 m^3 capacity).

The beach scraping could be undertaken with say four 17.5 m^3 tractors operating, for a round trip of approximately 1 km and 10 mins/trip.

Typically, scraping depth is limited to 0.2 to 0.3 m to minimise environmental impacts. Beach levels also need to recover before additional scraping can be undertaken. With a typical beach width of say 30 m (of trafficable sand between low water and the extent of wave runup) and a beach length of 600 m (i.e. CN managed land contained within the Newcastle LGA north of Mitchell Street revetment) the area would need to be scraped 10 times (to a depth of 0.2 m) to achieve 36,000 m^3. That is, each scraping exercise could yield 3,600 m^3 of sand.

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Permissibility

There are a range of land zoning and other regulatory considerations that would need to be addressed to facilitate the use of sand from Stockton Bight for beach nourishment purposes. Preliminary consultation has been undertaken with several stakeholders including DPIE – Crown Lands, Port Stephens Council and NPWS, as outlined below:

Feedback from DPIE - Crown Lands regarding coastal management/protection works:

The information is specific to Crown land in zones 1, 2, 3 and 4 of the Stockton CMP and seaward of the 2025 coastal hazard line (as provided by CN, email dated 16 April 2020).

- CN is required to undertake development on Crown reserves and Crown land in accordance with the relevant planning legislation.
- Public foreshore land immediately seaward of the 2025 hazard line at Stockton, zones 1, 2, 3 and 4, is Crown land under the management of CN - being Crown Reserve 79066, gazetted 9 Nov 1956. The reserve purpose is for: public recreation, additional purpose 'port facilities and services'.
- Under the *Crown Land Management Act 2016* (CLM Act) CN has authority to manage the Crown reserve in accordance with the reserve purpose or any purpose incidental or ancillary to the reserve purpose, or for a purpose specified in a plan of management for the reserve. Where these conditions are satisfied, CN does not generally need to seek additional approvals under the CLM Act for works undertaken by CN on the reserve.
- Under new arrangements under the CLM Act, refer Division 3.4, CN is authorised to manage its dedicated or reserved Crown land as if it were public land under the *Local Government Act 1993* (LG Act). Noting there are transitional arrangements in place until 30 June 2021 and more information is provided in the attached 'Transition guide for Crown land managers- local councils'. Under these new arrangements, CN is to prepare and adopt a plan of management (PoM) for the reserve by 20 June 2021. After the adoption of the PoM, CN will be directly responsible for the care, control and management of the reserve as carried out in accordance with the PoM prepared under the LG Act.
- Where works are to occur on Crown land not under the management of CN, for example beach nourishment or beach scraping works that are located on submerged Crown land below mean high water mark and outside of reserve 79066, then a form of tenure under the CLM Act will be required before the works can be carried out. Further details will need to be provided to determine the tenure that is appropriate to the works. Beach scraping works have generally required a Crown land licence at other locations, refer attached 'Licensing of Crown land—guidelines' for more information.
- The *Native Title Act 1993 (Cth)* needs to be considered by CN in the preparation of the PoM and any subsequent development on reserve 79066.
- The bed and banks of waterways below mean high water mark (MHWM) are typically Crown Waterway across much of the state (there are exceptions, for example those waterways managed under the *Ports and Maritime Administration Act 1995* e.g. Newcastle Port). Where actions are considered or proposed in, on or adjacent to Crown land, boundaries may need to be identified/verified by survey. Works and proposals should not rely on retaining structures or fencing as evidence of land boundaries.

Aboriginal Land Rights Act 1983 (ALR Act)

- DPIE - Crown Lands advised CN (letter dated 17 November 2017), that there are incomplete Aboriginal land claims (ALCs) made under the ALR Act on Crown land in the Stockton CMP area. This advice was specific to Crown land in the vicinity of Barrie Crescent, refer Table 1 below. There are three other incomplete ALCs in the southern zones of the Stockton CMP area, refer Table 2.
- DPIE - Crown Lands' ALC Unit has completed the investigation of ALC 5720/1933/19564. The investigation indicates these ALCs are not claimable as the land was likely to be needed for an essential public purpose. Crown Lands anticipate these ALCs should be determined by 30 June 2020. CN have not undertaken any investigation of ALC 6602/19468/19579 at this stage, but will commence an investigation of 19468 and 19579 shortly. In terms of ALC 6602, it is very likely the land will not be claimable as it is a waterway. As a result, it would not be unreasonable to proceed with planning for any works in this area, pending determination at some future point.

Feedback from Port Stephens Council regarding sand extraction within the Port Stephens LGA:

- The DPI land as well as Worimi Conservation Lands (WCL) are zoned as E1 National Parks and Nature Reserves.
- The Defence Housing Australia (DHA) land at Rifle Range is classified as E2 Environmental Conservation.
- Under the provisions of Port Stephens LEP2013, extractive industries are not permissible within E1 and E2 zones and the sourcing of sand is therefore not permissible.
- Furthermore, Clause 7(3) of *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* states that extractive industries may be carried out with consent on land where development for the purposes of agriculture or industry can be undertaken with consent, or on land that is part of a waterway, estuary in the coastal zone or coastal waters that are not within an environmental conservation zone. As the E1 and E2 zones do not permit agriculture or industrial development, and the land is zoned for environmental conservation, sand extraction would not be permissible in these areas.
- Under the provisions of Port Stephens LEP2013, extractive industries are permissible in RU1 Primary Production and RU2 Rural Landscape zones. Several commercial sand mines are currently operating along the foreshore areas that could potentially provide the sand required for the proposed rehabilitation activities (refer **Section 2.1** for discussion of local quarries as a potential sand source).

Feedback from DPIE regarding Worimi Conservation Lands:

- The WCL covers 4029 hectares, comprising 1812 hectares of national park, 881 hectares of state conservation area and 1336 hectares of regional park (**Figure 3**).
- Throughout 2005 and 2006, Worimi Local Aboriginal Land Council (LALC) representatives and an Aboriginal Negotiating Panel of Worimi Traditional Owners negotiated the Lease Agreement for the WCL with the Minister for the Environment. Once the Lease was agreed and entered into, the land was granted to the Worimi LALC under the *Aboriginal Land Rights Act 1983* and gazetted in 2007 under the *National Parks and Wildlife Act 1974* (NPW Act) as Worimi National Park, Worimi State Conservation Area and Worimi Regional Park.
- The intertidal zone extending to the mean low water mark was gazetted as part of Worimi Regional Park under Part 4 of the NPW Act, and therefore not returned to Aboriginal ownership. The Lease Agreement commits NPWS to managing the intertidal zone as part of the WCL

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- Sand extraction in all these classifications of reserve is prohibited either under the NPW Act and Regulations, or is contrary to the objectives and provisions of the existing statutory Plan of Management.

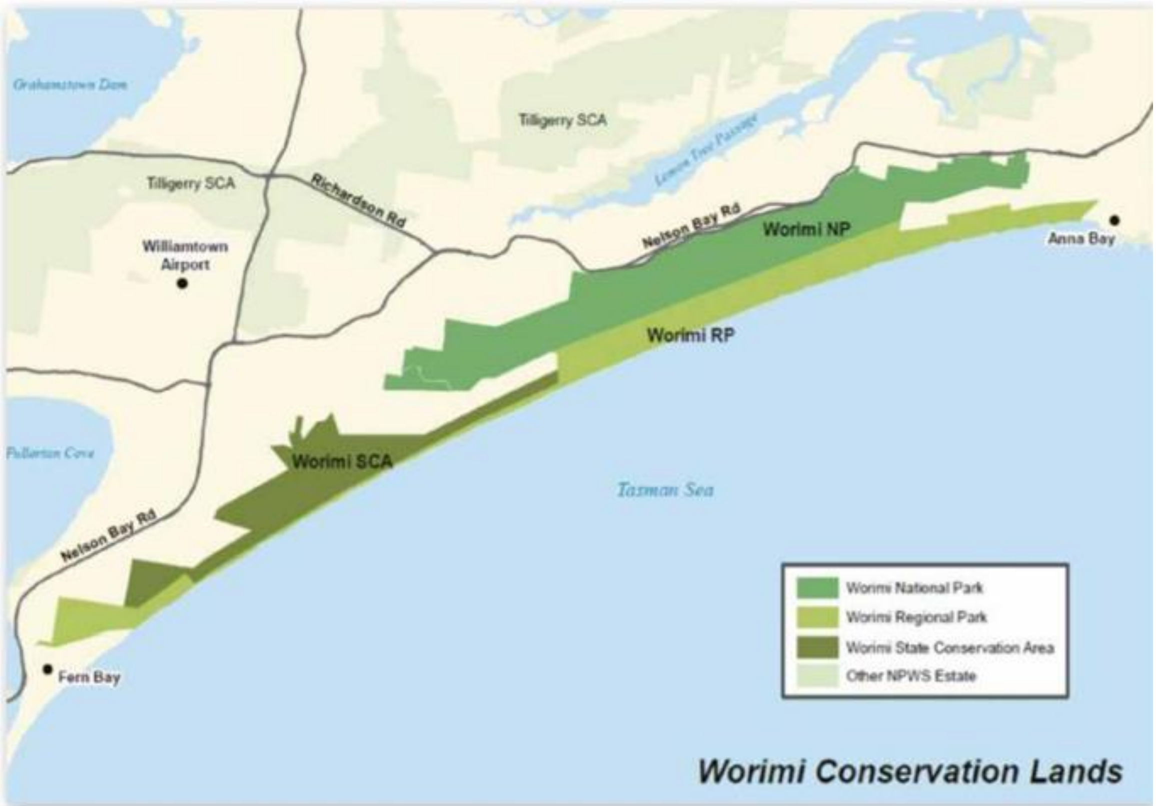

Figure 3: Reserves comprising the Worimi Conservation Lands

The following land zoning applies for parts of Stockton Bight located within the Newcastle LGA:

- DHA land at Fort Wallace is classified as E2 Environmental Conservation;
- the Hunter Water site is classified as SP2 Sewerage systems; and,
- Stockton Centre is classified as SP2 Health Services Facility.

For each of these zonings, extractive industries are prohibited under Newcastle LEP 2012. For this reason, the beach scraping activities and quantities described were limited to the 600 m frontage north of the Mitchell Street revetment up to the Hunter Water boundary. This constraint would need to be addressed by CN to enable beach scraping to occur further north.

Cost

A unit cost rate of around \$20/m^3 is estimated for this backpassing option.

Summary

For the purpose of the present assessment to inform the Stockton CMP, it has been assumed that a maximum of two to three scraping exercises could be undertaken each year, based on allowing four to six months between scraping exercises for the borrow area to recover. This equates to an annual maximum supply of 20,000 m³ to 30,000 m³ from this source. This is likely to fall well short of the volume requirements under the various management options.

A unit cost rate of $20/m³ could be adopted for this backpassing option.

Furthermore, it should be noted that the existing narrow beach widths would limit beach access for machinery at certain locations. Some areas may only be trafficable at very low tides with calm seas (e.g. Mitchell Street revetment frontage). This would effectively increase the down time for machinery, extend project timeframes and increase costs. Road access may therefore be necessary to transport the material to the southern side of Mitchell Street revetment. This limitation may make this option only feasible for transporting sand to the areas north of Mitchell Street revetment.

Overall, it is considered that the feasibility of this backpassing option is constrained by:

- the maximum quantity of material that can be regularly sourced from the borrow area;
- existing land zoning and regulatory provisions, particularly within the Port Stephens LGA; and,
- machinery access south of Mitchell Street.

2.4 Sand backpassing from Stockton Bight with Sand Shifter

RHDHV have assessed the option of backpassing sand from north of the Stockton township frontage using a submerged sand shifter system (refer **Figure 4**). Similar systems are currently operated at Noosa, Lakes Entrance Victoria, Mooloolaba and Bribie Island.

This sand backpassing option involves collection of sand using a submerged sand extraction unit buried under the sea floor with shore based pumping equipment at the northern end of the Newcastle LGA (prograding area) and pumping the material southwards, through approximately 3 km of land-based, buried HDPE pipeline with outlets onto the beach to the north of Mitchell Street revetment and terminating at the southern end of Mitchell Street revetment (refer **Figure 5**).

Figure 4: Example submerged sand extraction unit

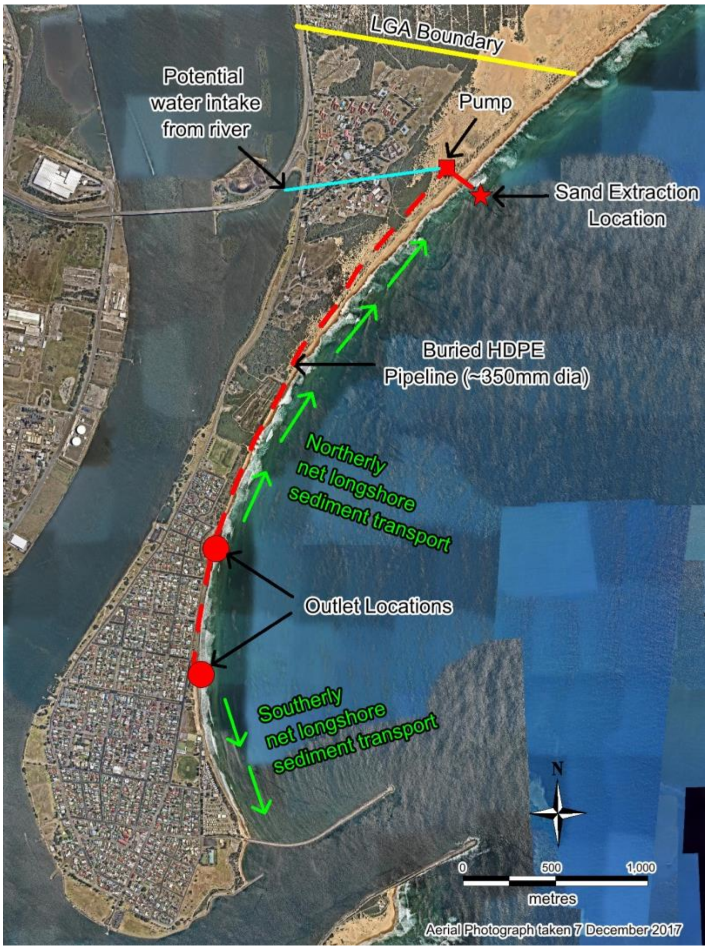

Figure 5: Sand backpassing schematic for Sand Shifter

Water supply for these systems is generally via a directionally drilled water intake line extending from the beach to 100 m offshore, or from a river source if feasible. At Stockton the most cost-effective option may be to source the water from the Hunter River rather than an offshore intake.

The temporary sand backpassing system was priced by RHDHV on the basis of a 100,000 m^3/year system to achieve a total nourishment of 500,000 m^3 over its 5-year life, followed by the installation of a permanent system (NB: a 85,000 m^3/year system was allowed for, although larger systems may be necessary based on the latest understanding of recession rates; Bluecoast (2020) estimated an annual nourishment volume requirement of up to 112,000 m^3/year).

These significant sand extraction volumes would inevitably lead to adverse impacts at the borrow site. Monitoring of the performance of the nourishment provided by the temporary system would enable further refinement of the permanent system capacity and design.

Based on the current understanding of sediment transport processes at Stockton Beach, the sand discharged to the south of Mitchell Street revetment, would be expected to move southward nourishing Zone 1 and 2 of the Stockton frontage via the net southerly sediment transport regime (refer **Figure 5**). Conversely, sand discharged to the north of Mitchell St revetment, would be expected to move northward nourishing Zone 4 to 7 of the Stockton frontage via the net northerly sediment transport regime. Sand could also be pumped onto beaches at intermediate locations on an as needs basis. The sand is assumed to initially be evenly distributed with 50,000 m^3/year to each of the southern and northern ends of

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Mitchell Street revetment. This breakdown can be monitored and adjusted as required within this flexible system.

Backpassing would likely be regarded initially on a trial basis, with monitoring and flexibility to modify the strategy to achieve optimum outcomes. Comprehensive monitoring of any backpassing together with flexible reactive response in terms of the back-passing location, rate and method are essential.

Costs

The estimated costs are set out below for this backpassing option.

For a trial diesel system (100,000 m^3/year capacity over a 5-year contract):

Capital Cost:

Mobilisation	\$ 1.6M
Demobilisation	\$ 0.35M
Total	**\$ 1.95M**

Recurring Costs

Operating costs	\$390,000/year (\$32,500/month)
Unit rate for sand	\$750,000/year (\$7.5/m^3 for 100,000 m^3/year)
Power	\$220,000 (\$2.2/m^3)
Total	**\$1.36M**/year for 5 years

For a permanent electrical system (85,000 m^3/year capacity):

Capital Cost:	**\$4.5M**
Recurring Costs:	**\$8/m^3** (operating costs including maintenance, power and unit rate for sand)

Summary

For the purpose of the present assessment to inform the Stockton CMP, it has been assumed that a trial diesel system (100,000 m^3/year capacity over a 5-year contract) would initially operate as per the details set out above. This would deliver 500,000 m^3 of nourishment over the first five years at an average cost rate of around \$17.50/m^3.

A permanent system with an appropriate pumping capacity would then be installed, based on annual pumping requirements. A capital cost of around \$4.5 million plus an ongoing rate of around \$8/m^3 would apply for this option. However, further investigations would be required to assess the feasibility of pumping systems able to keep pace with the Bluecoast (2020) high estimated recession rates of 112,000 m^3/year.

These volumes would inevitably lead to adverse impacts at the borrow site, which would require further investigations.

As such, it is considered that this backpassing option may be constrained by:

- the maximum quantity of material that can be sourced from the borrow area without yielding adverse impacts;

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- existing land zoning and regulatory provisions, although noting that sand would be sourced within the Newcastle LGA which would be expected to simplify the approvals process; and,
- pumping capacity of the permanent system, which may struggle to achieve maximum required rates of 112,000 m^3/year, subject to further investigations.

2.5 Beach Scraping within the Stockton CMP Area

Overview

Beach scraping involves the movement of small to medium quantities of sand from the lower part of the littoral beach zone to the dune system using mechanical means. Beach scraping is undertaken to augment the natural processes of building the subaerial portion of the beach profile. Beach scraping activities are undertaken on a periodic basis at numerous beaches along the NSW coast with successful outcomes being observed.

Periodic beach scraping practices aim to increase the volume of sand in the subaerial portion of the beach profile at locations which are vulnerable to episodic erosion. This measure is primarily to enhance coastal protection through building the upper profile and dune system while at the same time improving beach amenity. It is not a nourishment activity as it does not introduce additional sand into the beach profile, rather it is a redistribution of existing material within the profile.

Beach scraping is undertaken as a maintenance activity when sand is available in the intertidal zone. It must be noted that beach scraping does not address long-term recession or sand loss from the beach profile.

Beach Scraping at Stockton

Beach scraping is included as a management action in the Newcastle CZMP. CN have developed a scraping strategy for Stockton Beach that utilises material from within the Stockton CMP Area, i.e. from the Breakwater in the south to Corroba Oval in the north.

RHDHV (2018) estimated that a total sand volume of around 14,000 m^3 could be scraped from the lower profile to the upper dune face for a single project within the Stockton CMP Area, based on a scraping depth of 0.2 m.

The timing of beach scraping activities needs to account for a number of factors, including:

- seasonal variation in coastal processes and resulting beach profile fluctuations;
- potential threats to resident beach fauna (i.e. nesting birds and intertidal species);
- seasonality in beach usage and access; and,
- favourable conditions for dune vegetation planting.

The rate at which sand can be transferred for the rebuilding of the foredune is naturally limited by the rate of onshore movement of sand into the swash zone, i.e. availability of borrow material. The duration of scraping exercises is also highly dependent on the number and type of machinery used to undertake the works.

RHDHV (2018) noted that beach scraping at Stockton Beach would be best performed during Spring; when the probability of significant erosion events is lower, to avoid peak tourist or residential recreational periods over summer, and to maximise the period of natural rebuilding following the beach scraping before

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the following autumn and winter (when there is a greater probability of storm events). It is estimated that at least two scraping campaigns could be undertaken across all proposed areas during Spring.

Costs

Based on data provided by CN, it is understood that a cost of $7.20 was incurred for a 2017 beach scraping campaign at Stockton associated with the SLSC revetment works.

Carley (2010) noted that due to competitive tendering and depending on the degree of difficulty, beach scraping rates could potentially range from $6.20 to $12.50/m^3 (adjusted to 2020 prices). For budgeting purposes, an average rate of $9.30 could be adopted for beach scraping works.

Approvals Pathway

State Environmental Planning Policy (SEPP) (Infrastructure) 2007 and the recently introduced SEPP (Coastal Management) 2018 both have provisions for activities such as beach scraping to be undertaken by a public authority without development consent. The works are therefore classified as an activity under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

In accordance with Subdivision 1 under Part 5 of the EP&A Act, CN has been defined as the determining authority as the activity is to be carried out on behalf of CN. As the works are considered to have a greater than minimal but not significant impact, a Review of Environmental Factors (REF) was required to ensure compliance with Part 5 of the EP&A Act. The REF is detailed in RHDHV (2018).

CN has previously consulted with the DPIE – Crown Lands to determine the necessary approvals for beach scraping as it would occur within Crown land. CN was advised that the site is within Crown Reserve R79066 for Public Recreation and Other Purposes: Port Facilities and Services and CN is the Trust Manager of the Reserve. As such, DPIE's formal approval for NCC to undertake beach scraping works in this locality is not required. DPIE – Crown Lands advised that CN's modification of its planning assessment would suffice, enabling CN to undertake and maintain urgent coastal protection works at Stockton Beach, under their LEP.

Summary

Beach scraping using material sourced from within the Stockton CMP Area is a permitted activity for the ongoing coastal management of Stockton Beach. Beach scraping is a relatively low cost activity (around $9.30/m^3) that can be implemented with success to enhance coastal protection through building the upper profile and dune system. Short-term beach amenity benefits may also be realised.

However, it must be noted that beach scraping does not address long-term recession or sand loss from the beach profile. As such, it is not an adequate standalone measure for addressing the long-term sediment budget deficit at Stockton Beach.

Furthermore, a constraint of beach scraping is that the timing of this activity is limited to fair-weather periods when sand is available in the intertidal zone. Spring months are considered to be most feasible for this purpose.

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2.6 Swansea Channel Dredged Material

Dredging in Swansea Channel is regularly undertaken by DPIE – Crown Lands to maintain navigability of the channel. Investigations were made into the possibility of utilising material from previous Swansea Channel dredging campaigns, which is currently stored at the Belmont Sand Stockpile site (Pelican). DPIE – Crown Lands have provided sediment testing results and analysis of the sand from the channel.

The mean particle size of the stockpiled sand ranged between 0.209 to 0.411 mm depending where it has been dredged from in the channel. Review of the analysis indicates that approximately 70% of the 25 samples have physical properties within the technical specification criterion relating to median grain size for the nourishment material. Generally, the other samples had a finer median grain size (<0.35mm) meaning that the sand would be more readily mobilised either by wave action or aeolian transport. Accordingly, the nourishment sand would be more rapidly moved from the nourishment area than the native sediment.

The degree of compatibility is considered acceptable if the material is coarser than the technical specification criterion relating to median grain size of the nourishment material. It is noted that an inspection of the material undertaken by a potential contractor observed that there was a large amount of shell in the sand. This matter is a potential issue in terms of beach amenity and not the technical performance of the material.

An overfill factor of 2.0 was determined for dredged material from Swansea Channel, which is at the lower end of the typical range of overfill factors determined for quarry sands (1.8 to 5, refer **Section 2.1)**. However, it is noted that the high shell content may have skewed this result. Overall, based on the particle size distribution and overfill ratios, dredged material from Pelican is considered to be slightly more compatible than quarry sands.

However, dredged material from Pelican is not considered to be a financially viable option for nourishment of Stockton Beach due to the transport involved with costs exceeding $100/m^3 for sand supplied to site.

3 Marine Sources

3.1 Dredging of Offshore Sand Sources

General Information

While noting that offshore marine sand sources are not currently available due to regulatory constraints, there may be opportunities to access these sources in the future. For the purpose of the Stockton CMP, it has been assumed that the offshore marine source could be accessed by a Trailing Suction Hopper Dredger (TSHD) method.

A TSHD is a self-propelled ship which is mainly used for dredging loose and soft soils such as sand, gravel, silt or clay. TSHDs have a hull in the shape of a conventional ship and are both highly seaworthy and able to operate without any form of mooring or spud. They are equipped with either single or twin (one on each side) trailing suction pipes. A pump system sucks up a mixture of sand or soil and water and discharges it into the 'hopper' or hold of the vessel.

The hopper can be emptied in a nearshore location by opening the doors or valves in the hopper bottom ("bottom dumping"), by using the dredging pump to deliver material to shore through a floating pipeline, or by projecting material towards the shore using a special bow jet. This latter method of placement is commonly referred to as "rainbowing", whereby sand is sprayed in a high arc towards the deposition location, resembling a sand-coloured rainbow.

The above full suite of placement methods would ideally be used to create the desired beach profile. This is termed 'profile nourishment' and seeks to create the natural beach profile from the outset so as to minimise cross-shore redistribution of the placed sand.

The measure of size of a TSHD is the hopper capacity, which may range from a few hundred cubic metres to over 40,000 m^3.

Further details regarding TSHD methodologies, plant and costs are provided in RHDHV (2020).

Key Assumptions for TSHD

For the purpose of nourishing Stockton Beach, it is assumed that adequate and appropriate offshore sand sources (borrow areas):

- are available within a 7.5 nautical mile sailing distance of the site[1];
- comprise areas where no rock or wrecks are shown on Admiralty Charts; and,
- contain minimal amounts of fines[2] (<2%), noting that grain size at the borrow area would need to be established by sampling.

[1] *It should be noted that the costings adopted for mass nourishment options in the CBA assumed a 5 nautical mile limit with an allowance to dredge to depths of 28 m (Bluecoast, 2020).*

[2] *Fines is the collective term given to particle sizes less than 0.075mm (75 microns) and comprise silts and clays.*

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Review of potential marine sand resources for nourishment of Stockton Beach

Mining, Exploration and Geoscience (MEG) in Regional NSW recently carried out a desktop study to identify marine sand bodies that may be suitable for beach nourishment at Stockton Beach (GSNSW 2020). The main findings of this study included:

- Sand suitable for the nourishment of Stockton Beach is likely to occur on the inner shelf plain, the lobe and possibly the dredge spoil dumps in Stockton Bight (refer **Figure 6**).
- The available data indicates that the medium-grained, quartzose sands of the Newcastle inner shelf sand sheet (ISSS) that are lying on the inner shelf plain[3] appear to be suitable for beach nourishment and represent the largest potential sand resource in Stockton Bight.
- The lobe and spoil dumps off Nobbys Head also contain sand that may be suitable. However, some data suggest the variability of the sand in these areas may not be as uniform as that on the inner shelf plain to the northeast.
- A comprehensive offshore sampling program is required to confirm the extent, thickness and continuity of the sand sheet and to identify the most suitable areas to source sand for nourishment.
- MEG should continue with its attempts to locate and compile existing data that may be useful in the assessment of offshore marine sand sources, including previous sediment sampling and seismic data.

In consideration of current legislation, MEG recommends that CN should seek to source sand from State waters (i.e. within 3 nautical miles of the NSW coast) in the first instance. The boundary of State waters in the vicinity of the study area is shown on **Figure 6**. It is evident that extensive areas of the ISSS at appropriate dredging depths (approximately 30 m) lie within State waters and inside the 7.5 nautical mile limit . It is considered that adequate sand reserves are available in these areas to meet the volume requirements for mass nourishment at Stockton Beach.

[3] *The inner shelf plain is a seaward-sloping surface occurring between 20–65 m depth, between 1.5 km and 11 km wide with an average gradient of 0.05–0.42° (Boyd et al. 2004).*

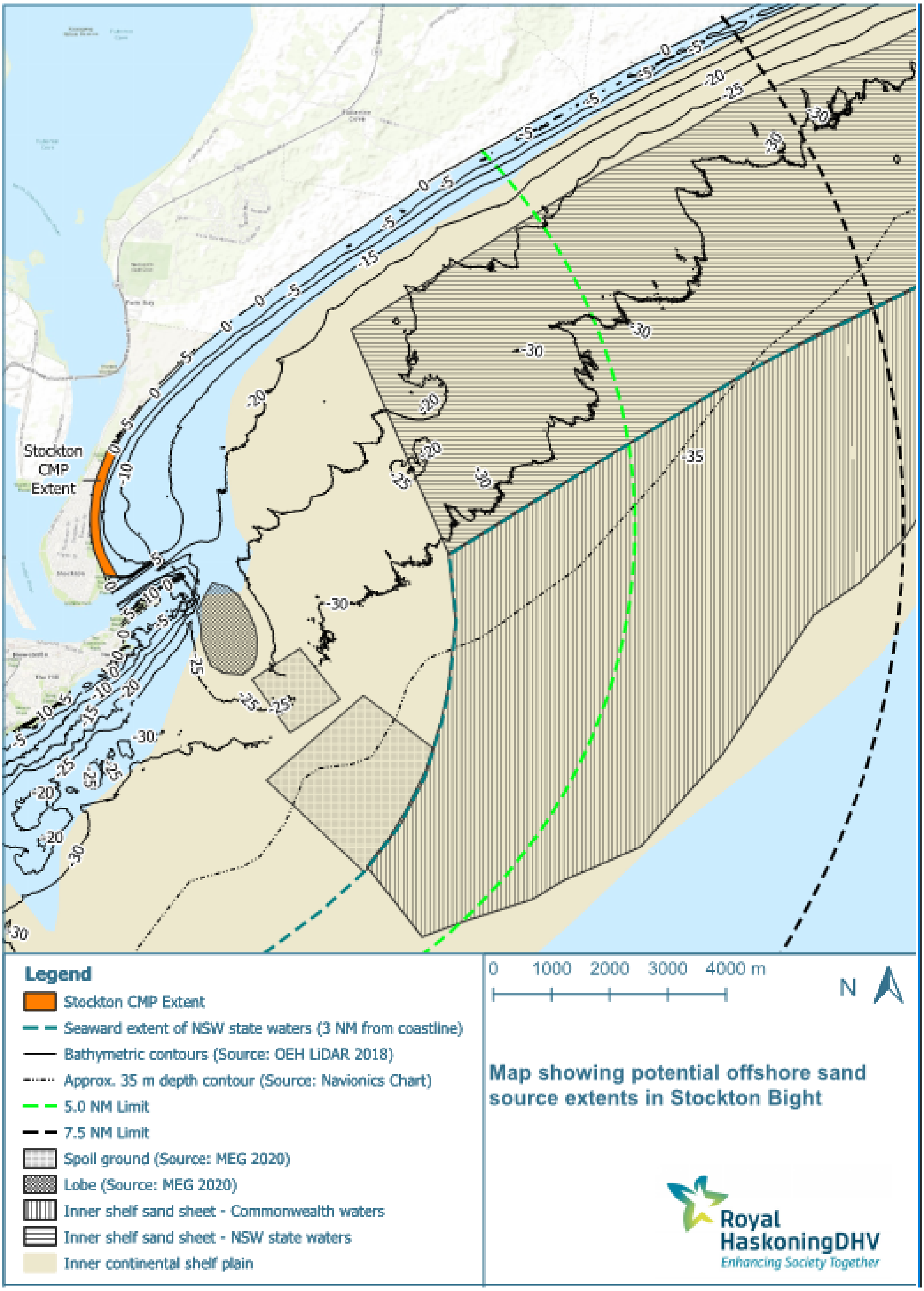

Figure 6: Map showing potential offshore sand source extents in Stockton Bight

Cost Estimates for TSHD

Cost rates for TSHD vary depending on a wide range of factors including (but not limited to):

- plant and equipment used (e.g. size of dredger);
- method of placement (e.g. bottom dumping, rainbowing, pumping);
- scale of project; and,
- mobilisation/demobilisation costs.

Detailed cost estimates for offshore sand sources at Stockton Beach are provided in RHDHV (2020). Cost rates (including mobilisation/demobilisation) determined for mass nourishment options in RHDHV (2020) range between around $17/m^3 and $19/m^3 for 1.8 million m^3 using a Trailing Suction Hopper Dredge (TSHD) within a 7.5 nautical mile limit to a depth of 40m and a combination of bottom dumping, rainbowing and pumping ashore

Cost rates (including mobilisation/demobilisation of TSHD) adopted for a 2.4 million m^3 mass nourishment campaign in the CBA (Bluecoast 2020) range between $6/m^3 and $8/m^3. It should be noted that these costings assumed a 5 nautical mile limit with an allowance to dredge in water depths up to 28 m, utilising a combination of bottom dumping and rainbowing (Bluecoast, 2020).

It should also be noted that economic efficiencies may be available if maintenance nourishment activities were undertaken on a regular basis (say, annually) by smaller vessels that undertake similar scale operations at other locations in Australia. In particular, there may be opportunities to secure low mobilisation and demobilisation costs if the maintenance nourishment campaigns could be coupled with other dredging operations.

Regulatory Constraints

Permissibility issues require resolution in relation to offshore marine sources. When considering extraction in NSW coastal waters (within 3 nautical miles of the NSW coast), the relevant NSW legislation is the *Offshore Minerals Act 1999*, which is supported by the *Offshore Minerals Regulation 2013*. Under the *Offshore Minerals Act 1999*, sand extraction is not permissible in NSW coastal waters without being authorised by a mining licence. An applicant cannot apply for a mining licence without the NSW Minister responsible for Resources (currently the Deputy Premier) first inviting applications. This is because NSW offshore waters have been reserved.

The *Offshore Minerals Act 1994* is the relevant Federal legislation and applies to Commonwealth waters (all Australian territorial waters more than 3 nautical miles from the coast). The Federal legislation is supported by the *Offshore Minerals Regulation 2018*. Commonwealth waters are managed by the Joint Authority, comprising the NSW and Federal Ministers responsible for resources. There is no current reservation of Commonwealth waters.

The NSW Deputy Premier has announced the formation of a Taskforce of government agencies, CN and community representatives, to work together to address Stockton's erosion issues, and to consider options to fund long-term solutions. CN is committed to working with the Deputy Premier's Taskforce and the NSW Government to explore all opportunities to source sand for beach nourishment that is affordable and suitable.

Furthermore, should offshore sand extraction become a viable option, then the role of DPIE - Crown Lands and any requirement to issue a licence under the *Crown Land Management Act 2016* would need to be further investigated. It could be expected that a license would be required under the *Crown Land Management Act 2016*.

Any offshore sand extraction would also need to be discussed directly with the Harbour Master as it relates to the creation of potential navigational hazards, with consideration of the *Ports and Maritime Administration Regulation 2012*.

Furthermore, an assessment of environmental impact would need to be undertaken in accordance with the EP&A Act and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

3.2 Port of Newcastle – Area E

Background

In 2014, the NSW Government granted a 98-year lease to Port of Newcastle (PoN) which included the management of 792 hectares of land within Newcastle Port, the right to manage the commercial use of the shipping channel and the obligation to maintain the shipping channel and navigational infrastructure, including the breakwaters, for the benefit of commercial shipping. The State retains ownership of Newcastle Port including all land, the channel and breakwaters.

As a result of the obligation to maintain channel depths for the safe navigation of commercial vessels, PoN dispose of sand material dredged from Area E (the port entrance) at the location described in the *Coastal Protection Regulation 2011 Notification of Concurrence for 'Dredging of Area E and disposal offshore at Stockton Beach*', issued by the (then) NSW Office of Environment and Heritage. The nourishment placement area is directly in front of the Mitchell Street revetment as indicated in **Figure 7**. Channel infilling in Area E comprises sand transported from outside the entrance under wave action and flood tide.

Figure 7: PoN dredge sand placement area and Stockton Beach CMP area (Source : Bluecoast 2020)

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Current Dredging Operations

Dredging at Newcastle Port is undertaken by a TSHD, the *David Allan*, which has a hopper capacity of 1,100 m^3. The dredger operates 12 hours per day, seven days per week. Material placement occurs via bottom dumping only.

PoN currently place up to 30,000 m^3 of sand from Area E at Stockton Beach each year. PoN have indicated that they will continue to support nourishment efforts with suitable sand dredged from Area E.

However, it should be noted that the frequency and amount of dredge material placement that occurs at Stockton Beach varies depending on harbour works requirements; maintaining navigable depths in the shipping channel for vessel safety is the main priority of the *David Allan*. For example, it is understood that it can take several months to clear the harbour channels following a major flood event, which would potentially delay any planned nourishment activities at Stockton.

Future Sand Placement Area

There would likely be a benefit in relocating the existing nourishment placement area (refer **Figure 7**) to a more inshore location, if feasible. This would be expected to lead to an increased rate of onshore sand movement from the placement area to the subaerial portion of Stockton Beach, resulting in a reduction of the erosion hazard and improved beach amenity.

The following is noted:

- PoN has indicated that relocation of the current nourishment placement area could potentially be accommodated. Hhowever, safety and efficiency considerations would need to be discussed with PoN.
- The existing nourishment placement area was previously nominated under a Part 5 Approval at a time when PoN was operating as Newcastle Port Corporation (NPC) and able to issue such approvals. A Review of Environmental Factors (REF) was also prepared. The existing approval and REF would need to be revisited and modified if the nourishment placement area was to change.
- Any changes to the nourishment placement area would need to consider the latest understanding of sediment transport processes, to ensure that the material placement will allow onshore movement of sand to nourish high priority areas.

Opportunities

There is the potential for CN to enter into a mutually beneficial commercial arrangement with PoN for the delivery of an annual increment of sand (e.g. in the order of 112,000 m^3/year, which was noted in Bluecoast (2020) to be the long-term volumetric rate of sand loss over the full profile within the Stockton CMP Area). This could provide significant cost savings in mobilisation costs and potentially the cost rates for material placement.

However, there may be limited scope to increase PoN's current dredging operations to a level that can meet the significant volume requirements for nourishment of Stockton Beach, while also satisfying the ongoing requirements to maintain navigable depths in the Port. Further discussions with PoN are required to investigate these possibilities, both technically and strategically. For example, it may be prudent to consider acquiring an alternative dredger with a larger capacity than the *David Allan* and also rainbowing capabilities for inshore sand placement. In addition, a larger dredger would be able to undertake Port maintenance operations more rapidly than can occur at present. This would potentially lead to opportunities to dredge other areas within the Port and further upstream for placement at Stockton Beach, including the North Arm of the Hunter River, subject to obtaining the necessary approvals (refer **Section 4.2**).

Larger PoN capital dredging campaigns in the entrance area could also be used to nourish Stockton Beach on an opportunistic basis. For example, in 2009, PoN dredged approximately 130,000 m^3 of clean marine sand from the mouth of the Hunter River and placed the material offshore of Stockton Beach. However, this would be subject to material availability, obtaining the necessary approvals, engagement with the proponent (noting that this may not be PoN), and commercial factors.

3.3 Sand Bypassing from Nobbys Beach

Sand bypassing from Nobbys Beach was assessed in WorleyParsons (2012) and has been further investigated by RHDHV. The features of the sand bypassing system included a Slurry Systems Marine submarine sandshifter unit to recover sand (38 m^3/hour) and a transfer pipeline (160 mm OD HDPE) beneath the shipping channel and an inline booster (located near the Stockton Memorial), and five outlets across the Mitchell Street revetment frontage.

WorleyParsons (2012) noted that the pipe work required to transport sand would need to cross the main shipping channel into Newcastle Harbour would require complex infrastructure to implement the scheme without disrupting ongoing shipping activities. Furthermore, there would be a high risk of damage to and failure of such a pipeline with maintenance dredging activities undertaken in the channel by PoN.

The assessment found this option to be not viable for capital nourishment due to insufficient sand reserves and high risk. While the modest sand reserves at Nobbys Head may be able to satisfy maintenance nourishment requirements, this option was noted to be cost prohibitive and high risk.

4 Hunter River Sources

Reworked marine sand from the inner and outer sand barriers of the Stockton embayment extend 10 km upstream in the Hunter River (WorleyParsons 2012). Throughout most of the estuary, these marine sands are overlain by silts and clays, which is the primary maintenance dredge material and is not suitable for beach nourishment purposes. An exception to this is the entrance area, where maintenance dredging involves sand (i.e. Area E, refer **Section 3.2**).

In general, capital dredging in the Hunter River for port development would be expected to generate potentially significant quantities of marine sand suitable for the nourishment of Stockton Beach.

Sand sources from the South Arm and North Arm of the Hunter River are considered below.

4.1 South Arm

General Information

Sand sources in the South Arm of the Hunter River could be accessed by a Cutter Suction Dredger (CSD) method.

A CSD is a stationary dredger which makes use of a rotating cutter head at the suction inlet to loosen the material to be dredged. The dredged material is usually sucked up by a wear-resistant centrifugal pump and discharged either through a pipeline to the shore (more typical) or into barges.

A CSD operates by swinging about a central working spud using two fore side-line wires leading from the lower end of the ladder to anchors. By pulling on alternate sides the dredger clears an arc of cut, and then moves forward by pushing against the working spud using a spud carriage. A generally smooth bottom can be achieved, and accurate profiles and side slopes are able to be dredged.

The size of a CSD is measured by the diameter of the suction pipe and by the installed machinery power. Pipe diameters generally range from 100 mm to 1,500 mm, and booster stations are utilised to improve productivity over longer pumping distances. Through consideration of site conditions and industry knowledge, four pipe diameters ranging from 500 mm to 900 mm and use of between one and three boosters have been selected to undertake comparative analysis of efficiency and cost for a CSD to supply nourishment sand to Stockton Beach from the South Arm.

Further details regarding CSD methodologies, plant and costs are provided in RHDHV (2020).

Cost Estimates for CSD

Cost rates for CSD vary depending on a wide range of factors including (but not limited to):

- plant and equipment used (e.g. size of dredger, number of boosters, etc);
- scale of project; and,
- mobilisation/demobilisation costs.

Detailed cost estimates for accessing sand sources in the South Arm for nourishment at Stockton Beach are provided in RHDHV (2020). Cost rates (including mobilisation/demobilisation) determined for mass nourishment options in RHDHV (2020) range between around \$15/m^3 and \$35/m^3. Cost rates adopted for the CBA (Bluecoast 2020) range between \$25/m^3 and \$30/m^3 for capital and maintenance campaigns, respectively

However, lower cost rates could apply on an opportunistic basis, particularly if reductions in mobilisation and/or demobilisation costs are possible due to local availability of dredge plant and equipment. For example, at the time of writing this document, it is understood that an experienced dredging contractor is in a position to offer a cost rate of around \$17.50/m^3 for dredging of clean sand from the South Arm and placement in the nearshore zone at Stockton Beach.

Material Availability

It is assumed that adequate and appropriate sand sources are available within the South Arm of the Hunter River below the Tourle Street Bridge for the purpose of nourishing Stockton Beach. It should be noted that the control of fines (material <75 microns) and grain size would be subject to the levels in available Soil Reports, with limited options to search for cleaner sand.

The availability of sand reserves in the South Arm would be on an opportunistic basis, dependant on activities of port developers as part of future port expansion.

Nevertheless, significant quantities of sand could be generated in one-off dredging campaigns that would be of value to Stockton Beach nourishment efforts. Furthermore, mutually beneficial commercial arrangements may be possible for CN and developers due to the close proximity of the South Arm to Stockton Beach, and complementary project objectives.

For example, it is understood that the proposed Newcastle GasDock LNG import terminal project would require capital dredging of around 4.0 million m^3 material, a substantial proportion of which is likely to be sand. The NSW Government has granted the GasDock project the status of Critical State Significant Infrastructure (CSSI), in recognition of its potential for securing the state's economic future. Subject to receiving all regulatory and planning approvals, and other commercial considerations, the project is anticipated to begin operations in the first half of 2021.

Furthermore, it should be noted that major dredging activities in the South Arm upstream of the navigable port waters would be expected to result in a range of additional benefits including:

- facilitating further development of this part of the Port; and,
- potentially acting as a sediment trap and reducing maintenance dredging requirements.

They were in a position to offer the below rates for dredging of clean sand from the already approved South Arm (T4 footprint) and placement at Stockton Beach nearshore

Regulatory Constraints

Approval for dredging of the Hunter River South Arm was granted in 2013 (DA-134-3-2003-i) for the GasDock, a proposed liquified natural gas (LNG) terminal (and previously in 2005 for the proposed T4 expansion of port coal facilities with a similar footprint). The approval covered dredging the channel and disposing of these materials at existing dumping grounds, which are about five kilometres offshore of the Port of Newcastle. This material could instead be potentially redirected to nourish Stockton beach for beneficial reuse.

As noted for the Sydney tunnelling opportunities (**Section 2.2**), it is considered to be essential to have a concept approval under Part 5 of the Coastal Management Act (2018) and State Environmental Planning Policy (Coastal Management) 2018for the placement of suitable nourishment material at Stockton Beach using opportunistic sources, including sand reserves in the South Arm. This is discussed further in **Section 5**

A pre-existing concept approval would reduce the risk of missing out on future significant sand sourcing opportunities in the South Arm.

4.2 North Arm

Overview

There are also potentially significant sand reserves in the North Arm of the Hunter River, which have the advantage of being closer to Stockton Beach. In particular, areas along the western bank of the North Arm, from Walsh Point to Stockton Bridge, should be considered in further detail as part of the SMP.

While sand reserves are also available north of Stockton Bridge, the environmental sensitivities in this section of the river would necessitate a more rigorous environmental assessment and approvals process, particularly in regard to the Ramsar listed wetland area. The potential impacts of dredging in areas south of the bridge would also need to be assessed in detail. However, this process would likely be more straightforward due to the relatively disturbed waterway in this area.

It is understood that there have been several commercial development prospects involving dredging of the North Arm in the past. However, RHDHV is not aware of any current proposals to develop this area.

Cost Considerations

Given the close proximity of the North Arm to Stockton Beach, dredging operations would be expected to attract lower mobilisation/demobilisation and dredging costs compared to similar operations in the South Arm. Mutually beneficial commercial arrangements may be possible for CN and developers due to the close proximity of the North Arm to Stockton Beach, and complementary project objectives.

Dredging of the North Arm may also provide synergies with PoN operations (e.g. reduced maintenance dredging in the lower port). Further consultation with PoN is required to explore these possibilities further. This could involve consideration of an alternative dredger that services the complementary objectives of CN and PoN as discussed in **Section 3.2**.

Regulatory Constraints

As noted above, detailed environmental assessments would be required to obtain an approval for major dredging activities in the North Arm. However, this is not considered to be a major constraint for this sand source, particularly if dredge footprints were confined to areas south of Stockton Bridge.

As noted previously, it is considered to be essential to have a pre-existing concept approval in place for the placement of nourishment material at Stockton Beach using opportunistic sand sources, which would include sand reserves in the North Arm. Such an approval could be used to facilitate opportunistic dredging of the North Arm in collaboration with a future development proposal, as part of a mutually beneficial arrangement with PoN, and/or stand-alone project(s) carried out for the sole purpose of nourishing Stockton Beach. This is discussed further in **Section 5.**

There may also be an opportunity for PoN to expand the current Part 5 approval for Area E dredging and placement at Stockton Beach, to include other dredge areas in the estuary such as the North Arm.

5 Beach Nourishment Conceptual Part 5 Approval Pathway

In order to ensure any appropriate sand source opportunities can be taken advantage of, a concept approval for beach nourishment is proposed. This would assist in giving proponents of projects increased confidence in pursuing this option.

CN could seek conceptual approval for the beach nourishment works under Part 5 of the EP&A Act. The approval could cover receiving material from a number of potential sources. The excavation, dredging or extraction of the source material would be covered by separate project approvals and not by CN's beach nourishment Part 5 approval. The environmental assessment to be prepared with the Part 5 approval would need to consider impacts of a defined range or upper limit volume from a variety of sources. Different source material will have different physical properties resulting in different placement methods and, or, locations on the beach. The potential impacts of these options would need to be assessed in the environmental assessment document. The Part 5 approval would also need to have a time limit which could, for example be linked to the CMP. The relevant legislation and clauses for the Part 5 approval pathway are described below.

SEPPs are drafted by the NSW State Government and apply to issues and developments of state significance. The SEPP relevant to beach nourishment works at Stockton is SEPP (Coastal Management) 2018. Under Clause 19(2) of SEPP (Coastal Management) 2018, a public authority may carry out coastal protection works without development consent if the works are:

- (i) identified in the relevant certified coastal management program, or
- (ii) **beach nourishment**, or
- (iii) the placing of sandbags for a period of not more than 90 days, or
- (iv) routine maintenance works or repairs to any existing coastal protection works

Beach nourishment at Stockton can therefore be undertaken without development consent (i.e. approval under Part 5 of the EP&A Act requiring the preparation of a REF or EIS).

Clause 19(2) of SEPP (Coastal Management) 2018 prevails over SEPP (State and Regional Development) 2011 and SEPP (Infrastructure) 2007.

In accordance with Clause 5.1 under Part 5 of the EP&A Act, a determining authority is defined as:

…a Minister or public authority and, in relation to any activity, means the Minister or public authority by or on whose behalf the activity is or is to be carried out or any Minister or public authority whose approval is required in order to enable the activity to be carried out.

CN would therefore be a determining authority for the beach nourishment as the activity is to be carried out on behalf of CN. As additional approvals will be required from other public authorities, these public authorities are also determining authorities e.g. Department of Planning, Industry and Environment (Crown Lands licence for elements of the proposed works that are below the MHWM) and Department of Primary Industries (Fisheries Permit).

Preparation of a REF or, if significant impacts are anticipated, an EIS could be prepared and approved (or "approved in principle") by the determining authorities based on an assessment of one or a number of potential sources of the material or specifying certain criteria which must be satisfied.

6 Summary of Potential Sand Sources

A traffic light assessment of each potential sand source is provided in **Table 2**, where:

- red - currently unfeasible,
- yellow - potentially feasible but dependant on individual factors / approval processes / costs; and
- green - currently feasible within existing approvals.

This assessment did not consider approvals required for material placement which are assumed to be feasible for each source.

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Table 2 Traffic light assessment of potential sand sources:

Source	Estimated Costs	Potential Volumes	Constraints / Considerations
TERRESTRIAL			
Local Quarries	$80/m³ supply and place	80,000 m³ per year (max)	• Compatibility constraints – overfill factor generally > 2 • Licence limits for extraction • Local traffic impacts • Beach amenity impacts – machinery on beaches • Insufficient quantities to address ongoing recession
Sydney tunnelling opportunities and local building sites	Less than $10/m³ for the extra-over cost to transport material to Newcastle	Variable but potentially significant	• Opportunistic source – subject to limited availability • Requires a pre-existing concept approval obtained by a government agency – proponents/developers generally unwilling to take on this responsibility • Mutual benefits for proponents – reduced land-based disposal • Material expected to be suitable if placed in the nearshore • Relatively low cost potential source of significant quantities of material

Sand backpassing from Stockton Bight (via scraping)	$20/m³	20,000 to 40,000 m³ per year (max)	• Advantages: relatively low cost, utilises material within the same coastal compartment.
			• The 1 km stretch of beach extending south from the LGA boundary (including part of Stockton Centre frontage) has been identified as the optimum location for beach scraping.
			• Key constraints:
			  ○ the maximum quantity of material that can be regularly sourced from the borrow area;
			  ○ existing land zoning and regulatory provisions, particularly within the Port Stephens LGA (see below); and,
			  ○ machinery access south of Mitchell Street.

Worimi Conservation Lands			• Zoned E1 (National Parks and Nature Reserves) - extractive industries prohibited under Port Stephens LEP 2012 • Sand extraction in all reserve classifications is prohibited either under the NPW Act and Regulations or is contrary to the objectives and provisions of the existing statutory Plan of Management.

Source	Estimated Costs	Potential Volumes	Constraints / Considerations
DHA Land (Fort Wallace, Rifle Range)			• Zoned E2 - extractive industries prohibited under Newcastle LEP 2012 (Fort Wallace) and Port Stephens LEP 2012 (Rifle Range)
Hunter Water Site			• Zoned SP2 Sewerage systems – extractive industries prohibited under Newcastle LEP 2012
Stockton Centre			• Zoned SP2 Health Services Facility - extractive industries prohibited under Newcastle LEP 2012
Sand backpassing from Stockton Bight (via sand shifter)	Initial Trial System (5 years): $17.50/m^3$ Permanent System: $4.5 million capital cost plus $8/m^3$ongoing costs	100,000 m^3/year pumping systems are common	• Advantages: ○ relatively low cost; ○ utilises material within the same coastal compartment; ○ flexible pumping rates. • Key constraints: ○ the maximum quantity of material that can be sourced from the borrow area without yielding adverse impacts; ○ existing land zoning and regulatory provisions, although noting that sand would be sourced within the Newcastle LGA which would be expected to simplify the approvals process; and, ○ pumping capacity of the permanent system, which may struggle to achieve required rates of 112,000 m^3/year, subject to further investigations.
Beach Scraping – within immediate areas	$9.30/m^3$	Small – 14,000 m^3 per project	• Currently permitted activity for the ongoing coastal management of Stockton Beach. • Relatively low cost. • Can be implemented with success to enhance coastal protection through building the upper profile and dune system. • Short-term beach amenity benefits may also be realised. • Does not address long-term recession or sand loss from the beach profile – i.e. not a nourishment activity. • The timing of this activity is limited to fair-weather periods when sand is available in the intertidal zone. Spring months are considered to be most feasible for this purpose.

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Source	Estimated Costs	Potential Volumes	Constraints / Considerations
Swansea Channel	>$100/m3	Variable	• Material is considered to be slightly more compatible than quarry sands. • Not considered to be a financially viable option due to the high transport costs involved.
MARINE			
Offshore Dredging	Varying between \$6- \$19/m³ depending on campaign volume, distance, depth, vessel, mobilisation	Unknown but potentially significant	• Permissibility issues require resolution for offshore sand extraction. When considering extraction in NSW state waters (within 3 nautical miles of the NSW coast), the relevant NSW legislation is the *Offshore Minerals Act 1999*, which is supported by the *Offshore Minerals Regulation 2013*. Under the *Offshore Minerals Act 1999*, sand extraction is not permissible in NSW coastal waters (3 nautical miles from the NSW coast) without being authorised by a mining licence. An applicant cannot apply for a mining licence without the NSW Minister responsible for Resources (currently the Deputy Premier) first inviting applications. This is because NSW offshore waters have been reserved. The *Offshore Minerals Act 1994* is the relevant Federal legislation and applies to Commonwealth waters (all Australian territorial waters more than 3 nautical miles from the coast). The Federal legislation is supported by the *Offshore Minerals Regulation 2018*. Commonwealth waters are managed by the Joint Authority, comprising the NSW and Federal Ministers responsible for resources. There is no current reservation of Commonwealth waters. • The NSW Government led Taskforce has been established to investigate these opportunities and navigate the legislative hurdles for accessing these sources. • Desktop review by GSNSW of potential sources has been completed, however additional investigations/survey work has been recommended to verify the results. • Other licences and approvals required. • Assessment of environmental impact required under the EP&A Act and the EPBC Act. • Economic efficiencies may be available if maintenance nourishment activities were undertaken on a regular basis (say, annually) by smaller vessels that undertake similar scale operations at other locations in Australia.
Port of Newcastle – Area E	Low	30,000 m³ per year (max)	• Currently undertaken on an as needs basis - up to 30,000 m³/year from channel entrance in accordance with existing Part 5 Approval. • Opportunity to modify existing approval to:

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Source	Estimated Costs	Potential Volumes	Constraints / Considerations
			○ nominate a more appropriate placement area; and, ○ include other dredge areas in the estuary such as the North Arm. • Potential for CN to enter into a mutually beneficial commercial arrangement with PoN for the delivery of an annual increment of sand (e.g. in the order of 112,000 m³/year), noting: ○ There may be limited scope to increase PoN's current dredging operations to a level that can meet the significant volume requirements for nourishment of Stockton Beach, while also satisfying the Port maintenance requirements. ○ It may be prudent to consider an alternative dredger for the port with a larger capacity.
Sand bypassing from Nobbys Beach	>$100 million	Insufficient	• Insufficient sand reserves to meet nourishment requirements. • Offshore sand extraction currently prohibited by the *Offshore Minerals Act 1999.* • High risk/cost.
HUNTER RIVER			
South Arm	$25/m³ - initial mass nourishment $30/m³ – maintenance nourishment $17.50/m³ – potential lower-bound rate for opportunistic prospects	Potentially significant (1 to 4 million m³)	• Likely limited to an opportunistic basis, dependant on activities of port developers. • Significant quantities of sand could be generated in one-off dredging campaigns that would be of significant value to Stockton Beach nourishment efforts. • Mutually beneficial commercial arrangements may be possible for CN, developers and/or PoN. • Requires a pre-existing concept approval obtained by a government agency – proponents/developers generally unwilling to take on this responsibility • Lower cost rates could apply on an opportunistic basis, particularly if reductions in mobilisation and/or demobilisation costs are possible due to local availability of dredge plant and equipment.

Source	Estimated Costs	Potential Volumes	Constraints / Considerations
North Arm	Lower cost than South Arm dredging due to proximity – further investigations required	Unknown but potentially significant (likely in the order of several million m^3)	• Potentially significant sand reserves with the key advantage of being very close to Stockton Beach. • Detailed environmental assessments would be required – more feasible if dredge footprints are confined to areas south of Stockton Bridge. • Mutually beneficial commercial arrangements may be possible for CN, developers and/or PoN. • Requires a pre-existing concept approval obtained by a government agency – proponents/developers generally unwilling to take on this responsibility.

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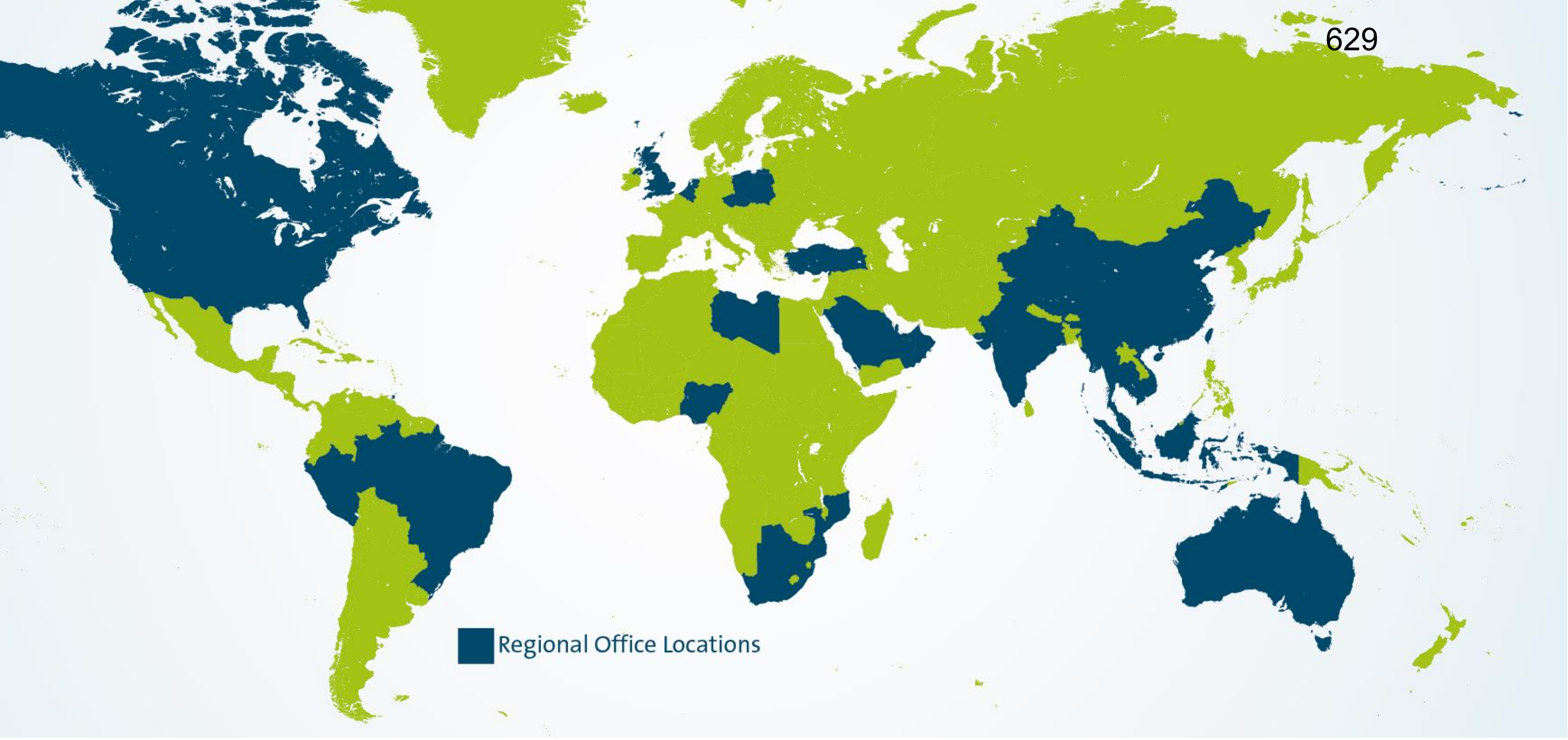

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