Government Gazette

of the State of

New South Wales

Number 98
Friday, 21 September 2018

The New South Wales Government Gazette is the permanent public record of official NSW Government notices. It also contains local council, private and other notices.

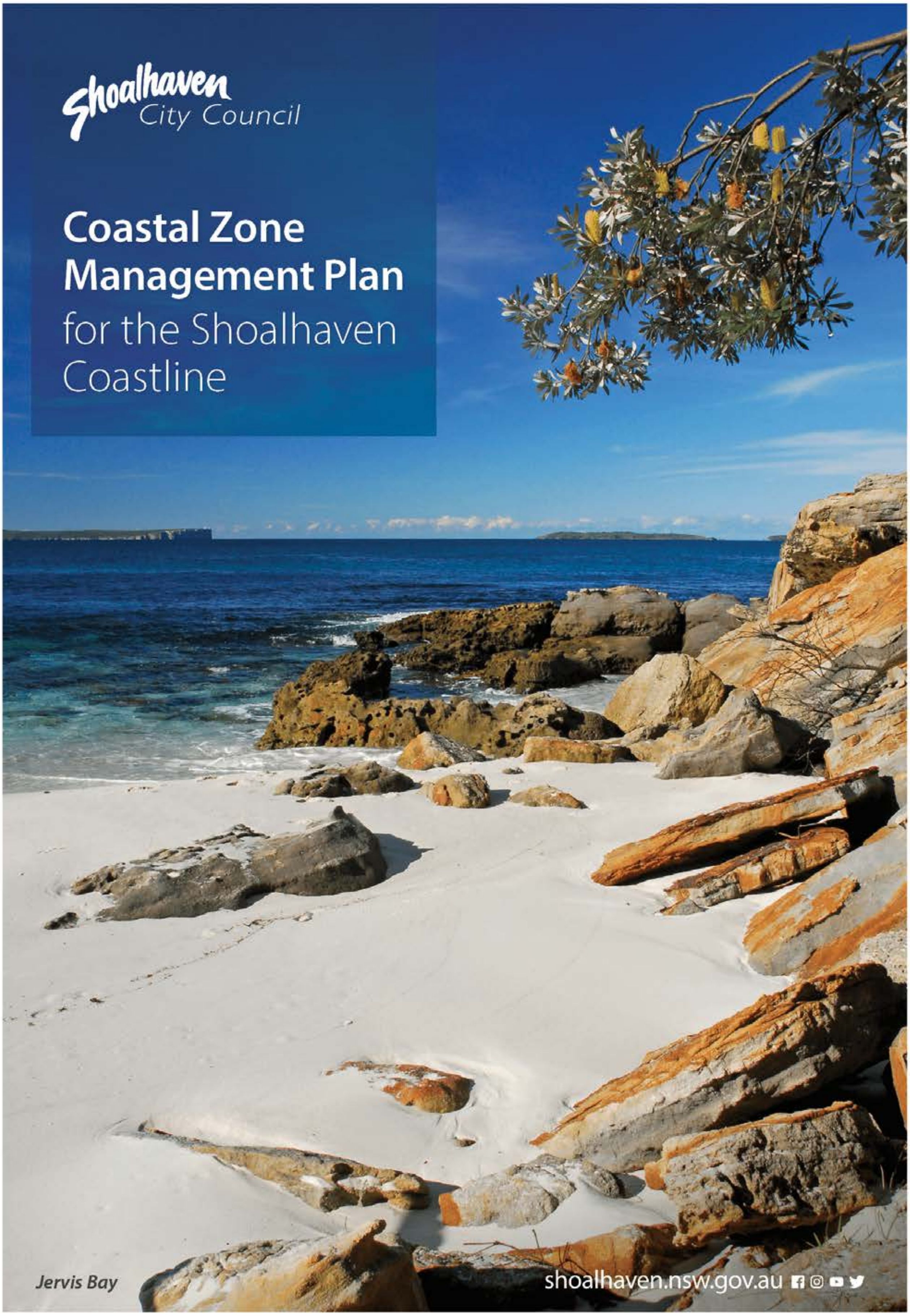
From 1 January 2018, each notice in the Government Gazette has a unique identifier that appears in square brackets at the end of the notice and that can be used as a reference for that notice (for example, [n2018-14]).

The Gazette is compiled by the Parliamentary Counsel's Office and published on the NSW legislation website (www.legislation.nsw.gov.au) under the authority of the NSW Government. The website contains a permanent archive of past Gazettes.

To submit a notice for gazettal – see Gazette Information.

By Authority
Government Printer

ISSN 2201-7534


Shoalhaven City Council
Coastal Zone Management Plan
for the Shoalhaven Coastline
Jervis Bay
shoalhaven.nsw.gov.au

Document Control Sheet

Document Reference	57599E	**Synopsis**	To manage coastal risks and hazards Council is taking action to care for the coastline. Integrated and sustainable management of the coastal zone is a high priority for Council as well as for local communities. This Coastal Zone Management Plan sets out the plan for coastal management within the Shoalhaven City local government area for the next five years and beyond. During the next 5 years Council will develop a new Coastal Management Program in accordance with the latest requirements of the NSW Coastal Management Act 2016. Important actions that go beyond five years in this Coastal Zone Management Plan can be included in the Coastal Management Program.
Title	Coastal Zone Management Plan for the Shoalhaven Coastline		
Staff Contact	Kelie Clarke – Environmental Services Manager		
Acknowledgements	Shoalhaven City Council has prepared this document with financial assistance from the NSW Government through OEH. This document does not necessarily represent the opinions of the NSW Government or OEH. This document is the result of various reports, studies and plans and includes content prepared by SMEC Pty Ltd, Umwelt (Aust) Pty Ltd, BMT WBM Pty Ltd, Royal Haskoning DHV and Advisian along with Shoalhaven City Council.		

Version	Date	Reviewer/ Approved
Exhibition Draft	22/5/18	Kelie Clarke
Final Draft	21/6/18	Kelie Clarke
Final Draft	21/6/18	Phil Costello
Final Draft	21/6/18	Russ Pigg
Final Draft	26/6/18	Adopted by Council (MIN18.462)
Final sent to Minister for certification	29/6/18	Kelie Clarke

Legal Notice

Disclaimer
Shoalhaven City Council is committed to quality and makes every attempt to ensure that the information contained in this document is accurate, current and complete, however, Shoalhaven City Council, its employees, servants or agents, make no warranty, express or implied, as to the accuracy or completeness of information in this document and takes no responsibility for actions based on this information. All material published is for information and communication purposes only. It is the responsibility of the user to make his / her own decisions about the correctness of information found.

Note: Cover Photo courtesy of Chris Grounds.

Contents

Document Control Sheet 2

Executive Summary 6

1. Introduction 9

- 1.1 Background 9
- 1.2 Coastal reforms 12
- 1.3 Shoalhaven's future coast 14
- 1.4 About this plan 14
- 1.5 Council's strategic approach to coastal zone management 19
- 1.6 How adaptive management works 20
- 1.7 Timeframes for action 21
- 1.8 Paying for coastal zone management 22
- 1.9 Compliance with statutory requirements 23

2. Key Considerations 25

- 2.1 Coastal processes, hazards, risks and issues 25
- 2.2 Understanding community values, concerns and issues 47
- 2.3 Protecting natural landscapes 54
- 2.4 Monitoring change 55

3. Choosing the right actions 58

- 3.1 How actions were selected 58
- 3.2 Evaluating and prioritising the options 58
- 3.3 Strategies for the coast and actions for local areas 59
- Strategy 1: Integrate management of the entire coastal zone 60
- Strategy 2: Engage communities and partners 61
- Strategy 3: Implement planning system controls 62
- Srategy 4: Protect coastal biodiversity and ecosystems 63
- Strategy 5: Prepare for emergency response 64
- Strategy 6: Incorporate coastal risk in public asset management 67
- Strategy 7: Implement adaptive management procedures 67
- Local Area Plan 1: Seven Mile Beach and Culburra Beach 72
- Local Area Plan 2: Warrain Beach and Penguin Head 77
- Local Area Plan 3: Jervis Bay Marine Park (JBMP) Area 81

Local Area Plan 4: Berrara, Bendalong, Inyadda Point, Manyana 94

Local Area Plan 5: Narrawallee Beach, Bannisters Point, Mollymook Beach and Collers Beach 98

Local Area Plan 6: Ulladulla Harbour, Rennies Beach and Racecourse Beach 106

4. Implementation 109

4.1 Implementation priorities 109

4.2. Implementation schedules.. 110

Glossary 128

Reference List 129

Figure 1.2 – Planning framework for the coastal zone 11
Figure 1.3 – NSW Coastal Reforms and Shoalhaven City's response 2012 to 2018 13
Figure 1.4 – Steps in preparing a Coastal Zone Management Plan 16
Figure 1.5 – Framework for adaptive management of coastal risks and four focus areas 19
Figure 1.6 – Key considerations for adaptive coastal zone management 21
Figure 2-1 – Global average mean sea level (CSIRO, 2016) 32
Figure 2-2 – The rate of sea-level rise around Australia from 1993 to 2015 (CSIRO, 2016) 32
Figure 2-3 – Terms used in assessing coastal hazards (Neilson et. al.,1992) 34
Figure 2.4 – Science and values working together in the management Shoalhaven's coast........ 54
Figure 3-1 – Citywide strategies and local area plans 60
Figure 3-2 – Coastal reserve land tenure/management arrangements 69
Figure 3-3 – Management responsibility of coastal reserves 70
Figure 3-4 - Local Area Plan Actions 71
Figure 3-5 - Coastal Hazard Map Seven Mile Beach 75
Figure 3-6 - Coastal Hazard Map Culburra Beach 76
Figure 3-7 - Coastal Hazard Map Warrain Beach 79
Figure 3-8 - Coastal Cliffs and Slopes Risk Areas Penguin Head 80
Figure 3-9 - Coastal Hazard Map Currarong 85
Figure 3.10 - Coastal Hazard Map Callala Beach 88
Figure 3.11 - Coastal Hazard Map Huskisson Beach 90
Figure 3.12 - Coastal Hazard Map Collingwood Beach 91
Figure 3.13 - Coastal Cliffs and Slopes Risk Areas Plantation Point 92
Figure 3.14 - Coastal Cliffs and Slopes Risk Areas Hyams Point 92
Figure 3.15 - Coastal Cliffs and Slopes Risk Areas Berrara 96
Figure 3.16 - Bendalong Boat Harbour Risk Map 96
Figure 3.17- Coastal Cliffs and Slopes Risk Areas Inyadda Point, Manyana 97
Figure 3.18 - Coastal Hazard Map Narrawallee Beach 102
Figure 3.19 - Coastal Hazard Map Mollymook Beach 103
Figure 3.20 - Coastal Hazard Map Collers Beach 104
Figure 3.21- Coastal Cliffs and Slopes Risk Areas Narrawallee and Bannisters Head 105
Figure 3.22 - Coastal Cliffs and Slopes Risk Areas Collers Beach 105
Figure 3.23- Coastal Cliffs and Slopes Risk Areas Rennies & Racecourse Beaches 108

Table 1-1 – Applying Coastal Zone Management Principles 17
Table 1-2 – Risk Management Approaches 19
Table 1.3 – Key Requirements from the Guidelines for Preparing Coastal Zone Management Plan (DECCW 2013) 23

Table 1.4 – Beach Short Term Erosion (Storm Cut) Advisian Appendix 1 (2016) 26
Table 2-1 – Coastal Hazard Zone Descriptions 35
Table 2.2 – Likelihood Scale for Coastal Risk Assessment 36
Table 2-3 – Evaluation of Coastal Values, Processes, Hazards, Risks and Consequences 38
Table 2-4 – Extreme Risks, 2050 and 2100 43
Table 2-5 – Residential lots and buildings within coastal hazard areas 44
Table 2-6 – Community Engagement Outcomes 50
Table 2-7 – Summary of Community Use, Access and Coastal Ecosystem Issues 55
Table 3-1 – Risk Management Options for Existing Development 59
Table 3-2 – Risk Management Options for New Development 59
Table 3-3 – Strategy 1 actions 60
Table 3-4 – Strategy 2 actions 61
Table 3-5 – Strategy 3 Actions 63
Table 3-6 – Strategy 4 actions 63
Table 3-7 – Strategy 5 actions 64
Table 3-8 – Coastal assets and risk rating 66
Table 3-9 – Strategy 6 actions 67
Table 3-10 – Strategy 7 actions 67
Table 3-11 – Local Area Plan 1 Actions - Seven Mile Beach, Culburra Beach 73
Table 3-12 – Local Area Plan 2 Actions - Warrain Beach, Penguin Head 78
Table 3-13 – Local Area Plan 3 Actions - Currarong Beach 83
Table 3-14 – Local Area Plan 3 Actions - Callala Bay, Callala Beach 86
Table 3-15 – Local Area Plan 3 Actions - Huskisson Beach, Collingwood Beach 89
Table 3-16 – Local Area Plan 4 Actions - Berrara, Bendalong, Manyana 95
Table 3-17 – Local Area Plan 5 Actions - Mollymook Beach, Narrawallee Beach, Collers Beach 99

Appendix 1 - Shoalhaven Coastal Hazard Mapping Review, Advisian 2016.

Appendix 2a – Shoalhaven Coastal Zone Management Plan – Risk Assessment, Advisian 2018.

Appendix 2b – Shoalhaven Coastal Zone Management Plan – Risk Mapping, Advisian 2018.

Appendix 3 – Submissions Tables.

Appendix 4 – Shoalhaven Beaches Emergency Action Sub Plans, Advisian 2018.

Appendix 5 – Shoalhaven Coastal Cliffs and Slopes Risk Management Program & Coastal Cliffs and Slopes Emergency Action Sub Plan, RoyalHaskoningDHV 2018.

Executive Summary

The Shoalhaven coastline

The coastal landscape of the Shoalhaven is a treasured natural, social and economic asset for the community. Council, often in partnership with state government agencies, manages 40 open coast beaches, bays, headlands, 11 coastal lakes and estuaries. This Coastal Zone Management Plan (CZMP) covers the Shoalhaven open coastline (including Jervis Bay). It does not include the estuaries.

To manage coastal risks and hazards, such as damage from storms, beach erosion and rising sea levels, Council is taking action to care for and manage the coastline. Integrated and sustainable management of the coastal zone is both a legal responsibility and high priority for Council as well as for local communities.

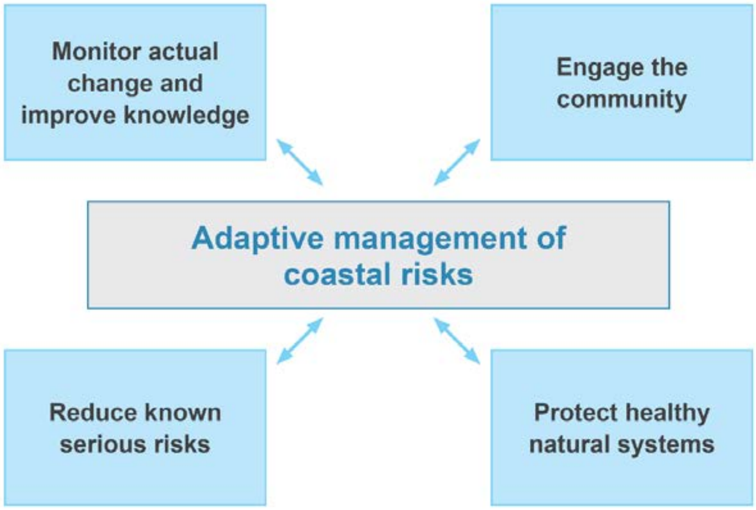
This draft Coastal Zone Management Plan sets out the plan for coastal management within the Shoalhaven City local government area for the next five years and beyond. During this time Council will develop a new Coastal Management Program in accordance with the latest requirements of the *NSW Coastal Management Act 2016*. Important actions that go beyond five years in this Coastal Zone Management Plan can be included in the Coastal Management Program.

Key strategies and action plans within the Coastal Zone Management Plan include:

- Regulating development in the coastal zone to ensure minimal environmental disturbance and long-term resident safety
- Ensuring a balance between beach stability and maintaining user amenity
- Providing mechanisms for management and risk mitigation for public and private assets in the coastal zone
- Ensuring the Shoalhaven coastline continues to be a valued natural asset for the broader community.

Taking a strategic approach

The Coastal Zone Management Plan has four main focus areas, as illustrated below. These focus areas are contained within, and interact with, an adaptive management framework. Adaptive management is a process for managing uncertainty, incomplete data and changing coastal systems to improve and refine management responses over time.



Framework for adaptive management of coastal risks and four focus areas

What Council needs to consider

Detailed studies of coastal processes, hazards and risks help us understand which issues need to take priority for sustainably managing the Shoalhaven coast. The Coastal Zone Management Plan contains detailed knowledge about coastal science. Information from technical studies gives us a deeper understanding of natural processes in particular locations. Scientific and community understanding of how beaches, dunes, lakes and estuaries respond to coastal processes, climate drivers and land management is improving.

Council develops coastal management options in response to coastal risks, that are based on the interaction of hazards and values. Options are evaluated against a range of criteria, including capacity to mitigate extreme risks, community acceptance, Council's capacity to pay, and alignment with existing programs. Adaptive responses are based on ongoing monitoring and evaluation of actual progress against expectations and targets.

The Shoalhaven coastline is highly valued by residents, ratepayers and visitors. During preparation of the Coastal Zone Management Plan, Council provided information using a special project website and listened to the community's views about important issues and potential management options.

Over the last six years Council has conducted multiple rounds of community briefings and workshops to discuss how local communities use and value the coast. Council considered community experience and observations of coastal change, objectives for the future of the coast, issues, hazards, risks and potential management responses.

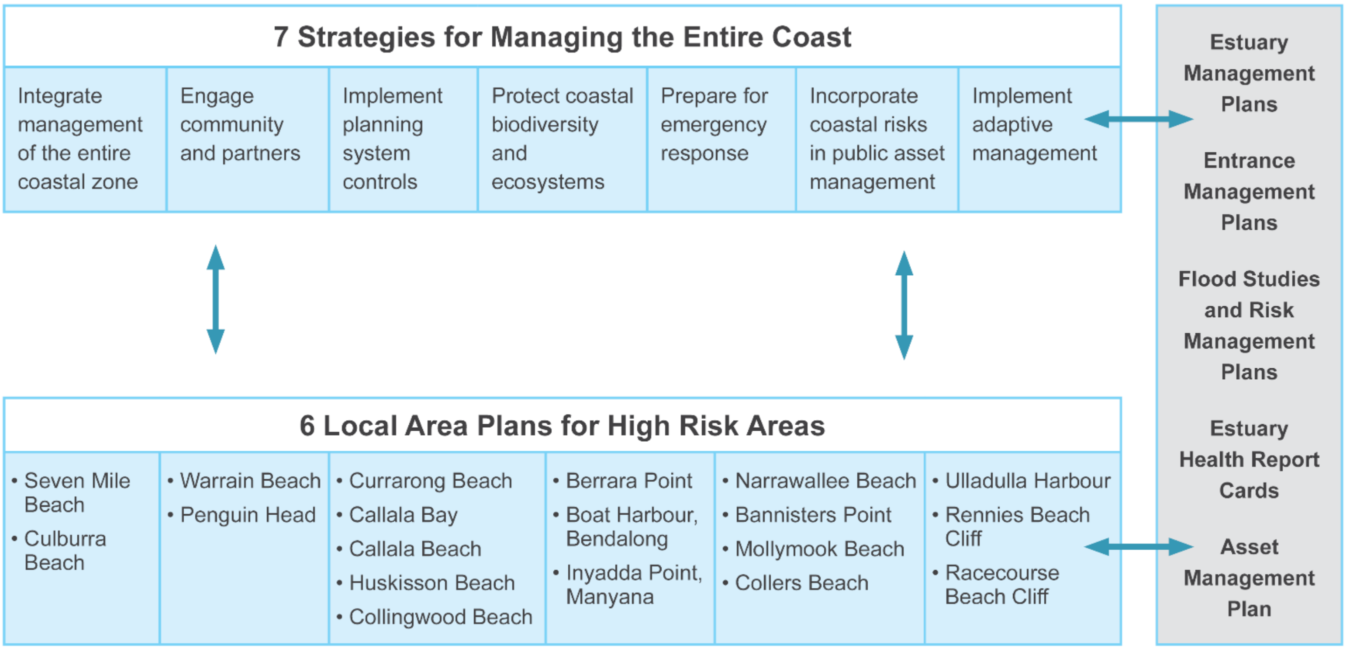
How Council responds

Strategies which apply to the whole of the Shoalhaven coastline include land use planning, emergency response management, and community involvement in monitoring and reporting.

Citywide strategies provide *general* benefit for the future management of coastal risks. They are designed to:

- Prevent risks escalating
- Raise awareness of coastal zone management issues and processes
- Protect important natural coastal systems
- Establish mechanisms to improve and refine management as new knowledge becomes available.

There are seven strategies for managing the entire coast and six local area plans, as shown over page. The six local area plans detail actions that are proposed to manage coastal risks and threats relevant to each particular area.



Relationship between area wide strategies, local area plans and estuary management plans

Implementation: setting priorities

Council has developed schedules that prioritise the broader strategy tasks and local actions. These schedules will help Council clearly identify the actions it needs to include in our corporate operational planning and budget cycles.

The strategies and actions set out in the schedules are mainly Council's responsibility. Many sections of Council will co-operate to achieve the objectives of the plan. To get the best results, Council will also need to work closely with local communities and relevant state agencies.

Taking these priorities and budget into account, Council has developed an operational program that balances the environmental priorities, community input and budget realities.

1. Introduction

1.1 Background

The coastal landscape of Shoalhaven City Council (SCC) is a treasured natural, social and economic asset for the community. The coastal zone extends 165 km along the NSW south coast, from Shoalhaven Heads to North Durras. Of the 109 beaches along the coast, Council manages 40, and of the 15 lakes and estuaries, Council manages 11. Figure 1.1 shows the extent of the Shoalhaven Coastal Zone, which this Coastal Zone Management Plan addresses. This Coastal Zone Management Plan (CZMP) covers the Shoalhaven open coastline from Shoalhaven Heads (including Jervis Bay) to North Durras but does not include the estuaries.

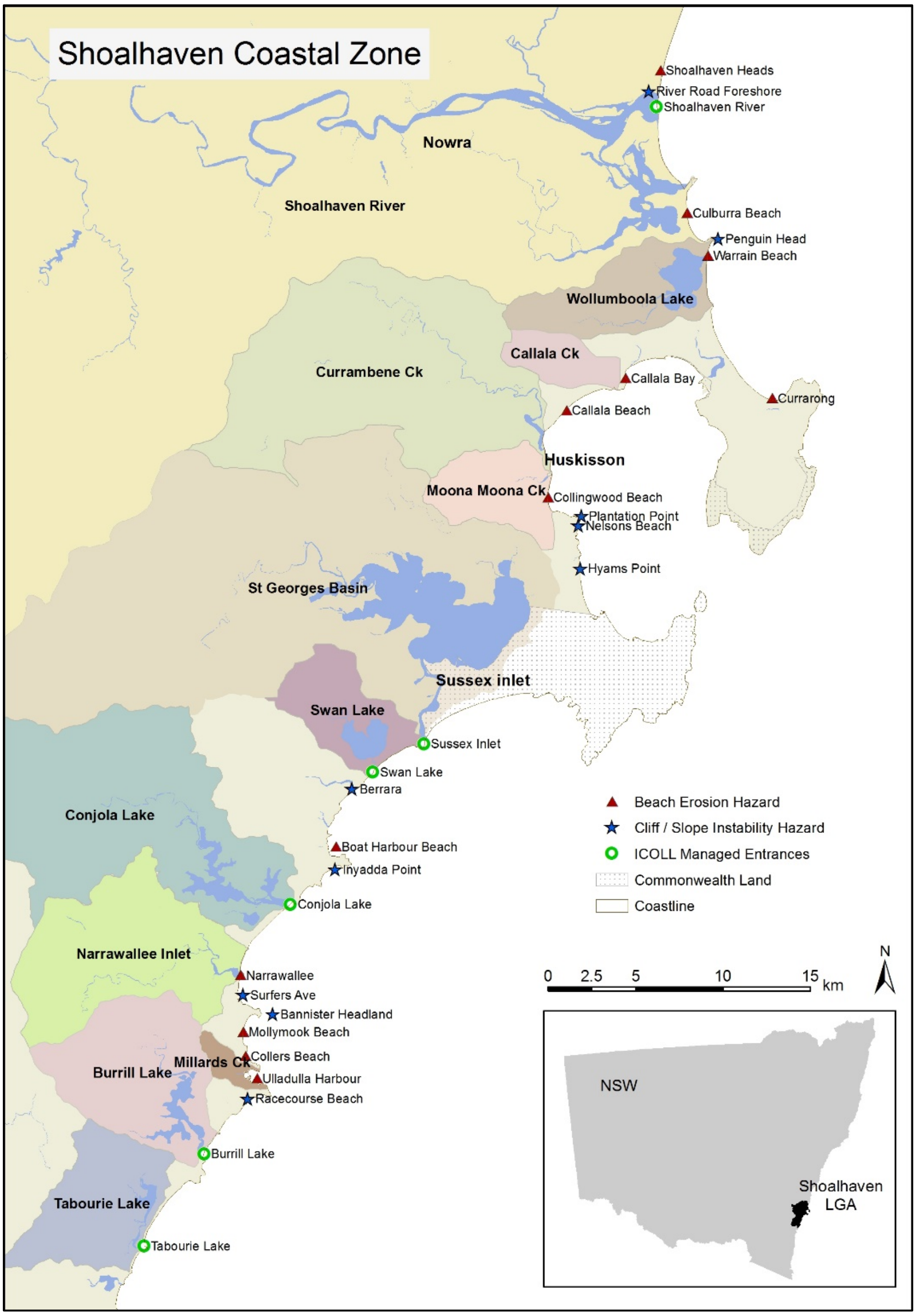


Figure 1.1 – Shoalhaven Coastal Zone

At least 55% of Shoalhaven's population (total 102,811[1]) lives in coastal areas. Residents and visitors alike enjoy the natural values of a healthy coastal zone.

Council manages beach access ways, lookouts, surf clubs, boat ramps, shared paths, parks and public amenities, natural areas, walking tracks, roads, water, storm water and sewerage infrastructure along the open coast. These assets and services support the community's enjoyment of the coast.

Integrated and sustainable management of the coastal zone is a high priority for Council and is linked to our key strategies for the Shoalhaven community. A Coastal Zone Management Plan that is adopted by Council, and certified by the Minister for the Environment, will provide a legal framework for future land use decisions along the open coast.

Council services and programs which are informed by plans for the coastal zone include:

- Land use planning through the Shoalhaven Local Environmental Plan 2014 (SLEP) and Shoalhaven Development Control Plan 2014 (SDCP)
- The Integrated Strategic Plan (ISP), including the Community Strategic Plan (CSP), Delivery Program and Operational Plan (DPOP) and Council's financials
- Asset management
- Water and sewerage services
- Biodiversity protection and invasive species control
- Recreation planning and community development
- Tourism and economic development.

Council's objectives and work programs in the coastal zone are influenced by and interact with state legislation, policies and plans. The Coastal Zone Management Plan has been prepared in accordance with the *Coastal Protection Act, 1979*, its associated Guidelines for Preparing Coastal Zone Management Plans (Office of Environment & Heritage (OEH), 2013), and other relevant NSW legislation. Figure 1.2 shows how the Coastal Zone Management Plan for the Shoalhaven coastline fits within the broader legislative and regional planning and Council's management framework.

[1] https://profile.id.com.au/shoalhaven (May 2018)

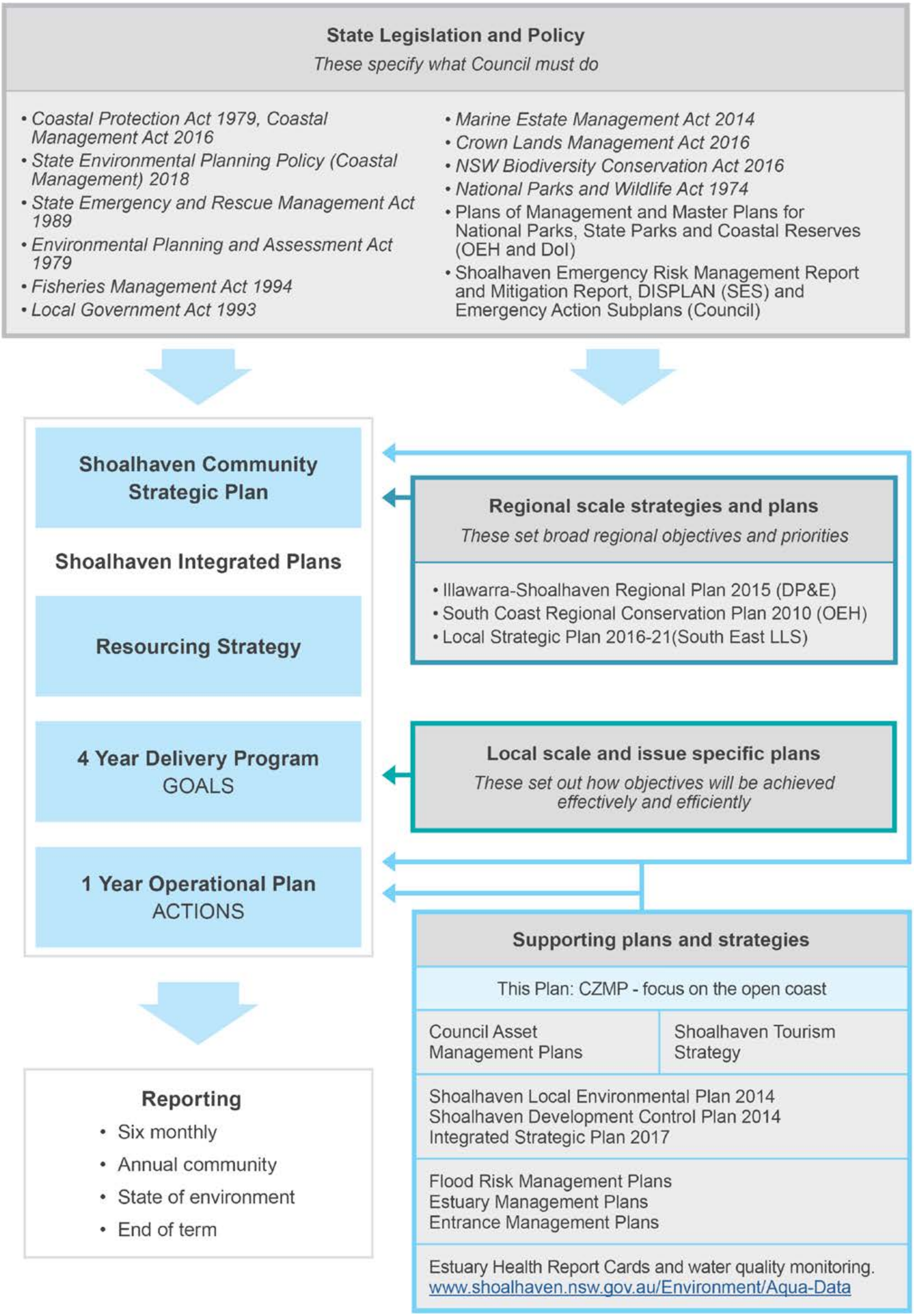


Figure 1.2 – Planning framework for the coastal zone

Council is the lead organisation for several plans which focus on managing risks associated with communities living within dynamic coastal landscapes. These plans include:

- The Coastal Zone Management Plan (this plan) – managing coastal hazards and risks on open coast areas managed by Council
- Estuary Management Plans for estuaries and coastal lakes – integrated management for the estuaries managed by Council
- Entrance Management Plans for intermittently closed and opened lakes and lagoons (ICOLLS) – when and why Council will open a lake entrance
- Flood Risk Management Plans for coastal lakes and rivers – how Council works with communities to avoid or reduce flood risks.

To inform these plans, scientific studies have been prepared by technical specialists. As new information becomes available these plans are reviewed. Council also assesses how well management plans and strategies are meeting objectives. This ongoing review and update enables Council and the community to adapt and plan using the best available knowledge of natural processes and community needs.

1.2 Coastal reforms

Since October 2012, just as the first draft of the Coastal Zone Management Plan was completed, the NSW Government began to introduce Coastal Reforms – Stage 1 and 2. These reforms have resulted in changing legislation which coastal councils must implement. Figure 1.3 over page outlines the chronology of the coastal reforms and Council's responses over the last six years.

2012

May

Draft Shoalhaven CZMP completed.

September

NSW Coastal Reforms Stage 1 announced, including withdrawal of the 2009 NSW sea level rise (SLR) benchmarks which had been used for the development of the coastal hazard lines shown in the draft 2012 CZMP.

Coastal councils were then required to set their own SLR benchmarks.

Certification of CZMPs was deferred until completion of the Stage 2 reform process.

2014

October

South Coast Regional Sea Level Rise Policy and Planning Framework Study completed in conjunction with Eurobodalla Shire Council, with support and funding from OEH.

November

NSW Coastal Reforms Stage 2 announced.

2015

February

SCC voted to adopt SLR projections of:

100mm – 2030, 230mm – 2050, 360mm – 2100

This policy will be reviewed at least every 7 years.

2016

March – July

Our Coast Our Lifestyle Community education and engagement project about management of coastal erosion.

August

Shoalhaven Coastal Hazard Mapping Review completed using SCC's SLR projections and other new data.

2017

June

Council resolved to adopt the Coastal Hazard Mapping Review and submit it with the 2012 CZMP seeking certification from the NSW Government. Certification was unsuccessful.

November

Council resolved to update the CZMP based on detailed feedback provided by DoI and OEH to secure eligibility under the NSW Coastal and Estuary Grant program whilst transitioning to a Coastal Management Program (CMP).

Concurrently, preparation of the new CMP began, with the development of a Scoping Study.

2018

Work continues on reviewing the CZMP in preparation for submission to the NSW Government. Work also continues on the development of the new CMP.

3 April

Commencement of the Coastal Management Act 2016.

June

Following public exhibition of the CZMP 2018, it was adopted by Council and forwarded to the NSW Minister for the Environment on June 29.

Figure 1.3 – NSW Coastal Reforms and Shoalhaven City's response 2012 to 2018

1.3 Shoalhaven's future coast

To achieve this vision, Council has set the following broad aims:

- Identify and manage coastal hazard and risk
- Protect the natural environment, coastal biodiversity and Aboriginal cultural heritage
- Enhance community access and appropriate recreational facilities
- Efficiently and effectively manage the coastal zone
- Enhance the social and economic wellbeing of coastal communities.

1.4 About this plan

Council's Coastal Zone Management Plan focuses on how Council will manage coastal risks in partnership with local communities and government stakeholders. The Plan has been prepared in accordance with:

- The requirements of Part 4A of the former Coastal Protection Act 1979 and the objectives of the former NSW Coastal Policy;
- Requirements of the NSW Guidelines for the Preparation of Coastal Zone Management Plans (2013);
- Requirements of Council under the Local Government Act 1993 (such as a Shoalhaven Community Strategic Plan) and the liability provisions of Section 733 of the Act.

1.4.1 Purpose, scope and process

Coastal risks emerge from the impacts of coastal processes such as waves, currents, tides and strong winds. At times, these create hazards such as storm bite erosion of beaches and dunes, medium to long-term recession of some beaches and slope instability on cliffs and bluffs.

Coastal risk areas are those impacted by coastal hazards now or projected to be impacted by coastal hazards in the foreseeable future. When assessing coastal risks, a plan must also consider the impacts of projected climate change and sea level rise for the period to 2100. Higher risks occur when an impact is more likely and when the land which will be impacted contains assets of higher value.

This plan focuses on two sets of coastal hazards:

- Beach erosion, wave runup and long-term recession
- Coastal cliff and slope instability.

High-risk areas in Shoalhaven were first identified in the 2004 Coastline Risk Management Report. All beaches managed by Council were risk assessed 'for the 1% event (100 year ARI) occurring today and at the end of 50 year and 100 year planning periods'. Based on this criterion, 10 beaches were prioritised as being at greater risk of coastal erosion and requiring the preparation of coastal hazard studies:

- Shoalhaven Heads
- Culburra Beach
- Warrain Beach
- Currarong Beach
- Callala Beach
- Collingwood Beach
- Narrawallee Beach
- Mollymook Beach
- Collers Beach
- Boat Harbour, Bendalong (included after the 2016 east coast low (ECL) event)

The coastal cliff and slope instability locations prioritised as being a greater risk were identified in 2008, 2011, 2012 and 2018[2]:

- Penguin Head
- Plantation Point
- Hyams Point
- Berrara Point
- Inyadda Point, Manyana
- Narrawallee
- Bannisters Point
- Collers Beach Headland
- Rennies Beach
- Racecourse Beach.

---

[2] Coastal Slope Instability Hazard Study (SMEC, 2008), Shoalhaven Public Asset Coastal Risk Management Review (Review (BMT WBM 2012), Peer Review, Supplementary Geotechnical Observations (of the Coastal Slope Instability Hazard Study 2008) (Douglas Partners 2011), Report on Scoping Study and Stability Assessment (Various Lots Surfers Avenue, Tallwood Avenue and Bannister Head Road, Narrawallee) (Douglas Partners 2011), Shoalhaven Coastal Cliffs and Slopes Risk Management Program (Royal Haskoning DHC, 2018).

The risk areas identified above have been included in the Shoalhaven Local Environmental Plan and Shoalhaven Development Control Plan for many years.

Review of the 2004 Coastline Risk Management Report is identified as a priority action in the Coastal Zone Management Plan. With so much new information now being available about coastal hazards in a changing climate, it's very likely that the list of high-risk beaches requiring coastal hazard assessment will increase.

In addition to managing risk, the Coastal Zone Management Plan provides strategic direction about important natural and community values, such as:

- The ecological health of beaches, coastal dunes and headlands
- The social health of coastal communities
- Appropriate locations and facilities to support and encourage community use of the coast.

The other important purpose of this plan is to maintain eligibility for NSW Government funding. Without a certified Coastal Zone Management Plan, coastal councils are not eligible to apply to the Coastal and Estuary Grants Program, for implementing works. This is the program that Council uses to seek financial support for coastal and estuary works.

Figure 1.4 shows the steps in preparing a Coastal Zone Management Plan.

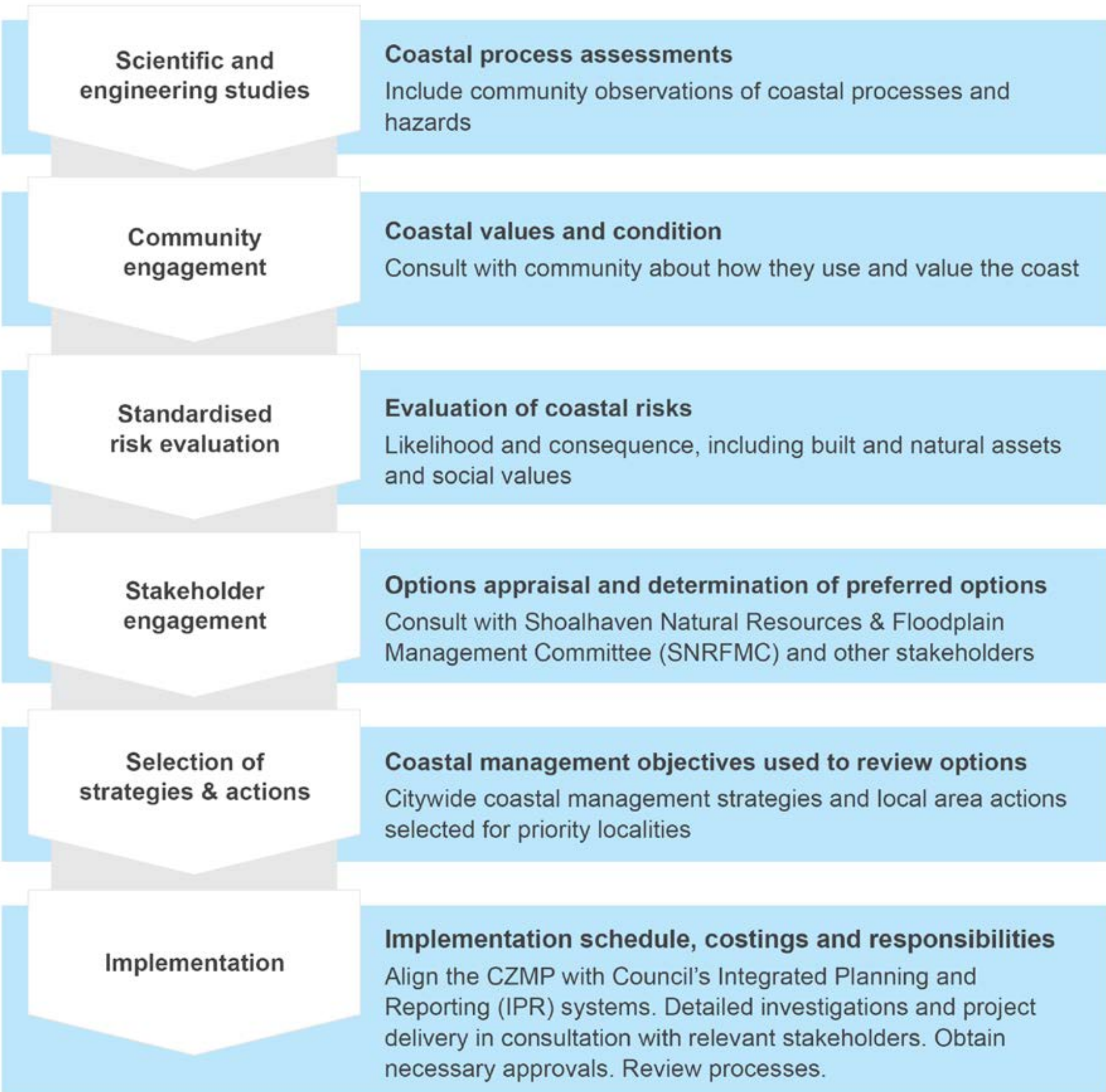


Figure 1.4 – Steps in preparing a Coastal Zone Management Plan

Concurrently with this 2018 Coastal Zone Management Plan, Council is preparing to transition to a new Coastal Management Program (CMP). The 2018 Coastal Zone Management Plan will provide the basis for the Coastal Management Program and any outstanding or ongoing Coastal Zone Management Plan actions will be transitioned into the new document.

1.4.2 Coastal management principles and objectives

The objectives of this Plan are to:

- Give effect to all relevant NSW legislation and policy, as applied to the coastal zone, in the Shoalhaven context
- Manage all coastal systems in an integrated manner that recognises the links between catchment, lake, estuary and open coast processes
- Align the Coastal Zone Management Plan with Council's estuary management plans, Local Environment Plan 2014, Development Control Plan 2014 and Integrated Strategic Plan
- Engage with the community in the review and preparation of coastal management programs
- Keep the community informed about coastal processes and management responses
- Manage the coastal zone adaptively, with a clear process for modifying management approaches as new knowledge becomes available
- Invest in effective and efficient strategies to achieve positive natural, social, cultural and economic outcomes within Council's responsibilities
- Take coastal hazards into account in Council's land use planning
- Maintain natural systems and processes to improve the health and diversity of natural systems
- Support the social and economic wellbeing of local communities by maintaining safe access to beaches and headlands and supporting recreational activities.

The relationship between principles and objectives

Council has adopted the 10 coastal zone management principles set out in the *NSW Guidelines for Preparing Coastal Zone Management Plans (DECCW, 2013)*. The principles are set out below in Table 1.1, together with Council's objectives for the Coastal Zone Management Plan.

Table 1-1 – Applying Coastal Zone Management Principles

Coastal Zone Management Principles (DECCW, 2013)	Coastal Zone Management Plan Objectives
1. Consider the objects of the *Coastal Protection Act 1979* and the goals, objectives and principles of the NSW Coastal Policy 1997 and the NSW Sea Level Policy Statement 2009.	1. Give effect to all relevant NSW legislation and policy, as applied in the Shoalhaven context.
2. Optimise the links between plans relating to the management of the coastal zone.	2. Manage all coastal systems in an integrated manner that recognises the links between catchment, lake, estuary and open coast processes. Align the CZMP with Council's Estuary Management Plans, Local Environment Plan 2014 and Council's Integrated Strategic Plan.
3. Involve the community in decision making and make coastal information publicly available.	3. Engage with the community in the review and preparation of coastal management programs.

Coastal Zone Management Principles (DECCW, 2013)	Coastal Zone Management Plan Objectives
	Keep the community informed about coastal processes and management responses.
4. Base decisions on the best available information and reasonable practice; acknowledge the interrelationships between catchment, estuarine and coastal processes; adopt a continuous improvement approach.	4. Manage the coastal zone adaptively, with a clear process for modifying management approaches as new knowledge becomes available.
5. Prioritise public benefit in expenditure to cost effectively achieve the best practical long-term outcomes.	5. Invest in effective and efficient strategies to achieve positive natural, social, cultural and economic outcomes within Council's responsibilities.
6. Adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risks where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions to manage high risks while long term options are implemented.	6. Take coastal hazards into account in Council's land use planning.
7. Adopt an adaptive risk management approach if risks are expected to increase over time, or to accommodate uncertainty in risk predictions.	7. Refer to objectives 4, 5 and 6
8. Maintain the condition of high value coastal ecosystems; rehabilitate priority degraded coastal ecosystems.	8. Maintain natural systems and processes to maintain or improve the health and diversity of natural systems.
9. Maintain and improve safe public access to beaches and headlands consistent with the goals of the NSW Coastal Policy.	9. and 10. Support the social and economic wellbeing of local communities by maintaining safe access to beaches and headlands and supporting recreational activities.
10. Support recreational activities consistent with the goals of the NSW Coastal Policy.	

1.5 Council's strategic approach to coastal zone management

The Coastal Zone Management Plan has four main focus areas, as illustrated in Figure 1.5. These focus areas are contained within, and interact with, an adaptive management framework. Adaptive management is a process for managing uncertainty, incomplete data and changing coastal systems to improve and refine management responses over time.

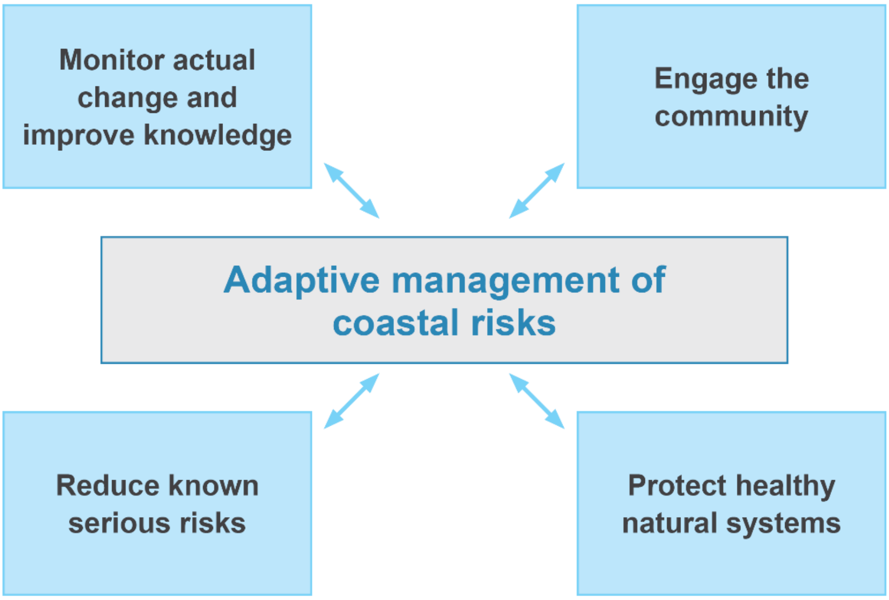


Figure 1.5 – Framework for adaptive management of coastal risks and four focus areas

1.5.1 Reduce known serious risks

The Plan uses five management approaches to reduce known serious risks, as shown in Table 1.2. More details are contained in Section 2.

Table 1-2 – Risk Management Approaches

Risk management approach	Measures and/or actions	Options Avoid, accommodate or accept (option may change as triggers are met)
Avoid risk	Planning controls and asset replacement plans for existing and future development, including homes and infrastructure.	Long term **managed retreat to avoid** risk or retreat from risk.
Change the likelihood	Beach and dune nourishment, revegetation and biodiversity programs; coastal protection works.	**Accommodate change** by building community capacity and understanding. Undertake protection and stability works to improve adaptability.
Change the consequence	Community awareness, building and infrastructure design; access management.	
Share the risk	Insurance measures and funding options for affected landowners.	**Accept risk** and manage costs – explain who pays and how.
Informed risk retention	Emergency action in the short term.	**Accept risk** and respond when events occur.

1.5.2 Engage the community

Effective coastal zone management depends on an informed and engaged community. Council will work with the community to:

- Build broad community knowledge of coastal processes and risks
- Create opportunities for local communities to be involved in protecting important values
- Provide facilities for appropriate use and enjoyment
- Monitor and report coastal change.

1.5.3 Protect healthy natural systems

A natural coastal landscape with high biodiversity is a highly valued and important feature of the Shoalhaven coastal zone. These healthy coastal ecosystems support valuable social and economic services for the community.

The Coastal Zone Management Plan supports ongoing Council and community effort to protect and enhance ecological communities on beaches, coastal dunes and headlands, reinforcing the resilience of the coastal landscape to changes in the intensity of coastal processes. Key actions include bush regeneration programs and managing access onto beaches. Council will continue to support Bushcare groups and the National Parks and Wildlife Shorebird Recovery Program.

1.5.4 Monitor change and improve knowledge

Council will work with the NSW Government, local communities, coastal experts and university researchers to build knowledge of coastal processes and to monitor changes to the coastal zone. Coastal zone monitoring has four main purposes:

- Track implementation of the Plan
- Determine how beach and dune profiles respond to management actions and to storm patterns and changes in sea level
- Assess the ecological health of dunes in response to management actions and to a changing climate
- Assess the adequacy of coastal access and facilities and community satisfaction with coastal amenity.

1.6 How adaptive management works

An adaptive management cycle has four key considerations as illustrated in Figure 1.6 over page. Managers track progress against expectations and evaluate effective responses to determine if community and environmental objectives have been met.

Council will continue to monitor the condition of the coast and shoreline responses to major storm or extreme water level events. This will ensure that Council and local communities have the best available knowledge to evaluate, review and adapt management actions.

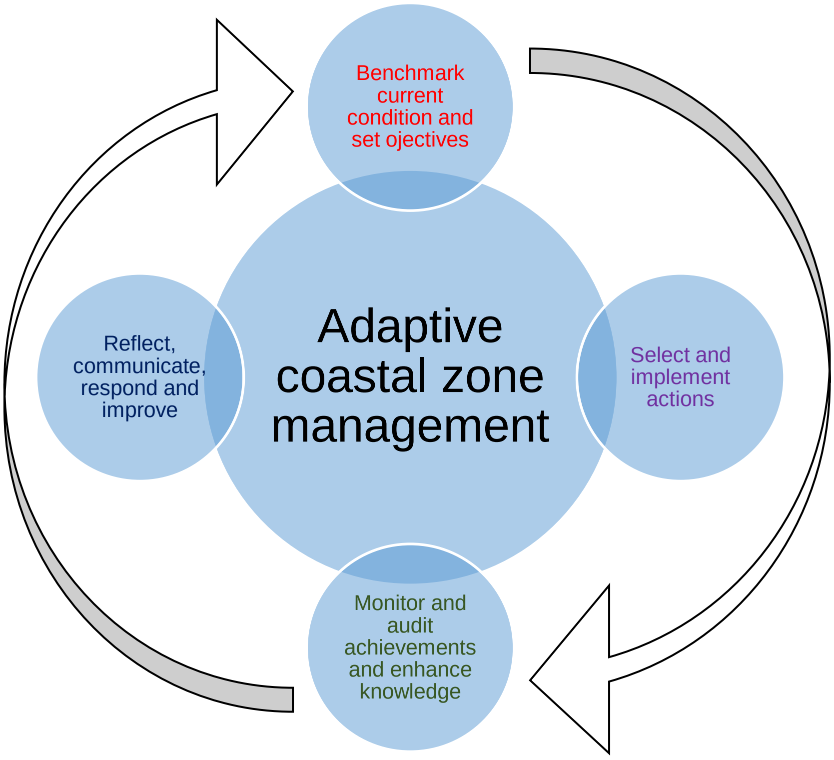


Figure 1.6 – Key considerations for adaptive coastal zone management

1.7 Timeframes for action

Prioritisation tables in Section 4 group all actions into either two year, three to five year or more than five year time frames. The Coastal Zone Management Plan will be superseded when the Shoalhaven Coastal Management Program is completed. At that time, actions will be incorporated into this new Program. Council envisages that the Coastal Zone Management Plan will remain in place for five years while the Coastal Management Program is being developed and certified.

1.7.1 Delivering actions

The strategies and actions set out in the Coastal Zone Management Plan are mainly the responsibility of Council. Many sections of Council cooperate to achieve the objectives of the Plan. Council will work closely with local communities along the coast to implement the Plan.

Council will also work closely with the NSW OEH, NSW Department of Industry (Crown Lands & Water), NSW Department of Primary Industries (Fisheries) and other agencies to ensure a consistent approach to:

- Coastal risks
- Decisions about coastal access
- Protection of important coastal ecosystem functions.

The Coastal Zone Management Plan does not duplicate existing management actions in plans made by these partners. It does make strategic recommendations to coastal management partners to help them deliver a coordinated, integrated, informed and adaptive management approach for the Shoalhaven coast.

As much as possible, the Coastal Zone Management Plan aligns with plans of management for Crown reserves, Council reserves, national parks and NSW marine parks. The Coastal Zone Management Plan also respects Aboriginal and European cultural heritage on the coast, recognising the need to ensure all relevant approvals, permits and licences are obtained for any works resulting from the implementation of this document. The Coastal Zone Management Plan has informed the current Shoalhaven Local Environmental Plan and Shoalhaven Development Control Plan 2014, ensuring that coastal erosion risks are considered in Shoalhaven land use planning into the future.

1.8 Paying for coastal zone management

Council has the statutory role in land use planning and in carrying out works to reduce serious coastal risks to community assets and infrastructure. Council owns and/or manages coastal land on behalf of the Crown and local communities. Council works in partnership with community organisations to manage coastal vegetation, protect sensitive coastal ecosystems and provide safe and attractive beach access facilities for residents and visitors. These responsibilities incur significant costs.

Council prepares budget estimates for all proposed actions. The estimates are considered within Council's internal budget planning cycles. However, as Council has limited resources, we need to draw on funds available from other sources to implement the Coastal Zone Management Plan.

1.8.1 Funding options

There are several ways Council can provide human and financial resources to implement the Plan. We are already addressing many issues using existing staff. We are also considering:

- Fostering partnerships with landholders and community-based organisations along the coast and with key NSW agencies such as OEH, Department of Industry – Crown Lands and Water and Department of Primary Industries Fisheries to promote research and on ground works programs relevant to Council's coastal issues and priorities.
- Reviewing and reallocating priorities in delivery and operation plans so that more resources are allocated to coastal zone management
- Applying for the grant funding
- Involving the community in dune vegetation rehabilitation and dune monitoring.
- Developing partnerships with private sector businesses for some coastal management works, to foster ecological resilience and manage assets.

Relevant and possible funding opportunities include:

- NSW Government Coastal and Estuary Grant Program
- NSW Government Coastal Lands Protection Scheme
- Other State or Federal Government Grants (especially climate change adaptation and resilience building funds)
- NSW Environmental Trust
- DPI Fisheries Habitat Action Grants
- Public Reserves Management Fund Program
- New Council levies or increased land rates
- Private financial institutions (e.g. banks)

The NSW Government may provide assistance to Council; however this will be subject to grant funding availability and prioritisation on a statewide basis.

In the longer term, all landholders could contribute in some way to the costs of managing community infrastructure in coastal hazard zones. This will help maintain both ecosystem and infrastructure services. The following options, for future investigation by Council, emerged in the Our Coast Our Lifestyle community engagement project:

- Implement a special levy on affected coastal landholders, to cover the costs of maintaining beach protection, amenity and access
- Implement a citywide levy (similar to the existing storm water levy or environment levies that other Councils have implemented) to provide additional capital funds to relocate or protect community assets and infrastructure
- Require all private landholders directly impacted by coastal hazards to pay for any coastal protection works from which they benefit, including maintenance of existing protection works
- Maintain Council's Coastal Management and Infrastructure Reserve into which Council allocates funding each year with the aim of building a financial reserve to fund emergency responses to coastal storm events and implement strategic coastal management actions.

1.9 Compliance with statutory requirements

The Coastal Zone Management Plan is prepared in accordance with the statutory requirements set out in the *NSW Guidelines for the Preparation of Coastal Zone Management Plans (DECCW, 2013)* and the previous *Coastal Protection Act 1979* (amongst other key pieces of legislation, policies and guidelines). The following table is a general guide to where the relevant information, relating to the key requirements of the guidelines and Coastal Protection Act, is located in the Plan.

When the new Coastal Management Program is prepared over the coming years, it will be prepared in accordance with the *Coastal Management Act 2016.* Guidelines to help coastal councils prepare Coastal Management Programs have been developed by the State Government.

Table 1.3 – Key Requirements from the Guidelines for Preparing Coastal Zone Management Plan (DECCW 2013)

Requirements from the Guidelines for Preparing Coastal Zone Management Plan (DECCW 2013)		**Where within this report?**	**How this relates to the CPA 1979?**
The CZMP must contain a description of:	How the relevant Coastal Management Principles have been considered in preparing the Plan.	Section 1 presents the Coastal Management Principles and the project objectives that have been developed to ensure each principle is addressed.	55D (1) - Draft Plan in accordance with the Ministers guidelines.
	The community and stakeholder consultation process, the key issues raised and how they have been considered.	The consultation and engagement processes are noted in Section 2.2. Council has consulted with the community about coastal management issues over a period of 6 years, including provision of web-based information, community meetings, briefings in multiple locations and a previous exhibition of the draft Plan.	55E and F- Public consultation and consideration of submissions has been undertaken.
	How the proposed management options were identified, the process followed to evaluate the management options, and the outcomes of the process.	Section 2 shows how hazards and risks were identified. Section 3 notes how options were identified following on from the hazard studies risk assessments. Council commissioned the separate *Shoalhaven Coastal Zone Management Plan - Risk Assessment* (Advisian, 2018) to analyse risks and propose appropriate risk mitigation strategies. This document updated the	55C(1) d, e, f Management of hazards and risks has been addressed.

Requirements from the Guidelines for Preparing Coastal Zone Management Plan (DECCW 2013)		Where within this report?	How this relates to the CPA 1979?
		previous study (BWT WBM, 2011) to account for the updated hazard mapping based on new data and Council's updated sea level rise projections.	
The CZMP must contain proposed management actions over the CZMP's implementation period in a prioritised implementation schedule which contains:	Proposed funding arrangements for all actions, including any private sector funding.	Section 1.8 and Section 4 looks at funding options and monetary responsibilities.	55C (1) g - funding responsibilities for works
	Actions to be implemented through other statutory plans and processes.	Sections 3 and 4 note each of the actions, the lead agency responsible and whether changes to statutory plans, zoning or policies will be required.	55D (1) - preparing a draft Plan in accordance with the Ministers guidelines
	Actions to be carried out by a Public Authority or relating to land or other assets it owns or manages, where the Authority has agreed to these actions.	Sections 3 and 4 note each time Council needs to consult or liaise with public authorities to obtain relevant approvals, permits and/ or licenses to enable CZMP actions to be completed. Sections 3 and 4 do not list any public authorities as being responsible for implementing the actions.	Section 55C (2) b
	Proposed actions which monitor and report to the community on the plan's implementation, plus a review timetable.	Section 3.2 proposes methods of adaptive management and methods to communicate monitoring results.	55D (1) - Draft Plan in accordance with the Ministers guidelines.
The CZMP must be prepared using a process that includes: **CZMPs are to achieve a reasonable balance between any potentially conflicting uses within the coastal zone.**	Evaluating potential management options by considering social, economic and environmental factors, to identify realistic and affordable actions.	Actions are included under key strategic themes and presented in Sections 3 and 4. A detailed evaluation of a wide range of potential management options is included in the 2009 draft of the CZMP and is not repeated in this document.	55D (1) - Draft Plan in accordance with the Minister's guidelines.
	Consulting with the local community and other relevant stakeholders. The minimum consultation requirement is to publicly exhibit a draft plan for not less than 21 days, with notice of the exhibition arrangements included in a local newspaper.	The exhibition period of the CZMP will be at least the 21 days required. Submissions made during the exhibition will be reviewed and any necessary amendments made to the final draft of the CZMP before reporting it to Council for adoption.	55E (a)(b) - Public consultation of the draft Plan will comply with these requirements.
	Considering all submissions made during the consultation period. The draft plan may be amended as a result of these submissions.	Initial comments from stakeholders have been considered and addressed during the Plan update process. After the Plan goes on public exhibition any further submissions will be considered and incorporated where necessary.	55F (1)(2)(3) – Consideration of submissions will comply with these requirements.
CZMPs are to achieve a reasonable balance between any potentially conflicting uses within the coastal zone.			55F (1)(2)(3) – submissions.

2. Key Considerations

2.1 Coastal processes, hazards, risks and issues

Detailed studies of coastal processes, hazards and risks over several years have built up an understanding of the issues requiring a priority response for the sustainable management of the Shoalhaven coast. The following sections of this Plan provide more information about the coastal science and technical studies.

2.1.1 Coastal processes

The coastal landscape is dynamic. It is continually changing in response to the coastal processes. These include waves, currents, tides, winds, rainfall and long-term water levels which shape coastal landforms and the coastal landscape. These natural processes change the coast by causing beach and dune erosion, dune instability, coastal recession, flooding due to waves, movement of creek entrances, and slumping or rock fall on cliffs and bluffs. Highly variable, these coastal processes can change daily. They also change periodically with natural cycles, all of which interact with each other. Examples include:

- Monthly tidal cycles from high water springs to neap tides
- Seasonal variations in storm patterns, which affect wave energy, wave direction and rainfall
- Southern oscillation index cycles of about 7 to 10 years, which affect droughts, floods, beach orientation and lake entrance processes
- Century or longer-scale variations in climate.

Within the Shoalhaven, the beach is often perceived to be the sandy area between the waterline and the dunes. It includes the beach berm, incipient foredune formations and hind dunes. On an open coast, the overall beach system typically extends for several kilometres offshore, in water depths of around 20 metres, to the back beach dune or barrier region. It may extend up to several hundred metres inland. When examining the coastal processes of a beach system, such as those in the Shoalhaven, it is often necessary to consider this wider definition.

The hydrodynamic forces controlling the rate of these processes and hazards comprise the prevailing wave climate and water levels.

Short-term coastal erosion

Storm cut

The beach is made up of unconsolidated sands that can be mobilised under certain meteorological conditions. The dynamic nature of beaches is often witnessed during storms when waves remove the sand from the beach face and the beach berm and transport it, by a combination of longshore and rip currents, beyond the breaker zone where it is deposited in the deeper waters as sand bars. During severe storms, with long durations of severe wave conditions, the erosion continues into the frontal dune, which is attacked. A steep erosion escarpment is formed. This erosion usually takes several days to a few weeks.

In general, the beaches within Jervis Bay are more sheltered than the open coast beaches. Wave transformation modelling undertaken by SMEC (2006), and validated against physical model tests, showed that the refracted wave heights into Jervis Bay near Callala Beach were approximately half of those experienced along the open coast. While the Jervis Bay beaches are generally more sheltered, wave height is not the only factor that determines how much storm erosion would occur as a result of a particular storm.

The amount of sand eroded from the beach during a severe storm will depend on many factors including the state of the beach when the storm begins, the storm intensity (wave height, period and duration), direction of wave approach, the tide levels during the storm, and the occurrence of rips. Storm cut is the volume of beach sand that can be eroded from the subaerial (visible) part of the beach and dunes during a design storm. It has generally been defined as the volume of eroded sand as measured above mean sea level (~ 0 m AHD datum). For a particular beach, the storm cut (or storm erosion demand) may be quantified empirically with data obtained from photogrammetric surveys. Alternatively, it may be quantified analytically using a verified numerical model.

In the coastal processes studies prepared for this Plan, short-term erosion for each beach was estimated on the basis of photogrammetric data and interpreted based on the occurrence of particular storm events. For many of the beaches, the measured storm erosion demand has been interpreted to have occurred as a result of the May to June 1974 storms as shown in the table below (Advisian 2016). While the measured storm erosion demand from this storm was generally higher at the open coast beaches than the sheltered beaches, there is a significant variation based on the following factors:

- Measured storm erosion demand at some beaches was recorded adjacent to rip-heads, for example at Callala Beach, which in a storm may occur at random locations along the beach.
- The southerly approach direction of the 1974 storm meant that areas that were sheltered to the south by headlands or reefs, even those on the open coast, will have recorded lower storm erosion demands than those most exposed toward the south.
- At some of the beaches, limited supply of sand to feed the storm erosion demand is available, due to the presence of bedrock below the beach or coastal protection structures.

Table 1.4 – Beach Short Term Erosion (Storm Cut) Advisian Appendix 1 (2016)

Beach	**Short term erosion (storm cut)** *Includes creek/river/lake entrance instability where relevant
Shoalhaven Heads	*350 m^3
Culburra Beach	100 m^3/m (south) 160 m^3/m (central) 280 m^3/m (north)
Warrain Beach	220 m^3/m (north of lake entrance) *400 m^3/m (at lake entrance)
Currarong Beach	60 m^3/m
Callala Beach	120 m^3/m (north & south) 180 m^3/m (central)
Collingwood Beach	100 m^3/m (south) 120 m^3/m (central-north)
Narrawallee Beach	110 m^3/m
Mollymook Beach	100 m3 /m (north) 170 m3 /m (north of nourished dune) *130 m3 /m (north of Blackwater Creek, behind nourished dune) *230 m3 /m (immediately south of Blackwater Creek entrance) 150 m3 /m (Surf Club) 90 m3 /m (south – Golf Club)
Collers Beach	105 m^3/m

Slope instability

In Shoalhaven slope instability, on coastal cliffs and slopes, can affect assets at 10 locations (1.4.1).

Dune slumping is also treated as a slope instability hazard. Following storm cut the dune face dries out and may slump. This is due to the dune sediments losing their apparent cohesive properties that come from the negative pore pressures induced by the water in the soil mass. This subsequent slumping of the dune face causes further dune recession.

Dune slumping can be quantified with stability computations, which can serve as a guide to determining safe setback distances on frontal dunes that are prone to wave attack and slumping during storms.

Behaviour of creek and estuary entrances

Various coastal hazards can be created by both trained and natural estuary entrances. Natural entrances tend to migrate along the beach in response to freshwater flooding and coastal storm effects (NSW Government, 1990). This phenomenon has been seen at some beaches in Shoalhaven, including Mollymook, where Blackwater Creek and Mollymoke Farm Creek entrances had migrated north in some storms, threatening both public and private assets. Training walls have been constructed on the northern side of both creeks to mitigate these threats.

A major storm event can also cause entrance break through at unexpected locations. This leads to destruction of dunes that have formed near creek entrances and renders any assets behind the dunes vulnerable to future storms. At Currambene Creek (southern end of Callala Beach) a training wall was constructed to reduce the risk of creek breakout at Myola.

Longer term beach changes and shoreline recession

Following storms, ocean swell replaces the sand from the offshore bars onto the beach face where onshore winds move it back onto the frontal dune. Typically, the beach building phase, spans many months to several years. Following the build-up of the beach berm and the incipient fore dunes, and the re-growth of the sand-trapping grasses, the beach can appear fully recovered. Beach erosion is offset by beach building.

However, in some instances, not all of the sand removed from the berm and dunes is replaced during the beach building phase. Sand can be lost to sinks, resulting in longer term ongoing recession of the shoreline. Over decadal time scales, changes in wave climate can also result in beach rotation.

Currently in Shoalhaven, recession is not a major issue; however, the following beaches have been identified as experiencing shoreline recession (Advisian 2016)

- Currarong: 0.10 – 0.29 m/y
- Culburra: 0.025 m/y (south-central), zero (north)
- Callala: 0.1 – 0.15 m/y (central-north), zero (south)

All other high-risk beaches have been assessed as having a zero long term recession rate for the whole beach (Advisian 2016).

Sediment budget deficit

Once the sand has been transported offshore into the surf zone, it may be moved alongshore under the action of the waves and currents and out of the beach compartment. Some of the sand that is transported directly offshore during storms may become trapped in offshore reefs, thereby preventing its return to the beach. Other direct losses of material from the beach may include the inland transport of sand under the action of onshore winds (known as aeolian sand transport). Over the longer term, if the amount of sand taken out of the compartment by alongshore processes exceeds that moved into the compartment from adjacent beaches or other sources, there will be a direct and permanent loss of material from the beach. There will also be a deficit in the sediment budget for the beach. This will result in an increasing potential for dune erosion during storms and long-term beach recession.

Obvious processes that may lead to a deficit in the sediment budget of a beach include sand blown off the beach by wind (aeolian sand transport causing transgressive dune migration), mining the beach for heavy minerals and beach sand extraction operations. Other processes, which are not so obvious because they occur under water, include the deposition of littoral drift into estuaries and the transport of quantities of littoral drift alongshore and out of a beach compartment, which may be larger than any inputs.

The NSW coastline can be subdivided into a series of sediment compartments, which are subdivisions of the coast separated by major obstacles such as headlands, which stop longshore transport of sediment. Council must consider the natural processes of the coast managing the coastline. The use of coastal sediment compartments as 'natural' management units must be incorporated into coastal management and coastal zone management plans. The coastal sediment compartment approach identifies local government areas that share the same compartment. This requires consultation between adjoining local councils in developing coastal management plans. Shoalhaven City Council shares the Shoalhaven sediment compartment (encompassing Seven Mile Beach) with neighbouring Kiama Council to the north.

Carvalho and Woodroffe (2015) have completed a study of the coastal compartments of the eastern coast of NSW. Compartments were delineated based on physical characteristics as well as review and interpretation of hydrologic, geomorphic and sedimentological data. The following primary sediment compartments were identified for the Shoalhaven coast:

A compartment centred on the Shoalhaven River estuary, encompassing Seven Mile Beach at Shoalhaven Heads, Culburra, Warrain and Currarong beaches;

- A compartment centred on Jervis Bay, encompassing Callala and Collingwood beaches;
- A compartment between Bannisters Point and Jervis Bay, encompassing Narrawallee beach;
- A compartment between Warden Head and Bannisters Point, encompassing Ulladulla Harbour, Collers and Mollymook beaches.

These compartments have been further subdivided into secondary and tertiary sediment compartments by the presence of smaller headlands, and based on sediment characteristics and transport. The Shoalhaven coastal compartment is dominated by the Shoalhaven River which is responsible for delivering significant quantities of sediment to the beaches in the compartment. Sand transport to the north is limited by the presence of Black Head; sand transport to the south is blocked by Beecroft Peninsula.

For the Shoalhaven River Estuary compartment, the sediment budget is highly dependent on the dynamics of the Shoalhaven River entrance. The Shoalhaven entrance dynamics have an influence on the sediment budgets at Shoalhaven Heads, Culburra, Warrain and Currarong beaches. Within the Shoalhaven sediment compartment, the following significant components of the sediment budget are identified as sources (Carvalho and Woodroffe, 2015):

- Fluvial sand and mud supply
- Erosion of river flanks (mostly along Berry's canal)
- Sediment supply from rock headland erosion
- Biogenic production

Sink components include:

- Estuarine deposition
- The flood-tidal delta
- The loss of sand from the beach to the barrier system
- Dredging around Pig Island

Areas of exchange of sediments which can act as sources and/or sinks include the beach-shoreface and the shoreface-inner shelf.

The sediment supply from the Shoalhaven River has influenced the morphology of the beaches and has had the greatest impact at Shoalhaven Heads, with the sediment supply reducing toward the south with distance from the estuary entrance.

For the other sediment compartments, sediment exchange can occur between beaches within the same compartment. There is limited sediment exchange between these compartments due to the presence of physical barriers to this transport. With no large estuaries to supply sediment to the southern compartments of the Shoalhaven coastline, the dominant process for the beaches within the other compartments is onshore-offshore sediment transport and sediment exchange between the beach-shoreface and the shoreface-inner continental shelf. At a macro level and over geologic timescales, the onshore-offshore transport sources and sinks are approximately in balance. As a result, the beaches are relatively stable over the long term.

The quantification of sediment budgets for coastal compartments is exceedingly difficult. The budget is calculated over the net quantity of sediments that cross the boundaries of the sector. The methodology, in summary, consists of quantifying the amount of sediment in a sector and calculating the addition (sources) and subtraction (sinks) due to relevant drivers and processes such as: fluvial, biogenic and geologic (dune, terrace, headland erosion) input; longshore, cross-shore and aeolian transport; estuarine sink; and human activities (Thom, 2014).

For the Shoalhaven beaches, measurements of volumetric and morphological changes at the beaches over time have been taken using photogrammetric techniques. The processes leading to those changes have been inferred based on available information. Subtraction or losses of sediment from a compartment can manifest itself on the beach as long-term beach recession, which indicates that the sediment losses from a beach are greater than the gains. For the Shoalhaven coast, long term changes have been evaluated by analysing photogrammetric data from the 1940's to 2014. As the natural fluctuations of a beach and dune are large compared with any underlying long-term trend in beach change, sometimes it can be difficult to quantify an accurate rate of erosion or accretion. Measuring beach recession by mapping the response of the dune erosion escarpment over time is often more accurate.

For the Shoalhaven beaches, the local sediment budgets have been examined by understanding the long-term trends in sediment volumes and beach dune locations over time on a beach-by-beach basis. This provides a localised view of the influences to the local sediment budget, such as loss of sand due to onshore-offshore transport into deep water, losses into and supply from local estuary entrances and losses due to anthropogenic factors such as destabilisation of dunes by destruction of vegetation or urban development of the dunes which can cut off the sediment supply to the beach.

Beach rotation

Studies of embayed beaches on the NSW coast have identified a sensitivity of shoreline alignment to wave direction. This has been linked to the Southern Oscillation Index (SOI). This is a number calculated from the monthly or seasonal fluctuations in the air pressure difference between Tahiti and Darwin.

Sustained negative values of the SOI usually are accompanied by sustained warming of the central and eastern tropical Pacific Ocean, a decrease in the strength of the Pacific Trade Winds and a reduction in rainfall over eastern and northern Australia. This is called an El Niño episode. During these episodes, a more benign easterly wave condition is expected on the NSW coast.

Positive values of the SOI are associated with stronger Pacific trade winds and warmer sea temperatures to the north of Australia, popularly known as a La Niña episode. Waters in the central and eastern tropical Pacific Ocean become cooler during this time. Together, these give an increased probability that eastern and northern Australia will be wetter than normal. During these episodes, severe storms may be expected on the Australian eastern seaboard.

Oceanic inundation of low lying areas

An increase in water level at the shoreline results from the breaking action of waves causing what is termed wave set-up and wave run-up. Wave set-up may be perceived as the conversion of part of the wave's kinetic energy into potential energy. The amount of wave set-up will depend on many factors including the type, size and periods of the waves, the nearshore bathymetry and the slope of the beach and foreshore. Typically, wave setup on an open-coast beach during severe storms can be around 1 metre to 2 metres.

The energy of a wave is dissipated finally as the water runs up the beach or shoreline. Wave run-up is the vertical distance the wave will reach above the level of the tide and storm surge, and can be several metres. Wave run-up at any particular site is a function of the wave height and period, the foreshore profile and slope, surface roughness and other shoreline features on which the breaking waves impinge.

If dune levels are low or the foreshore not protected by dunes, the coincidence of elevated ocean water levels and wave run-up can result in flooding and damage to structures. In Shoalhaven this has happened at sections of Culburra, Warrain, Collingwood, Narrawallee and Collers Beaches.

2.1.2 Processes acting at different time scales

The interaction between processes operating at different time scales means there is much uncertainty about exactly what conditions will prevail at specific times in the future. Council's coastal zone management proposals are designed to deal with this uncertainty and to help local communities adapt to change.

Scientific and community understanding of how beaches, dunes, lakes and estuaries respond to coastal processes, climate drivers and land management is improving. Natural system responses include changes to landforms such as beach and dune erosion, creek entrance migration and dune instability. There may also be changes to ecological health, such as water clarity, salinity, chlorophyll and dissolved oxygen, which affect algal blooms, sea grass distribution and fish populations.

2.1.3 Long-term trends in climate and sea level rise

CSIRO's State of the Climate Report (2016) concludes that sea level rose at a global-averaged rate of about 2.6 to 2.9 mm per year between 1993 and 2013 shown in Figure 2.1.

The rates of sea level rise to the north, west and southeast of Australia have been higher than the global average. Globally, sea level has risen over 20cm since the late 19th century (CSIRO, 2016), see Figure 2.2.

The *South Coast Regional Sea Level Rise Planning and Policy Framework (2014)* was prepared by Whitehead & Associates as a joint Shoalhaven City Council-Eurobodalla Shire Council project, supported by the Office of Environment & Heritage (OEH) to provide advice to both councils for selecting regional seal level rise benchmarks. They concluded that 'Sea levels offshore of the study area will rise at a similar rate to the global average, and that any differences between the study area and Sydney will be minimal'. They also found that 'the highest value of sea level rise projected by AR5 (5th assessment report from IPCC) to 2100 do not differ largely from the information presented in previous IPCC reports, or the previous NSW state government policy.'

The document was prepared as an outcome of the NSW Government withdrawing the 2009 benchmarks (i.e. 0.4 and 0.9m above 1990 mean sea levels by 2050 and 2100) and recommending that individual councils adopt regional projections based on 'competent scientific opinion'.

Changes to the frequency of different types of storms are also predicted but details are poorly understood. On the South Coast, changes to patterns of East Coast lows (ECLs) and the southern extent of tropical cyclones are both possible. ECLs in particular drive major step changes in coastal morphology. ECLs will continue to be informed by The Eastern Seaboard Climate Change Initiative (ESCCI), which is a major research collaboration led by NSW Office of Environment and Heritage (OEH) with partner organisations (established in 2010). The research aims to improve our understanding of past, current and future ECLs and assess how they influence extreme rainfall, coastal processes and water security.[3]

The landforms we now see along the Shoalhaven coast are the result of relatively stable sea level and climatic conditions over the last 6,000 years. Over this period, sea level fluctuations on the east coast have been restricted to about two metres. This is the same order of magnitude as sea level changes that are currently projected for the next century. Coastal erosion and accretion occurred in response to these sea level changes in the past, affecting dune stability, estuary ecology and rock platform ecological communities.

[3] http://climatechange.environment.nsw.gov.au/Impacts-of-climate-change/East-Coast-Lows/Eastern-Seaboard-Climate-Change-Initiative

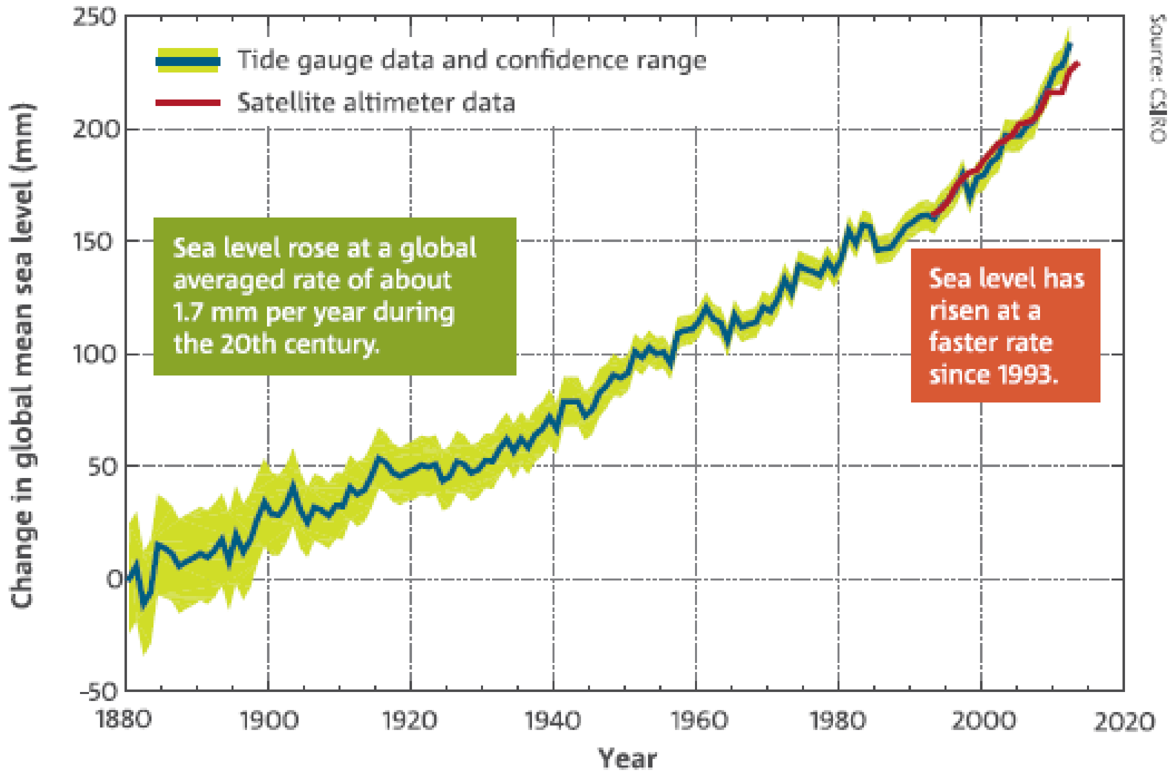


Figure 2-1 – Global average mean sea level (CSIRO, 2016)

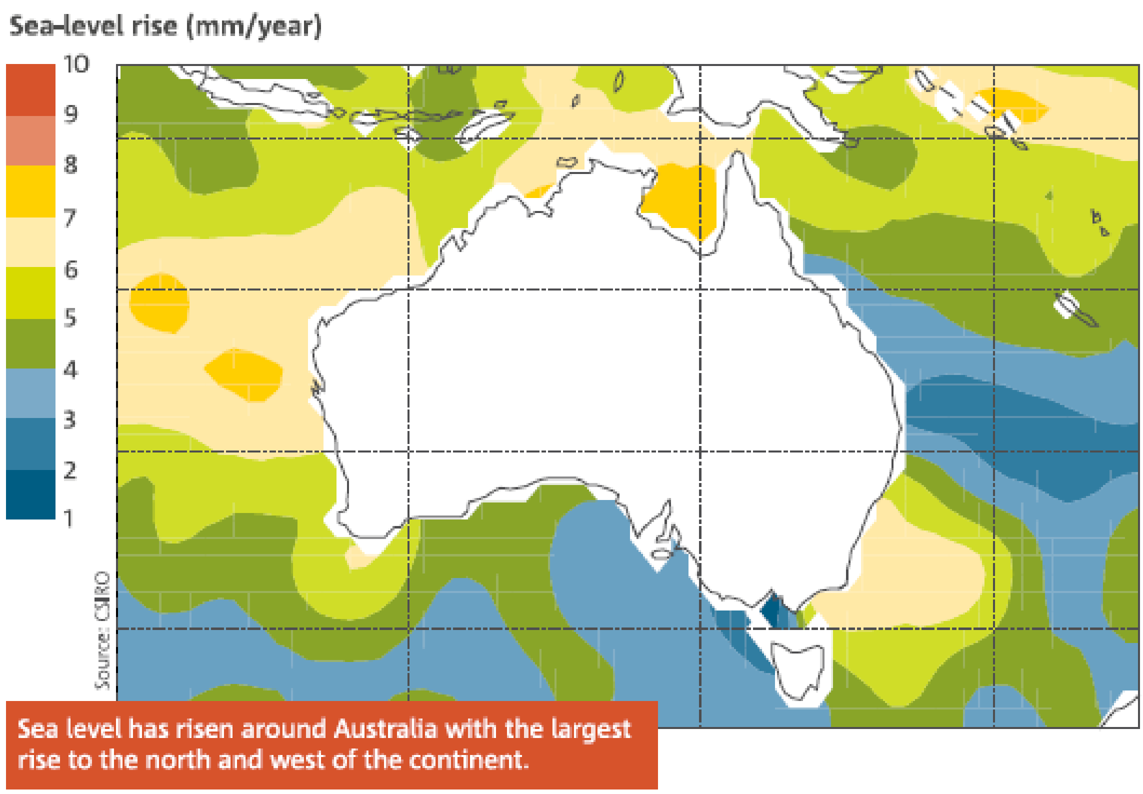


Figure 2-2 – The rate of sea-level rise around Australia from 1993 to 2015 (CSIRO, 2016)

2.1.4 Studies of coastal hazards and risks

In 2009 the *Sea Level Rise Policy Statement (NSW Government*) was adopted. It provided councils with sea level rise (SLR) planning benchmarks of 40cm and 90cm above 1990 sea levels by 2050 and 2100 respectively. In the same year, Council commissioned SMEC to update coastal hazard studies for nine Shoalhaven beaches, incorporating these state government benchmarks.

In 2012 the NSW Government withdrew the benchmarks so that councils could consider coastal hazards, and select benchmarks, locally.

In 2015, following completion and consideration of the *South Coast Regional Sea Level Planning and Policy Framework (2014)* report prepared by Whitehead & Associates as a joint Shoalhaven City Council-Eurobodalla Shire Council project, Council adopted sea level rise projections of:

- 10cm by 2030
- 23cm by 2050
- 36cm by 2100.

At this time, Council also resolved to review these projections at least every seven years to ensure that the policy is newly informed as better information about SLR becomes available.

The 2009 SMEC coastal hazard studies were reviewed in 2016 by specialist consultants, Advisian, using the adopted Council sea level rise projections (see Appendix 1).

The Advisian study noted

'The principal hazards induced by the coastal processes that are relevant for a coastal hazard risk assessment of the beaches in the study area include:

- Short-term coastal erosion from severe storms and consequent slope instability
- Long term coastline recession resulting from imbalances in the sediment budget, such as aeolian (wind-driven) sand transport, climate change and beach rotation
- Oceanic inundation of low-lying areas.

The hydrodynamic forces controlling the rate of these processes and hazards comprise the prevailing wave climate and water levels.' A summary of the relevant processes and coastal hazard parameters and the methodology adopted for undertaking the hazard assessment is provided within their study.

Further detail of the methodology used by Advisian and the results of their assessment of coastal hazards, including maps can be found in Appendix 1 and on Council's website:

http://shoalhaven.nsw.gov.au/Environment/Coastal-Landscape/Council-and-climate-change.

Coastal hazard studies for erosion, recession and inundation have been completed for the following beaches, which are partially backed by urban development and are considered to have assets at risk:

- Shoalhaven Heads
- Culburra Beach
- Warrain Beach
- Currarong Beach
- Callala Beach
- Collingwood Beach
- Boat Harbour Beach (Bendalong)
- Narrawallee Beach
- Mollymook Beach
- Collers Beach

Coastal hazard maps are included in Section 3.

The Advisian review provides updated, detailed hazard assessments for the beaches listed above. It describes the coastal processes affecting each beach and the impact of these processes on areas where property is at risk. As well as using Council's 2015 adopted SLR projections, the assessments used updated beach photogrammetry and survey transects, LiDAR data, bathymetric surveys and post storm information obtained following the June 2016 ECL.

Note: For planning purposes the NSW Planning Guideline: Adapting to Sea Level Rise (Department of Planning, 2010) and the NSW Coastal Risk Management Guide: Incorporating Sea Level Rise into Risk Assessments (DECCW, 2010) define a coastal risk area by the most landward hazard impact boundary for each time frame (i.e. the landward boundary of the Zone of Reduced Foundation Capacity). Figure 2.3 illustrates schema relating to these terms.

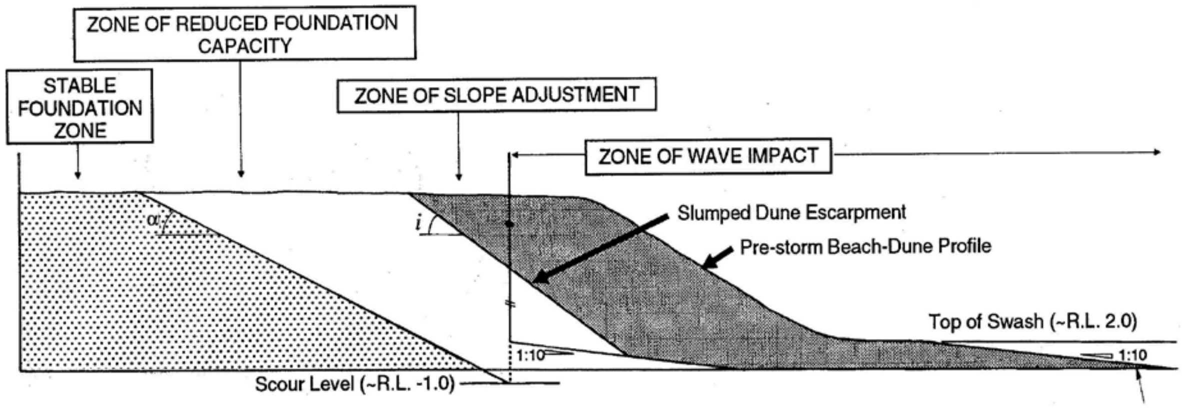


Figure 2-3 – Terms used in assessing coastal hazards (Neilson et. al.,1992)

The coastal hazard zones are predicted using the best available information and analysis techniques.

Specifically, the zones have been calculated based on:

- Known erosion impacts of the largest storm ever recorded at each beach (for most the 1974 or 1978 storm), as well as data available from the ECL of 2016. Impacts of such a storm vary at each beach and have been added to long term predicted changes in beach behaviour.
- Known long-term changes (loss or gain of sand, changes in the location of the dunes) that have been occurring at each beach since the 1940s, as a result of local coastal processes. These changes have been measured by looking at changes in beach volumes and profiles over historical records. The trends for these changes are assumed to continue into the future and are forecast for 2030, 2050 and 2100, consistent with coastal engineering best practice.
- Long-term future changes in beach behaviour that are forecast to occur, based on the best available information at the regional scale.

The immediate, 2030, 2050 and 2100 coastal hazard zones are reasonably conservative (generally worst case based on known historical evidence). However, more landward impacts are also possible, such as a very rare extreme storm or sea level rising faster than the current projections. The medium to long-term hazard zones will be reviewed as better information about sea level rise becomes available. The various coastal hazard zones to which Council refers in its planning guidance are described in Table 2.1 over page.

Table 2-1 – Coastal Hazard Zone Descriptions

Immediate hazard zone	2030 hazard zone	2050 hazard zone	2100 hazard zone
Immediate ZSA (Zone of Slope Adjustment) This area is bounded by the estimated limit of frontal dune collapse following a storm equivalent to the largest storm ever recorded on that beach. Frontal dune erosion in such a storm would occur seaward of the landward limit of this area. The boundary line indicates how far back the dune collapse would reach following such a storm. Erosion within this area could occur at any time.	2030 ZSA By 2030, some sea level rise is expected to have occurred as a result of climate change. This is predicted to lead to some landward movement of the frontal dune over time. At some of the beaches, there are local coastal processes which are known to have caused a landward movement of the frontal dune over time (e.g. at Currarong). This area is bounded by the estimated location of frontal dune collapse following a storm equivalent to the largest storm ever recorded, should that storm occur in 2030. It takes into account estimated beach changes that are expected to occur between now and 2030.	2050 ZSA Similar to 2030 except, by 2050, further sea level rise is expected to have occurred as a result of climate change. This is predicted to lead to further landward movement of the frontal dune over time. It takes into account estimated beach changes that are expected to occur between now and 2050.	2100 ZSA Similar to 2030 and 2050, except, by 2100, further sea level rise is expected to have occurred.
Impact for building: Immediate ZRFC (Zone of Reduced Foundation Capacity) In this area, the frontal dune would have a reduced capacity to carry building foundations and buildings within this zone could be damaged, if a storm equivalent to the biggest storm ever recorded on the beach, were to occur tomorrow.	2030 ZRFC In this area, buildings may suffer damage as a result of reduced capacity of the soil to carry building foundations, should a storm equivalent to the largest storm that has ever been recorded occur in 2030.	2050 ZRFC Similar to 2030, except it considers the largest storm that has ever been recorded occur in 2050.	2100 ZRFC – Similar to 2030 and 2050 except it considers the largest storm that has ever been recorded occur in 2100.

2.1.5 Risk analysis – coastal erosion and recession

Coastal erosion and recession will affect:

- Land use capability with land that is affected now or within the life of a development, potentially not being suitable for certain types of development (e.g. homes, shops, schools and hospitals)
- The feasibility and cost of repairing and maintaining the function of community infrastructure (e.g. access ways, roads, car parks, storm water drains and sewerage systems)
- Beach access, amenity and safety
- Amenity of foreshore parks and reserves
- The attractiveness of the coast for visitors (compared to now and to other landscapes).
- Dune vegetation and rock platform ecology
- Accessibility of rock platforms.

All of these impacts influence the social and economic wellbeing of communities along the Shoalhaven coastline. In addition, slope instability hazards affect some homes and assets on coastal cliffs and bluffs.

Council commissioned a risk assessment (BMT WBM, 2012) to assess coastal erosion, recession and inundation hazards over time. The risk assessment and associated risk mapping has since been updated (Advisian, 2018) to reflect the most recent coastal hazard mapping completed in 2016 (Appendix 2a and 2b).

A structured risk assessment uses a standardised matrix of likelihood and consequence to calculate risk. For the Shoalhaven coastline, BMT WBM used the hazard lines for 2025, 2050 and 2100 to define likelihood. Advisian (2018) has updated these to align with the definition of the re-defined hazard zones.

As the erosion hazard lines have been delineated using nominally a 1% AEP storm event, the present day probability that erosion would occur to the immediate zone of slope adjustment (ZSA) coincides with the ‘possible’ descriptor in Table 2-2. Advisian (2016) considers that by 2050, erosion up to a particular landward extent will become more likely than it is today and that by 2100 it will become more likely still.

If an asset, such as a road, has an adopted design life of, say, 30 years and it is located at the 2050 ZSA, the likelihood that the 1% AEP storm event would be exceeded within that timeframe is 20%. Therefore, the likelihood that erosion would reach the location of the road between now and 2050 is approximately 20%. The likelihood of such a storm being exceeded between now and 2100 is greater than 50%. That is, it is likely to occur between now and 2100, even though it is unlikely to occur in any particular year.

The likelihood scale used to assign risk to the various assets in the Shoalhaven is shown in Table 2.2 below.

Table 2.2 – Likelihood Scale for Coastal Risk Assessment

Likelihood descriptor	Immediate	For 2050	For 2100
Almost certain Expected to occur, many recorded incidents, strong anecdotal evidence, great opportunity, reason or means to occur. May occur or be exceeded once every 1–5 years.	Immediate ZSA line	2050 ZSA line	2100 ZSA line
Likely Will probably occur, consistent record of incidents and good anecdotal evidence; considerable opportunity, reason or means to occur. May occur or be exceeded once every 20 years.	Immediate ZSA line	2100 ZSA line	2050 ZRFC line
Possible Might occur, a few recorded incidents in the locality and some anecdotal evidence in the community; some opportunity, reason or means to occur. May occur or be exceeded once every 100 years. Will generally be close to or exceed past records of severity.	Immediate ZRFC line	2050 ZRFC line	2100 ZRFC line
Unlikely Is not expected to occur. Isolated recorded incidents in this country with anecdotal evidence in other communities. Little opportunity, reason or means to occur. May occur or be exceeded once every 250 years. Will almost always break previous records of severity.	Landward of the Immediate ZRFC line and wave inundation limit	Landward of the 2050 ZRFC line	Landward of the 2100 ZRFC line

The consequence scale for risk assessment takes into account financial, governance, environmental, health and safety and beach amenity consequences. Some consequences in the coastal zone can be described quantitatively (i.e. assigned a dollar value). With the currently available information and methodologies, many consequences can be described qualitatively only. The current risk assessment prepared for the Shoalhaven coast relies principally on quantitative consequence scales for built assets such as roads, pathways, water mains, sewerage systems (pipes and pump stations), car parks, bridges, surf clubs, community halls and other buildings. Over time, the risk assessment will be revised by Council as new methodologies and data become available for other natural, social and cultural values.

Surf clubs are an example of an asset that has important social values as well as a financial value. Surf Life Saving Australia commissioned a study on the vulnerability of surf clubs to extreme events and to climate change[4]. The study found that surf club buildings are very vulnerable because of their location on frontal dune systems. The financial and technical capacity of clubs and local Councils to respond to erosion impacts is also limited.

Storms and sea level rise increase risks for surf clubs in other ways, including:

- Loss of sand on beaches affects safety and the suitability of club areas for major competitions and events with potential social and economic impacts on the clubs and on their local communities
- Loss of club equipment, or increased safety risks when using the equipment
- Increased emergency response training requirements
- Significant coast and time to development assessment requirements for relocation or for protection works
- Lack of coordinated response strategy between clubs, local government areas, regions or states.

2.1.6 Risk analysis of geotechnical and slope instability hazards

Hazardous landslides occurred in parts of the Shoalhaven in 2008, and again in 2015. The landslides occurred in areas previously identified to be at risk of coastal cliff and slope instability. Several expert reports to assess slope instability and the risk of landslide hazards have been commissioned in the past.

Most recently, Royal Haskoning DHV has prepared the Shoalhaven Coastal Cliffs and Slopes Risk Management Program (2018) to allow Council to adequately manage emergency incidents and define future actions, in relation to cliffs and slopes in key risk areas. Relevant actions are included in Section 3 of this Coastal Zone Management Plan and the associated Emergency Action Sub Plan (Appendix 5).

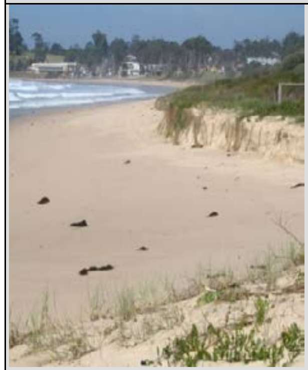
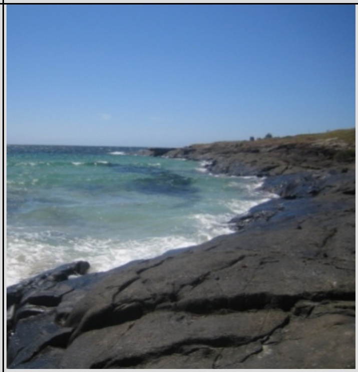
2.1.7 Evaluation process

Table 2-3 summarises how studies of community use and coastal values, coastal processes, coastal hazards and risks, p likely consequences, inform management responses and accordingly the preparation of the Coastal Zone Management Plan. Coastal management options are developed in response to coastal risks that are based on the interaction of hazards and values. Options are evaluated against a range of criteria, including capacity to mitigate extreme risks, community acceptance, Council's capacity to pay and alignment with existing programs. As noted in Section 1, an adaptive approach to management is essential to manage uncertainty in the dynamic coastal environment. Adaptive responses are based on ongoing monitoring and evaluation of actual progress against expectations and targets.

[4] Impact of Extreme Weather Events and Climate Change on Surf Life Saving Services: A Road Map for Adaptive Action, report prepared for Surf Life Saving Australia, Coastal Zone Management, (2011).

Table 2-3 – Evaluation of Coastal Values, Processes, Hazards, Risks and Consequences

STEP 1: Understand coastal processes – consider now, and for years 2030, 2050 and 2100		
Waves	Currents	Long term sea level changes
Tides	Storms – strong winds, elevated water levels and storm surge	Land slip and debris flows on cliffs and bluffs

STEP 2: Assess coastal hazards – consider now and for years 2030, 2050 and 2100					
Storm bite erosion	Long term recession – sediment deficit	Long term recession – sea level rise.	Creek entrance migration and lake entrance condition	Slope instability	Coastal inundation
					
Dramatic changes occur on the coast during major storms. Many communities have experienced the impact of occasional extreme events on the coastline. For instance, the 1974 and 1978 storms that affected the NSW coastline resulted in well documented severe erosion of the beach and dunes at Shoalhaven Heads, Currarong, Callala Beach and Collingwood Beach. The storms also resulted	Major storms are separated by long periods of calmer weather allowing beaches and dunes to recover. However, these periods can mask long term recession trends and beaches and dunes may appear more robust than they really are. Long term erosion and coastal recession occurs when sand is permanently lost from beaches and dunes.	Projected sea level rise will increase coastal recession hazards. As sea level rises, a proportional retreat of the sandy coastline is predicted. Sea level rise also affects sediment transport between embayments. The impacts of this hazard include: • Loss or disruption of safe community access to beaches, dunes and headlands, and impacts on surf clubs • Impacts on residential property – some properties along the Shoalhaven	Meandering creek entrances can add to the erosion of frontal dunes. Changes to entrance conditions, shoaling and scouring as sea level rises may affect lake ecology and beach sediment budgets. Changes to entrance dynamics affect the navigability of lake entrance channels and boating access to the ocean. Increased water levels reduce the area of	The geological structure of the Shoalhaven coastline makes some headlands and bluffs susceptible to rock fall and land slip. A geotechnical hazard assessment (SMEC 2008 & RHV 2018) has identified two high risk aspects of this hazard. On cliffs and bluffs, geotechnical instability events also recur especially at a time scale of decades. Examples include landslip (e.g. at Penguin Head, Culburra Beach) and rare rock topple events that cumulatively result in the	Coastal inundation occurs when storm waves overtop the frontal dune system, flooding low lying land and buildings or infrastructure. Extreme water level events are predicted to become more common as sea level rises. Natural and community assets that are adapted to or have been planned to be safe and serviceable at particular water levels will be impacted by

in overtopping of the Princes Highway south of Ulladulla. Homes along the Shoalhaven coastline are located within the immediate coastal erosion risk area. The 2016 ECL storms resulted in storm bites at Currarong, Culburra and Collingwood Beaches leading to the closure of many beach access ways and the erosion of some foreshore protection structures such as the Princes Highway at Ulladulla Harbour. Community access to beaches, dunes and headlands is disrupted during and after storms and coastal erosion events. Intermittent storm waves impact on breeding sites for migratory shore birds.	A number of Shoalhaven village communities have experienced slow long-term loss of beach or frontal dune landforms over a period of decades. Examples are Currarong and Callala Bay.	coast are partly or wholly within the 2050 coastal erosion hazard area at Callala Beach (82 lots), Collingwood Beach (34 lots), Culburra Beach (28 lots), Mollymook Beach (21 lots)[5] • Impacts on community assets and infrastructure, such as roads and sewerage systems at Mollymook Beach • Ongoing impacts on coastal biodiversity, associated with disruption or dislocation of endangered ecological communities on costal dunes • Specific impacts on cultural heritage sites and places.	foreshore reserve available for public recreation – both around lake shores and open ocean.	retreat of the cliff face and accumulation of sandstone boulders and cobbles on intertidal rock platforms at the base of cliffs. Important hazards include: • Potential block fall and landslip affecting public safety on headlands and rock platforms • Impacts of existing rotational slumping on private property at Culburra Beach (Penguin Headland) and a potential large slump at Inyadda Point.	more frequent high water levels. Council is also dealing with this issue through Flood Risk Management Plans and Entrance Management Strategies for coastal lakes. The coastal hazard mapping is shown in Section 3 and Council's website shows potential coastal inundation lines.

[5] Shoalhaven City Council Shoalhaven Coastal Zone Management Plan Risk Assessment – Draft (Advisian, 2018)

STEP 3: Assess community use, natural and built asset value						
Coastal ecological communities on cliffs, dunes, rock platforms and off shore	Beach amenity and recreational use, including visual appeal, access and facilities	Beach, bluff and rock platform safety	Homes and holiday homes	Economic value of tourism, fisheries	Community assets and infrastructure	Cultural values – Aboriginal and historic heritage
						
Coastal lakes and estuarine creeks along the Shoalhaven coast provide diverse, healthy and productive aquatic habitats of high ecological value, extensive areas of several endangered ecological communities and roosting, feeding and breeding habitat for migratory shorebirds. There are whale migrations along the cost each autumn and spring.	Multiple sandy beaches and rocky headlands provide a high level of naturalness and exceptional visual appeal. The coastline is almost entirely in public ownership. Diverse recreational uses include swimming, diving, surfing, boating, water skiing, fishing, coast and bush walking, picnics, art and photography, conservation activities, sightseeing.	High social and cultural value is associated with individual, family and community experiences, memories and anticipation of good times spent on safe beaches, headlands, rock platforms and coastal lakes.	Residential homes within the coastal zone are highly valued both for their lifestyle attractions and potential investment return. However, a relatively high proportion of owners are absentee landowners, with a long history of holiday occupation. Holiday properties often become permanent residences as people retire.	The coastal zone supports activities such as tourism and fisheries that have important economic values for the region. The economic value of the coastal zone to the overall economy of the region is substantial.	Infrastructure includes surf clubs, rock walls, sewerage systems, water supply and power infrastructure.	Several rock platforms and headlands are listed in the Register of the National Estate or the National Heritage List (primarily for their fossils, other geological features, heritage sites, Aboriginal cultural heritage and landscape character).

STEP 4: Evaluate coastal risks and likely consequences - consider for now, and for years 2030, 2050 and 2100

The likelihood and consequences of coastal hazards impacting on the natural, social, cultural, built and economic values of the coast.

Impacts associated with interactions between coastal values.

Consider existing controls.

Consequences associated with damage to the structure, environmental impacts (such as raw sewage discharges), health and safety impacts, resource demands etc.

This process helps Council identify the most important and urgent issues requiring management actions.

More detail about the analysis and management of coastal risks is in **Appendix 2a and 2b**.

Low risk	Medium risk	High risk	Extreme risk
Examples: Occasional minor damage or occasional inundation of access ways, walking paths.	Examples: Frequent or severe damage to beach access ways (ramps, steps, lookouts). Wave impacts or erosion on local community halls and sporting venues. Occasional shallow inundation of residential property.	Examples: Erosion of residential and commercial properties. Erosion or undermining of sea walls. Frequent marine inundation of residential properties. Frequent or permanent inundation of foreshore reserves. Damage or destruction to important cultural sites. Loss of important or endangered ecological communities or threatened and protected species.	Examples: Erosion and undermining or flooding of surf clubs, sewage reticulation infrastructure (pipes and pump stations). Golf Club at Mollymook, major roads and bridges.

STEP 5: Choose and implement coastal risk management strategies

Identify, evaluate, prioritise and implement.

Protect, accommodate, retreat, avoid, share.

Consider priority actions for now and for 2030, 2050 and 2100.

Examples include:

Land use planning (controls on the location of development, the design of development and triggers for lapse of consent).

Structural protection such as sea walls.

Purchase of land.

Beach nourishment and dune management.

Vegetation management and habitat protection.

Design and maintenance of access ways.

Asset and infrastructure maintenance and relocation schedules.

Community information, awareness, education and involvement.

Actual change monitoring in relation to triggers for management action.

Research to address knowledge gaps.

Ongoing adaptive improvement of coastal management.

(These are addressed in the Actions in Section 3 and Section 4 of this document) .

STEP 6: Monitor, review, evaluate and reflect
Is management action achieving its intended outcomes? Is the condition of the coast stable or improving? Is ecological and community resilience maintained? Have triggers for changing management been reached? What's changed and why? New science, new community aspirations, new threats, new legislation and policy. Inform the revised plan with best available knowledge about processes, condition and values. **This is the feedback loop that informs ongoing adaptive management to achieve agreed outcomes**.

2.1.8 Results of the risk assessment – beach erosion, recession and inundation

Table 2.4 summarises the highest risks for 2050 and 2100. The full risk register (Advisian, 2018) is included in Appendix 2a with specific risk mapping in Appendix 2b. Based on asset value, the highest risks are associated with surf club infrastructure and sewerage infrastructure. High risks relate to assets at Collingwood Beach, Callala Beach, Culburra Beach, Mollymook Beach, Warrain Beach and Shoalhaven Heads.

As can be seen from the nature of the assets that are rated as extreme risks in coastal erosion risk areas, these risks have serious implications for Council. Damage or destruction of these assets would disrupt essential community services, create health risks and impact on the social fabric of small communities.

The study (Advisian, 2018) indicates the following financial implications for Council from coastal hazard impacts on important community infrastructure.

- Surf clubs (estimated $5 million, 2050 and 2100)
- Wastewater infrastructure (estimated $5.3 million 2100)
- Roads, car parks and bridges (estimated $13 million at 2100).

Sound risk management practice requires that Council takes action to reduce the extreme risks, on a priority basis.

Proposed management actions to mitigate extreme and high risks are discussed in Sections 3 and 4.

Table 2-4 – Extreme Risks, 2050 and 2100

Risk 2050	**Unmitigated risk rating 2050**	**Mitigated risk rating 2050**
Mollymook SLSC	High	High
Warrain Beach SLSC	High	High
Shoalhaven Heads SLSC	Extreme	High
Pump Station, south end Mollymook	Extreme	High
Pump station near 57 Mitchell Parade, Mollymook	Extreme	Extreme
Mollymook Golf Club (private asset)	Extreme	Extreme
Risk 2100	**Unmitigated risk rating 2100**	**Mitigated risk rating 2100**
Mollymook SLSC (as above)	Extreme	High
Warrain Beach SLSC (as above)	High	High
Shoalhaven Heads SLSC (entire building)	Extreme	Extreme
Pump station at south end, Mollymook (as above)	Extreme	High
Pump station near 57 Mitchell Parade, Mollymook	Extreme	Extreme
Pump station near Beach Road, Mollymook	Extreme	Extreme
Mollymook Golf Club (private asset) (as above)	Extreme	Extreme

Table 2-5 – Residential lots and buildings within coastal hazard areas

KEY:	<5 lots	5 – 9 lots	10 -19 lots	20 – 50 lots	>50 lots

Beach	Asset Class	Immediate ZSA	Immediate ZRFC	2030 ZSA	2030 ZRFC	2050 ZSA	2050 ZRFC	2100 ZSA	2100 ZRFC	Inundation	Risk now	Risk 2050	Risk 2100	SDCP G6	SLEP	Recommended Future Strategy	Response Category (OEH 2013)[6]
Shoalhaven Heads	No. Lots	-	-	-	-	-	-	-	-	-	Low	Low	Low			• No private properties at risk. Implement CZMP actions for Shoalhaven Heads SLSC.	C
	No. Buildings	-	-	-	-	-	-	-	-	-							
Culburra	No. Lots	1	1	2	3	3	28	4	62	17	Low	Moderate	High	✓	✓	• Dune vegetation management and manage accessways to maintain dune resilience. • Apply development controls through SDCP and SLEP.	C
	No. Buildings	1	1	1	1	1	1	1	2	-							
Warrain Beach	No. Lots	-	-	-	-	-	-	2	-	1	Low	Low	Low			• Dune vegetation management and manage accessways to maintain dune resilience.	C
	No. Buildings	-	-	-	-	-	-	-	-	-							
Currarong	No. Lots	5	20	5	23	7	29	15	43	4	Moderate	Moderate	High	✓	✓	• Undertake detailed technical investigation of coastal hazard management options. Consider trial geotextile groyne and shoreline protection works at Beecroft Parade. • Reroute Peel St access. • Regular foreshore profile surveys. • Dune vegetation management and manage accessways to maintain dune resilience • Apply development controls through SDCP and SLEP.	A (coastal protection works would also protect essential public infrastructure)
	No. Buildings	-	9	-	9	-	19	10	21	-							
Callala Beach	No. Lots	80	82	82	82	82	82	82	82	74	High	Extreme	Extreme	✓	✓	• Apply development controls through SDCP and SLEP to reduce risk as properties are redeveloped. Immediate erosion hazard affects < 25% of area of most lots, and lots have enough area to allow setback of future development. • Dune vegetation management and manage accessways to maintain dune resilience.	C[7]
	No. Buildings	16	53	16	63	55	68	55	76	-							

[6] Council's intended response to managing risks to property from Table 6 of NSW Guidelines for Preparing Coastal Zone Management Plans (OEH 2013). The response category considers the feasibility of Council funded coastal protection works other than temporary Coastal Protection Works.
[7] For Callala Beach, although risk to private property is high, the risk can be managed through the use of the DCP/LEP for future development. Erosion risk can be managed in the short term through temporary coastal protection works (i.e. post-storm beach scraping with approval from JBMPA). Coastal protection works other than temporary coastal protection works are not considered feasible at this stage but the need for works would be reassessed in subsequent revisions of the CZMP.

																• Obtain approval from Jervis Bay Marine Park Authority (JBMPA) to undertake post-storm NABE as a coastal protection measure.	
Collingwood	No. Lots	-	1	-	13	1	34	1	42	58	Low	Moderate	High	✓	✓	• Apply development controls through SDCP and SLEP. • Monitor dune crest levels. • Options for managing dune heights include dune scraping. • Dune vegetation management and manage accessways to maintain dune resilience. • Obtain approval from JBMPA to undertake post-storm NABE as a coastal protection measure.	C
	No. Buildings	-	-	-	-	-	-	-	1	-							
Bendalong	No. Lots	-	-	-	-	-	-	-	-	-	Low	Low	Low			• Implement CZMP actions and future masterplan	C
	No. Buildings	-	-	-	-	-	-	-	-	-							
Narrawallee	No. Lots	-	-	-	-	-	2	-	2	-	Low	Low	Low			• Dune vegetation management and manage accessways to maintain dune resilience.	C
	No. Buildings	-	-	-	-	-	-	-	-	-							
Mollymook	No. Lots	-	-	-	4	-	21	1	32	-	Moderate	Moderate	Moderate	✓	✓	• Apply development controls through SDCP and SLEP. • Golf Club is a private asset at immediate risk, resilience of existing works to be assessed • Condition assessment of tripper wall at northern end of beach at creek entrance near Beach Road. • Dune vegetation management and manage accessways to maintain dune resilience. • Monitor dune nourishment and buried training wall at Blackwater creek	A (at southern end of beach, coastal protection works for Golf Club would also protect essential public infrastructure)
	No. Buildings	1 (Golf Club)	1 (Golf Club)	1 (Golf Club)	1 (Golf Club)	1 (Golf Club)	3	1 (Golf Club)	7	-							
Collers	No. Lots	1	1	1	1	1	1	1	1	1	Low	Low	Low	✓	✓	• Apply development controls through SDCP and SLEP.	C
	No. Buildings	1	1	1	1	1	1	1	1	1							

The risk assessment (Advisian Appendix 2a) identified private lots and dwellings at several beaches located within the various coastal hazard areas. The number of private lots with a portion in the zone of slope adjustment and zone of reduced foundation capacity, as well as the number of residential buildings partially within these zones, has been quantified for each beach and is presented in Table 2.5. The property risk and response categories are also shown in Table 2.5.

From Table 2.5 it can be seen that the beach with the highest number of residential lots and buildings within the coastal hazard area is Callala, followed by Currarong and Collingwood beaches.

The risk to the private assets has not been quantified in monetary terms. This is because the risk will vary depending on the value of each asset, the portion of the lot or building within the hazard area and the existing controls on each asset, such as whether individual buildings are on deep-piled foundations. However, Table 2.5 allows a qualitative assessment of the level of risk to private assets at each beach, based on the quantum of assets located within the coastal hazard area and the likelihood scale provided in Table 2.5.

Risk to private development in the coastal hazard areas is being managed through the application of development controls through the Shoalhaven Development Control Plan (DCP) and Local Environmental Plan (LEP). This includes application of foreshore setbacks and deep-piled foundations for new development. This approach is feasible in the medium term, where existing building lots have sufficient area to accommodate foreshore setbacks for new development so that it can be located outside the coastal hazard area and can accommodate future erosion within an acceptable planning horizon.

2.1.9 Results of the risk assessment – landslide risk management

The results of the following studies informed recommendations for landslide risk management measures:

- Coastal Slope Instability Hazard Study (SMEC, 2008)
- Shoalhaven Public Asset Coastal Risk Management Review (Review (BMT WBM 2012)
- Peer Review, Supplementary Geotechnical Observations (of the Coastal Slope Instability Hazard Study 2008) (Douglas Partners 2011)
- Report on Scoping Study and Stability Assessment (Various Lots Surfers Avenue, Tallwood Avenue & Bannister Head Road, Narrawallee) (Douglas Partners 2011)
- Shoalhaven Coastal Cliffs and Slopes Risk Management Program (Royal Haskoning DHC, 2018)

These are relevant to each of the risk areas, being:Penguin Head

- Plantation Point
- Hyams Point
- Berrara Point
- Inyadda Point, Manyana
- Narrawallee
- Bannisters Point
- Collers Beach Headland
- Rennies Beach
- Racecourse Beach

The risk areas have been included in the Shoalhaven Local Environmental Plan and Shoalhaven Development Control Plan for many years. The recommendations form an integral part of the landslide risk management (LRM) process. The measures are outlined, where applicable, to Council, private property owners and utility owners. They include landslip remediation works, infrastructure works, access arrangements to public sites, further geotechnical assessment and monitoring and policy changes. Relevant actions, based upon the recommendations of this risk assessment and associated program, are included in Section 3 of this Coastal Zone Management Plan, along with associated mapping.

2.2 Understanding community values, concerns and issues

This section outlines how Council has consulted with stakeholders and its community during the preparation of the Coastal Zone Management Plan in 2012, 2016 and 2018.

2.2.1 Characteristics of the Shoalhaven coastal community

Some important social and economic characteristics of the Shoalhaven coastal zone, which affect community attachment to the coast and interest in its management, include:

- The coastline is almost entirely in public ownership and is therefore accessible to all the community as National Park, Crown land or Council reserve
- Two to three hours travel from Sydney and Canberra, the Shoalhaven coastline has been a favourite holiday location for decades; peak summer population of coastal villages is double or triple its normal level. In recent years the Shoalhaven has seen a significant increase in day trip visitors to the Shoalhaven coastal zone and tourism outside of peak season has increased by 40%[9]
- There is a relatively high proportion of absentee landowners who use coastal residences in the small villages scattered along the coast for holidays. Many of the small villages have permanent residential occupancy rates of less than 50%
- Local villages are economically dependent on income from holiday makers who use tourist parks, other accommodation, restaurants and coastal recreation activities
- There are diverse recreational uses including swimming, diving, surfing, boating, water skiing, fishing, coast and bush walking, picnics, art and photography, birdwatching, conservation activities, sightseeing and car touring. Holiday makers use the open coast, estuaries and coastal bushland environments
- High social and cultural value is associated with individual, family and community experiences, memories and anticipation of enjoyment of time spent on beaches, lakes, headlands and rock platforms
- As owners of holiday homes reach retirement age, some choose to make the coastal property their permanent residence. Increasing permanent settlement by retirees also increases the age of the population and provides a group of well-educated and aware residents with strong interests in protecting long established values of the coast
- Based on the 2016 Census, at least 55.5% of Shoalhaven's population lives in coastal areas, of which 37% live in the Huskisson/Vincentia and Ulladulla/Mollymook urban areas. These have both been identified as growth centres (Illawarra-Shoalhaven Regional Plan).

2.2.2 Community engagement during Plan preparation 2012–2018

The Shoalhaven coastline is highly valued by residents, ratepayers and visitors. During preparation of the initial draft Coastal Zone Management Plan in 2012, Council provided information using a special project website. Council listened to the community's views about important issues and potential

---

[9] (April – Sept Quarters, 2014- 2017, visitor numbers extracted from *Tourism Research Australia; National & International Visitor Survey*).

management options through direct feedback opportunities as well as meetings, workshops and briefings. A Council Committee was also formed that included community and government agency representatives.

Throughout the project, the website provided background about coastal hazards, coastal legislation and policy, coastal research and coastal management. It also provided Council's progress on a range of projects that affect the future quality of the coastal environment and lifestyle of residents. Copies of all draft technical reports were available on the project web site, as well as in hard copy from Council. The web site included information about the science of climate change and sea level rise, which are major concerns for coastal property owners. People were also able to submit questions and comments via the website. All comments were forwarded to Council officers for direct response.

Over this six-year period, Council conducted multiple rounds of community briefings and workshops to discuss how local communities use and value the coast. Consideration was also given to community experience and observations of coastal change, objectives for the future of the coast, issues, hazards, risks and potential management responses. Meetings were held at Nowra (Council Chambers), Callala Bay, Callala Beach, Ulladulla, Huskisson and Mollymook. Separate and concurrent to the briefings and workshops, Council engaged with coastal residents and stakeholders about potential land use planning measures such as its draft Shoalhaven Local Environmental Plan and Shoalhaven Development Control Plan 2014 for coastal risk planning areas. Consultation about the coastal planning clauses in the draft LEP provided further opportunities for community feedback on coastal hazards, risks and their management.

In 2014, the Shoalhaven Local Environment Plan and the Shoalhaven Development Control Plan 2014 were both finalised. At the time of development of the initial 2012 Plan, Council established a Coastal Committee made up of representatives of several Shoalhaven Resource and Floodplain Management Committees (NRFM). These Committee members included state agency representatives, Councillors and representatives of local community organisations. Regular Committee briefings during the development of the hazard studies, risk assessments, draft plans, plus current updates and review of the draft plans provided opportunities for stakeholders to discuss issues and provide written feedback.

2.2.3 Groups consulted

The following community groups and regional and local community organisations were consulted and contributed to the development of the draft Coastal Zone Management Plan:

- Council's Community Consultative Bodies (CCBs)
- Bushcare groups and Dunecare groups
- Other community and environment groups including surf clubs, fishing clubs, sailing clubs, environmental groups, bird watching groups and the South Coast Shore Bird Recovery Program
- Aboriginal community groups and organisations, including Wreck Bay community, Local Aboriginal Land Councils
- Businesses and Chambers of Commerce
- All interested Residents and Property Owners
- Visitors to the Shoalhaven.

2.2.4 Public exhibition 2012

During 2012 the draft Coastal Zone Management Plan was placed on public exhibition; 22 submissions from individuals, associations and community groups were received and one from a government agency. The submissions are grouped by type (general or specific) and location. Council also notes the frequency of issues raised. Full details of the submissions and details of how these submissions were addressed in the revised Coastal Zone Management Plan and/or other studies, undertaken since 2012, are provided in Appendix 3.

2.2.5 Our Coast Our Lifestyle 2015 - 2016

In 2015 - 2016 Council engaged extensively with the community to:

- Educate the community about the risks of coastal erosion and the coastal management options that are available to respond to that risk
- Understand community preferences for those different management options and the factors Council to consider when responding to coastal erosion risks and storm damage.

Key findings are that the community:

- Is concerned about coastal erosion
- Is unaware of Council's coastal management role
- Strongly values the natural environment
- Supports Council prioritising community assets and infrastructure when spending taxpayers' money on coastal management
- Expects Council to take a long-term, cost-effective approach to managing the risk of coastal erosion, based on scientific evidence and expert advice
- Except in specific circumstances, supports soft over hard protection options, in particular for dune management
- Would support other management options for existing assets if they are the most effective option in the long term
- Is strongly concerned about new development in areas known to be at risk and does not support Council approving it, especially if it will require protecting in the future
- Considers that environmental impact and community safety are important for coastal management
- Supports the cost of coastal management being shared across the whole community, via rates or levies if necessary, and wishes Council to consider other revenue sources.

The updated draft Coastal Zone Management Plan was publicly exhibited in 2016 before Council submitted the plan for certification. The submissions are summarised in Appendix 3.

2.2.6 What the community said about the coast 2012 to 2018

Table 2.6 summarises the main community concerns, organised by locality and theme. These issues are an overview of the input from meetings, briefings and submissions from the 2012, 2016 and 2018 public exhibitions and Our Coast Our Lifestyle engagement processes. This input has been used in scoping potential coastal management responses and in evaluating the capacity of responses to meet community needs. The submissions from all exhibitions are summarised in Appendix 3.

During the 2018 exhibition, in addition to the public exhibition of the draft Coastal Zone Management Plan and Appendices, three widely advertised public information sessions were held (Nowra, Vincentia and Ulladulla) which provided the community with an added opportunity to ask questions and provide input into the updated Coastal Zone Management Plan, Emergency Action Subplans, Coastal Risk Assessment and Mapping and the Coastal Cliffs and Slopes Risk Management Report and Emergency Action Sub Plans.

Table 2-6 – Community Engagement Outcomes

Issue or concern reported by community representatives	Reported in these localities	How Council has addressed the issue or concern
Impacts of coastal processes and climate change		
Impact of climate change induced erosion and inundation on coastal dunes and beach amenity, as well as on foreshore reserve properties.	Currarong, Culburra Beach, Collingwood, Callala Bay, Callala Beach, Mollymook	Throughout the course of developing this CZMP, numerous studies to assess the impact of climate induced erosion on coastal beaches and headlands (as included in appendices, references and supporting documents). C1.7, C2.1, C2.2 See relevant sections and mapping in Section 3 – Local Area Actions. Section 2 and citywide strategies recognise review SLR projections and hazard studies over time as required or new information becomes available.
Impact of climate change driven processes on the integrity of community infrastructure including roads, pathways, sewerage systems and water supply	Currarong, Mollymook, Berrara, Ulladulla, Collingwood	Numerous risk assessments into the impact of climate induced erosion on coastal beaches and headlands (as included in appendices, references and supporting documents), including the Shoalhaven Coastal Zone Management Plan – Risk Assessment (Advisian 2018) and Shoalhaven Coastal Zone Management Plan – Risk Mapping (Advisian 2018) in Appendix 2a & 2b. Section 2 explains hazards and risks. See relevant sections and mapping in Section 3 – Local Area Actions
Impact of coastal erosion and recession on private property – damage to existing assets but also the impact of risk controls on the value of assets.	Callala Beach, Collingwood Beach, Culburra, Mollymook	Numerous risk assessments into the impact of climate induced erosion on coastal beaches and headlands (as included in appendices, references and supporting documents), including the Shoalhaven Coastal Zone Management Plan – Risk Assessment (Advisian 2018) and Shoalhaven Coastal Zone Management Plan – Risk Mapping (Advisian 2018) in Appendix 2a & 2b. See relevant sections and mapping in Section 3 – Local Area Actions, specifically LA1.10.
Adequacy of coastal hazard mapping of beaches	Collingwood Beach	The coastal hazard mapping takes into account current conditions such as existing dune heights as well as coastal inundation from historical and recent storm events. Hazard mapping has been prepared in accordance with CZMP Guidelines, current coastal engineering practice and is in line and comparable with methodologies used by other neighboring Councils.
Impact of geotechnical instability of cliffs and bluffs on private property.	Penguin Head, Bannisters Point	Numerous risk assessments into the impact of climate induced erosion on coastal cliffs and bluffs (as included in appendices, reference and supporting documents). C2.4, table 3-9, LA2.1, LA4.3, LA4.4, LA4.5, LA5.9, LA5.18, LA6.3, LA6.4. See also, relevant mapping in Local Area Actions
Impact of geotechnical instability of cliffs and bluffs on public safety (paths, viewing spaces on the edge of the bluff).	Nelson, Orion, Barfleur Beaches, Plantation Point, Hyams Beach	Numerous risk assessments into the impact of climate induced erosion on coastal cliffs and bluffs (as included in appendices, reference and supporting documents). C2.4, table 3-9, LA3.22, See also, relevant mapping in Section 3 – Local Area Actions
Urban water management - flows and quality		
Management of discharges from storm water drains and small coastal creeks. Discharges are considered to affect water quality (urban runoff and/or septic tank effluent), land surface geotechnical stability and dune erosion.	Wowley Creek, Moona Creek, Mollymook Creek, various headlands, Kioloa Creek	Not in the scope of the CZMP. Water quality monitoring data can be viewed in Aqua Data Geotechnical stability addressed as above.
Access management through coastal reserves		
Decision-making and communication processes relating to the number of tracks, spacing of tracks and maintenance	Currarong, Culburra Beach, Shoalhaven Heads, Mollymook, Narrawallee, Cudmirrah,	C4.1, pages 54-57. • Development of the Walking Track Asset Management Plan: Paths on headlands and linking beaches are usually incorporated into the Walking Tracks AMP and are risk assessed regularly.

Issue or concern reported by community representatives	Reported in these localities	How Council has addressed the issue or concern
of tracks across dunes, on headlands and along bluffs (linking beaches).	Berrara, Collingwood Beach, Gannet Beach, Cormorant Beach	• Development of The Coastal and Estuary Asset Management Plan 2015 which forms an integral part of the Coastal Zone Management Plan: Following storm events, beach access tracks assessed as being a public safety risk, are closed. If any of those tracks are then assessed to be excess to need, and following public consultation, tracks may be closed and removed from the asset register. In this way, beach access tracks are slowly being rationalised. This is also addressed in the Emergency Action Sub-Plan – Beaches (Appendix 4).
Private use of public reserve lands on dunes and bluffs, including garden encroachment, private access ways and blocking other public access (reported as both dune vegetation and equitable access to the coast issue).	Bannisters Point, Mollymook Beach, Collingwood Beach, Callala Beach	C1.8, C2.2 • Development of the Foreshore Reserves Policy, which forms an action resulting from the Coastal Zone Management Plan citywide strategies. • Reporting of encroachment issues to Council's compliance staff for individual action. • Development of a Citywide Tree Vandalism Policy.
Conflicts on beaches - most often in relation to dog exercise areas.	Shoalhaven Heads Beach, Mollymook Beach, Narrawallee Beach	Not in the scope of the Coastal Zone Management Plan – addressed in Council's policy, Access Areas for Dogs and enforced by Ranger Services. Signage and maps regarding on-leash, off-leash areas are often added to beach access sign posts.
Access suitability for diverse user groups - aged, disabled, variety of recreational users, permanent residents and visitors.	Callala, Huskisson, Vincentia, Mollymook	C2.6, LA1.5, LA1.8, LA2.4, LA3.23, LA5.6 Development of the Coastal and Estuary Asset Management Plan; beach access is being upgraded incrementally to provide for diversity e.g. passive craft launching ramps, addition of handrails to beach access tracks, contrast step marking on beach access steps, disabled access boardwalk to Conjola Beach.
Access by people, dogs and vehicles close to nesting sites for migratory shorebirds disrupts breeding success.	Applicable at most nesting areas.	C2.3, section 1.5.3 Signage regarding shorebird nesting areas added to relevant beach access sign posts, enforced by Council Ranger Services. Council staff liaise with the NPWS Shorebird Recovery Coordinator when needed.
Vegetation in foreshore reserves		
The priority given to maintaining natural coastal features including beach, dunes, headlands and intertidal rock reefs. Conservation of endangered communities, threatened species and habitat.	All locations	Section 1.5.3 Protection provided for coastal features via the Coastal Zone Management Plan and resultant policies such as the Foreshore Reserves Policy, which is consistent with the Coastal Zone Management Plan citywide strategies. Council also has planning controls in place through SLEP 2014 and administers development related aspects of the NSW Biodiversity Conservation legislation. Council liaises with Jervis Bay Marine Parks staff as needed.
Management of vegetation on coastal bluffs and cliffs, including weed removal, drainage, species selection and contribution to instability.	Penguin Headland, Racecourse Headland, Bannisters Point	C2.4, table 3-9, See relevant sections and mapping in Section 3 – Local Area Actions Management of vegetation on public land (under its care, control and management) through policies such as: • The Foreshore Reserves Policy • Building controls within Shoalhaven Development Control Plan 2014 Chapter G6 • The Coastal Slope Instability Hazard Study, SMEC 2008 • Peer Review, Supplementary Geotechnical Observations (of the Coastal Slope Instability Hazard Study 2008) Douglas Partners 2011 • Coastal Cliffs and Slopes Emergency Action Sub Plan. Royal Haskoning DHV 2018 • Coastal Erosion Road Stormwater Assessment Footprint Engineering 2015 • Council's Weed Management Policy

Issue or concern reported by community representatives	Reported in these localities	How Council has addressed the issue or concern
		• Bushcare and Parkcare Policy and Procedures (POL09/78) These policies, studies and reports are consistent with the actions within the Citywide Strategies contained within the Coastal Zone Management Plan.
Vegetation management on coastal dunes, particularly in relation to height and density of rehabilitated vegetation along urban foreshores. Narrow margin of vegetation and dune between the tidal zone, the dunes and residential development. Impact on views; intent and function of rehabilitated landscapes.	Collingwood Beach, Mollymook Beach, Narrawallee Beach, Berrara, Cormorant Beach, Gannet Beach	C1.8, C2.2 LA1.5, LA1.6, LA1.10, LA3.16, LA3.17, LA5.13, LA5.14, Management of vegetation on public lands (see comment above) through policies such as Foreshore Reserves Policy, Shoalhaven Development Control Plan 2014 Chapter G6, Collingwood Beach Vegetation Action Plan (2018 revision), Weed Management Policy, and planning controls such as SLEP 2014. These policies and plans are consistent with the Coastal Zone Management Plan citywide strategies. Council is also developing a Citywide Vegetation Vandalism Policy to address vandalism of foreshore vegetation.
Participation by Bushcare and Dunecare Groups.	Most beaches	C2.1, section1.5.3 & 3.2.2.3 Involvement of residents through the Bushcare Policy and Procedures.
Management of invasive species on coastal dunes.	All beaches	C1.9 Addressing of community concerns through Foreshore Reserves Policy, Weed Management Policy and its weed management program and Bushcare and Parkcare Policy and Procedures Provision of dedicated resources (Natural Areas Officer) Engagement of contractors to support Bushcare Group actions or where there is no Bushcare Group.
Other social and cultural concerns		
Management Plans and Reports are currently in various forms and stages of implementation. This can create confusion for local communities about how the various pieces of coastal management fit together.	All areas	Supporting documents list is the first step in making a library of coastal and estuary management document available to the public. Production of the Frontline News newsletter, Council's coastal and estuary web pages to facilitate good communications. These actions are consistent with the aims and objectives of the Coastal Zone Management Plan.
Protection and recognition of Aboriginal culturally significant sites.	All areas	C2.2, C4.6, 3.2.2.2 Description of Aboriginal Cultural Heritage for each Local Area in Section 3 Engagement of consultant archaeologists when required Due diligence by Council staff who and work closely with OEH on the protection of Aboriginal Cultural Heritage. Installation of interpretive signage, where appropriate, in coastal areas. Recognition of Aboriginal cultural heritage in vision.
General concern over water quality, particularly in high-use areas, including the impacts of fishing, mooring on seagrass beds and high-impact areas.	Jervis Bay, Mollymook	Involvement of several state and local government agencies. Protection of Jervis Bay via the provisions of the Marine Park management plan. A substantial Council water quality monitoring program. Aqua Data Protection of seagrass, saltmarsh and fringing vegetation Council (with Department of Primary Industries Fisheries when required)
Vehicles in reserves and on beaches can create safety issues and damage the natural environment.	Foreshore reserves and beach access ways	C.2.3 Administration of the provisions of the Foreshore Reserves Policy, which includes appropriate signage and prosecution action by Ranger Services.

Issue or concern reported by community representatives	Reported in these localities	How Council has addressed the issue or concern
Lack of signage for environmentally sensitive areas.	All localities	With other state agencies consistent with the citywide strategies within the Coastal Zone Management Plan: • Installation of interpretive signs at many locations around the Shoalhaven coast (e.g. Red Head (Bendalong), • Installation of saltmarsh signs at various estuarine locations (e.g. Burrill Lake, signs explaining estuarine processes e.g. Lake Conjola, Lake Tabourie) Sign installation will continue
Where concrete/rock walls have been built to protect a foreshore area, they should be properly designed and maintained and allow for safe access.	Generally provided at surf clubs and high usage areas	C6.1, LA1.1, LA5.4, LA5.5, LA5.7 Any actions relating to these works include on-going maintenance and monitoring provisions. Preparation of studies, including: • Mollymook Golf Club Coastal Hazard Assessment, Maunsell Australia 2008 • Ulladulla Harbour Coastal Erosion Remediation - Design Advice SMEC 2011 • Geotechnical Assessment of storm erosion and remedial works Ulladulla Harbour, Douglas Partners 2012 • Foreshore Stabilisation at Mollymook Beach (south) – concept design report Royal Haskoning DHV 2016 • Shoreline Protection Condition Assessment (review) GHD 2016 • Foreshore Stabilisation at Mollymook Beach (south) concept design report, Royal Haskoning DHV 2016
Estuaries not included in CZMP	Most localities	Following advice from OEH, estuary management plans could not be included in the CZMP because they were not prepared in accordance with CZMP Guidelines. At the time when EMPs were prepared they were never intended to be CZMPs. Council will continue to progressively update EMPs and incorporate into future coastal management programs as appropriate.

2.3 Protecting natural landscapes

Figure 2.4 below shows how the different landscape elements – beaches, dunes, lakes, estuaries and catchments - fit together in the coastal landscape. It also shows how management of the coastal zone draws on knowledge about coastal systems and the values of local communities. This Coastal Zone Management Plan is one part of Council's overall integrated framework for managing the coastal landscape. Estuary management plans, flood studies and plans, estuary health monitoring programs and other plans and programs described below are all part of Council's overall management framework of the coastal landscape.

Coastal landscapes continually change responding to the dominant natural forces of wind, waves, rainfall and tides. Council's understanding of how these beach and estuary systems operate within natural dynamics is improving. Council's management priorities need to recognise how we can best adapt and minimise community risk and environmental impact. Coastal Zone Management in NSW now integrates estuary and open coast management planning directions. This CZMP will, over time, be fully integrated with plans for coastal lakes and estuaries.

Estuaries

The NSW South-East Coast Region has three main estuary types:

- Wave dominated barrier estuaries
- Wave dominated deltas
- Coastal lagoons

Estuary flood plains are areas that are inundated by both catchment runoff and by oceanic waters (tides and wave overtopping of dunes). Many homes and services are currently located in flood risk areas around estuaries. Flood risks are partly managed by entrance management strategies for coastal lakes.

Estuary health monitoring

The Monitoring Evaluation and Reporting (MER) strategy was developed to form a consistent program of 'indicators' for a state-wide assessment of ecological condition of estuary systems.

Core indicators include:

- Chlorophyll a (measuring microalgae abundance), turbidity, salinity, temperature, pH and dissolved oxygen (DO)
- DO level is critical to aquatic life. Low DO causes fish kills
- Nutrients such as Nitrogen and Phosphorus track catchment inputs from erosion or land use
- Habitat mapping measures seagrass, mangroves and salt marsh communities
- Fecal Coliforms indicate sewerage pollution and is critical information for oyster producers and recreation.

The physical and ecological monitoring results are combined into an estuary health score for the system, like a school report. Scores range from D (needs a lot of improvement) to A (a healthy system functioning well).

All Council's water quality monitoring results can be found in Aqua Data

What communities value

- Knowledge of coastal processes and systems
- Certainty about planning requirements
- Safe pedestrian access to beaches, headlands and rock platforms
- Safe boating access
- Safe vehicle access at selected locations
- Healthy coastal vegetation communities
- Views across coastal waterways
- Stable coastal landforms
- Facilities for families to enjoy the coast – as residents, long term holiday makers or occasional visitors
- Residential areas near beaches and coastal waterways
- Engagement with community groups and Council's Natural Resources and Floodplain Management Committee
- Community surveys
- Joint Council and community projects such as Bushcare

Beaches and headlands

Shoalhaven has long sandy barrier beaches, rocky beaches and rocky headlands. Wave height varies (0.5 m to 1.6 m+) with beach orientation and protection by offshore reefs. Many of the open coast beaches have one or two offshore bars and are rip dominated. The height and extent of coastal dunes is also linked to embayment orientation, wave approach and exposure to strong south easterly winds, as well as the very long term geomorphic evolution of the coast.

Coastal risk management

The Shoalhaven's coastal urban areas have been, and will continue to be, exposed to the impacts of coastal hazards. These hazards include beach erosion, shoreline recession, coastal entrance instability, sand drift, coastal inundation, storm water erosion, slope instability and climate change.

The CZMP focuses on managing risks associated with these hazards.

Managing other coastal values

The CZMP is also about protecting the resilience and functions of coastal ecosystems on a changing coastline.

Flood risk management

Council is committed to sound floodplain management in accordance with the process outlined in the NSW Government's 2005 Floodplain Development Manual. To achieve this goal, the Natural Resources and Floodplain Management Committee meet regularly to assist Council in the development and implementation of Floodplain Risk Management Plans for catchments within the City's boundaries.

Council has given priority to catchments that are at a higher risk of flooding. Flood studies and floodplain risk management studies and plans have been completed for the high priority catchments - https://www.shoalhaven.nsw.gov.au/Environment/Flood-risk Flood risks around estuaries are partly managed by entrance management strategies for coastal lakes. Entrance management Plans are updated when a review of the floodplain risk management study and plan is undertaken.

Figure 2.4 – Science and values working together in the management Shoalhaven's coast

2.3.1 Community use and access issues

Coastal ecosystems are threatened by existing uses and management as well as future coastal hazards. Impact issues can arise when the location and design of coastal access facilities conflict with different user groups, who may value the coast in different ways (Table 2.7).

Information to define these issues comes from ecological condition assessments, from asset condition assessments (particularly for access ways) and from community input about values, recreational uses, concerns and management gaps.

Table 2-7 – Summary of Community Use, Access and Coastal Ecosystem Issues

Community use, access and coastal ecosystem issues
• Balancing ecological function with other ecosystem services valued by local communities – protecting and rebuilding dunes and dune vegetation • Providing species and landscaping concepts for coastal reserves on dune and headlands • Maintaining views for residents and visitors • Managing invasive species in coastal bushland (dunes and headlands), especially near urban areas • Providing adequate beach access ways to prevent trampling of dunes but not excessive access ways that will cause wind funnelling across coastal dunes, gullying on headlands • Providing cycleways and pathways between coastal communities • Maintaining safe access ways after coastal storms or other damaging events • Providing adequate disabled access in communities with high elderly population • Providing adequate of recreation, beach amenity and tourism facilities in high profile locations • Minimise poorly located and designed signage • Monitor water quality in recreational areas and natural places • Respond to whale strandings and protecting habitat for migratory shorebirds • Comply with requirements of Jervis Bay Marine Park Authority when managing or responding to coastal risk at beaches within Jervis Bay.

2.4 Monitoring change

2.4.1 Monitoring coastal condition and coastal change

Recent LiDAR data and aerial photographs provide the baseline for coastal landform condition. Ongoing change will be measured using a combination of ground survey and new LiDAR data, allowing three dimensional changes to be calculated rapidly at the landscape scale and for local areas. High resolution spatial data can also be used to monitor changes to coastal vegetation. Targeted local area photographic and ground survey will augment LiDAR for high risk localities. For instance, photo monitoring can be used to provide a record of change at regular intervals and immediately after major storm events.

Priorities for monitoring of changes to beach profile and dune height and volume include:

- Mollymook Beach
- Narrawallee Beach
- Collingwood Beach
- Currarong Beach
- Callala Beach
- Shoalhaven Heads Beach.

Council will develop priorities for monitoring the condition of coastal ecological communities in consultation with OEH, including a sample of both dune ecological communities and headland ecological communities. The extent of invasive species in important ecological communities suggests that periodic assessment of invasive species impacts should be included in any ecological monitoring program.

Council and OEH have established a water quality and ecological health scorecard program for Shoalhaven estuaries and coastal lakes. Ongoing monitoring will improve knowledge about estuary health and how it responds to catchment and ocean events.

Currently there is a lack of understanding of the:

- Baseline ecological condition of the hazard sites and associated operational areas
- Natural benthic population variability caused by natural processes and the expected recovery dynamics
- Construction impacts and potential mitigation measures to be included
- Monitoring programs that should be deployed as an integral part of the project.

Council commissioned a report to better document these ecological values and potential impacts. In 2013 Professor Steve Smith completed the study ‘Design for baseline data collection, and ongoing monitoring, to assess the impact of beach scraping and nourishment at Jervis Bay’ and in 2015 Dr Nathan Knott completed the *Coastal Erosion Remediation – Environmental Baseline Study Preliminary Report* at 9 sites on Jervis Bay beaches. This first round of beach sampling provided information about the spatial patterns of the biodiversity. It also identified that changes are needed to the study design. Another sampling round is needed due to limited funding and logistical problems collecting the samples.

At intervals of 5 years, Council will report on what has been achieved in terms of implementation of the Coastal Zone Management Plan and changes to the condition of the coast.

The preparation of these review reports will be an opportunity for Council committees to review priorities for the next five -year period and to note the impact of any specific events on progress towards a healthy and safe coast.

A full review of the implementation of the Coastal Zone Management Plan (or new Coastal Management Program) will be conducted after 10 years. It is expected to contain a full review of the hazard studies, based on new climate change and sea level information and any new techniques for modelling the behaviour of beaches and dunes.

2.4.2 Triggers for changes to management strategy

Uncertainty is a significant challenge for Council in managing its open coast. A fundamental principle for coastal zone management is that the coast will change over time. It has already changed and will continue to do so, in response to processes operating at various time scales.

Our assessment of coastal risks is based on assumptions and processes established in the NSW Government policy framework. Council acknowledges that actual coastal hazards may, at specific times in the future, have a greater or lesser than projected impact on natural, cultural and built assets. Actual impacts depend on interactions between patterns of major coastal storms, medium term climate cycles and longer-term changes to climate and the rate of sea level change.

Council’s proposed approach to strategic management of coastal zone risks and issues gives high priority to immediate high risks. At the same time, Council is applying a precautionary approach to longer term and less certain risks and issues. A precautionary approach prepares the community for change. It includes land use controls, dune resilience works, information sharing and involvement activities, monitoring and reporting of management outcomes.

Council will regularly review the suitability of management actions for its coastal zone and for local areas. There are several reasons why the currently proposed management approach could change over time. These include:

- Reliable sea level measurements may show that sea level is rising at a rate different from the projected rate (this changes the coastal risk by changing the likelihood of an event occurring).
- The frontal dune system may recede faster or slower than predicted, whether or not sea level and other climate change parameters have changed as projected. This would change the consequence.
- Coastal storms, sediment budget imbalances and/or recession due to sea level rise mean that the frontal dune escarpment moves closer to built assets, such as houses, sewerage and road infrastructure. For major infrastructure assets subject to a high or extreme level of risk, a trigger distance greater than 20m would be appropriate to change from a monitoring and reporting approach to detailed feasibility and design studies and/or to on ground works (protection or relocation). The appropriate trigger is influenced by the type of asset, expected asset life, local risk to the asset and the types of risks associated with failure.
- A change to NSW or Australian government policy for coastal zone risk management. Such policy reviews are expected to occur when new IPCC and/or CSIRO climate change and sea level rise data and analyses are released. These could also occur at other times if the logic underlying connections between science and policy responses is shown to be inappropriate.
- New information about the costs and benefits of defend, retreat or accommodate approaches for specific localities becomes available. This could be affected, for instance, by changes to the regulatory framework for access to sand resources, or the cost of sand resources for beach nourishment.

3. Choosing the right actions

3.1 How actions were selected

Options considered in the Coastal Zone Management Plan take into account outcomes and recommendations from several detailed studies, NSW Government agency policy and technical advice, as well as community feedback. These are listed below:

- Additional actions to respond to significant coastal risk issues (or changed priorities) which have emerged since 2009. These issues may have arisen from changes to state-wide policies, community feedback to Council, or from Council's routine monitoring of the condition of coastal assets.
- Relevant planning controls from Council's Citywide Shoalhaven Development Control Plan 2014, G6 Coastal Management Areas and the Shoalhaven Local Environmental Plan 2014.
- Options shown in tables 3-1, Risk Management Options for Existing Development and 3-2, Risk Management Options for New Development
- Our Coast Our Lifestyle community engagement program (2.2.5), which specifically tested community response to the risk options in tables 3-1 and 3-2
- Community feedback from previous public exhibitions of the CZMP and various consultants' reports e.g. Shoalhaven Coastal Hazard Mapping Review 2018
- Actions resulting from detailed studies at specific locations
- Shoalhaven Public Asset Coastal Risk Management Review (BMT WBM 2012) and the Coastal Hazards Risk Assessment (Advisian 2018)
- Initiatives and requirements from agencies which contribute to the objectives and targets of the Coastal Zone Management Plan, including NSW agency policy documents
- Council's regular monitoring of coastal assets
- Actions to better integrate the Coastal Zone Management Plan with existing estuary management plans, flood risk management plans and entrance management strategies.

3.2 Evaluating and prioritising the options

A risk assessment was used to prioritise risks from the identified coastal hazards (through staff workshops, Councillor workshops and technical studies). To identify the preferred management approaches, Council also canvassed potential management options with the community and state agencies.

The purpose of the Our Coast Our Lifestyle (OCOL) community engagement program (2016), was to

- Educate the community about the risks of coastal erosion and the coastal management options that are available to respond to that risk
- Understand community preferences for those different management options and the factors Council to consider when responding to coastal erosion risks and storm damage.

A striking outcome of OCOL, noted by the consultants, was the consistency of views expressed and concerns raised, across all engagement activities and all sectors of the community. Given there were over 1,650 participants, it provides Council with robust evidence of community views on coastal management.

Five strategic approaches to managing coastal risks are available to Council's, individually or in combination (Table 3.1 and Table 3.2). Suitable strategic approaches for mitigating coastal risks affecting existing development are different from those suitable for making decisions about future development. Relevant OCOL outcomes regarding prioritisation are:

- Supports Council prioritising community assets and infrastructure when spending taxpayers' money on coastal management
- Expects Council to take a long-term, cost-effective approach to managing the risk of coastal erosion, based on scientific evidence and expert advice
- Except in specific circumstances, supports soft over hard protection options, in particular for dune management
- Would support other management options for existing assets if they are the most effective option in the long term
- Is strongly concerned about new development in areas known to be at risk and does not support Council approving it, especially if it will require protecting in the future

The social, environmental, economic and risk factors were all used to evaluate the options and actions within this Plan. Section 4 of this Plan further prioritises the actions for Council and its partners to manage risks in the coastal zone.

Table 3-1 – Risk Management Options for Existing Development

PROTECT	ACCOMMODATE	RETREAT	SHARE	ACCEPT
Protect Structures such as sea walls, and break-walls. Build up the sand buffer by beach nourishment, dune enhancement.	Make development more resilient to coastal risks: Lease back arrangements for less intensive or more flexible/relocatable uses. Retrofit and redesign (e.g. piered foundations or raised floor levels)	Identify and act on triggers for when buildings must be moved or abandoned. Set time frames for relocation of infrastructure.	Share insurance schemes and acquisition and land swap arrangements	Plan emergency response including reparation and action during erosion events.

Table 3-2 – Risk Management Options for New Development

AVOID	ACCOMMODATE	ACCEPT	SHARE
Prohibit specific development types in coastal risk areas. Locate new critical infrastructure outside high coastal risk areas. Require set- backs.	Make development more resilient to coastal risks: Design requirements for new development such as piered foundations and relocatable structures. Develop time limited approvals	Plan emergency response and evacuation (generally only for infill areas, not greenfields sites)	Share appropriate insurance arrangements

3.3 Strategies for the coast and actions for local areas

Actions which apply to the whole of the Shoalhaven coastline (those sections managed by Council) incorporate land use planning, emergency response management and community involvement in monitoring and reporting.

These strategies and actions provide *general* benefit for the future management of coastal risks. They are designed to:

- Prevent risk escalation

- Raise awareness of coastal zone management issues and processes
- Protect important natural coastal systems
- Establish mechanisms for continuing improvement and refinement of coastal zone management as new knowledge becomes available.

There are seven strategies for managing the whole coast (3.2.1) and six local area plans (3.2.2), as shown in Figure 3.1. The local area plans focus on proposed actions to manage coastal risks and threats relevant to each area.

The detail regarding expected costs, sources of funding and responsibility for leading the response is outlined in the implementation schedules in Section 4. Council will make implementation choices based on needs and priorities across the whole of the City's coastline. In general, work will begin on actions that reduce extreme or very high risks and for which funding is available.

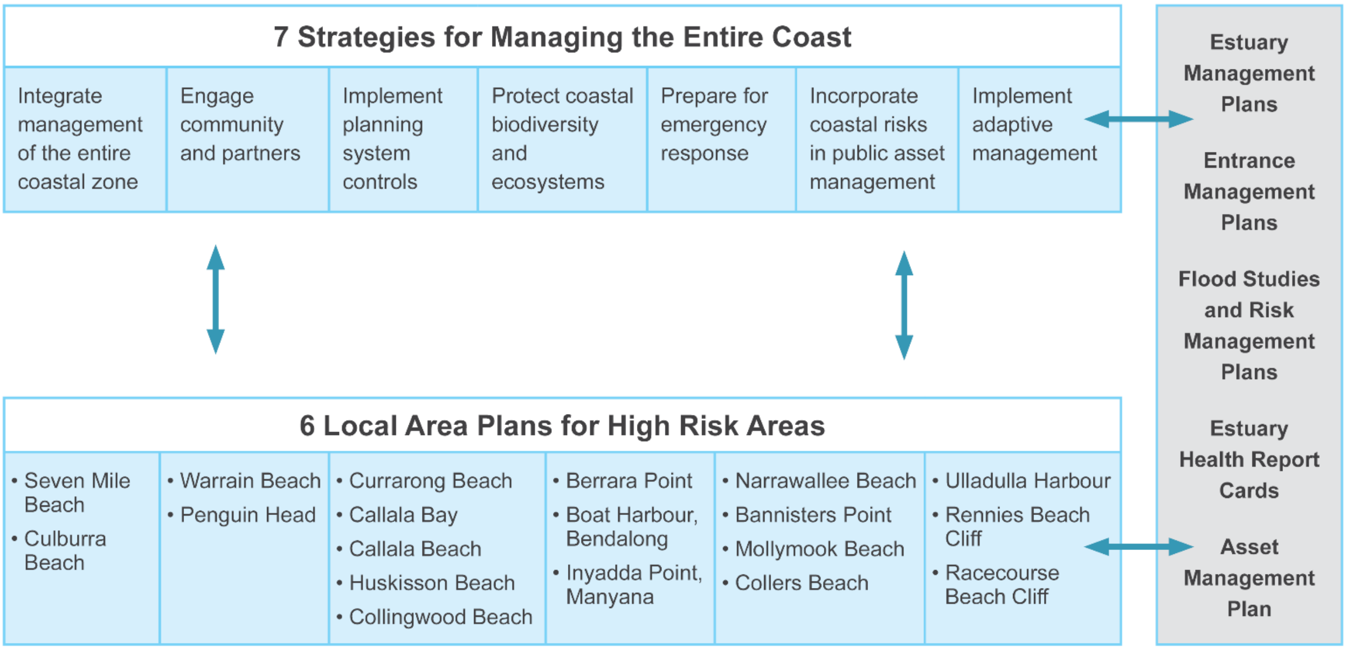


Figure 3-1 – Citywide strategies and local area plans

3.2.1 Strategies for the whole coast (Citywide)

Strategy 1: Integrate management of the entire coastal zone

Council manages a very large coastal landscape. Council embraces the concepts of integrated management of the natural values that support the wellbeing of our communities and recognise coastal hazards that could threaten local community assets now and into the future.

Strategy 1 outlines the first steps towards more complete integration of Council's coastal zone management activities.

Table 3-3 – Strategy 1 actions

Action	What is proposed	Responsibility
C1.1	In consultation with the community, identify coastal zone objectives and principles, for application in future reviews of this Plan and future coastal management programs.	Council

Action	What is proposed	Responsibility
C1.2	Present information on Council's website and in community engagement activities that shows how coastal zone systems function and how integrated management responses benefits Council's and local communities. This will include reporting on long term improvements to efficiency and to the condition of coastal zone systems.	Council
C1.3	Work with all sections of Council to improve integration of coastal zone risk management and protection.	Council
C1.4	Investigate and scope feasible, long-term funding options for effective, integrated management of the Shoalhaven coastal zone. Funding strategies will include Council rates and levies, leveraged by grant applications.	Council New funding mechanisms would require approval from the NSW Government.
C1.5	Review and update Council's Coastline Risk Management Report 2004.	Council Environmental Services
C1.6	Review and assess management coastal erosion concept designs, and other technical reports containing management options for high risk beaches to identify appropriate future actions for community consultation and progression to detailed design where appropriate.	Council Environmental Services
C1.7	Collate all monitoring actions within the Coastal Zone Management Plan, and other supporting documents, to develop an Environmental Monitoring Program (EMP), which will address matters such as dune crest height monitoring, effectiveness of sustainable tourism strategies, plastics and rubbish, water quality, encroachment or trampling from access ways and dune vegetation vandalism. The EMP will include 'citizen science' opportunities.	Council Environmental Services
C1.8	Maintain the Ecological Monitoring Program (which forms part of the EMP above) to ensure assessment of the extent of invasive species impact.	Council Environmental Services
C1.9	At intervals of five years, report on what has been achieved in terms of implementation of the Coastal Zone Management Plan.	Council Environmental Services
C1.10	Each year, review actions to ensure they are appropriate and current, and remove actions if implementation has been successful. These reviews will be reported in Council's annual report.	Council Environmental Services
C1.11	After 10 years, conduct a full review of the implementation of the Coastal Zone Management Plan (or new Coastal Management Program).	Council Environmental Services
C1.12	Maintain a full-time coastal zone coordinator position to coordinate design investigations, develop the implementation strategy (including long-term funding options) and build Council's capacity to respond.	Council Environmental Services

Strategy 2: Engage communities and partners

The community continues to be interested in protecting the natural environment while also supporting local recreation and tourism businesses. These matters are addressed in Strategy 2.

Table 3-4 – Strategy 2 actions

Action	What is proposed	Responsibility
C2.1	Prepare and deliver community information for residents at key risk beaches and other emerging priority coastal areas.	Council Environmental Services and Communications and Media

Action	What is proposed	Responsibility
	Community information could include regular updates on Council's website, social media sites, educational signage, presentations at community meetings, field days, training for Bushcare volunteers, Frontline News.	
C2.2	Engage with foreshore reserve property owners, residents and beach goers around risk, environmental, cultural and social issues such as: • The value of dune vegetation (e.g. trapping wind-blown sand and maintaining dune resilience, ecological functions and buffering against coastal hazards) • Recognising Aboriginal cultural heritage on the coast • The importance of foreshore vegetation in providing shade and wind protection, filtering runoff, improving water quality and providing habitat • Managing the interface between coastal bushland and private property, including edge impacts, encroachments, garden refuse dumping, storm water discharges, vegetation retention, fire protection zones and weed management • Illegal pruning, poisoning and removal of trees, private vehicle access and illegal structures/items which restrict public use of the reserve. Enforce regulations in high conservation value areas as a priority	Council Environmental Services and Communications and Media
C2.3	Continue to work collaboratively with National Parks and Wildlife Service staff and volunteers to implement the NSW South Coast Shorebird Recovery Program to: • Raise awareness amongst residents and visitors of migratory shorebirds which are protected under international agreements, federal and state legislation • Manage the impacts of vehicles, pest animals and dogs on beaches, especially in regard to the breeding success of migratory shorebirds	Council Environmental Services and Communications and Media
C2.4	Prepare information for landholders living adjacent to geotechnical hazards and how they can contribute to risk reduction through: • Maintaining an adequate surface drainage path into and out of the property • Draining piped storm water away from steep slopes to avoid saturation and scouring • Maintaining vegetation cover of appropriate species • Repairing leaking or broken underground drainage or sewer pipes as soon as faults are identified • Periodically inspecting the property to observe changes	Council Environmental Services and Communications and Media
C2.5	Collaborate with Council's Tourism and Visitor's Services staff to encourage sustainable tourism strategies and 'citizen science' opportunities	Council Environmental Services and Tourism
C2.6	Review relevant asset management plans and incorporate opportunities for disabled access where feasible. Investigate opportunities for disabled access at beaches and progress to detailed design where appropriate.	Council's Access Committee, Community & Recreation, relevant asset custodians, in consultation with Department of Industry – Crown Lands & Water where relevant

Strategy 3: Implement planning system controls

Council manages coastal risks for existing and future development through controls in the Shoalhaven Local Environmental Plan 2014 and Shoalhaven Development Control Plan 2014.

These planning measures:

- Avoid future risk by preventing intensification of land use in coastal risk areas, without unnecessarily sterilising the use of these lands in the short to medium term.
- Adapt to existing and future risks by requiring certain design features in new development (or retrofitted to existing development in coastal risk areas).
- Inform land holders about coastal risks that affect their property.

The planning controls will be linked to specific risks for different types of development. Triggers defined by the proximity of a storm bite erosion scarp to development can be used to specify when an existing development must be removed, relocated or redesigned to adapt to the changing coastal risk profile.

Council conducted detailed consultation about coastal risk clauses in its draft LEP in 2011 and 2013 and DCP in 2014.

Table 3-5 – Strategy 3 Actions

Action	What is proposed	Responsibility
C3.1	Update and maintain notation to section 10.7 (5) certificates for properties affected by coastal hazards consistent with NSW Government legislation.	Council
C3.2	Implement and maintain planning controls, in Shoalhaven Local Environmental Plan 2014 and Shoalhaven Development Control Plan 2014 G6 Coastal Management Areas, which require specific information and assessment for proposed development in coastal hazard areas.	Council
C3.3	Use appropriate zoning in the Shoalhaven Local Environmental Plan to protect frontal dune systems from development that reduces resilience to coastal hazards.	Council
C3.4	Make necessary amendments to the Shoalhaven Local Environmental Plan 2014 and Shoalhaven Development Control Plan 2014, including: • Council to require geotechnical assessments to support applications for landslip remediation works on private property, including confirmation that risk will be reduced to levels considered acceptable (geotechnical engineer to approve the design of the remediation measures and works) • Development consent conditions to include maintenance requirements for new developments on sloping blocks within risk areas • All risk areas to be included in the appropriate locations in the Shoalhaven Local Environmental Plan 2014 and/ or Shoalhaven Development Control Plan 2014 • Mapping in Shoalhaven Development Control Plan 2014 and SLEP 2014 (Coastal Risk Planning) to be updated to reflect the revised Coastal Hazard Mapping for beaches (Advisan, 2016)	Council

Strategy 4: Protect coastal biodiversity and ecosystems

The community highly values the coastal foreshore reserves at beaches and on headlands along the Shoalhaven coastline. These reserves provide the 'naturalness' that many people have identified as important to them. However, many of the coastal ecological communities in these reserves are threatened by pressures from adjoining land uses and by invasive species.

There are differing community perspectives about the appropriate balance between biodiversity protection and amenity enhancement in coastal reserves. Strategy 4 focuses on detailed planning and on-ground actions to protect biodiversity and reduce the encroachment of the urban footprint into natural areas.

Reserves on coastal dunes and headlands are affected by a number of invasive plants. Council has weed control programs on public reserves, provides resources and encourages local community involvement.

Table 3-6 – Strategy 4 actions

Action	What is proposed	Responsibility
C4.1	Update the Coastal Asset Management Plan to include a beach access strategy that includes a methodology for rationalisation of beach accesses based on environmental, social and economic risks	Council Environmental Services
C4.2	Review and update plans of management and the Foreshore Reserves Policy 2005 to ensure consistency with the Coastal Zone Management Plan	Council

Action	What is proposed	Responsibility
C4.3	Maintain and enhance ecological communities in coastal reserves (including dunes), considering appropriate ecological strategies for urban (foreshore recreation reserve) and non-urban areas	Council Environmental Services
C4.4	Wherever possible, use zoning and planning controls in Shoalhaven Development Control Plan 2014 to maintain open spaces where coastal dunes and associated habitats can roll landward in response to climate change and sea level rise. On the open coast, this management action is linked to planning for vegetated foreshore reserves on coastal dunes.	Council Environmental Services and Strategy Planning
C4.5	Support bush regeneration programs in coastal reserves	Council Environmental Services
C4.6	Incorporate measures to protect Aboriginal cultural heritage. This will include appropriate Aboriginal cultural heritage due diligence assessments for all coastal works **Where actions are proposed on Crown land, Aboriginal Land Claims lodged under the NSW Aboriginal Land Rights Act 1983 must be considered. Any works will need to be compliant with the *Commonwealth Native Title Act 1993*.**	Council's Aboriginal community liaison officer and Environmental Services. Works and Services - for new structures or facilities in reserves

Strategy 5: Prepare for emergency response

For some existing development in coastal risk areas, Council and the relevant local communities have chosen to accept coastal erosion risk in the short term and manage impacts as they occur during or after coastal storm events. This was particularly relevant to localities that were recognised as coastal hotspots or authorised locations under the *Coastal Protection Act 1979*.

The Coastal Management Act 2016 does not include authorised locations but identifies coastal hotspots. There are currently no identified hotspots in Shoalhaven.

The following beaches were recognised as authorised locations under the Coastal Protection Act,

- Part of Mollymook Beach
- Part of Collingwood Beach
- Part of Callala Beach.

An Emergency Action Sub Plan was prepared for these beaches in 2011 (Appendix 4) as well as for Culburra Beach, Currarong Beach, Narrawallee Beach and beaches where Surf Lifesaving Club buildings are located. The Plan was updated in 2018. It explains the actions that may be taken by Council before and after a storm.

Table 3-7 – Strategy 5 actions

Action	What is proposed	Responsibility
C5.1	Activate emergency action sub-plans as required	Council Environmental Services and Asset Management
C5.2	Prepare and implement Nature Assisted Beach Enhancement (beach scraping) plans for all Council managed beaches to support the emergency action sub-plans.	Council Environmental Services
C5.3	As part of any beach scraping activities, establish a monitoring program to continue investigations of baseline ecological condition or diversity for affected beaches. The monitoring program will be established in consultation with DPI Fisheries.	Council Environmental Services

Beach access management

Managing beach access is an important component of coastal management. It requires a balance between meeting community needs and protecting dune values which in turn protects the public and private assets behind the dunes.

Beach access ways:

- Segment vegetation and therefore impact on habitat and ecosystem health
- Reduce dune resilience to storm erosion by allowing pathways for wave runup during storms
- Allow a wind funneling effect that can result in the loss of sand from beaches, reducing dune resilience.

Currently, Council maintains 220 beach accesses. These accesses are spread over the 40 beach compartments managed by Council.

Many coastal access ways were inherited from the NSW Government's Beach Improvement Program in the 1980s and 1990s following the extreme storms of the 1970s. As part of this program beaches were re-formed, dune fencing was constructed to protect dune plantings and fenced beach access ways were created through the replanted dunes. Much of this fencing has been removed, as it has reached the end of its life, and/or vegetation growth has successfully taken on the role of keeping people 'on track'.

In addition to these formalised beach access ways, many more tracks have emerged over time, as informal 'desire lines' and have gradually become part of the maintained asset base.

Council considers that access to Council managed beaches is adequate and, in many places, more than adequate.

Due to the incremental accumulation of beach access ways, some beaches have too many accesses and, for the reasons outlined above, are compromising dune resilience. An excess of access ways is also an unnecessary drain on Council's coastal maintenance budget. However, maintaining adequate public access to beaches is a key priority of this Plan and this is reflected in the actions.

Many beach accesses are closed post storm, to manage public risk (consistent with the Emergency Action Sub Plan in Appendix 4). Some of these accesses will then be permanently decommissioned, following discussion with communities and there is sufficient alternative access. At other times, access may be closed because vegetation maintenance is withdrawn to maintain dune resilience and there is sufficient alternative access.

Rationalisation of beach access ways has resulted in a net reduction of 15 since 2015.

Beach access ways are listed in Council's asset register, together with other coastal assets, and shown on Council's GIS mapping system. They will be also included in the updated Asset Management Plan when it is reviewed and adopted by Council in 2019.

A Nature Assisted Beach Enhancement (NABE), also known as beach scraping, plan will be prepared (Action 5.2) to provide guidance for post storm beach repair for the 40 beaches managed by Council and has also been included in the Emergency Action Subplan for Beaches in Appendix 4. This plan will support the Emergency Action Sub Plan.

Depending on the direction of the storm, and with reference to the plan, beach scraping will be implemented at the relevant beaches. Post storm, and following beach scraping, most beach accesses can be re-opened for safe public use.

Table 3.8 below Lists all coastal assets, including access ways, together with potential risks at each location.

Table 3-8 – Coastal assets and risk rating

Beach / foreshore area	Coastal assets	Potential risks
Shoalhaven Heads	7 beach accesses 1 lookout 2 service vehicle accesses	erosion accretion (vehicle access at SLC) inundation
Culburra Beach/Penguin Head	19 beach accesses 2 lookouts (beach) 3 lookouts (Penguin Head)	erosion inundation slope instability (Penguin Head)
Warrain Beach	10 beach accesses 3 lookouts 1 service vehicle access	erosion inundation
Currarong Beach & Abrahams Bosom Beach	5 beach access ways 1 tractor access (Currarong) 1 beach access (Abrahams Bosom)	erosion inundation accretion (at Peel St)
Callala Bay – beach and cliffs	9 beach accesses	erosion inundation
Callala Beach	18 beach accesses 2 lookouts	erosion inundation
Huskisson urban area, includes Shark Net Beach and Huskisson Beach	14 beach accesses 3 lookouts	erosion inundation
Collingwood Beach	14 beach accesses	erosion inundation
Vincentia south, includes Orion, Barfler, Nelsons and Blenheim Beaches	12 beach accesses 1 lookout 1 service vehicle access	erosion inundation
Hyams Beach	2 beach accesses 1 lookout	erosion inundation
Cudmirrah Beach	2 beach accesses 1 service vehicle access 1 lookout	erosion inundation
Cudmirrah / Berrara foreshore, includes Kirby Beach	9 beach accesses 5 lookouts 1 service vehicle access	erosion inundation
Manyana Foreshore, includes Inyadda (south) Beach, Inyadda Point and Manyana Beach (to Cunjurong Pt)	8 beach accesses 2 lookouts	erosion inundation
Conjola coast	3 beach accesses 1 boardwalk 1 lookout	erosion inundation
Narrawallee Beach Jones Beach (north side of Bannister Point)	11 beach accesses 1 beach access at Jones Beach	erosion inundation
Mollymook Beach	12 beach accesses 2 service vehicle accesses 2 creek training walls, foreshore protection structures (south Mollymook)	erosion, inundation
Bogey Hole/Collers Beach	4 beach accesses	erosion, inundation
Ulladulla Harbour	2 beach accesses Foreshore protection structure	erosion, inundation
Rennies Beach/The Bombie	5 beach accesses 4 lookouts	erosion, inundation
Burrill Beach/Dolphin Point	7 beach accesses 1 lookout	erosion, inundation
Wairo Beach	5 beach accesses 2 lookouts 1 service vehicle access	erosion, inundation
Bawley Point shoreline, includes Bawley, Cormorant & Gannet beaches.	20 beach accesses 3 lookouts 2 service vehicle accesses	erosion, inundation
Racecourse (1 beach access on an easement), Shelly (1 beach access on an easement), Kioloa (south end) Beaches.	6 beach accesses 1 lookout 1 service vehicle access Shoreline protection structures at Kioloa boat ramp.	erosion, inundation

Strategy 6: Incorporate coastal risk in public asset management

Council manages roads, water and sewerage infrastructure on behalf of its communities. Council also supports local community recreational and socio-economic activities by providing community buildings, surf clubs, pathways, parks and reserves. Many of these community assets are within coastal hazard areas.

Strategy 6 outlines how Council will manage these assets.

Table 3-9 – Strategy 6 actions

Action	What is proposed	Responsibility
C6.1	Review and update all asset management plans (AMPs), relevant to the coastal zone. AMPs by asset type will be updated by relevant asset custodian. Include an asset management approach to provide for replacement, relocation or retrofitting of public assets that are currently in coastal risk areas including surf clubs and sewer, water and sewerage infrastructure, foreshore protection infrastructure, roads and access paths. Align the asset management plans with emergency action sub-plans	Council Asset Management and relevant asset custodians, in consultation with DoI – Crown Lands & Water where relevant
C6.2	Implement high priority recommendations from the Coastal Erosion Stormwater Impact Assessment (Footprint Sustainable Engineering, 2015)	Council Asset & Works
C6.3	Review the coastal cliff and slopes hazard lines and extent of risk areas, to be informed by the on-going geotechnical assessment of foreshore sites undertaken to date.	Council Environmental Services
C6.4	Incorporate monitoring of public land and infrastructure, including viewing platforms, stormwater drainage, sewer and water infrastructure in identified coastal cliffs and slopes risk areas, to ascertain any leaks or requirements for repair, into Council's maintenance programs. Relocate viewing platforms where necessary.	Council Environmental Services
C6.5	Undertake a hydraulic assessment to assess stormwater drainage adjacent to or within identified coastal cliffs and slopes risk areas	Council Environmental Services

Strategy 7: Implement adaptive management procedures

Understanding how coastal systems respond to storms, medium term weather patterns and long term climate change is an evolving process. Actual timeframes and scales of coastal change are uncertain.

To ensure that coastal risk management actions continue to use the best available science and implement best practice coastal management, Council will track implementation progress and outcomes within an adaptive framework. Council will also work with partner organisations to address current knowledge limitations about coastal processes, hazards and risks, particularly in response to climate change and sea level rise. These studies will provide greater certainty for planners and communities.

Table 3-10 – Strategy 7 actions

Action	What is proposed	Responsibility
C7.1	Establish coastal monitoring program to collect baseline condition data for post storm beach erosion, king tide monitoring and entrance condition (e.g. use LiDAR data for beaches and dunes, when available from the NSW Government, to analyse change to coastal landforms and vegetation). Utilise 'citizen scientists' where applicable.	Council Environmental Services team. Support from OEH
C7.2	Carry out surveys to ground-truth and map the distribution and condition of EECs in coastal erosion risk areas using the Biodiversity Conservation Act, Biodiversity Assessment Methodology.	Council Environmental Services

Action	What is proposed	Responsibility
C7.3	Continue to collaborate with universities, government agencies and others in research that focuses on: • Climate change impacts on coastal processes and coastal landforms, including new data on sea level rise, storm behaviour, sediment transport processes and coastal recession modelling • Impact of sea level rise on rock platform communities • Coastal lake entrance behaviour (sediment budget, morphology, opening and closing regimes) with sea level rise and other aspects of climate change and climate variability • Ecological services and functions of dune species and most effective vegetation structure to enhance dune resilience • Monitoring the impacts of erosion remediation works at Currarong Beach • Assessing and monitoring the impacts of NABE works at all beaches where it's implemented	Council Environmental Services
C7.4	Continue the role of the Council's Natural Resources & Floodplain Management Committee in implementing the Coastal Zone Management Plan. In particular the Committee will be involved in reviewing and evaluating progress and outcomes from implementing the Coastal Zone Management Plan.	Council Environmental Services

Note: Additional Information for Actions C7.1 is available in section 2.4.

3.2.2 Local area plans

Six local area plans are tailored to the coastal risks and issues of concern for areas made up of small communities along the Shoalhaven coast.

The six areas align with Council's community engagement framework and are based on areas of similar physical and social coastal character, such as:

- Coastal embayments and sediment compartments, bounded by major headlands
- Similar types of settlements
- Land use and land tenure (e.g. areas dominated by national park lands or by tourism and recreation uses)
- General locality and access.

3.2.2.1 Plans and actions to care for local areas

Each local area plan provides a brief introduction to the character of the area and the priority local issues. These issues are derived from the coastal erosion risks, coastal slope instability risks and community input on other important matters. Coastal hazard maps are provided for each area.

The six local area plans give more detail about how the whole of coast strategies (Strategies 1 to 7) will be implemented at the local scale. They show how different aspects of coastal zone management fit together for each local area along the coast.

The implementation priority for actions is shown is Section 4.

For each of the local areas, the following general information applies regarding Aboriginal cultural heritage, bushcare and land management arrangements in coastal reserves.

3.2.2.2 Aboriginal cultural heritage

Aboriginal people have used the rich resources of the South Coast for more than 20,000 years and this long association continues today. Therefore, much of the coastline has the potential to contain important Aboriginal cultural heritage items.

Council uses the NSW Aboriginal Heritage Impact Management System (AHIMS) database through its internal GIS system to assist staff with the identification of known sites. Council follows the NSW Due Diligence Code of Practice for the Protection of Aboriginal Objects when carrying out activities that may harm Aboriginal objects.

Council also works closely with NSW Office of Environment and Heritage to protect Aboriginal objects. Through an Aboriginal Heritage Impact Permit (AHIP) Council applies for consent to undertake works that may harm Aboriginal objects across the coastal landscape. Information from the cultural heritage reports (included in the AHIP applications), together with other local knowledge, is provided in the introduction to each Local Area Plan.

3.2.2.3 Bushcare

Bushcare Groups supported by Council operate at most beaches with an urban interface. Activities generally focus on ecological restoration on dunes and in coastal reserves. Bushcare groups are valuable partners for ecosystem management in coastal areas where active groups exist.

3.2.2.4 Land management arrangements in coastal reserves

The total area of coastal reserves (excluding national parks and state forests) in the Shoalhaven local government area (LGA) is approximately 2,085 ha.

Figure 3.2 below shows the breakdown of tenure and management of these reserves.

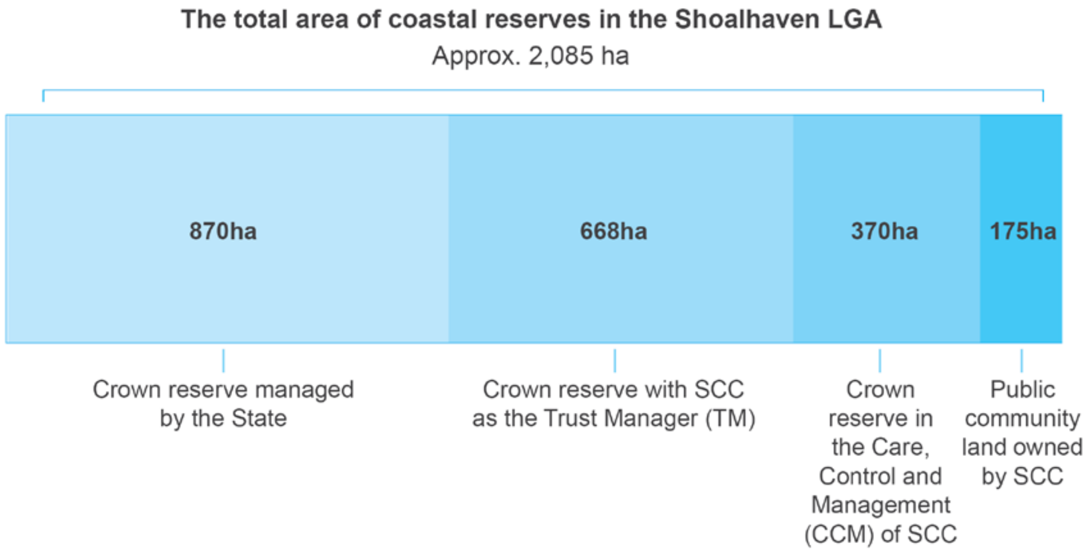


Figure 3-2 – Coastal reserve land tenure/management arrangements

The Crown Land Management Act 2016 will come into force on Sunday 1 July 2018. From the commencement of the new Act, Council will be automatically appointed as Crown land manager for all reserves which they are currently the appointed reserve trust manager. The Act authorises councils to manage this Crown land as if it were public land under the Local Government Act 1993 (LG Act) with the default classification of community land.

It will be important that council prepares plans of management under the LG Act for coastal Crown land that it manages, and that these plans align with relevant strategies and actions in this CZMP.

Depending on the management arrangements in place for coastal Crown land affected by the actions set out in this CZMP, Council may need to consult with and seek approval from the Department of Industry – Lands & Water (Crown Lands), to carry out activities and works on this land, for example to construct foreshore coastal protection works, dredging and beach nourishment, beach scraping activities. Approvals will be subject to a range of considerations including potential impacts on the environment and coastal processes, beach amenity and access.

Where actions are proposed on Crown land, Aboriginal Land Claims lodged under the NSW Aboriginal Land Rights Act 1983 must be considered. In addition, any works will need to be compliant with the Commonwealth Native Title Act 1993.

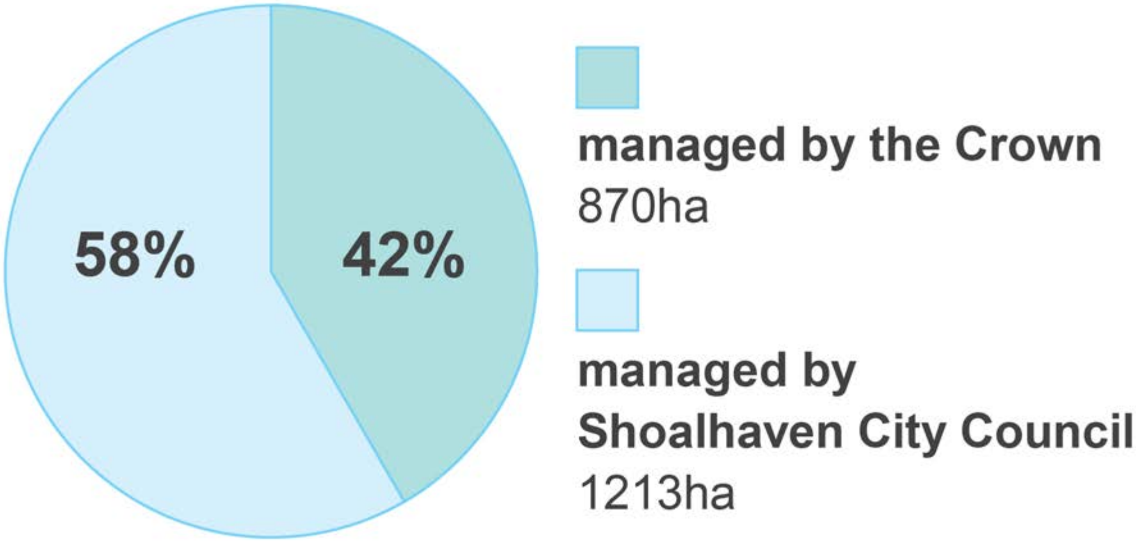


Figure 3-3 – Management responsibility of coastal reserves

Generally, Crown land identified as ‘local land’ will be transferred to Council, as community land. The proportion of Crown land that Council manages is therefore likely to change.

The other major change will allow Council to apply the *Local Government Act* to locally significant Crown land. The requirement to develop plans of management for each reserve will be phased in over time.

Council consults with, and seeks approval from, the Department of Industry to carry out activities such as foreshore protection works on Crown reserves still managed by the NSW Government.

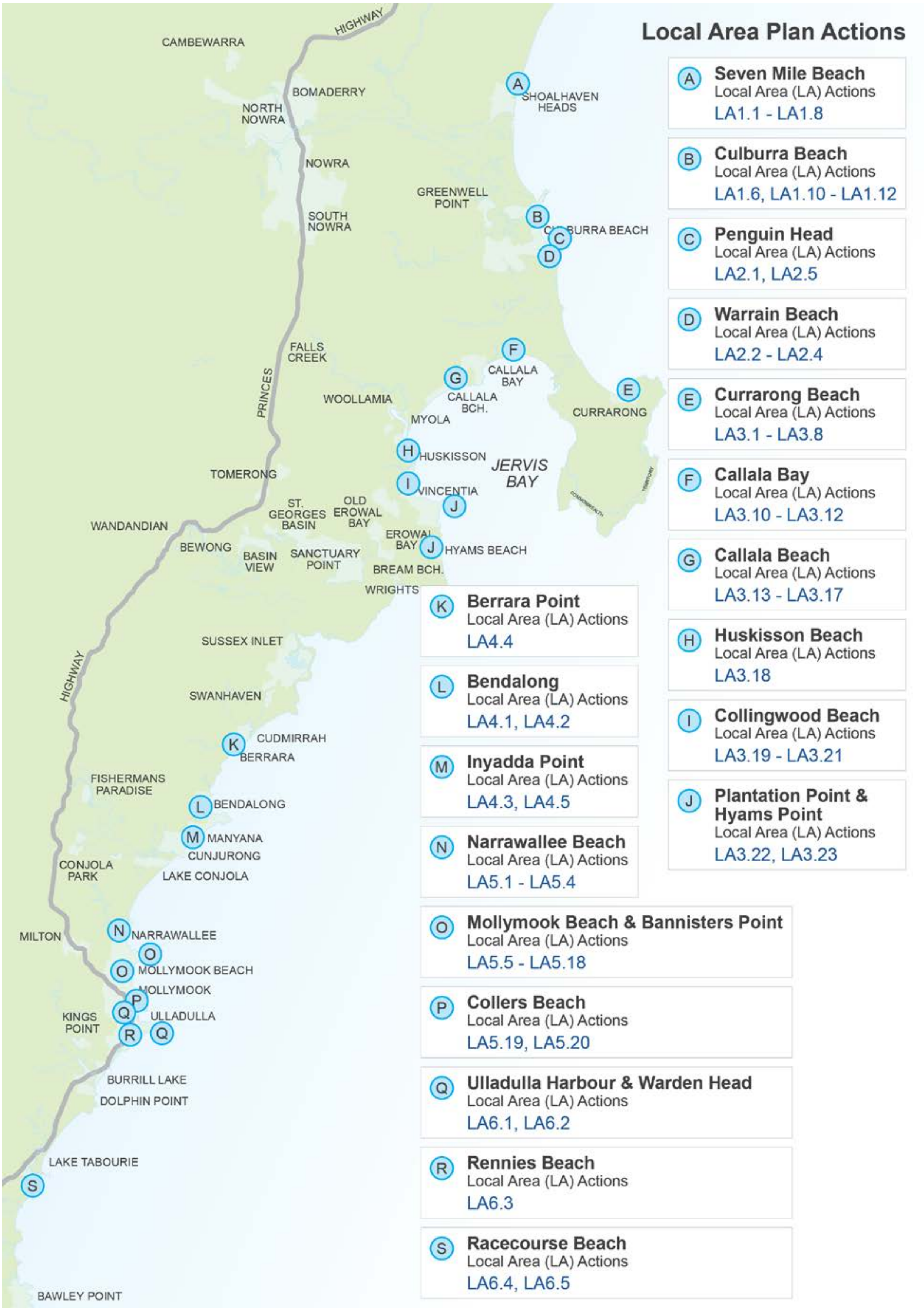


Figure 3-4 - Local Area Plan Actions

Local Area Plan 1: Seven Mile Beach and Culburra Beach

This area includes the long barrier beaches to the north and south of the mouth of the Shoalhaven River estuary. Settlements are separated by national park and nature reserve.

Shoalhaven Heads is a small coastal town on the northern side of the Shoalhaven River entrance. There is a large tourist park, located near the surf club and patrolled beach area. South of the Crookhaven River, Culburra, has access to two long ocean beaches; Culburra Beach and Warrain Beach (see Local Plan Area 2 for Warrain Beach).

Identified Aboriginal cultural heritage values in this area focus mainly on Crookhaven Headland. It was, and continues to be, a focal point for traditional cultural activities. The Jerrinja Aboriginal people have continued to live in the area adjacent to the headland at 'Roseby Park' (formerly an Aboriginal reserve). This is also the location of the Jerrinja Local Aboriginal Land Council office.

An Aboriginal Cultural Heritage Report (1998), prepared for the Crookhaven Headland Plan of Management, notes that the area 'has been the subject of archaeological inspection and recording since the early 1970s .. providing insight into the cultural significance and values attached to the area.' The Aboriginal Site Register records several of these: a natural ceremonial King's Chair, natural water holes, ceremonial artefacts, shell middens (one with quartz flakes), a tribal burial and a traditional swimming hole. While most of these items are representative of coastal archaeological sites, the ceremonial artefacts site (concealed) is very rare and the King's Chair is unique.

Key issues

Figures 3.5 and 3.6 show coastal hazards for these localities.

Shoalhaven Heads

Community infrastructure (SLSC, SLSC car park, boatshed, viewing platform) is at ***high*** risk rating in 2050.

SLSC is at ***extreme*** risk rating in 2100.

River and oceanic flooding of low lying residential areas.

Threats to shore bird habitat from recreational use.

Spacing of access tracks and general compatibility of diverse beach uses.

Culburra (Culburra Beach)

Large car park and access loop road is at ***high*** risk rating in 2050.

Other issues and risks

More than 30 lots could be affected by coastal erosion in the 2050 planning period.

Other community infrastructure (including car parks) and wastewater infrastructure is at low/ medium risk in 2050 planning period.

Shoalhaven Heads SLSC 1978 Storm

Culburra Beach

Table 3-11 – Local Area Plan 1 Actions - Seven Mile Beach, Culburra Beach

Strategic risk management

Accommodate coastal change (short term), moving to managed retreat. Shoalhaven Heads Surf Club is already protected by rock revetment which changes the likelihood of coastal hazard impacts.

Triggers for change

- Asset life of Shoalhaven Heads Surf Club
- Asset life of sewerage and water infrastructure
- Cost benefit of ongoing rock protection at Shoalhaven Heads Surf Club and capacity to mitigate offsite impacts.

Note: For major infrastructure assets subject to a high or extreme level of risk, a trigger distance greater than 20m would be appropriate to change from a monitoring and reporting approach to detailed feasibility and design studies and/or to on ground works (protection or relocation). The appropriate trigger is influenced by the type of asset, expected asset life, local risk to the asset and the types of risks associated with failure.

Action	What is proposed	Responsibility	Status
Seven Mile Beach			
LA1.1	Assess the condition of the rock revetment in front of the Shoalhaven Heads Surf Club if and when it's exposed during a major storm. The revetment was designed and constructed following the 1970s storms	Council Asset Management and Environmental Services	
LA1.2	Audit site constraints and foundation capacity for the Shoalhaven Heads surf club, to inform decisions about the timing of relocation	Council Asset Management	
LA1.3	Investigate zoning, land tenure and approval processes for relocation of the Shoalhaven Heads Surf Club landward of its current position, outside the 2050 coastal erosion risk area. The move will be triggered by the asset life of the existing building, or significant storm damage to the building, and the cost compared to the benefit of maintaining the existing rock protection. This surf club was seaward of the dune alignment after the 1974 storms.	Council Asset Management in consultation with DoI – Crown Lands & Water	
LA1.4	Depending on outcome of LA1.3, at end of building asset life or in the event of significant storm damage, relocate surf club landward and construct on deep piled foundations.	Council Asset Management in consultation with DoI – Crown Lands & Water	
LA1.5	Prepare a dune action plan to manage the dune height and beach access in front of the Shoalhaven Heads SLSC. Lower dune if needed for safety.	Council Environmental Services	Initial dune lowering, conducted in December 2017.
LA1.6	Maintain dune vegetation at both Shoalhaven Heads and Culburra to promote dune stability and minimise loss of sand from the littoral systems that would contribute to long term recession of the beach.	Council Environmental Services	Beach surveys are undertaken by Council following significant storm events.
LA1.7	Develop a design for reuse of excavated 'dry notch' (flood notch) sand, and other suitable sand, at the river entrance for: • Erosion sites fronting River Road • Low dune crest locations • The northern side of the entrance area, to increase the volume of the beach and dunes, and provide interim protection from large southerly waves during storms. **Note that dredging and nourishment works will require approvals under the Crown Lands Act**	In consultation with relevant public authorities including, OEH, DoI – Crown Lands & Water	The River Road Foreshore - Assessment of Coastal Management Options, was prepared following the June 2016 storm and will be implemented during 2018/19.

	1989 or Crown Land Management Act 2016 which commences 1 July 2018.		
LA1.8	Repair and replace or relocate the beach access infrastructure, including viewing platforms, if and when required following a large storm. Consider designing and installing a beach access and viewing platform for people with disabilities where possible as part of future upgrades or replacement where feasible.	Council Environmental Services	
Culburra Beach			
LA1.9	Engage with foreshore reserve property owners, residents and beach goers around the values of dune vegetation (e.g. trapping wind-blown sand and maintaining dune resilience, ecological functions and buffering against coastal hazards, the importance of foreshore vegetation in providing shade and wind protection, filtering runoff, improving water quality and providing habitat).	Council Environmental Services	
LA1.10	Consult with residents along Culburra Beach about reducing the frequency of pedestrian access ways from private dwellings across the dunes. The aim is to reduce pressures on dune vegetation and to enhance the resilience of dune landforms.	Council Environmental Services	

Figure 3-5 - Coastal Hazard Map Seven Mile Beach

Figure 3-6 - Coastal Hazard Map Culburra Beach

Local Area Plan 2: Warrain Beach and Penguin Head

Warrain Beach is a long sandy embayment stretching south from Penguin Head to Beecroft Head and includes the entrance to Lake Wollumboola. Lake Wollumboola is managed by Jervis Bay National Park. The lake and beach are important habitat for migratory shorebirds in the summer months. The local community has strongly supported conservation management of the lake and local beaches to protect natural values and low-key recreation opportunities.

The Nowra Culburra Surf Club is located at the northern end of Warrain Beach.

Identified Aboriginal cultural heritage in this area of the coast consists mainly of middens (17), indicating important food sources for the Jerrinja people. AHIMS also identifies a well or waterhole, many artefacts and a burial site in the dunes at the northern end of Lake Wollumboola.

Aboriginal people camped at Kinghorn Point and around Lake Wollumboola. Kinghorn Point is the subject of an AHIP due to the presence of a shell midden which is being disturbed by vehicle traffic. The road has recently been re-routed (2017) and the area of the carpark reduced. Once the AHIP is completed, repairs to the beach access and dune face will be undertaken. Due the large number of recorded sites, and its proximity to Roseby Park, this coastal area is of high social and cultural value for Aboriginal people.

Key issues

Figures 3.7 and 3.8 show coastal hazards for these localities.

Warrain Beach

Nowra Culburra (Warrain Beach) Surf Club is at ***high*** risk rating in 2050.

Warrain Beach car park and sewerage infrastructure are within the 2050 coastal erosion risk area (low risk rating). .

Shorebird nesting sites near Lake Wollumboola are affected by high tides, wave events and predators.

Penguin Head

Few properties will be affected in the immediate timeframe. However, risk to cliff properties will increase through time (rotational slumping hazards).

There are also concerns about the interaction of vegetation management on headlands and bluffs, and slope instability.

Nowra Culburra Surf Club – Warrain Beach

Penguin Head

Table 3-12 – Local Area Plan 2 Actions - Warrain Beach, Penguin Head

Strategic risk management

Accommodate coastal risks (short term, existing development), moving to managed retreat as coastal recession becomes more apparent. Avoid risk for new development.

Triggers for change

- Asset life of Nowra Culburra (Warrain Beach) Surf Club, car park, public roads and gravity mains

Note: For major infrastructure assets subject to a high or extreme level of risk, a trigger distance greater than 20m would be appropriate to change from a monitoring and reporting approach to detailed feasibility and design studies and/or to on ground works (protection or relocation). The appropriate trigger is influenced by the type of asset, expected asset life, local risk to the asset and the types of risks associated with failure.

Action	What is proposed	Responsibility	Status
LA2.1	At Penguin Head, implement emergency response actions in the Coastal Cliffs and Slopes Emergency Action Sub Plan, Appendix 5, Section 2.1 to manage risk to safety and assets.	Council Environmental Services, Assets & Works	
LA2.2	Audit site constraints and foundation capacity at Nowra Culburra Surf Club to inform decisions about future relocation or reconstruction on deep-piled foundations.	Council Asset Management	
LA2.3	Investigate zoning, land tenure and approval processes for relocation of the Nowra Culburra Surf Club landward of its current position, outside the 2050 coastal erosion risk area. The move will be triggered by the asset life of the existing building or significant storm damage to the building.	Council Assets & Works in consultation with DoI – Crown Lands & Water	
LA2.4	Investigate opportunities for disabled access to the beach at Nowra Culburra Surf Club. Note: Beach wheelchairs are available, free of charge at several locations.	Council Environmental Services and Community & Recreation	Council Disability Inclusion Action Plan 2017, Actions A2.4.6 & 7, refer to improving access to beaches and calm water sites
LA2.5	Undertake a geotechnical assessment to assess the impact of potential cliff and slope instability to provide suitable and site specific Landslide Remediation Management recommendations for the lookout at Penguin Head or consider relocation of this assets where feasible.	Council Environmental Services	

Figure 3-7 - Coastal Hazard Map Warrain Beach

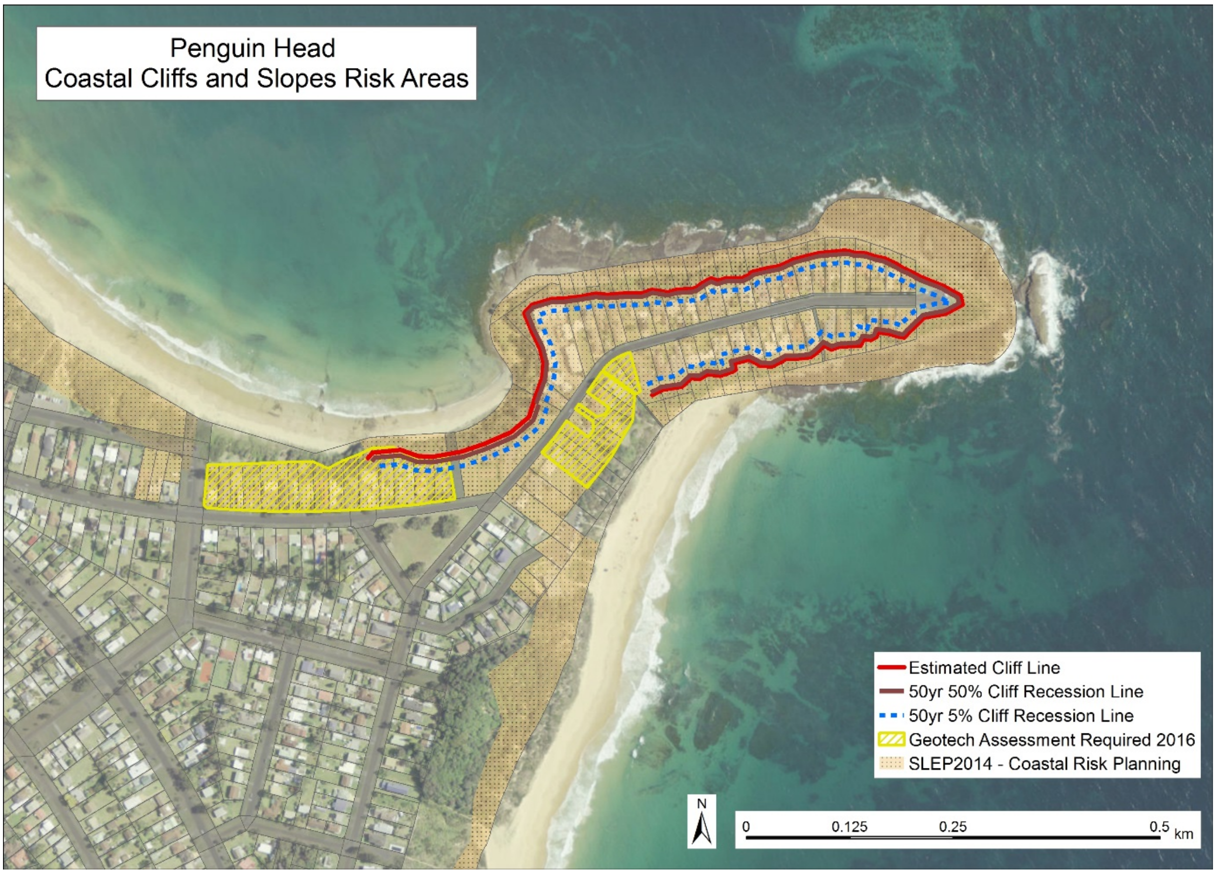


Figure 3-8 - Coastal Cliffs and Slopes Risk Areas Penguin Head

Local Area Plan 3: Jervis Bay Marine Park (JBMP) Area

The Jervis Bay Marine Park area includes the larger centres of Huskisson and Vincentia and the smaller villages of Currarong, Callala Bay, Callala Beach and Hyams Beach. The villages are separated by National Park. The white sands of Jervis Bay, the low wave energy and low gradient beaches are a major attraction for visitors. Both residents and visitors also value foreshore access ways for walking and cycling.

Depending on the direction of the storm, different beaches are impacted. Callala Beach, which faces east, was more exposed to erosion in the 1974 storm. Currarong Beach, which faces north, was more heavily impacted during the June 2016 storm.

The ACHAR prepared for the shared path project on the Callala Bay headland states, 'The wider area is known to contain many archaeological sites and is part of an Aboriginal traditional cultural landscape.' There are middens at Callala Point and on the northern bank of Callala Creek and another large midden of mud oyster was found on the southern side of the headland during investigations for the shared path AHIP.

Another significant midden was exposed at Currarong Beach during the June 2016 ECL.

Key issues

Figures 3.9 to 3.14 show coastal hazards for these localities.

Currarong

Currarong has experienced beach erosion during severe storms over many years.

The June 2016 storm caused severe erosion and all beach access stairs were destroyed.

The eastern end of the beach is at immediate risk, including water infrastructure, community infrastructure, private buildings and several lots.

Community infrastructure (car park, amenities, playground, roads) and water infrastructure is at ***high*** risk rating in 2050.

Council's caravan park and properties on Currarong Creek are potentially affected by flooding.

Callala Bay

A low gradient beach, susceptible to erosion at high tides, with slow recovery.

Access ways and the reserve edge are intermittently undermined.

A coastal hazard study was undertaken in 2003 for Callala Bay. It concluded the boat ramp, constructed in the 1970s interrupted natural sand migration which accelerated erosion on the northern side of the ramp. The new ramp, built in 2000, partially addressed this with a permeable structure and erosion rates have slowed.

No private property will be at risk in the 50 year planning period.

Callala Beach

Sixteen residences are within the immediate coastal erosion risk area (ZSA). Every private property along the seaward side of Quay Rd is partially within the immediate hazard area (ZRFC).

Community infrastructure at immediate risk are the community centre, tennis club and tennis courts.

Currarong - erosion post storm June 2016

Callala Bay - erosion post storm 2005

Callala Beach

Community infrastructure (tennis club and amenities) is at ***high*** risk rating in 2050.

Collingwood Beach

Community infrastructure (car park, picnic shelter, cycleway) and roads (Ilfracombe Ave/ Beach St) are at ***high*** risk rating in 2050.

Ninety lots are potentially affected by coastal recession (ZRFC) by 2100.

Collingwood Beach

Huskisson Beach

Community infrastructure (including picnic shelters and a cycleway) have been identified as being in the erosion hazard area at Huskisson Beach.

There are no private properties at risk from coastal erosion at Huskisson Beach.

Huskisson

Plantation Point and Hyams Point

At Plantation Point the public reserve and Plantation Point Parade are impacted by cliff recession lines.

Plantation Point

Hyams Point

Table 3-13 – Local Area Plan 3 Actions - Currarong Beach

<table>
<tr><td colspan="4">Strategic risk management
Accommodate change by protecting healthy natural systems and building community capacity, with preparation for long-term managed retreat of community infrastructure and assets and planning controls to prevent increases in risk. In the short to medium term, accommodate change by building community capacity and by targeted land management, combined with planning controls to avoid future risk. For Currarong, this includes immediately trialling limited coastal protection works.
Triggers for change
Note: For major infrastructure assets subject to a high or extreme level of risk, a trigger distance greater than 20m would be appropriate to change from a monitoring and reporting approach to detailed feasibility and design studies and/or to on ground works (protection or relocation). The appropriate trigger is influenced by the type of asset, expected asset life, local risk to the asset and the types of risks associated with failure.</td></tr>
<tr><th>Action</th><th>What is proposed</th><th>Responsibility</th><th>Status</th></tr>
<tr><td colspan="4">Currarong Beach</td></tr>
<tr><td>LA3.1</td><td>Undertake technical studies to investigate the feasibility of medium term, to long term, relocation of water and road infrastructure along the eastern end of Warrain Crescent to the landward boundary of housing lots – currently these assets are on the seaward boundary. Similarly, where sewerage infrastructure is provided, investigate feasibility of locating it to a more landward position.</td><td>Council Asset Management
and Shoalhaven Water</td><td></td></tr>
<tr><td>LA3.2</td><td>Undertake a detailed, technical investigation of coastal hazard management options for Currarong Beach that are feasible for this location, cognisant of coastal processes and risks (over defined timeframes), as well as the social, environmental and economic impacts of the options, including its benefits and costs. Develop and implement a management strategy in consultation with key stakeholders including DoI Crown Lands.
Currarong Beach is a receding beach (Advisian 2016) and, following the June 2016 ECL, the beach was left vulnerable with a major erosion scarp and 20,000m^3 of sand lost. It became clear that beach erosion remediation measures, investigated in 2011 (SMEC) needed to be reassessed. This is to reduce risks to erosion of the dune, the beach and public access to it, public reserve, the road (Warrain Cres), water and sewage infrastructure.
Prepare asset management plan for any erosion and remediation works to ensure ongoing maintenance as required, monitoring program to determine efficacy of works and management of any impacts.</td><td>Council Environmental Services in consultation with DoI – Crown Lands & Water, OEH and JBMP (for necessary approvals and permits)</td><td>Draft technical design report and REF for the trial groyne, beach nourishment and beach access works, are complete. The REF includes arrangements for monitoring, maintenance and managing impacts associated with the works, during the 5 year trial. Approvals and feedback being sought from NSW Government. All design, reports and works are subject to an Aboriginal Heritage Impact Assessment and Permit and ongoing community consultation.
Works subject to community consultation, obtaining necessary approvals and budget availability.</td></tr>
<tr><td>LA3.3</td><td>Undertake a detailed, technical investigation of coastal hazard management options for shoreline in front of Beecroft Parade, that are feasible for this location, cognisant of coastal processes and risks (over defined time frames), as well as the social, environmental and economic impacts of the options, including its benefits and costs. Develop and implement a management strategy</td><td>Council Environmental Services in consultation with DoI – Crown Lands & Water, OEH and JBMP</td><td>The report above includes a design option for protection works at Beecroft Parade. Draft technical design report and REF are complete. The REF includes arrangements for monitoring, maintenance and managing impacts associated</td></tr>
</table>

	in consultation with key stakeholders including DoI Crown Lands. Currarong coast faces north, erosion impacts were severe as a result of the June 2016 storm, including the shoreline in front of Beecroft Parade. Any erosion and remediation works will include an asset management plan to ensure ongoing maintenance as required and management of any impacts.		with the works. Approvals and feedback being sought from NSW Government. All design, reports and works are subject to an Aboriginal Heritage Impact Assessment and Permit and ongoing community consultation. Works subject to community consultation, obtaining necessary approvals and budget availability
LA3.4	Undertake a cost benefit analysis, if required, for the erosion protection works in LA3.2 and LA3.3 above	Council Environmental Services in consultation with DoI – Crown Lands & Water, OEH and JBMP	
LA3.5	Undertake ongoing regular foreshore profile surveys to inform refinement of erosion/ long term recession hazard for Beecroft Parade area.	Council Environmental Services	Monitoring will begin following completion of works
LA3.6	Monitor dune crest and profile. Manage dune heights with beach scraping and dune nourishment, if sand source is available Note that beach scraping and nourishment works may require approvals under the Crown Lands Act 1989 or Crown Land Management Act 2016 which commences 1 July 2018.	Council Environmental Services in consultation with DoI – Crown Lands & Water, OEH and JBMP	Beach surveys are undertaken by Council following significant storm events
LA3.7	Construct two beach accesses between Warrain Crescent and Peel Street. This will provide Currarong Beach with five reconstructed beach accesses, all of which were destroyed in the June 2016 storm.	Council Environmental Services in consultation with DoI – Crown Lands & Water, OEH and JBMP	Works subject to community consultation, obtaining necessary approvals and budget availability
LA3.8	Re-route the Peel Street beach access to address sand loss from beach. Fence and revegetate the nourished dune and beach accesses that have been closed to stabilise the dune	Council Environmental Services in consultation with DoI – Crown Lands & Water, OEH and JBMP	Works subject to community consultation, obtaining necessary approvals and budget availability. Fencing and revegetation works will be undertaken following completion of the erosion remediation works.
LA3.1, LA3.2, LA3.3, LA3.7 and LA3.8	Location of proposed actions LA3.1, LA3.2, LA3.3, LA3.7 and LA3.8		

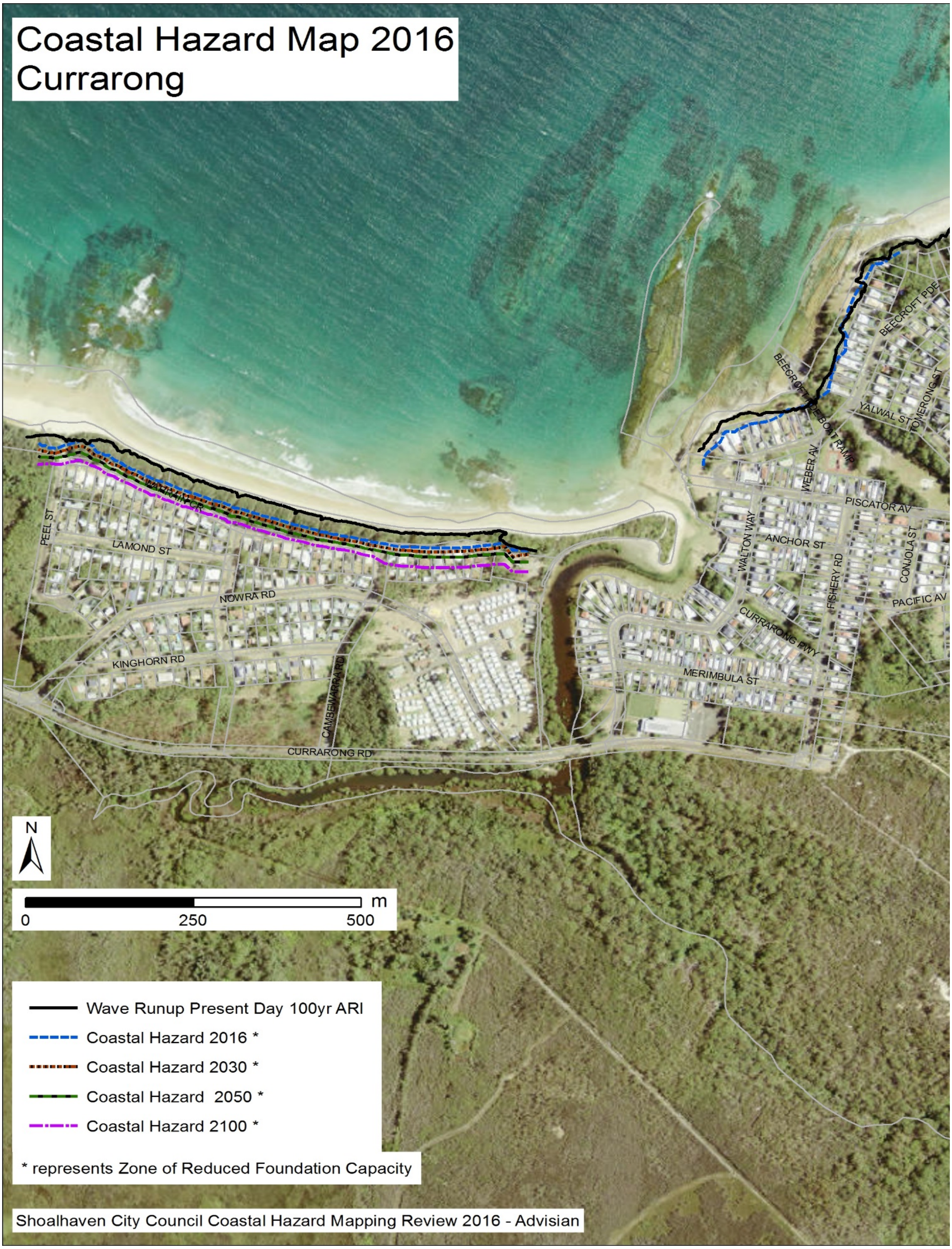


Figure 3-9 - Coastal Hazard Map Currarong

Table 3-14 – Local Area Plan 3 Actions - Callala Bay, Callala Beach

Strategic risk management

Accommodate change by protecting healthy natural systems and building community capacity, with preparation for long term managed retreat of community infrastructure and assets and planning controls to prevent increases in risk. In the short to medium term, accommodate change by building community capacity and by targeted land management, combined with planning controls to avoid future risk.

Triggers for change

Note: For major infrastructure assets subject to a high or extreme level of risk, a trigger distance greater than 20m would be appropriate to change from a monitoring and reporting approach to detailed feasibility and design studies and/or to on ground works (protection or relocation). The appropriate trigger is influenced by the type of asset, expected asset life, local risk to the asset and the types of risks associated with failure.

Action	What is proposed	Responsibility	Status
Callala Bay			
LA3.9	Undertake a detailed, technical investigation of small scale coastal hazard management options that are feasible at Callala Bay to protect public infrastructure if required, cognisant of coastal processes and risks (over defined time frames), as well as the social, environmental and economic impacts of the options, including its benefits and costs. Develop and implement a management strategy in consultation with key stakeholders including DoI Crown Lands.	Council Environmental Services and Asset Management in consultation with DoI – Crown Lands & Water, OEH and JBMP	
LA3.10	Investigate foreshore protection options to stabilise the shoreline at Sheaffe Street, Callala Bay. The works are proposed to protect the road, control storm water flows across the beach and slow loss of sand to the north.	Council Asset Management	A draft landscape plan has been prepared for the area between Sheaffe St and the sailing club. It includes storm water redesign and rock protection. The plan is yet to be adopted by Council.
LA3.11	Investigate site constraints (coastal hazards, topography and land availability) and foundation capacity of the Callala Bay Sailing Club to inform management of this asset.	Council Asset Management	
Callala Beach			
LA3.12	At Callala Beach, monitor dune crest levels. A minimum of 6.0m AHD may minimise the risk of wave overtopping. Options for managing dune heights include beach scraping and dune nourishment, if sand source is available. Note that beach scraping and nourishment works are likely to require approvals under the Crown Lands Act 1989 or Crown Land Management Act 2016 which commences 1 July 2018.	Council Environmental Services in consultation with DoI – Crown Lands & Water, OEH and JBMP	Beach surveys are undertaken by Council following significant storm events
LA3.13	Monitor beachfront area and implement post-storm emergency action measures when required to repair or replace public beach access	Council Environmental Services	

LA3.14	Investigate future relocation of tennis club and amenities. Audit site constraints and foundation capacity of community buildings and infrastructure. Apply requirements of Shoalhaven DCP to future upgrades of tennis club buildings and infrastructure as well as development on private lots.	Council Environmental Services, Asset Management and specialist consultants as required.	
LA3.15	Engage with foreshore reserve property owners, residents and beach goers around the values of dune vegetation (e.g. trapping wind-blown sand and maintaining dune resilience, ecological functions and buffering against coastal hazards, the importance of foreshore vegetation in providing shade and wind protection, filtering runoff, improving water quality and providing habitat)	Council Environmental Services	
LA3.16	Consult with residents along Callala Beach about reducing the frequency of pedestrian access ways from private dwellings across the dunes. The aim is to reduce pressures on dune vegetation and to enhance the resilience of dune landforms, while still providing access ways in appropriate locations along the beach.	Council Environmental Services	

Figure 3.10 - Coastal Hazard Map Callala Beach

Table 3-15 – Local Area Plan 3 Actions - Huskisson Beach, Collingwood Beach

Strategic risk management

Accommodate change by protecting healthy natural systems and building community capacity, with preparation for long term managed retreat of community infrastructure and assets and planning controls to prevent increases in risk. In the short to medium term, accommodate change by building community capacity and by targeted land management, combined with planning controls to avoid future risk.

Triggers for change

Note: For major infrastructure assets subject to a high or extreme level of risk, a trigger distance greater than 20m would be appropriate to change from a monitoring and reporting approach to detailed feasibility and design studies and/or to on ground works (protection or relocation). The appropriate trigger is influenced by the type of asset, expected asset life, local risk to the asset and the types of risks associated with failure.

Action	What is proposed	Responsibility	Status
Huskisson Beach			
LA3.17	Continue to consult with the community and implement the Huskisson Beach Management Action Plan.	Council Environmental Services and Assets & Works	Ongoing operational works
Collingwood Beach			
LA3.18	Initiate technical studies to investigate feasibility of future relocation of sewerage infrastructure along the beach front reserve at Collingwood Beach, between Argyle and Berry Streets	Council Asset Management and Shoalhaven Water	
LA3.19	At Collingwood Beach, monitor dune crest levels to minimise wave overtopping onto shared path and road, accept risk and repair cycleway if subject to erosion. A minimum of 5.0m AHD may minimise the risk of wave overtopping. Manage dune heights with beach scraping and dune nourishment, if sand source is available. Note that beach scraping and nourishment works are likely to require approvals under the Crown Lands Act 1989 or Crown Land Management Act 2016 which commences 1 July 2018.	Council Environmental Services team in consultation with DoI – Crown Lands & Water, OEH and JBMP.	Beach surveys are undertaken by Council following significant storm events
LA3.20	Implement a two-year trial at two sites – one for revegetation and one for managing views (resolved by Council following preparation of a draft vegetation management plan for the Collingwood Beach Reserve). Any vegetation action plan must reduce the likelihood of erosion (Advisian 2018).	Council Environmental Services in consultation with DoI – Crown Lands & Water, JBMP, OEH and community.	Council resolved to implement a 5 year trial in two sites – one for revegetation and one for selected pruning.
Plantation Point and Hyams Point			
LA3.21	At Plantation Point and Hyams Point, implement emergency response actions in the draft Coastal Cliffs and Slopes Emergency Action Sub Plan, Appendix 5, Sections 2.2 and 2.3 to manage risk to safety and assets.	Council Environmental Services	The draft Coastal Cliffs and Slopes Emergency Action Sub Plan is yet to be adopted by Council
LA3.22	Investigate opportunities for disabled access at Plantation Point (Barfleur Beach)	Environmental Services and Recreation and Community	Council's Disability Inclusion Action Plan 2017, Actions A2.4.6 & 7, refer to improving access to beaches and calm water sites

Figure 3.11 - Coastal Hazard Map Huskisson Beach

Figure 3.12 - Coastal Hazard Map Collingwood Beach

Figure 3.13 - Coastal Cliffs and Slopes Risk Areas Plantation Point

Figure 3.14 - Coastal Cliffs and Slopes Risk Areas Hyams Point

3.2.2.5 Beach management in Jervis Bay Marine Park

http://www.nationalparks.nsw.gov.au/visit-a-park/parks/jervis-bay-national-park

Private and public assets are at risk from coastal erosion and recession at four villages adjacent to the Jervis Bay Marine Park. For each of these locations, the proposed management includes beach scraping to manage the local sand resources to provide a more resilient frontal dune system. Beach scraping is defined (Carley et. al. 2010) as 'the movement of sand from the intertidal zone to the dune or upper beach by mechanical means.' Beach scraping is designed to mimic and speed up natural beach and dune recovery processes after storms. It does not involve importing sand from outside the active littoral compartment of the beach.

The foreshore around Jervis Bay lies within the Jervis Bay Marine Park. The villages where beach scraping works are proposed are within Habitat Protection Zones in the Park. Any action that has the potential to disturb habitat within the Jervis Bay Marine Park must comply with the *Marine Estate Management Act 2014*, Regulations and Zoning.

Marine Parks (Zoning Plans) Regulation (1999), Clause 1.13, specifically addresses dredging for beach replenishment in Sanctuary Zones in Jervis Bay Marine Park. Beach scraping is within the definition of dredging for beach replenishment in the Regulation.

Beach replenishment activity means the excavation of or extraction of sand or other material for the purpose of replenishing a beach. Dredging activity means any activity that involves the excavation of land submerged (whether permanently or intermittently) by water.

Under Clause 1.13 it is an offence to carry out dredging for beach replenishment without the consent of the relevant Minister. In particular, the Minister must not grant consent for dredging for beach replenishment in a sanctuary zone unless the Minister is (a) satisfied that the activity is necessary to prevent a serious risk of injury to a person, damage to property or harm to the environment, or (b) the activity is dredging activity and it is being carried out as part of an organised research activity.

To carry out beach scraping (or other beach replenishment) and dune nourishment works at beaches around the shore of Jervis Bay or at Currarong, Council must first obtain the consent of the Ministers responsible for Marine Parks and Primary Industries, and Environment.

Separately, the Fisheries Management Act sets out provisions to protect marine vegetation (mangroves, seagrass and seaweeds whether alive or dead) from 'harm'. 'Harm' includes 'gather, cut, pull up, destroy, poison, dig up, remove, injure, prevent light from reaching or otherwise harm the marine vegetation, or any part of it'. A permit is required from NSW Department of Primary Industries to harm marine vegetation, including seagrasses. NSW Department of Primary Industries will generally not permit collection of seagrass from declared Intertidal Protected Areas, Aquatic Reserves and Marine Parks (NSW Department of Primary Industries 2007). These regulations mean that Council must be able to demonstrate that proposed intertidal beach scraping will not harm seagrass (alive or dead).

There is relatively limited research evidence about the significance of impacts of beach scraping on beach biodiversity, particularly in low wave energy environments such as Jervis Bay and/or environments where there is a low level of other disturbance. As part of proposed beach scraping activities, Council proposes to continue investigations of baseline ecological condition and diversity for affected beaches and monitor changes over time. The monitoring program will be established in consultation with Department of Primary Industries Fisheries.

Local Area Plan 4: Berrara, Bendalong, Inyadda Point, Manyana

The coastline of the central Shoalhaven is highly valued by residents and visitors for the natural environment. Recreational values are based on beaches, estuary swimming, good surfing breaks, fishing (rock, estuary and near shore) and coastal walks.

There are multiple coastal walking tracks that pass through coastal reserves and connect the villages, as well as short local area walks along coastal creeks and lagoon shorelines.

The villages are popular family holiday destinations, with camping grounds and cabin accommodation. Peak summer population is three to five times the normal population of the villages. Unlike the larger centres to the north and south, the area is still not crowded for most of the year.

Identified Aboriginal cultural heritage in this area of the coast consists of middens, stone artefacts and, in two locations, burials. Boat Harbour beach at Bendalong has been the focus of an AHIP to begin beach remediation works and a range of other operational activities. The ACHAR refers to a burial that was discovered many years ago under a fire pit, a midden and silcrete artefacts. At another recorded site closer to Manyana, more silcrete artefacts were found, together with a midden, on either side of a creek. At Conjola, skeletal remains were exposed following erosion of the sand dune on the southern side of the lake.

Key issues

Figures 3.15 and 3.17 show the coastal hazard areas.

Residential areas are not affected by beach erosion hazards.

Properties at Berrara Point and Inyadda Point are impacted by cliff recession lines.

Visitor infrastructure, including walking paths, picnic areas and boat ramps, is low key.

High value ecological communities are affected by invasive species.

Berrara

Bendalong

Boat Harbour Beach Bendalong emerged as being at risk of coastal erosion following the June 2016 storm.

A Coastal Hazard report was prepared as for other coastal erosion risk beaches.

Red Point Rd (beach access road only) is at ***high*** risk rating at 2050.

Bendalong

Table 3-16 – Local Area Plan 4 Actions - Berrara, Bendalong, Manyana

Strategic risk management In the short to medium term, accommodate change by building community awareness and capacity and the resilience of natural systems. Monitor actual changes in slope instability hazards; use planning controls to require additional knowledge of hazards. **Triggers for change** Note: For major infrastructure assets subject to a high or extreme level of risk, a trigger distance greater than 20m would be appropriate to change from a monitoring and reporting approach to detailed feasibility and design studies and/or to on ground works (protection or relocation). The appropriate trigger is influenced by the type of asset, expected asset life, local risk to the asset and the types of risks associated with failure.			
Action	**What is proposed**	**Responsibility**	**Status**
LA4.1	Prepare and implement the Boat Harbour Master Plan and the Stormwater Upgrade Plan	Council Environmental Services, Recreation & Community and Asset Management	
LA4.2	Prepare and implement bush regeneration plan for coastal reserves around the Bendalong Point Holiday Haven Tourist Park	Council Environmental Services and Holiday Haven	Prepare plan 2018 -19
LA4.3	At Inyadda Point, implement emergency response actions in the draft Coastal Cliffs and Slopes Emergency Action Sub Plan, Appendix 5, Section 2.5 to manage risk to safety and assets.	Council Environmental Services	
LA4.4	At Berrara Point, implement emergency response actions in the draft Coastal Cliffs and Slopes Emergency Action Sub Plan, Appendix 5, Section 2.4 to manage risk to safety and assets.	Council Environmental Services	
LA4.5	Rehabilitate the landslide area on public land at Inyadda Point consistent with the Landslide Risk Assessment undertaken for this area[10]	Council Environmental Services and Development Services	

[10] Coffey 2016

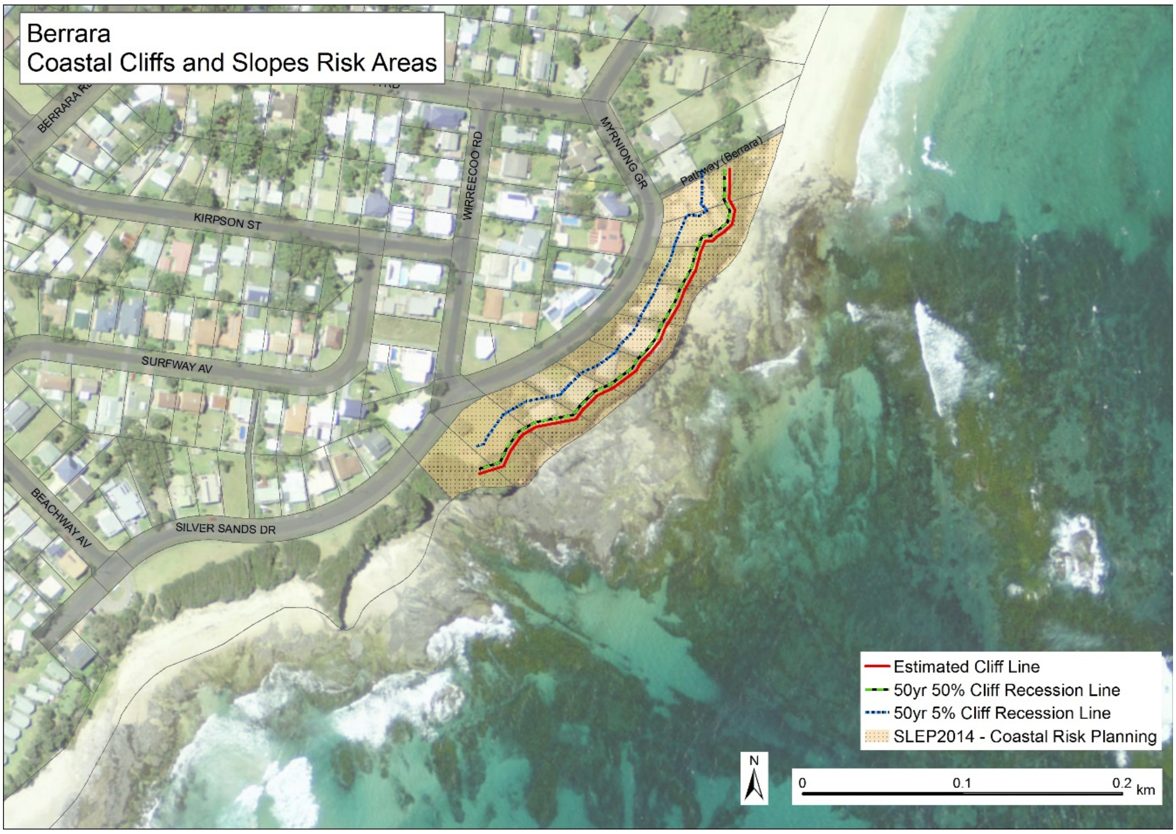


Figure 3.15 - Coastal Cliffs and Slopes Risk Areas Berrara

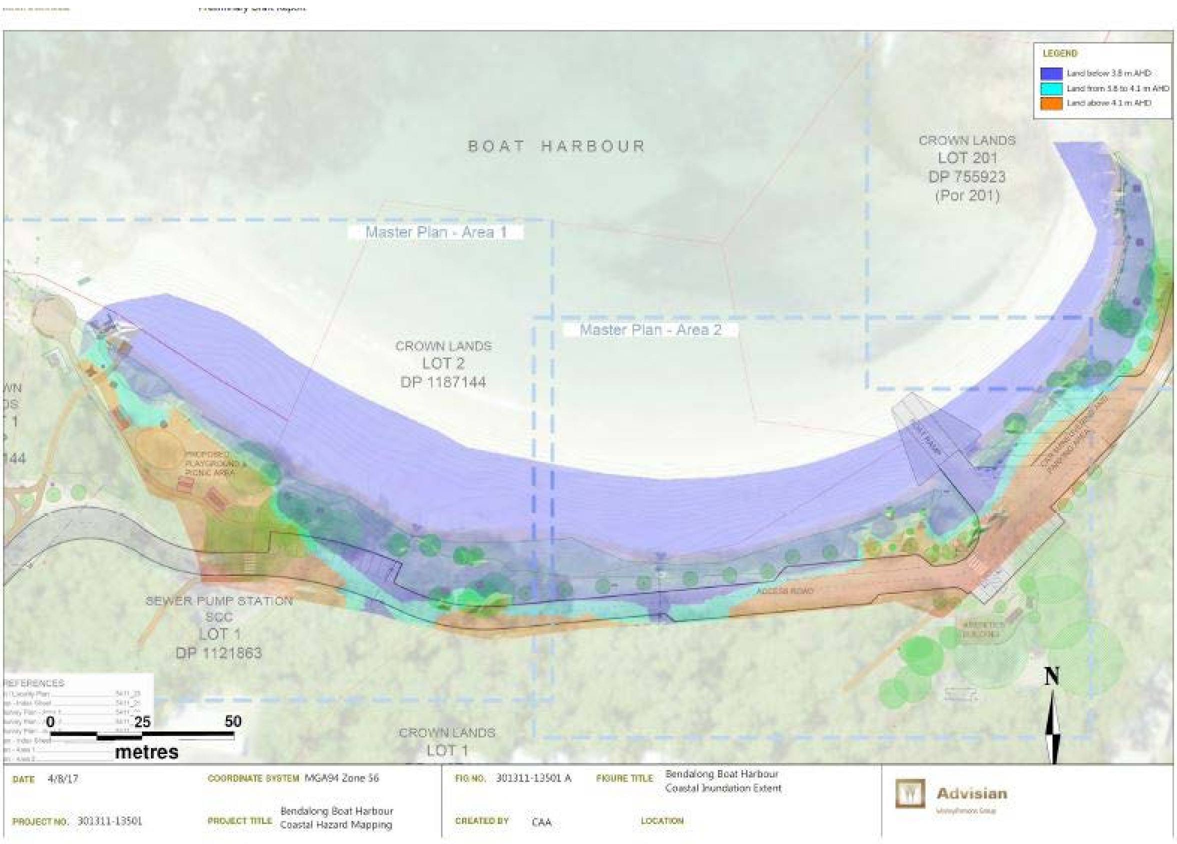


Figure 3.16 - Bendalong Boat Harbour Risk Map

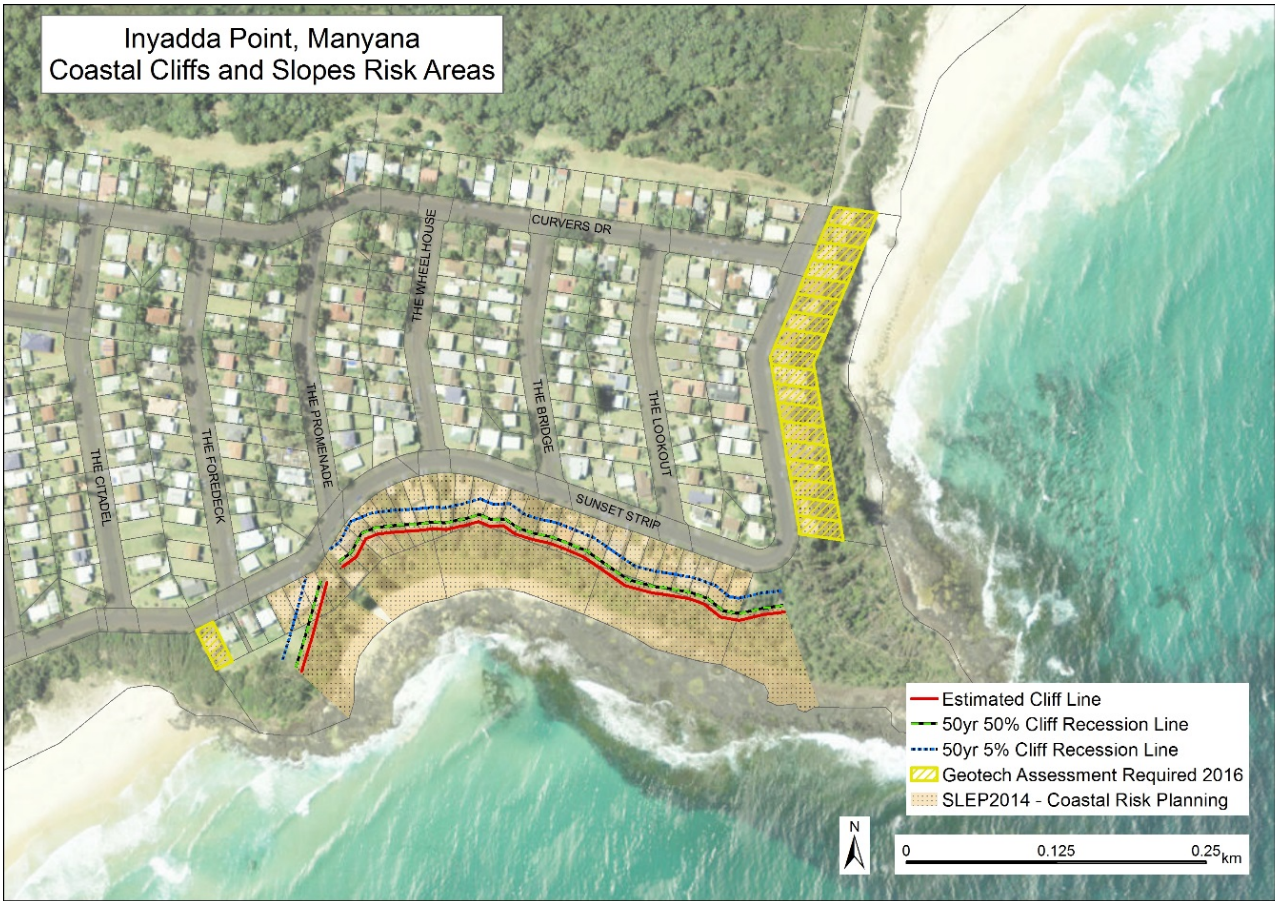


Figure 3.17- Coastal Cliffs and Slopes Risk Areas Inyadda Point, Manyana

Local Area Plan 5: Narrawallee Beach, Bannisters Point, Mollymook Beach and Collers Beach

Narrawallee is an established residential area, separated from Mollymook by bushland reserve and Bannisters Point. Residential development is separated from the beach by an extensive bushland foreshore reserve, enhancing the 'natural' atmosphere.

Mollymook and Bannisters Point is an established seaside residential area, developed in the 1960s and 1970s. Mollymook is a highly urbanised beach with very high summer visitation rates. The Mollymook Surf Club is at the southern end of the beach and both ends of the beach are patrolled during peak holiday times. The Mollymook Golf Club is also at the southern end of the beach. Low dunes and narrow foreshore reserves provide easy public beach access at multiple locations.

Collers Beach is a pocket beach, just south of Mollymook Beach with high value, residential development immediately adjacent.

There are few recorded Aboriginal sites in this area as most of the subdivision development occurred in the 1960s and 70s. There is one recorded midden site and one unrecorded midden site in Narrawallee although, we can assume that Narrawallee Inlet would have been a valuable food resource for Aboriginal people.

Key issues

Figures 3.18 to 3.22 shows coastal hazard areas.

Narrawallee

Wastewater infrastructure is at ***high*** risk rating at 2050.

Low frontal dunes at the southern end of Narrawallee Beach are susceptible to wave overtopping.

Mollymook

Wastewater infrastructure (small pump station opposite 57 Mitchell Pde) and Golf Club (private) are at ***extreme*** risk rating at 2050, and further wastewater infrastructure (Beach Rd pump station) is at ***extreme*** risk rating at 2100.

Community infrastructure (SLSC), Mitchell Parade and further wastewater infrastructure are at ***high*** risk rating at 2050.

Bannisters Headland is affected by slope instability which affects the safety of public access and the design of private residences.

Collers Beach

Wastewater infrastructure (pump station) is at ***high*** risk rating at 2050.

4 properties require further geotechnical assessment.

Narrawallee

Exposed rock protection Mollymook (adjacent Golf Club) – post storm 2015

Collers Beach

Table 3-17 – Local Area Plan 5 Actions - Mollymook Beach, Narrawallee Beach, Collers Beach

Strategic risk management

Accommodate change by protecting healthy natural systems and building community capacity, with preparation for long term managed retreat of community infrastructure and assets and planning controls to prevent increases in risk. Some assets in this area are already protected by sea walls.

Triggers for change

- Asset life of sea walls, roads, water and sewerage infrastructure.
- Actual recession of the dune escarpment and/or actual changes to slope stability.

Note: For major infrastructure assets subject to a high or extreme level of risk, a trigger distance greater than 20m would be appropriate to change from a monitoring and reporting approach to detailed feasibility and design studies and/or to on ground works (protection or relocation). The appropriate trigger is influenced by the type of asset, expected asset life, local risk to the asset and the types of risks associated with failure.

Action	What is proposed	Responsibility	Status
Narrawallee Beach			
LA5.1	At Narrawallee Beach, monitor dune crest levels. A minimum of 6.0m AHD may minimise the risk of wave overtopping. Options for managing dune heights include post storm beach scraping and dune nourishment, if sand source is available. Note that beach scraping and nourishment works are likely to require approvals under the Crown Lands Act 1989 or Crown Land Management Act 2016 which commences 1 July 2018.	Council Environmental Services in consultation with DoI – Crown Lands & Water	Beach surveys are undertaken by Council following significant storm events
LA5.2	At Surfers Avenue and Bannister Head Road Narrawallee, implement emergency response actions in the draft Coastal Cliffs and Slopes Emergency Action Sub Plan, Appendix 5, Sections 2.6 to manage risk to safety and assets.	Council Environmental Services and Assets & Works	
LA5.3	Investigate whether localised protection for the sewerage assets is required and the feasibility of the relocation of the sewerage infrastructure.	Council Environmental Services and Shoalhaven Water	
LA5.4	Install groundwater monitoring instrumentation at Surfers Avenue and Tallwood Avenue Narrawallee to better understanding of groundwater levels and ground movements.	Council Environmental Services	
Mollymook Beach and Bannisters Point			
LA5.5	Prepare Cost Benefit Analysis to determine the most feasible management option (such as protect or retreat and relocate) at the southern end of Mollymook Beach to protect both public and private assets.	Council Asset Management and Environmental Services in consultation with DoI – Crown Lands & Water and OEH	Cost Benefit Analysis and coastal hazard are currently being prepared. This information will determine future actions
LA5.6	Subject to outcome of LA5.5, consider implementation of recommendations of above mentioned Cost Benefit Analysis, and undertake detailed design, planning and approvals process for works required to protect assets most at risk, such as seawall reconstruction, sandstone block wall, concrete wall and new revetment as required. Modifications should include provision for safe disabled access onto the beach.	Council Asset Management and Environmental Services in consultation with DoI – Crown Lands & Water and OEH	

	If works proceed, prepare an asset management plan for the ongoing maintenance and monitoring.		
LA5.7	Ongoing monitoring of buried training wall at Blackwater Creek to measure effectiveness in mitigating coastal hazards (see location map below).	Council Environmental Services in consultation with DoI – Crown Lands & Water	Annually
LA5.8	A minimum dune height of 5.5m AHD may minimise the risk of wave overtopping. Options for managing dune heights include beach scraping and dune nourishment, if sand source is available. Note that beach scraping and nourishment works are likely to require approvals under the Crown Lands Act 1989 or Crown Land Management Act 2016 which commences 1 July 2018.	Council Environmental Services in consultation with DoI – Crown Lands & Water	Beach surveys are undertaken by Council following significant storms. Dune height was raised to 5.5m AHD in conjunction with construction of the Blackwater Creek training wall in 2016.
LA5.9	At Bannisters Point, implement emergency response actions in the draft Coastal Cliffs and Slopes Emergency Action Sub Plan, Appendix 5, Section 2.7 to manage risk to safety and assets.	Council Environmental Services and Assets & Works	
LA5.10	Audit site constraints and foundation capacity of community buildings and infrastructure at Mollymook, including surf club and wastewater pump stations, to inform decisions about future relocation or reconstruction on deep-piled foundations and timing of these actions may need to be implemented.	Council Environmental Services, Shoalhaven Water and Assets & Works, along with appropriate specialist consultant.	
LA5.11	Undertake technical studies and planning for relocation or protection of Council owned sewer infrastructure including a pipeline and pumping stations that are located seaward of the Mollymook Beach 50 year ZSA (in the areas outside the study area for the cost-benefit study currently underway).	Council Environmental Services, Shoalhaven Water and Assets & Works, along with appropriate specialist consultant.	
LA5.12	Undertake condition assessment of existing training wall at Mollymoke Farm Creek at the northern end of beach.	Council Asset Management	
LA5.13	Investigate localised protection options consistent with the Coastal Erosion Stormwater Impact Assessment (Footprint Sustainable Engineering, 2015) around the two stormwater outlets on Mitchell Parade (e.g. opposite 55 Mitchell Parade) as these are the locations where the Mitchell Parade roadway is at highest erosion risk	Council Asset Management, Shoalhaven Water and Environmental Services.	
LA5.14	Engage with foreshore reserve property owners, residents and beach goers about the values of dune vegetation e.g. trapping wind-blown sand and maintaining dune resilience, ecological functions and buffering against coastal hazards, the importance of foreshore vegetation in providing shade and wind protection, filtering runoff, improving water quality and providing habitat.	Council Environmental Services	
LA5.15	Consult with residents along Mollymook Beach about reducing the frequency of pedestrian access ways from private dwellings across the dunes. The aim is to reduce pressures on dune vegetation and to enhance the resilience of dune landforms, whilst still providing opportunity for passive craft launching	Council Environmental Services	

	ramps and addition of handrails to access way in appropriate locations along the beach.		
LA5.16	Rehabilitate the landslide area at Mitchell Parade if required, consistent with the Landslide Risk Assessment undertaken for this area (Coffey, 2016) and assess and improve drainage and sewer infrastructure in the vicinity of the landslide area where feasible.	Council Environmental Services	
LA5.17	Undertake geotechnical assessment to assess the impact from potential cliff and slope instability to provide suitable and site-specific landslide risk management (LRM) recommendations for lookout at Bannisters Point or consider relocation of assets where feasible.	Council Environmental Services	
Collers Beach			
LA5.18	At Collers Beach cliff, implement emergency response actions in the draft Coastal Cliffs and Slopes Emergency Action Sub Plan, Appendix 5, Sections 2.8 to manage risk to safety and assets.	Council Environmental Services and Assets & Works	
LA5.19	Investigate whether localised protection, redesign or landward relocation of the sewerage assets at Collers Beach is required.	Council Environmental Services, Assets & Works and Shoalhaven Water	

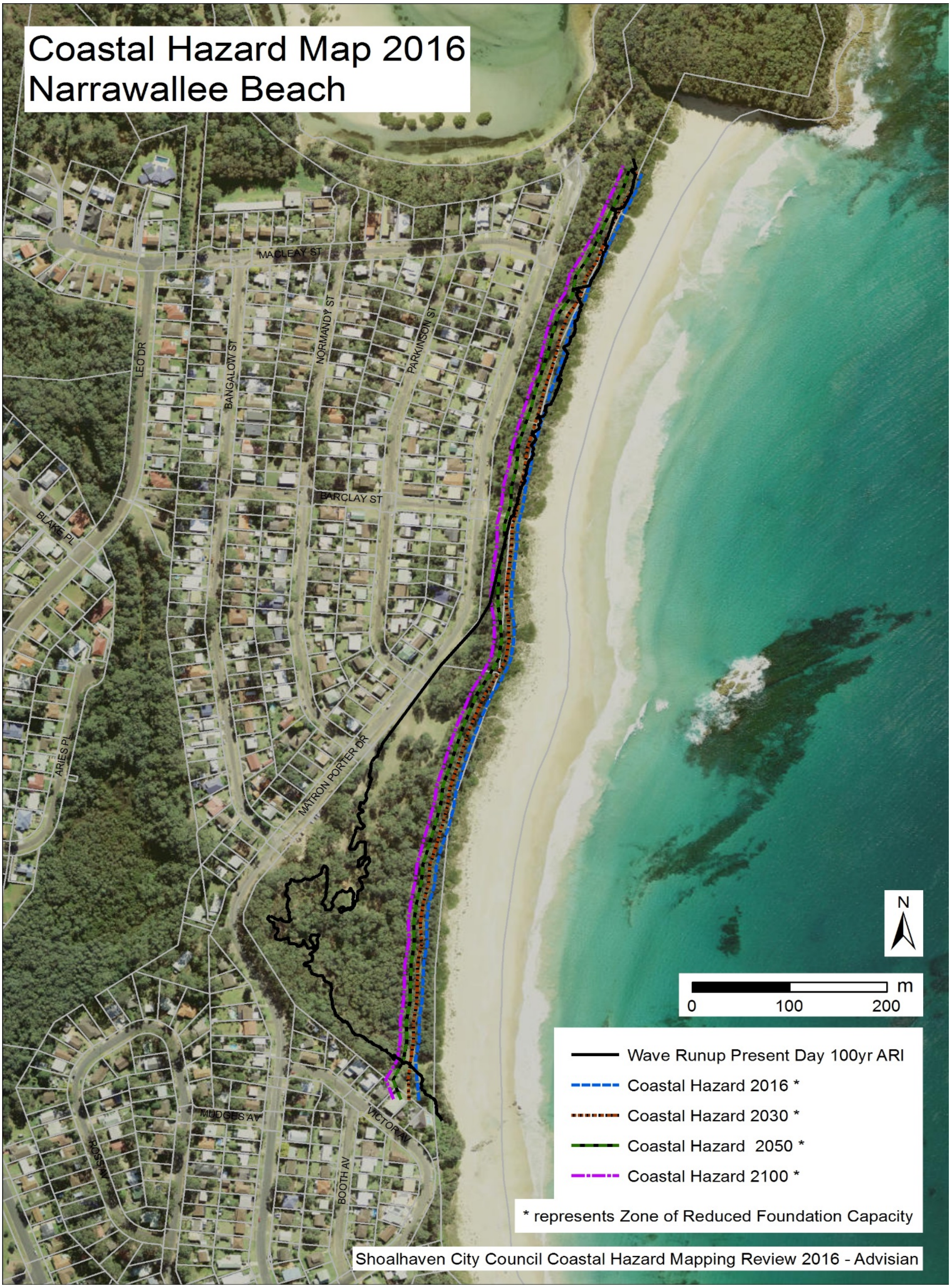


Figure 3.18 - Coastal Hazard Map Narrawallee Beach

Figure 3.19 - Coastal Hazard Map Mollymook Beach

Figure 3.20 - Coastal Hazard Map Collers Beach

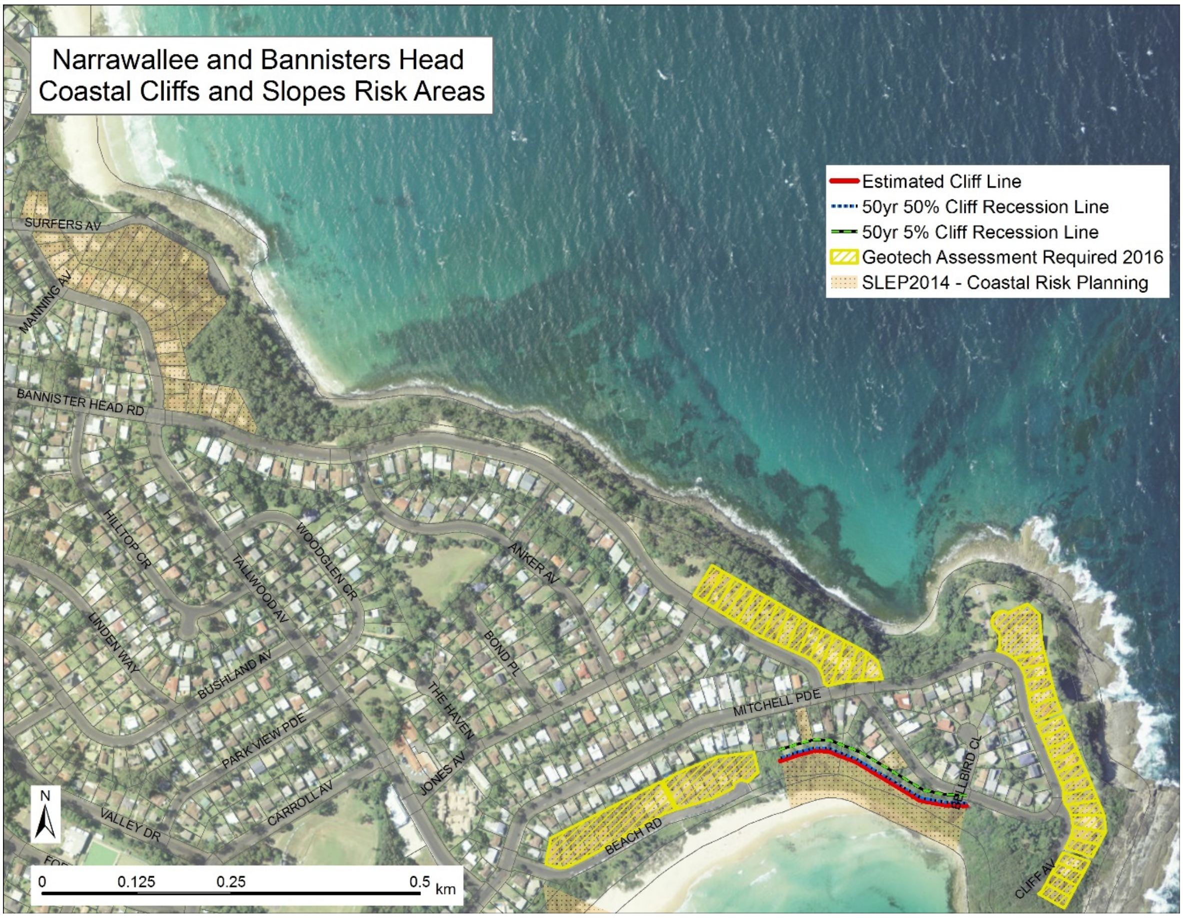


Figure 3.21- Coastal Cliffs and Slopes Risk Areas Narrawallee and Bannisters Head

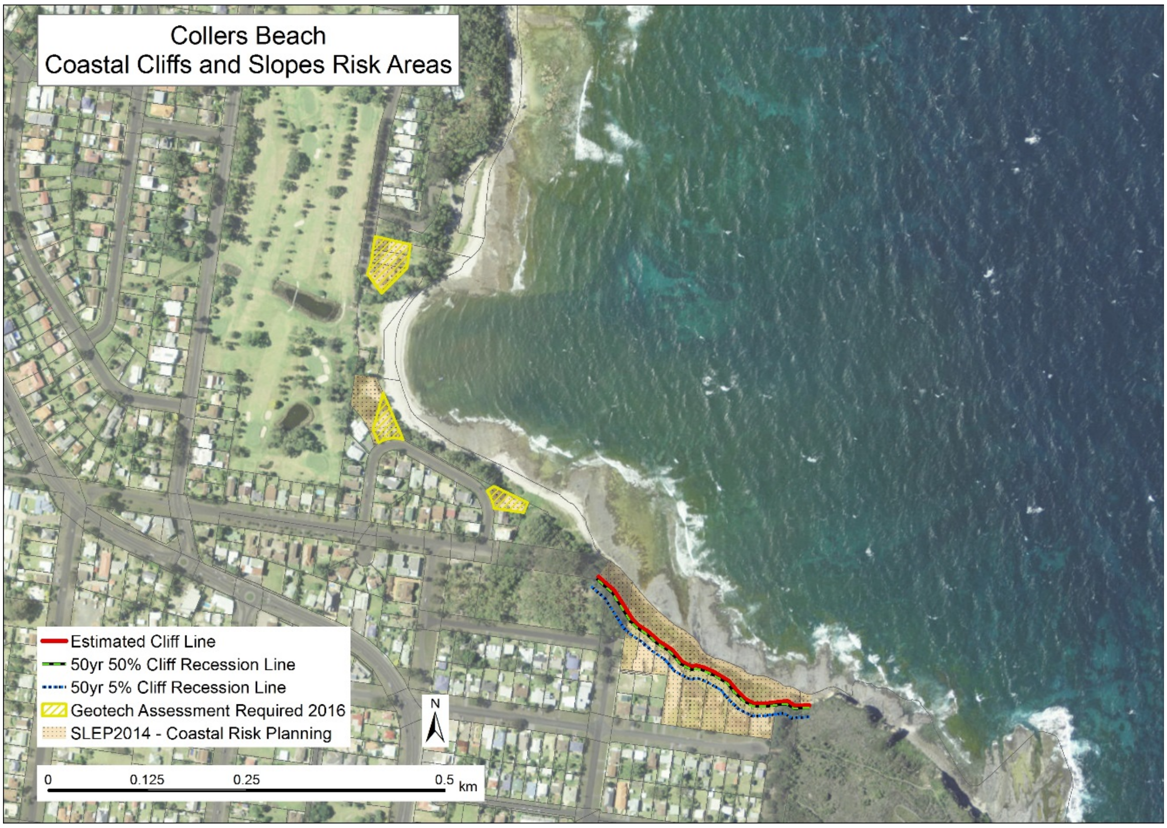


Figure 3.22 - Coastal Cliffs and Slopes Risk Areas Collers Beach

Local Area Plan 6: Ulladulla Harbour, Rennies Beach and Racecourse Beach

Ulladulla is the urban and commercial centre for southern Shoalhaven. The Princes Highway passes through the centre of town, adjacent to the Ulladulla Harbour shoreline. Ulladulla has a strong Indigenous and European marine and fishing heritage. Urban development is framed by large reserves on the headlands, with strong natural and cultural values.

Rennies Beach is a relatively isolated beach, with steep stairway access at two locations. The beach is backed by steep bluff and bushland reserve.

Evidence of Aboriginal cultural heritage around Ulladulla Harbour is mainly found in historical records rather than documented sites. The Harbour was one of the first places in Shoalhaven to be occupied by Europeans with the town being gazetted in 1829. There are illustrations and texts depicting Aboriginal people living around the Harbour and fishing from bark canoes. The rock platforms would also have been a rich food resource. Right up to the 1940s Aboriginal people still camped on the southern headland where a freshwater spring flowed into the Harbour and today there is an area known locally as the 'Danceground' on the headland where large numbers of Aboriginal people gathered for ceremonies.

Key issues

Figure 3.23 show the coastal hazard areas.

Private properties at Rennies Beach and Racecourse Beach are impacted by cliff recession.

Rennies Beach

The sea wall around the shore of Ulladulla Harbour is subject to storm damage, with related risks for safety and for the stability of the Princes Highway.

The shoreline is continuing to adjust to changed hydrodynamic conditions associated with the construction of the breakwaters.

Ulladulla Harbour

Ulladulla Harbour – repair rock protection post June 2016 storm

Ulladulla Harbour – beach scraping post June 2016 storm

Table 3-18 – Local Area Plan 6 Actions - Ulladulla Harbour, Rennies Beach, Racecourse Beach

Strategic risk management

Accommodate change by building community awareness and capacity and by targeted protection of healthy natural systems. Hazard likelihood is already managed by coastal protection works at Ulladulla Harbour, but a design review and seawall reconstruction are required. Planning controls will require additional information from proponents in coastal hazard areas on cliffs and bluffs.

Triggers for change

- Evidence of change in slope instability risk profile.
- Cost-benefit analysis of maintenance of coastal protection structures

Note: For major infrastructure assets subject to a high or extreme level of risk, a trigger distance greater than 20m would be appropriate to change from a monitoring and reporting approach to detailed feasibility and design studies and/or to on ground works (protection or relocation). The appropriate trigger is influenced by the type of asset, expected asset life, local risk to the asset and the types of risks associated with failure.

Action	What is proposed	Responsibility	Status
LA6.1	Monitor and maintain the rock protection structure on the landward shore of Ulladulla Harbour to provide protection for the public reserve and the Princes Highway.	Council Environmental Services and Assets and Works	Rock protection structure repaired and extended following the June 2016 ECL
LA6.2	Prepare a management plan for Warden Head public reserves. The plan will be prepared in consultation with Ulladulla Local Aboriginal Land Council, including the preparation of a Memorandum of Understanding about the maintenance of walking tracks on the headland. Note that beach scraping and nourishment works are likely to require approvals under the Crown Lands Act 1989 or Crown Land Management Act 2016 which commences 1 July 2018.	Any works will be in collaboration with DoI - Crown Lands & Water & Ulladulla Aboriginal Land Council, with particular reference to Crown land Lot 30 DP 821467 and Lot 290 DP 755967 (Por 290).	
LA6.3	At Rennies Beach, implement emergency response actions in the draft Coastal Cliffs and Slopes Emergency Action Sub Plan, Appendix 5, Section 2.9 to manage risk to safety and assets.	Council Environmental Services and Assets & Works	
LA6.4	At Racecourse Beach, implement emergency response actions in the draft Coastal Cliffs and Slopes Emergency Action Sub Plan, Appendix 5, Section 2.10 to manage risk to safety and assets.	Council Environmental Services and Assets & Works	
LA6.5	Undertake a geotechnical assessment to assess the impact from potential cliff and slope instability to provide suitable and site specific recommendations for the carpark at Racecourse Beach or consider relocation of these assets where feasible.	Council Environmental Services	

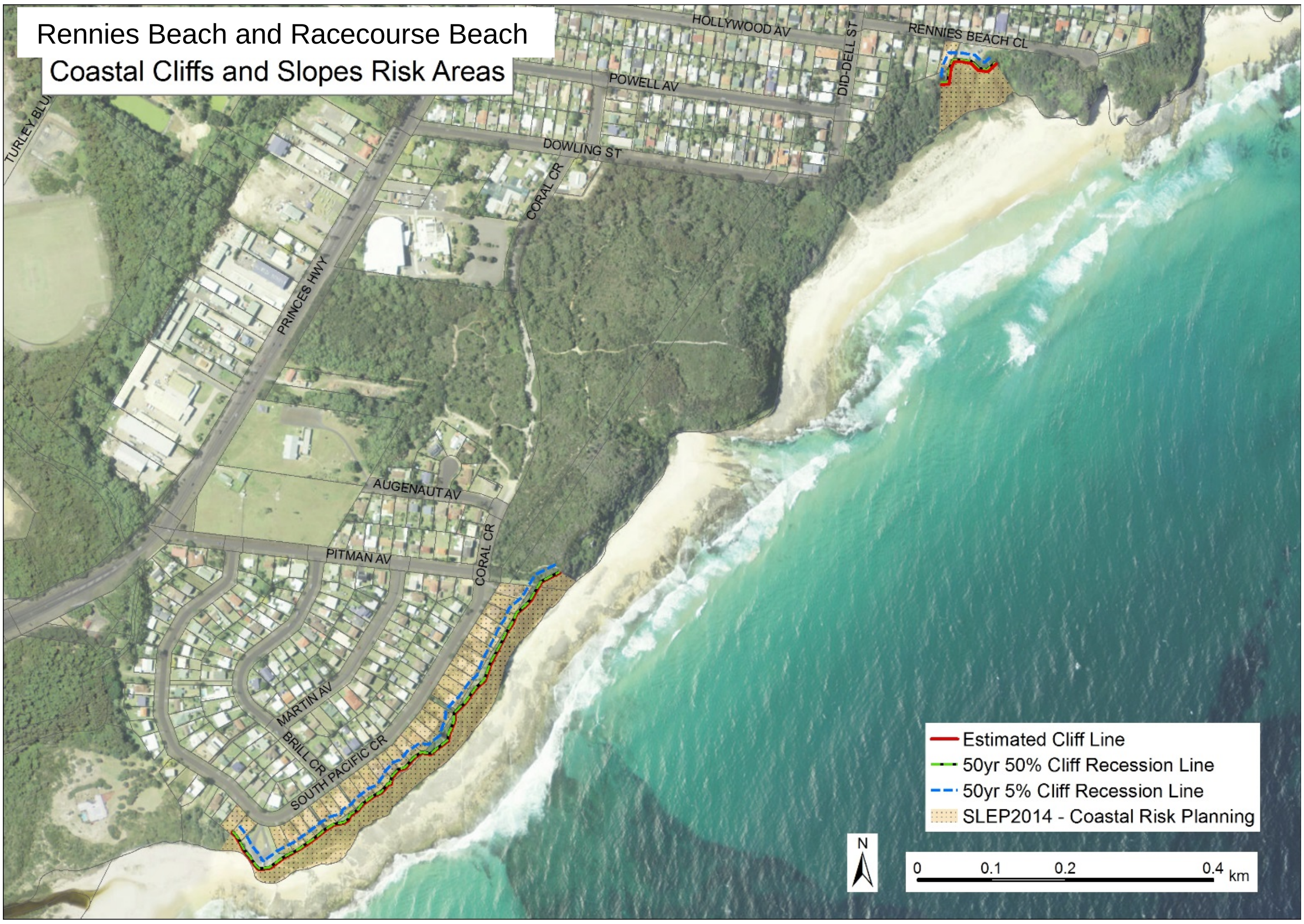


Figure 3.23- Coastal Cliffs and Slopes Risk Areas Rennies & Racecourse Beaches

4. Implementation

4.1 Implementation priorities

Council has identified strategies and actions to achieve its vision for the coast.

In the implementation tables over page, actions are grouped into two, five and beyond year priorities.

Higher priority actions are selected on the basis of extreme and very high risks. These are actions that:

- Reduce risk as a precautionary measure (a high priority for land use planning provisions for coastal risk areas)
- Protect or enhance the biodiversity values of coastal ecological communities, at the same time building the resilience of frontal dune systems, are a high priority.
- Build community awareness, knowledge and resilience
- Establish an adaptive management framework.
- Achieve several of these criteria, compared to those which achieve only single criteria.

The options appraisal process, including outcomes of the OCOL community engagement program, and desired action tables are detailed in Section 3. Council has further assessed priorities after considering desired actions, priorities and budget. The implementation priorities balance the risks, environmental priorities, community input and budget realities that Council must address. The implementation tables highlight the priority actions that will:

- Ensure there are resources for managing the implementation process
- Build resilience of beach and dune landforms and coastal ecosystems
- Clarify the likely asset life and foundation capacity of built assets in immediate (or short term) coastal hazard zones
- Build community understanding of coastal processes and coastal zone management interactions to prepare for change.

The estimated cost of implementation in the first two years is more than $3.3M, excluding construction of the South Mollymook foreshore protection structure. The cost of these actions exceed Council's existing budget capacity, therefore Council will need to seek external grant funding to supplement it's budget.

4.2. Implementation schedules

All actions which appear in this Plan, either as Citywide Strategies or in the Local Area Action Plans, are grouped in the three tables below and according to the criteria listed at 4.2.

The priority listing in each implementation schedule below includes 1, 2 and 3, with 1 being the highest priority within that time period.

As a component of the completion of the new Coastal Management Program, all unimplemented actions from the Coastal Zone Management Plan 2018 will be transferred into the new document.

The instigation of all actions included in the Implementation Schedules below is the responsibility of Council.

Table 4-2– Actions in the short term (0-2 years) ranked by priority

Action	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
C1.2	Present information on Council's website and in community engagement activities that shows how coastal zone systems function and how integrated management responses benefits Council's and local communities. This will include reporting on long term improvements to efficiency and to the condition of coastal zone systems.	3	Create awareness and improve capacity to respond	Whole of coast	Council – existing operational budgets and seek funding from NSW coastal and estuary grant program and/or other funding sources	3 years
C1.3	Work with all sections of Council to improve integration of coastal zone risk management and protection.	1	Create awareness and improve capacity to respond	Whole of coast	Council – existing operational budgets	1 year
C1.7	Collate all monitoring actions within the Coastal Zone Management Plan (CZMP), and other supporting documents, to develop an Environmental Monitoring Program (EMP). The EMP will address matters such as: dune crest height monitoring, effectiveness of sustainable tourism strategies, plastics and rubbish, water quality, encroachment and trampling from access ways and dune vegetation vandalism. The EMP will include 'citizen science' opportunities.	1	Important component of integrated management and evaluation	Whole of coast	Council – existing operational budgets	2 years
C1.10	Each year, review actions to ensure they are appropriate and current, and remove actions if	1	Important component of integrated management and evaluation	Whole of coast	Council – existing operational budgets	Annually

Action	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
	implementation has been successful. These reviews will be reported in Council's annual report.					
C1.12	Maintain a full-time coastal zone coordinator position to coordinate design investigations, develop the implementation strategy (including long-term funding options) and build Council's capacity to respond.	Council	Important component of integrated management and evaluation	Whole of coast	Council - $120,000 per annum Council budget	1 year
C2.1	Prepare and deliver community information for residents at high risk beaches and other emerging priority coastal areas. Community information could include regular updates on Council's website, social media sites, educational signage, presentations at community meetings, field days, training for Bushcare volunteers, Frontline News.	1	Important component of community engagement	Whole of coast	$10,000 From Council operational budgets and seek funding from NSW coastal and estuary grant program and/or other funding sources	2 years
C2.4	Prepare information for landholders living adjacent to geotechnical hazards and how they can contribute to risk reduction through: • Maintaining an adequate surface drainage path into and out of the property • Draining pipe storm water away from steep slopes to avoid saturation and scouring • Maintaining vegetation cover of appropriate species • Repairing leaking or broken underground drainage or sewer pipes as soon as faults are identified • Periodically inspecting the property to observe changes	1	Important component of community engagement	Private land near geotechnical hazards	$10,000 - from existing operational budgets	2 years
C2.5	Collaborate with Council Tourism and Visitor's Services staff to encourage sustainable tourism strategies and 'citizen science' opportunities.	2	Important component of community engagement and partnering	Whole of coast	Council – $20,000 from existing operational budgets	2 years
C3.1	Update and maintain notation to section 10.7 (5) certificates for properties affected by coastal hazards consistent with NSW Government legislation.	1	Implement planning system controls	Whole of coast	Council – existing operational budgets	1 year

Action	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
C3.2	Implement and maintain planning controls, in Shoalhaven Local Environmental Plan 2014 and Shoalhaven Development Control Plan 2014 G6 Coastal Management Areas, which requires specific information and assessment for proposed development in coastal hazard areas.	1	Important component of implementing planning system controls	Whole of coast	$30,000 – Council budget	3 years
C3.4	Make necessary amendments to the Shoalhaven Local Environmental Plan 2014 and Shoalhaven Development Control Plan 2014, including that: • Council to require geotechnical assessments to support applications for landslip remediation works on private property, including confirmation that risk will be reduced to levels considered acceptable (geotechnical engineer to approve the design of the remediation measures and works) • Development consent conditions to include maintenance requirements for new developments on sloping blocks within risk areas • All risk areas to be included in the appropriate locations in the Shoalhaven Local Environmental Plan 2014 and/ or Shoalhaven Development Control Plan 2014 • Mapping in Shoalhaven Development Control Plan 2014 and Shoalhaven Local Environmental Plan 2014 (Coastal Risk Planning) to be updated to reflect the revised Coastal Hazard Mapping for beaches (Advisan, 2016).	1	Implement planning system controls	Whole of coast	$10,000 – Council budget	1 year
C4.1	Update the Coastal Asset Management Plan to include a beach access strategy that includes a methodology for rationalisation of beach accesses based on environmental, social and economic risks.	2	Important component of integrated management and managing risk	Whole of coast	$20,000 (seek potential $10,000 OEH funding)	1 year
C4.3	Maintain and enhance ecological communities in coastal reserves (including dunes), considering appropriate ecological strategies for urban (foreshore recreation reserve) and non-urban areas.	1	Protection of coastal biodiversity and ecosystems	Whole of coast	Council – existing operational budgets and seek	1 year

Action	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
					supporting funding from OEH	
C4.5	Support bush regeneration programs in coastal reserves.	1	Protection of coastal biodiversity and ecosystems	Whole of coast	$50,000 p.a from existing Bushcare budget, OEH	3 years
C4.6	Incorporate measures to protect Aboriginal cultural heritage. This will include appropriate Aboriginal cultural heritage due diligence assessments for all coastal works.	1	Important component of integrated management and planning system control	Whole of coast	Ongoing and part of individual project costs	2 years
C5.1 LA2.1 LA3.21 LA4.3 LA4.4 LA5.2 LA5.4 LA5.9 LA5.16 LA5.18 LA6.3 LA6.4	Activate Coastal Cliffs and Slopes Emergency Action Sub Plans as required[11]	1	Important component of managing risk	Whole of coast	Dependent on timing and extent of event; seek supporting funding from OEH or other grant programs	3 years
C6.2	Implement high priority recommendations from the Coastal Erosion Stormwater Impact Assessment (Footprint Sustainable Engineering, 2015)	1	Important component of managing risk	Whole of coast	$50,000 annually seek supporting funding from OEH or other grant programs;	1 year
C6.4	Incorporate monitoring of public land and infrastructure, including viewing platforms, stormwater drainage, sewer and water infrastructure in identified coastal cliffs and slopes risk areas, to ascertain any	1	Important component of managing risk	Identified risk areas in coastal cliffs and slopes	$60,000 annually; seek supporting funding from OEH	3 years

[11] Appendix 4 – Shoalhaven Beaches Emergency Action Sub Plans, Advisian 2018 and Appendix 5 – Shoalhaven Coastal Cliffs and Slopes Risk Management Program & Coastal Cliffs and Slopes Emergency Action Sub Plan, RoyalHaskoningDHV 2018.2.1

Action	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
	leaks or requirements for repair, into Council's maintenance programs. Relocate viewing platforms where necessary.				or other grant programs	
C6.5	Undertake a catchment wide hydraulic assessment to assess stormwater drainage adjacent to or within identified coastal cliffs and slopes risk areas	1	Important component of managing risk	Identified risk areas in coastal cliffs and slopes	$200,000; seek supporting funding from OEH or other grant programs	5 years
C7.1	Establish coastal monitoring program (which forms part of the EMP in C1.7) to collect baseline condition data for post storm beach erosion, king tide monitoring and entrance condition e.g. use LiDAR data for beaches and dunes, when available from the NSW Government, to analyse change to coastal landforms and vegetation. Use 'citizen scientists' where applicable.	1	Important component of integrated management and evaluation	Whole of coast	Allow $30,000 from Council over 2 years, OEH funding or other grant programs	2 years
C7.3	Continue to collaborate with universities, government agencies and others in research that focuses on: • Climate change impacts on coastal processes and coastal landforms, including new data on sea level rise, storm behaviour, sediment transport processes and coastal recession modelling • Impact of sea level rise on rock platform communities • Coastal lake entrance behaviour (sediment budget, morphology, opening and closing regimes) with sea level rise and other aspects of climate change and climate variability • Ecological services and functions of dune species and most effective vegetation structure to enhance dune resilience • Monitoring the impacts of erosion remediation works at Currarong Beach • Assessing and monitoring the impacts of NABE works at all beaches where it's implemented.	2	Implement adaptive management procedures	Whole of coast	Ongoing; Council operation budgets; seek supporting funding from OEH or other grant programs	3 years

Action	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
C7.4	Continue the role of the Council Natural Resources & Floodplain Management Committee in implementing the CZMP. In particular, involve the Committee in reviewing and evaluating progress and outcomes from implementing the CZMP.	1	Implement adaptive management procedures	Whole of coast	Ongoing Council operational budgets	3 years
LA1.5	Prepare a dune management plan to manage the dune height and beach access in front of the Shoalhaven Heads SLSC. Lower dunes if required for safety.	1	Important component of risk management for surf life saving	Shoalhaven Heads	$10,000 annually from Council operational budgets	3 years
LA1.6	Maintain dune vegetation at both Shoalhaven Heads (Seven Mile beach) and Culburra to promote dune stability and minimise loss of sand from the littoral systems that would contribute to long term recession of the beach.	1	Council	Shoalhaven Heads and Culburra	Council – existing natural areas and Bushcare budgets, (supplement with grant funding e.g. OEH)	3 years
LA1.10 LA3.16	Consult with residents along Culburra Beach, Callala Beach and Mollymook about reducing the frequency of pedestrian access ways from private dwellings across the dunes. The aim is to reduce pressures on dune vegetation and to enhance the resilience of dune landforms.	3	Important component of risk management and protection of coastal biodiversity and ecosystems	Culburra Beach Callala Beach Mollymook	Council – existing operational budget (supplement with grant funding e.g. OEH or other grant programs)	3 years
LA3.2	Undertake a detailed, technical investigation of coastal hazard management options for Currarong Beach that are feasible for this location, cognisant of coastal processes and risks (over defined timeframes), as well as the social, environmental and economic impacts of the options, including its benefits and costs. Develop and implement a management strategy in consultation with key stakeholders including DoI Crown Lands. Currarong Beach is a receding beach (Advisian 2016) and, following the June 2016 ECL, the beach was left vulnerable with a major erosion scarp and 20,000m3 of sand lost. It became clear that beach erosion remediation measures, investigated in 2011 (SMEC) needed to be reassessed. This is to reduce risks to erosion of the dune, the beach and public access to it,	1	Important component of risk management	Currarong	$750,000 (seek 50% grant funding from OEH or other grant programs)	3 years

Action	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
	public reserve, the road (Warrain Cres), water and sewage infrastructure. Prepare asset management plan for any erosion and remediation works to ensure ongoing maintenance as required, monitoring program to determine efficacy of works and management of any impacts.					
LA3.3	Undertake a detailed, technical investigation of coastal hazard management options for shoreline in front of Beecroft Parade, that are feasible for this location, cognisant of coastal processes and risks (over defined time frames), as well as the social, environmental and economic impacts of the options, including its benefits and costs. Develop and implement a management strategy in consultation with key stakeholders including DoI Crown Lands. Currarong coast faces north, erosion impacts were severe as a result of the June 2016 storm, including the shoreline in front of Beecroft Parade. Any erosion and remediation works will include an asset management plan to ensure ongoing maintenance as required and management of any impacts.	1	Important component of risk management	Currarong	$100,000 for technical investigation $600,000 for works subject to technical review and approval from agencies (seek 50% grant funding from OEH or other grant programs)	3 years
LA3.4	Undertake a Cost Benefit Analysis, if required, for the erosion protection works in LA3.2 and LA3.3.	1	Important component of risk management	Currarong	$100,000 (seek 50% grant funding from OEH)	2 years
LA3.5	Undertake ongoing regular foreshore profile surveys to inform refinement of erosion or long term recession hazard for Beecroft Parade area (part of the Coastal Management Program & EMP – see Actions C1.7 & C7.1).	1	Important component of risk management	Currarong	A cost component of C1.7.	3 years
LA3.6	Monitor dune crest and profile. Options for managing dune heights include beach scraping and dune nourishment if sand source is available. Note that beach scraping and nourishment works may require approvals under the Crown Lands Act 1989 or	1	Important component of risk management	Currarong	A cost component of C1.7. $40,000 (to investigate sand availability for beach scraping and nourishment if necessary)	3 years

Action	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
	Crown Land Management Act 2016 which commences 1 July 2018.				Council operational budgets and OEH funding or other grant programs	
LA3.19	At Collingwood Beach, monitor dune crest levels to minimise wave overtopping onto shared path and road, accept risk and repair cycleway if subject to erosion. A minimum of 5.0m AHD may minimise the risk of wave overtopping. Options for managing dune heights include beach scraping and dune nourishment, if sand source is available. Note that beach scraping and nourishment works are likely to require approvals under the Crown Lands Act 1989 or Crown Land Management Act 2016 which commences 1 July 2018.	1	Important component of risk management	Collingwood Beach	A cost component of C1.7. $40,000 (to investigate sand availability for beach scraping and nourishment if necessary and seek funding) Council operational budgets and OEH funding or other grant programs	3 years
LA3.7	Construct two beach accesses between Warrain Crescent and Peel Street. This will provide Currarong Beach with five reconstructed beach accesses, all of which were destroyed in the June 2016 storm.	2	Important component of risk management and providing opportunities for recreation planning and community development	Currarong	$90,000 Council operation budgets and OEH funding or other grant programs	3 years
LA3.12	At Callala Beach, monitor dune crest levels. A minimum of 6.0m AHD may minimise the risk of wave overtopping. Options for managing dune heights include beach scraping and dune nourishment, if sand source is available (see Action C1.7 and C7.1). Note that beach scraping and nourishment works are likely to require approvals under the Crown Lands Act 1989 or Crown Land Management Act 2016 which commences 1 July 2018.	1	Important component of risk management and evaluation	Callala Beach	A cost component of C1.7. $40,000 (to investigate sand availability for beach scraping and nourishment if necessary and seek funding); Council operational budgets and OEH funding or other grant programs	3 years

Action	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
LA5.8	At Mollymook Beach, monitor dune crest levels. A minimum of 5.5m AHD may minimise the risk of wave overtopping. Options for managing dune heights include beach scraping and dune nourishment, if sand source is available. Note that beach scraping and nourishment works are likely to require approvals under the Crown Lands Act 1989 or Crown Land Management Act 2016 which commences 1 July 2018.	1	Important component of risk management and evaluation	Mollymook	A cost component of C1.7. $40,000 (to investigate sand availability for beach scraping and nourishment if necessary); Council operational budgets and OEH funding or other grant programs	3 years
LA5.11	Undertake technical studies and planning for relocation or protection of Council owned sewer infrastructure including a pipeline and pumping stations that are located seaward of the Mollymook Beach 50 year ZSA (in the areas outside the study area for the cost-benefit study currently underway).	1	Important component of risk management and evaluation	Mollymook	$60,000 Council operational budgets and OEH funding or other grant programs	1 year
LA5.12	Assess condition of existing tripper wall at northern end of beach at creek entrance near Beach Road.	1	Important component of risk management and evaluation	Mollymook	$10,000 Council operational budgets and OEH funding or other grant programs	1 year
LA5.13	Investigate localised protection options consistent with the Coastal Erosion Stormwater Impact Assessment (Footprint Sustainable Engineering, 2015) around the stormwater drains along Mitchell Parade (e.g. opposite 55 Mitchell Parade) as these are the locations where the Mitchell Parade roadway is at highest erosion risk.	1	Important component of risk management	Mollymook	$100,000 Council operational budgets and OEH funding or other grant programs	1 year
LA5.19	Investigate whether localised protection, redesign or landward relocation of the sewerage assets at Collers Beach is required.	1	Important component of risk management	Collers Beach	$20,000 (excluding design) Council operational budgets and OEH	2 years

Action	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
					funding or other grant programs	
LA3.17	Continue to implement the Huskisson Beach Management Action Plan and opportunities for passive craft launching ramps and addition of handrails to access ways in appropriate locations along the beach.	2	Important component of risk management and providing opportunities for recreation planning and community development	Huskisson Beach	$15,000 Council operational budgets and OEH funding or other grant programs	3 years
LA3.20	Implement a two-year trial at two sites – one for revegetation and one for managing views (resolved by Council following preparation of a draft vegetation management plan for the Collingwood Beach Reserve). Any vegetation action plan must reduce the likelihood of erosion (Advisian 2018).	1	Important component of risk management and protection of coastal biodiversity and ecosystems	Collingwood Beach	$90,000 Council operational budgets and OEH funding or other grant programs	2 years
LA3.22	Investigate opportunities for disabled access at Plantation Point.	1	Important component of providing opportunities for recreation planning and community development	Plantation Point	$230,000 (seek grant funding) Council operational budgets and OEH funding or other grant programs	2 years
LA4.2	Prepare and implement bush regeneration plan for coastal reserves around the Bendalong Point Holiday Haven Tourist Park.	2	Important component of risk management and protection of coastal biodiversity and ecosystems	Bendalong	$20,000 to prepare plan, $15,000 p.a Council operational budgets and OEH funding or other grant programs	3 years
LA4.5 LA5.16	Rehabilitate area of public land at Inyadda Point and Mitchell Parade, Mollymook consistent with the Landslide Risk Assessment undertaken for this area as required.	1	Important component of risk management and protection of coastal biodiversity and ecosystems	Inyadda Point Mollymook	$250,000 (seek 50% grant funding) Council operational budgets and OEH funding or other grant programs	3 years

Action	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
LA5.1	At Narrawallee Beach, monitor dune crest levels. A minimum of 6.0m AHD may minimise the risk of wave overtopping. Options for manging dune heights include beach scraping and dune nourishment, if sand source is available. Note that beach scraping and nourishment works are likely to require approvals under the Crown Lands Act 1989 or Crown Land Management Act 2016 which commences 1 July 2018.	1	Important component of risk management and protection of coastal biodiversity and ecosystems	Narrawallee Beach	A cost component of C1.7. $40,000 (to investigate sand availability for beach scraping and nourishment if necessary and seek funding) Council operational budgets and OEH funding or other grant programs	3 years
LA5.5	Prepare cost benefit analysis to determine the most feasible management option (such as protect or retreat and relocate) at the southern end of Mollymook Beach. This relates to both public and private assets.	1	Important component of risk management	Mollymook	$100,000 ($50,000 OEH grant funding) Council operational budgets and OEH funding or other grant programs	1 year
LA5.6	Consider implementation of recommendations of abovementioned cost benefit analysis, LA5.5 at South Mollymook Beach. Undertake detailed design, planning and approvals process for works required to protect assets most at risk (e.g. seawall reconstruction, sandstone block wall, concrete wall and new revetment. Modifications should include provision for safe disabled access onto the beach) as required. If works proceed, prepare asset management plan for on-going maintenance and monitoring of works.	1	Important component of risk management	Mollymook	$150,000 (design, planning, approvals) $3,500,000 (construction) (Seek at least 50% grant funding from sources such as OEH and contribution from private asset owners)	1 year
LA5.7	Continue to monitor buried training wall at North Mollymook to measure effectiveness of mitigating	1	Important component of risk management	Mollymook	A cost component of C1.7.	3 years

Action	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
	coastal hazards (part of the Coastal Management Program & EMP – see Actions C1.7 & C7.1).				Council operational budgets and OEH funding or other grant programs	
LA2.5	Undertake a geotechnical assessment to assess the impact from potential cliff and slope instability to provide suitable and site specific LRM recommendations for lookout at Penguin Head or consider relocation of these assets where feasible.	2	Important component of risk management	Penguin Head	$10,000 Council operational budgets and OEH funding or other grant programs	3 years
LA6.5	Geotechnical assessment to assess the impact from potential cliff and slope instability to provide suitable and site specific recommendations for the carpark at Racecourse Beach or consider relocation of these assets where feasible.	2	Important component of risk management	Racecourse Beach	$10,000 Council operational budgets and OEH funding or other grant programs	3 years
LA5.17	Undertake geotechnical assessment to assess the impact from potential cliff and slope instability to provide suitable and site-specific landslide risk management (LRM) recommendations for lookout at Bannisters Point or consider relocation of assets where feasible.	2	Important component of risk management	Bannisters Point	$10,000 Council operational budgets and OEH funding or other grant programs	3 years

Table 4-3 – Actions for 3 to 5 years ranked by priority

	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
C1.4	Investigate and scope feasible, long-term funding options for effective, integrated management of the Shoalhaven coastal zone. Funding strategies will include Council rates and levies, leveraged by grant applications.	1	Shares costs of coastal management	Whole of coast	$25,000 Council operational budgets and OEH funding or other grant programs	3 years
C1.5	Review and update Council's Coastline Risk Management Report 2004.	1	Identify priority risk areas	Whole of coast	$40,000	1 year

	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
					Council operational budgets and OEH funding or other grant programs	
C1.6	Review and assess coastal erosion concept designs, and other technical reports containing management options for high risk beaches to identify appropriate future actions for community consultation and progression to detailed design where appropriate.	1	Address potential risks	High risk locations	Allow $100,000 for review, assessment and community engagement, plus Council officer time for negotiation with OEH and MPA	2 years
C1.8	Maintain the Ecological Monitoring Program (which forms part of the EMP C1.7) to ensure assessment of the extent of invasive species impact.	1	Important component of integrated management and evaluation	Whole of coast	Council – existing operational budgets	2 years
C1.9	At intervals of 5 years, report on what has been achieved in terms of implementation of the CZMP.	1	Important component of adaptive management procedures	Whole of coast	Council – existing operational budget	5 years
C5.2	Prepare and implement Nature Assisted Beach Enhancement (beach scraping) plans for all Council managed beaches to support the emergency action sub-plans.	3	Important component of managing risk	Whole of coast	$20,000 Council operational budgets and OEH funding or other grant programs	3 years
C5.3	As part of any beach scraping activities, establish a monitoring program to continue investigations of baseline ecological condition/diversity for affected beaches. The monitoring program would be established in consultation with DPI Fisheries.	3	Important component of managing risk and protection of coastal biodiversity and ecosystems	Whole of coast	$10,000	3 years
C7.2	Carry out surveys to ground-truth and map the distribution and condition of EECs in coastal erosion risk areas using the Biodiversity Conservation Act, Biodiversity Assessment Methodology.	3	Important component of protecting coastal biodiversity and ecosystems	Identified EECs	$25,000 for each monitoring or assessment area seek funding from OEH	5 years
LA1.1	Assess the condition of the rock revetment in front of the Shoalhaven Heads Surf Club if and when it's exposed during a major storm. The revetment was designed and constructed following the 1970s storms.	1	Important component of risk management	Shoalhaven Heads	Dependent on timing and extent of event but allow $50,000 Council operational budgets and OEH funding or other grant programs	3 years

	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
LA1.2 LA2.2 LA5.10	Audit site constraints and foundation capacity for the Shoalhaven Heads SLSC building, Nowra Culburra (Warrain Beach) SLSC Building and community buildings and infrastructure at Mollymook, including SLSC building and wastewater pump stations, to inform decisions about the timing of relocation or reconstruction on deep-piled foundations.	2	Important component of risk management	Shoalhaven Heads Warrain Beach Mollymook	$150,000 (seek OEH funding or other grant programs)	3 years
LA1.4	Depending on outcome of LA1.3, at end of building asset life or in the event of significant storm damage, relocate surf club landward and construct on deep piled foundations.	2	Important component of risk management	Shoalhaven Heads	>$1,000,000 (seek at least 50% grant funding)	10 years
LA1.7	Develop a design for reuse of excavated 'dry notch' (flood notch) sand, and other suitable sand, at the River entrance for • Erosion sites fronting River Road • Low dune crest locations • The northern side of the entrance area, to increase the volume of the beach and dunes, and provide interim protection from large southerly waves during storms. Note that dredging and nourishment works will require approvals under the Crown Lands Act 1989 or Crown Land Management Act 2016 which commences 1 July 2018.	1	Important component of risk management and protection of coastal biodiversity and ecosystems	Shoalhaven Heads	Council – existing operational budget and seek OEH funding	3 years
LA1.8	Repair and replace or relocate the beach access infrastructure, including viewing platforms, if and when required following a large storm. Consider designing and installing a beach access and viewing platform for people with disabilities where possible as part of future upgrades or replacement where feasible.	1	Important component of risk management	Shoalhaven Heads	Dependent on timing and extent of event (seek 50% grant funding from OEH and other sources)	5 years
C2.2 LA1.9 LA3.15 LA5.14	Engage with foreshore reserve property owners, residents and beach goers about the values of dune vegetation e.g. trapping wind-blown sand and maintaining dune resilience, ecological functions and buffering against coastal hazards, the importance of foreshore vegetation in providing shade and wind protection, filtering runoff, improving water quality and providing habitat.	1	Important component of risk management and protection of coastal biodiversity and ecosystems	Whole of coast	$40,000 (seek 50% grant funding from OEH or other sources)	3 years
LA3.1	Undertake technical studies to investigate the feasibility of medium term, to long term, relocation of water and	1	Important component of risk management	Currarong	Staff time or consultancy $50,000 (excluding	3 years

	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
	road infrastructure along the eastern end of Warrain Crescent to the landward boundary of housing lots (assets are currently on the seaward boundary). Similarly, where sewerage infrastructure is provided, investigate feasibility of locating it to a more landward position.				construction and easement acquisition costs)	
LA3.13	Monitor beachfront area and implement post-storm emergency action measures when required to repair or replace public beach access.	1	Important component of risk management	Callala Beach	Dependent on timing and extent of event (seek 50% grant funding)	5 years
LA3.14	Investigate future relocation of tennis club and amenities. Audit site constraints and foundation capacity of community buildings and infrastructure. Apply requirements of Shoalhaven DCP to future upgrades of tennis club buildings and infrastructure as well as development on private lots.	2	Important component of risk management	Callala Beach	$50,000 (seek 50% grant funding)	5 years
C2.3	Continue to work collaboratively with NPWS staff and volunteers to implement the NSW South Coast Shorebird Recovery Program to: • Raise awareness amongst residents and visitors of migratory shorebirds which are protected under international agreements, federal and state legislation • Manage the impacts of vehicles, pest animals and dogs on beaches, especially in regard to the breeding success of migratory shorebirds.	1	Important component of protection of coastal biodiversity and ecosystems	Whole of coast	$5,000 Council operational bugets	5 years
C2.6 LA2.4 LA5.7	Review relevant asset management plans and incorporate opportunities for disabled access where feasible. Investigate opportunities for disabled access at beaches and progress to detailed design where appropriate.	1	Important component of providing opportunities for recreation planning and community development	Whole of coast	$15,000 (seek grant funding opportunities) $50,000 (excluding detailed design) OEH funding or other grant programs	5 years

	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
C3.3	Use appropriate zoning in the Shoalhaven Local Environmental Plan to protect frontal dune systems from development that reduces resilience to coastal hazards	2	Important component of implementing planning system controls	Whole of coast	$30,000 (seek funding)	3 years
C4.2	Review and update plans of management and the Foreshore Reserves Policy 2005 to ensure consistency with this CZMP.	1	Important component of implementing planning system controls	Whole of coast	$30,000 (seek funding)	1 year
C6.1	Review and update all asset management plans (AMPs), relevant to the coastal zone. AMPs will be updated by relevant asset custodian. Include an asset management approach provision for replacement, relocation or retrofitting of public assets that are currently in coastal risk areas including surf clubs and sewer, water and sewerage infrastructure, foreshore protection infrastructure, roads and access paths. Align the asset management plans with emergency action sub-plans.	1	Important component of integrating management and risk management	Whole of coast	$150,000 (seek funding)	3 years
LA3.8	Re-route the Peel Street beach access to address sand loss from beach. Fence and revegetate the nourished dune and beach accesses that have been closed to stabilise the dune.	1	Important component of risk management and providing opportunities for recreation planning and community development.	Currarong	$15,000 (seek 50% funding from OEH)	3 years
LA3.9	Undertake a detailed, technical investigation of small scale coastal hazard management options that are feasible at Callala Bay to protect public infrastructure if required, cognisant of coastal processes and risks (over defined time frames), as well as the social, environmental and economic impacts of the options, including its benefits and costs. Develop and implement a management strategy in consultation with key stakeholders including DoI Crown Lands.	2	Important component of risk management and providing opportunities for recreation planning and community development.	Callala Bay	$30,000 (seek 50% funding from OEH)	3 years

	What is proposed	Priority	Why this action is a high priority	Location	Cost estimate & likely funding source	Review period
LA3.10	Investigate foreshore protection options to stabilise the shoreline at Sheaffe Street, Callala Bay. The works are to protect the road, control storm water flows across the beach and slow loss of sand to the north.	2	Important component of risk management	Callala Bay	$15,000 (excluding detailed design) (seek 50% funding from OEH))	3 years
LA3.11	Investigate site constraints (coastal hazards, topography and land availability) and foundation capacity of the Callala Bay Sailing Club to inform management of this asset.	1	Important component of risk management and providing opportunities for recreation planning and community development.	Callala Bay	$30,000 (OEH funding or other grant programs)	3 years
LA4.1	Prepare and implement the Boat Harbour Master Plan and the Stormwater Upgrade Plan.	1	Important component of risk management and providing opportunities for recreation planning and community development.	Bendalong	$100,000 (seek OEH funding or other grant programs)	2 years
LA5.3	Investigate whether localised protection for the sewerage assets is required and the feasibility of the relocation of the sewerage infrastructure.	1	Important component of risk management	Narrawallee	$50,000 (OEH funding or other grant programs)	1 year
LA6.2	Prepare a management plan for Warden Head public reserves. The plan will be prepared in consultation with Ulladulla Local Aboriginal Land Council, including the preparation of a memorandum of understanding about the maintenance of walking tracks on the headland. Note that beach scraping and nourishment works are likely to require approvals under the Crown Lands Act 1989 or Crown Land Management Act 2016 which commences 1 July 2018.	3	Protection of Aboriginal cultural heritage, recreation planning and community development and protection of coastal biodiversity and ecosystems	Ulladulla	$100,000 (OEH funding or other grant programs)	2 years
LA3.18	Investigate potential for medium, to long term relocation of sewerage infrastructure along the beach front reserve at Collingwood Beach, between Argyle Street and Berry Street.	2	Important component of risk management	Collingwood Beach	$150,000 (OEH funding or other grant programs)	3 years

Table 4-4 – Actions proposed for beyond 5 years

Action	What is proposed	Rank	Rationale for this action	Location	Cost estimate & likely funding source	Review period
C1.11 C1.1	After 10 years, conduct a full review of the implementation of the CZMP (or new CMP). As part of this review, in consultation with the community, identify coastal zone objectives and principles, for application in future reviews of this Plan and future coastal management programs.	1	Important component of integrating management of the entire coastline.	Whole of coast	$200,000 (OEH funding or other grant programs)	10 years
C4.4	Wherever possible, use zoning and planning controls in Shoalhaven Development Control Plan 2014 to maintain open spaces where coastal dune terrain and associated habitats can roll landward in response to climate change and sea level rise. On the open coast, this management action is linked to planning for vegetated foreshore reserves on coastal dunes.	3	Important component of implementing planning system controls, adaptive management procedures and protection of coastal biodiversity and ecosystems	Whole of coast	$40,000 Council budgets	4 years
C6.3	Review the coastal cliff and slopes hazard lines and extent of risk areas. Review will be informed by the on-going geotechnical assessment of foreshore sites completed to date.	1	Important component of risk management and implementation of planning system controls	Coastal cliffs and slopes	$150,000 (OEH funding or other grant programs)	5 years
LA1.3 LA2.3 LA5.10	Investigate zoning, land tenure and approval processes for relocation of the Shoalhaven Heads, Nowra Culburra and Mollymook Surf Club landward of its current position, outside the 2050 coastal erosion risk area. The move will be triggered by the asset life of the existing building or significant storm damage to the building.	1	Important component of risk management	Shoalhaven Heads Warrain Beach Mollymook	$200,000 (OEH funding or other grant programs)	5 years
LA6.1	Monitor and maintain the rock protection structure on the landward shore of Ulladulla Harbour to provide protection for the public reserve and the Princes Highway.	1	Important component of risk management and recreation planning and community development	Ulladulla	$20,000 to assess, $100,000 repairs (OEH funding or other grant programs)	5 years

Glossary

Accreting	Forming (a composite whole) by gradual accumulation.
Aeolian	Relating to or arising from the action of the wind.
Bathymetry	The measurement of depth of water in oceans, seas, or lakes.
Littoral Drift	The transport of non-cohesive sediments, i.e. mainly sand, along the foreshore and the shoreface due to the action of the breaking waves and the longshore current.
LiDAR	Light detection and ranging.
AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
CCB	Community Consultative Body
CZMP	Coastal Zone Management Plan
CMP	Coastal Management Plan
ECL	East Coast Low
ESCCI	Eastern Seaboard Climate Change Initiative
DCP	Development Control Plan
ICOLL	Intermittently Closed and Opened Lakes and Lagoons
IPCC	Intergovernmental Panel on Climate Change
LEP	Local Environmental Plan
NRFM	Natural Resources & Floodplain Management
OCOL	Our Coast Our Lifestyle
OEH	Office of Environment & Heritage
SLEP	Shoalhaven Local Environmental Plan
SLR	Sea Level Rise
SOI	Southern Oscillation Index
ZSA	Zone of Slope Adjustment
ZRFC	Zone of Reduced Foundation Capacity

Reference List

- NSW Coastal Management Act 2016
- NSW Coastal Protection Act 1997
- NSW Environmental Planning & Assessment Act 1979
- NSW Crown Land Management Act 2016
- NSW Aboriginal Land Rights Act 1983
- NSW Native Title Act 1993
- NSW Local Government Act 1993
- NSW Biodiversity Conservation Act 2016
- NSW National Parks & Wildlife Act 1974
- NSW State Emergency and Rescue Management Act 1989
- NSW Marine Estate Management Act 2014 (Regulations and Zonings 1999)
- NSW Fisheries Management Act 1994
- NSW Guidelines for Preparation of Coastal Zone Management Plans (2013)
- NSW Aboriginal Heritage Impact Management System(AHIMS) Database
- NSW Due Diligence Code of Practice for the Protection of Aboriginal Objects
- NSW Dune Management Manual
- NSW Guidelines for ICOLL Management
- NSW National Parks Plans of Management – Comerong Island and Seven Mile Beach
- NSW Planning Guideline: Adapting to Sea Level Rise (2010)
- NSW Coastal Risk Management Guide: Incorporating Sea Level Rise into Risk Assessments (2010)
- Shoalhaven Emergency Risk Management Report & Mitigation Report
- DISPLAN (SES)
- Illawarra -Shoalhaven Regional Plan
- CSIRO State of the Climate Report 2016
- Healthy Rivers Commission Independent Inquiry into Coastal Lakes
- Jervis Bay National Park Management Plan
- Register of the National Estate
- National Heritage List
- The Council's Foreshore Reserves Policy
- Shoalhaven Public Asset Coastal Risk Management Review (BMT WBM 2012)
- Coastal Slope Instability Hazard Study (SMEC 2008)
- Peer Review, Supplementary Geotechnical Observations (of the Coastal Slope Instability Hazard Study 2008) Douglas Partners 2011
- Report on Scoping Study and Stability Assessment (Various Lots Surfers Avenue, Tallwood Avenue & Bannister Head Road, Narrawallee) (Douglas Partners 2011)
- Shoalhaven Coastal Cliffs and Slopes Risk Management Program (Royal Haskoning DHC, 2018)
- Council's Weed Management Policy
- Council Bushcare/ Parkcare Policy & Procedures (POL09/78)

- Council Population Profile 2016
- Council Management Options for Improving Flows of the Shoalhaven River at Shoalhaven Heads
- Council Currarong Dunecare Action Plan
- Council Currarong Creek NRM Strategy
- Council Local DISPLAN
- Council Coastal Erosion Road Stormwater Assessment (Assets & Works Group) 2015
- Council Drainage Asset Management Plan
- Council Disability Inclusion Action
- Council River Road Erosion Design 2017
- Council River Road Foreshore -Shoalhaven Heads – Assessment of Coastal Management Options Plan 2017-2012
- Council Narrawallee Inlet NRM Strategy 2002
- Council Narrawallee Inlet Sustainability Assessment & Management Strategy 2009
- Council Narrawallee Surfers Ave/Bannisters Head Road/Tallwood Ave. Geotechnical Study & Stability Assessment 2012
- Council Millards Creek Corridor Management Plan 2007
- Council Monitoring Evaluating and Reporting (MER) Strategy
- Council Aboriginal Cultural Heritage Report (Council's Crookhaven Headland Plan of Management) 1998
- Shoalhaven Local Environmental Plan 2014
- Shoalhaven Development Control Plan 2014
- Coastal Erosion Stormwater Impact Assessment (Footprint Sustainable Engineering, 2015)
- Neilson et al 1992
- Vulnerability of Surf Clubs (CZM, 2011)
- Prof. Steve Smith 'Design for Baseline Data Collection and on-going Monitoring to Assess the Impact of Beach Scraping and Nourishment at Jervis Bay' 2013
- Dr Nathan Knott 'Coastal Erosion Remediation – Environmental Baseline Study – Preliminary Report' 2015
- Royal Haskoning, 'Currarong Coastal Erosion Protection Technical Design Report' 2017
- Environmentally Friendly Sea Walls (OEH) 2012
- Carley et al. 2010

Acknowledgements (also included on document control page)

- Umwelt(Aust) Pty Ltd 2012
- SMEC Pty Ltd

Shoalhaven Coastal Hazard Mapping Review

Final Report

29/08/2016

Level 12, 141 Walker St
North Sydney NSW 2060
Australia

301311-13501-001

www.**advisian**.com

Advisian
WorleyParsons Group

Synopsis

This report describes the derivation of the coastal hazard for Shoalhaven's beaches, based on updated information available since the previous coastal hazard assessment undertaken for Council in 2009.

Disclaimer

Project No: 301311-13501-001 – Shoalhaven Coastal Hazard Mapping Review: Final Report

Rev	Description	Author	Review	Advisian Approval	Date
A	Draft for Internal Review	C. Adamantidis	A. Nielsen	A. Nielsen	
B	Draft	C. Adamantidis	A. Nielsen	A. Nielsen	
C	Final	C. Adamantidis	A. Nielsen	A. Nielsen	

Table of Contents

1 Introduction 1
2 Study area 3
2.1 Shoalhaven Coastal Sediment Compartments 3
2.2 Shoalhaven Heads 4
2.3 Culburra Beach 7
2.4 Warrain Beach 8
2.5 Currarong 10
2.6 Callala Beach 11
2.7 Collingwood Beach 13
2.8 Narrawallee 15
2.9 Mollymook 17
2.10 Collers Beach 20
3 Coastal Hazard Assessment Methodology 22
3.1 Short Term Coastal Erosion 22
3.1.1 Creek entrance instability 26
3.2 Long Term Coastline Recession 26
3.3 Future Beach Recession - Sea Level Rise 26
3.3.1 Estimation of Closure Depth 28
3.3.2 Discussion on application of the Bruun Rule 32
3.4 Inundation 33
3.4.1 Coastal Inundation 33
4 Coastal Hazard Assessment Results 36
4.1 Shoalhaven Heads 36

4.1.1 Summary 36
4.2 Culburra Beach 37
4.2.1 Summary 37
4.3 Warrain Beach 38
4.3.1 Summary 38
4.4 Currarong Beach 39
4.4.1 Summary 39
4.5 Callala Beach 40
4.5.1 Summary 40
4.6 Collingwood Beach 41
4.6.1 Summary 41
4.7 Narrawallee Beach 42
4.7.1 Summary 42
4.8 Mollymook Beach 43
4.8.1 Summary 43
4.9 Collers Beach 44
4.9.1 Summary 44
5 Conclusion 45
6 References 46
1 Detailed Coastal Hazard Assessment 1
1.1 Shoalhaven Heads 1
1.1.1 Short Term Erosion 2
1.1.2 Long Term Recession 3
1.1.3 Future Beach Recession due to Sea Level Rise 6
1.1.4 Wave Runup 7

1.2 Culburra Beach ... 7
1.2.1 Short Term Erosion ... 8
1.2.2 Long Term Recession ... 9
1.2.3 Future Beach Recession due to Sea Level Rise ... 12
1.2.4 Wave Runup ... 13
1.3 Warrain Beach ... 14
1.3.1 Short Term Erosion ... 14
1.3.2 Long Term Recession ... 14
1.3.3 Future Beach Recession due to Sea Level Rise ... 17
1.3.4 Wave Runup ... 17
1.4 Currarong Beach ... 18
1.4.1 Short Term Erosion ... 19
1.4.2 Long Term Recession ... 20
1.4.3 Future Beach Recession due to Sea Level Rise ... 23
1.4.4 Wave Runup ... 24
1.5 Callala Beach ... 25
1.5.1 Short Term Erosion ... 26
1.5.2 Long Term Recession ... 27
1.5.3 Future Beach Recession due to Sea Level Rise ... 31
1.5.4 Wave Runup ... 32
1.6 Collingwood Beach ... 33
1.6.1 Short Term Erosion ... 33
1.6.2 Long Term Recession ... 35
1.6.3 Future Beach Recession due to Sea Level Rise ... 38
1.6.4 Wave Runup ... 39

1.7 Narrawallee Beach 39
1.7.1 Short Term Erosion 40
1.7.2 Long Term Recession 40
1.7.3 Future Beach Recession due to Sea Level Rise 44
1.7.4 Wave Runup 44
1.8 Mollymook Beach 45
1.8.1 Short Term Erosion 47
1.8.2 Long Term Recession 48
1.8.3 Future Beach Recession due to Sea Level Rise 51
1.8.4 Wave Runup 51
1.9 Collers Beach 52
1.9.1 Short Term Erosion 53
1.9.2 Long Term Recession 53
1.9.3 Future Beach Recession due to Sea Level Rise 56
1.9.4 Wave Runup 56

Appendix List

Appendix A: Detailed assessment

Appendix B: Hazard Maps

1 Introduction

Coastal hazards of the Shoalhaven coastline were mapped and identified based on coastal engineering studies undertaken as part of the risk assessment for the current Shoalhaven Coastal Zone Management Plan (Umwelt Australia, 2012). That mapping took into account sea level rise benchmarks under the previous NSW Government Sea Level Rise Policy Statement (Department of Environment Climate Change and Water, DECCW 2009), which set sea level rise benchmarks for planning purposes of 40cm above 1990 levels by 2050, and 90cm above 1990 levels by 2100.

Since 2012, the NSW Sea Level Rise Policy no longer applies. The State Government, through its Stage 1 Coastal Reforms, which came into effect in January 2013, stipulated that "Councils should consider information on historical and projected future sea level rise which is widely accepted by competent scientific opinion." In response, Council in partnership with Eurobodalla Council engaged expert consultants to develop a South Coast Regional Sea Level Rise Policy and Planning Framework. That document was not adopted by Council. However, part of it together with submissions from the Nongovernmental International Panel on Climate Change (IPCC) and a local civil engineer were used by Councillors to adopt the following sea level rise projections on 10 February 2015.

- 100mm for 2030;
- 230mm for 2050 and
- 350mm for 2100.

These numbers correspond to the sea level rise projections associated with the IPCC's Representative Concentration Pathways RCP6.0 (mid-range greenhouse gas emissions scenario, from IPCC Assessment Report 5, 2013). The adopted 2030 and 2050 projections have a 15% chance (high probability line) of being exceeded while the 2100 projection of 360mm has a 85% chance of being exceeded (low probability line).

In light of the revised sea level rise projections adopted by Council, updated coastal hazard mapping undertaken using the adopted sea level rise projections is required. This report presents the derivation of the refined coastal hazards based on the latest available data and Council's adopted sea level rise projections, at each of the following coastal locations within the Shoalhaven LGA:

- Shoalhaven Heads
- Culburra Beach
- Warrain Beach
- Currarong
- Callala Beach

- Collingwood Beach
- Narrawallee
- Mollymook
- Collers Beach.

This report summarises the updated detailed coastal hazard assessments undertaken for the above beaches, which have been undertaken using photogrammetric data analysis and analytical assessments. It describes the coastal processes affecting the beaches and the impact of these processes on the areas where property is at risk. The assessments quantify the observed long-term beach changes with reference to updated beach survey transects, LiDAR data and updated photogrammetry, as well as estimating the beach recession that may be caused by sea-level rise as a result of climate change. The risk to property is defined in terms of the present day risk, the risk by 2030, the risk by 2050 and the risk by 2100.

This report uses advances in analysis techniques developed by Advisian since the previous assessment to build upon and refine the earlier coastal hazard mapping (SMEC, 2009). It also incorporates additional data obtained from field surveys at each beach, bathymetric surveys and post storm survey information obtained following a severe East Coast Low event that occurred in June 2016.

2 Study area

The study area for this investigation includes those beaches that were analysed as part of the initial coastal hazard studies undertaken by SMEC (2009). The study area for this investigation is shown in Figure 1. A site visit of all the beaches was undertaken for this study in May 2016. Further to this site visit, a major east coast low occurred on June 5 – 6, 2016. Where available, updated data have been used to quantify the impact of this significant storm event.

A brief description of the coastal compartmenbts of the Shoalhaven coast, a description of each of the beaches in the study area, as well as a summary of additional data available for hazard analysis since the previous assessment in 2009 is provided below.

2.1 Shoalhaven Coastal Sediment Compartments

Carvallo and Woodroffe (2015) have undertaken a study of the coastal compartments of the eastern coast of NSW. They considered sediment compartments as subdivisions of the coast separated by major obstacles such as headlands, which stop longshore transport of sediment. Compartments were delineated based on physical characteristics as well as review and interpretation of hydrologic, geomorphic and sedimentological data. The following primary sediment compartments were identified for the Shoalhaven coast:

- A compartment centred on the Shoalhaven River estuary, encompassing Seven Mile Beach at Shoalhaven Heads, Culburra, Warrain and Currarong beaches;
- A compartment centred on Jervis Bay, encompassing Callala and Collingwood beaches;
- A compartment between Bannisters Point and Jervis Bay, encompassing Narrawallee beach;
- A compartment between Warden Head and Bannisters Point, encompassing Ulladulla Harbour, Collers and Mollymook beaches.

These compartments have been further subdivided into secondary and tertiary sediment compartments by the presence of smaller headlands and based on sediment characteristics and transport. The Shoalhaven coastal compartment is dominated by the Shoalhaven River which is responsible for delivering significant quantities of sediment to the beaches in the compartment; with sand transport to the north limited by the presence of Black Head and sand transport to the south blocked by Beecroft peninsula.

McPherson *et al.* (2015) have delineated the coastline into similar sediment compartments when compared with those presented in Carvallo and Woodroffe (2015) – they identified secondary sediment compartments centred on the Shoalhaven River, Jervis Bay and a compartment between Ulladulla and Jervis Bay based on baseline reference data sets and a workshop with coastal experts.

When considering management of the coastline, under the NSW Coastal Reforms, coastal management programs (CMPs) are to be developed with regard to the natural processes of the coast including incorporating the use of coastal sediment compartments as 'natural' management units. The coastal sediment compartment approach identifies local government areas that share the same compartment, therefore requiring consultation between adjoining local councils in developing their CMPs. For the beaches of the Shoalhaven, Council shares the Shoalhaven sediment compartment (encompassing Seven Mile Beach) with neighbouring Kiama Council to the north.

2.2 Shoalhaven Heads

Shoalhaven Heads is located on the open-coast beach of Seven Mile Beach. The township of Shoalhaven Heads is located on the beach immediately to the north of the entrance to Shoalhaven River. The beach is approximately 15 kilometres long and is flanked by Gerroa at the northern end, and the trained entrance to the Crookhaven River at Crookhaven Heads at the southern end. The surf club and town of Shoalhaven Heads are located north of the entrance to Shoalhaven River, which is largely a natural, untrained entrance. The main entrance to Shoalhaven River is now located at Crookhaven Heads, following the cutting of a channel known as "Berrys Cut" which has connected the Crookhaven and Shoalhaven Rivers. Urban development on along the beachfront is located well back from the main beach and the dune is in a relatively natural, vegetated state. The closest development to the beachfront is located at the Surf Club which came under threat during the combined flood/storm event of 1978. The remainder of the beach remains undeveloped. The dune at Shoalhaven Heads has undergone erosion due to storms and flood events in the Shoalhaven River in the past. The entrance to the Shoalhaven River has opened and closed naturally due to flood events and wave action on many occasions. Council has a long standing policy of providing a v-shaped notch through the beach berm at the entrance to Shoalhaven River that activates when water levels in the Shoalhaven River reach a certain trigger value. This allows the river to open through the notch to alleviate flooding in the Shoalhaven River upstream. Shoalhaven Heads is unique among beaches on the Shoalhaven Coast as the sediment dynamics are highly dependent on the state of the Shoalhaven River entrance.

Since the 2009 hazard assessment, additional photogrammetry data (dated 9/8/2014) is available, as well as LiDAR ground level information, bathymetric survey from 2011 and ground survey transects through the beach berm at the Surf Club dated March 2010, February 2013 and February 2014. Survey transects were also taken in the vicinity of the Surf Club by the Office of Environment and Heritage (OEH) in the weeks following the June 2016 East Coast Low. In addition, a sediment compartment study undertaken by Carvalho and Woodroffe (2014) examining factors influencing the sediment budget of Shoalhaven Heads, Culburra, Warrain and Currarong beaches is available. These additional data have been used to update the hazard assessment for Shoalhaven Heads.

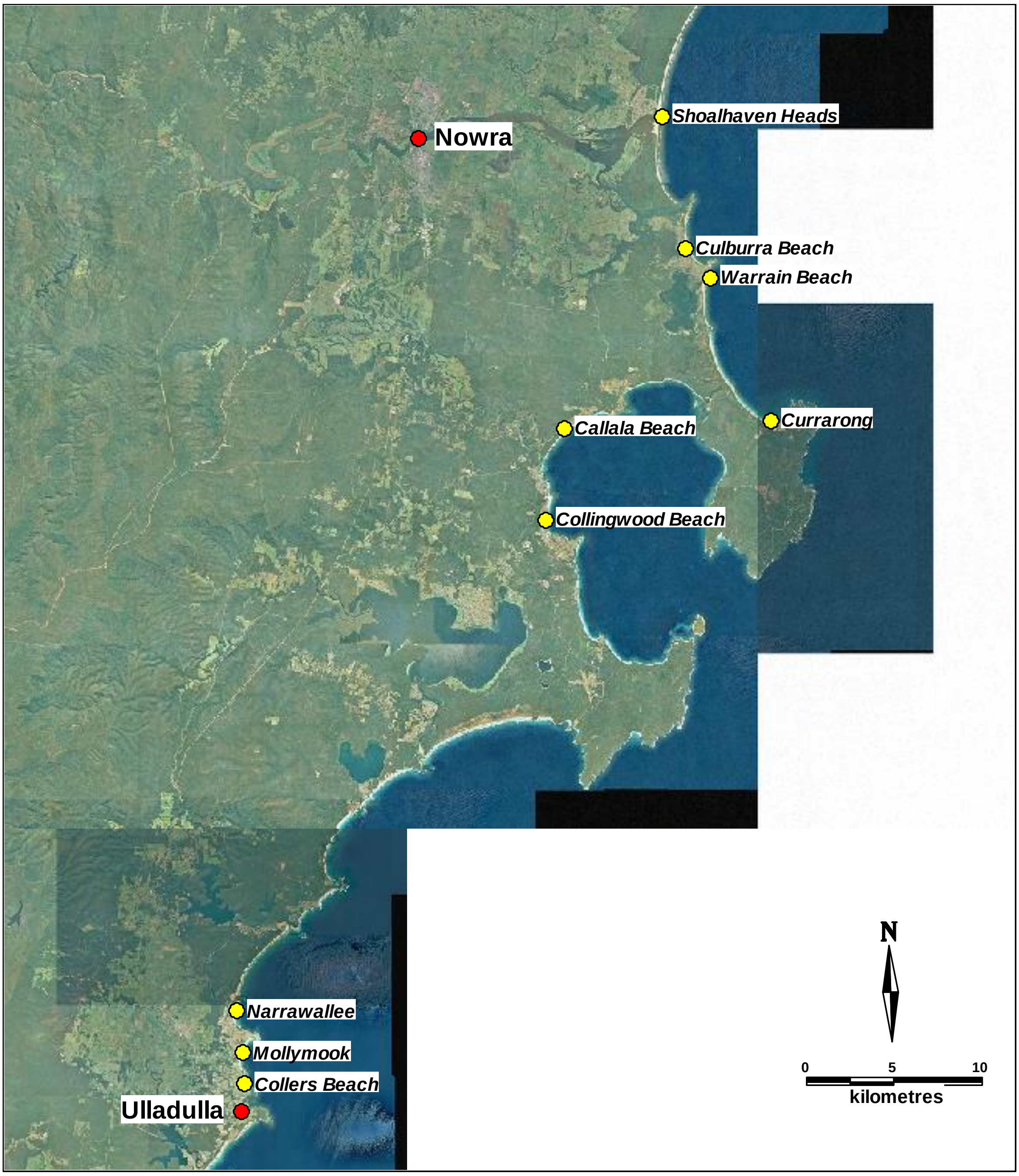


Figure 1 - Study area

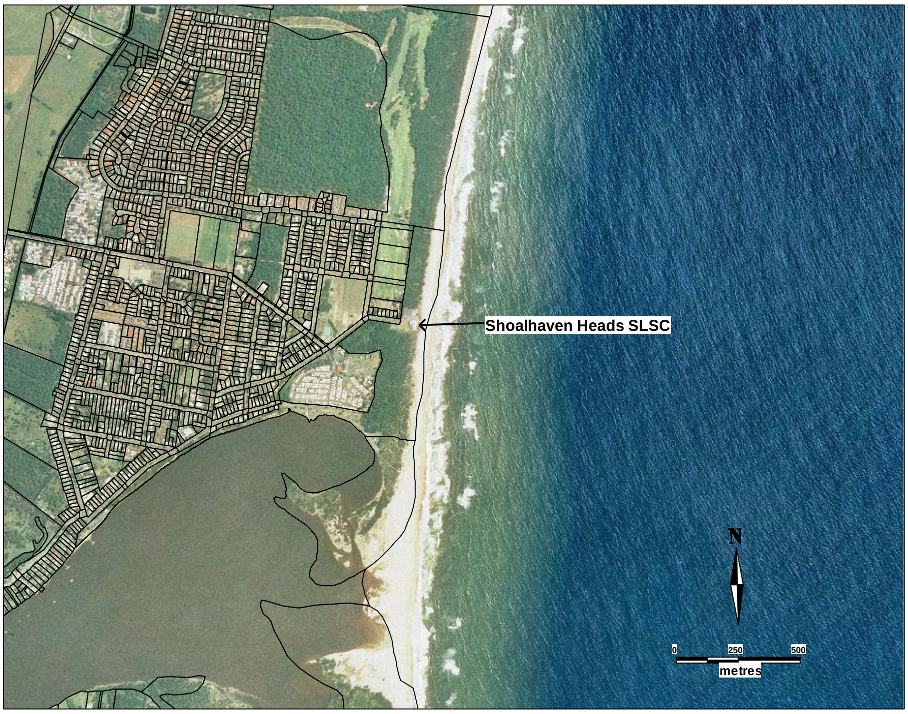


Figure 2 – Shoalhaven Heads, showing surf club and Shoalhaven River entrance

Figure 3 – Shoalhaven Heads Beach at surf club (May 30 2016)

2.3 Culburra Beach

Culburra Beach is an open-coast beach located north-east of Jervis Bay on the Shoalhaven coast. The beach is approximately 3.5 kilometres long and is flanked by Penguin Head at the southern end, Greenwell Point and the entrance to Crookhaven River at the northern end. Urban development along the beachfront is located behind a relatively high vegetated dune, which has undergone erosion due to storms and wind-borne sediment transport in the past. The dune at the northern end of the beach is wide and in a relatively natural state, with a caravan park development located well behind the dune.

Since the 2009 hazard assessment, additional photogrammetry data (dated 9/8/2014) is available, as well as LiDAR ground level information, bathymetric survey from July 2010 and ground survey of the dune dated July 2010. Ground survey of the dune was provided by OEH following the East Coast Low of June 2016. In addition, a sediment compartment study undertaken by Carvalho and Woodroffe (2014) examining factors influencing the sediment budget of Shoalhaven Heads, Culburra, Warrain and Currarong beaches is available. These additional data have been used to update the hazard assessment for Culburra Beach.

Figure 4 – Map of Culburra Beach

Figure 5 – Culburra Beach, looking south, 30 May 2016

2.4 Warrain Beach

Warrain Beach is an open-coast beach located north-east of Jervis Bay on the Shoalhaven coast. The beach is approximately 10 kilometres long and is flanked by Penguin Head at the northern end, Currarong and Beecroft Head at the southern end and is separated into two distinct compartments by Kinghorne Point. Urban development on along the beachfront is located behind a relatively high vegetated dune and is restricted to the extreme northern end of the beach, north of the entrance to Lake Woolumboola. Warrain Surf club is the only infrastructure located on the frontal dune. The dune at the northern end of the beach has undergone erosion due to storms and wind-borne sediment transport in the past. The dune along the entire beach is wide and in a relatively natural state.

Since the 2009 hazard assessment, LiDAR ground level information, recent bathymetric survey and ground survey of the dune were available for analysis. In addition, a sediment compartment study undertaken by Carvalho and Woodroffe (2014) examining factors influencing the sediment budget of Shoalhaven Heads, Culburra, Warrain and Currarong beaches is available. These additional data have been used to update the hazard assessment for the northern end of Warrain Beach.

Figure 6 – Map of Warrain Beach

Figure 7 – Warrain Beach (northern end), showing surf club and Lake Woolumboola entrance (30 May 2016)

2.5 Currarong

Currarong Beach is an open-coast beach located north-east of Jervis Bay on the Shoalhaven coast. The beach is approximately 900 metres long and is flanked by the entrance to Currarong Creek at the eastern end, and a bedrock outcrop at the western end, with a prominent rock outcrop along the beach around 300 metres west of the creek entrance. The presence of the rock outcrop near the centre of the beach has resulted in the formation of a small salient and has influenced the planform of the beach. Urban development on Warrain Crescent is located behind a vegetated dune, the front face of which is very steep due to severe erosion. Urban development is also located behind the creek entrance at the eastern end of the beach.

Long term beach recession has been previously identified as a potential hazard (WP Geomarine, 1995; CES, 2003; SMEC Australia, 2004, 2009).

Since the 2009 hazard assessment, additional photogrammetry data (dated 2014) is available, as well as LiDAR ground level information and ground survey of the dune dated December 2009, May 2010, September 2010 and June 2011. Council undertook survey of the entire beach following the East Coast Low of June 2016. The data collected from that survey allowed an accurate assessment of storm erosion demand and wave runup levels as a result of the June 2016 storm event. In addition, a sediment compartment study undertaken by Carvalho and Woodroffe (2014) examining factors influencing the sediment budget of Shoalhaven Heads, Culburra, Warrain and Currarong beaches is available. These additional data have been used to update the hazard assessment for Currarong.

Figure 8 – Map of Currarong

Figure 9 – Currarong Beach, looking north-west (30 May 2016)

2.6 Callala Beach

Callala Beach is located on the northern shores of Jervis Bay, a semi-enclosed embayment on the Shoalhaven coast. It is subject to both ocean swell waves and wind waves, although the ocean swell wave climate at Callala Beach is much reduced compared with that which, typically, is experienced on open-coast beaches along Shoalhaven City coastline.

The beach is approximately five kilometres long and is flanked by the rocky sandstone headlands of Callala Point at the northern end and Tapalla Point to the south. The Currambene Creek estuary crosses the beach at the southern end and Callala Creek crosses the beach at the northern end.

Callala Beach consists of fine quartz sand and, along much of its length, the incipient dune and frontal dune remain in their natural state, relatively undisturbed and covered in natural vegetation. However, urban development has taken place along some sections of the frontal dune at its northern end and the dune has been reshaped and denuded of natural vegetation. In some cases, structures have been constructed on the dune to delineate property boundaries or to protect property from erosion.

Since the 2009 hazard assessment, additional photogrammetry data (dated 2014) is available, as well as LiDAR ground level information and ground survey of the dune dated March 2010 and May 2015. These additional data have been used to update the hazard assessment for Callala Beach.

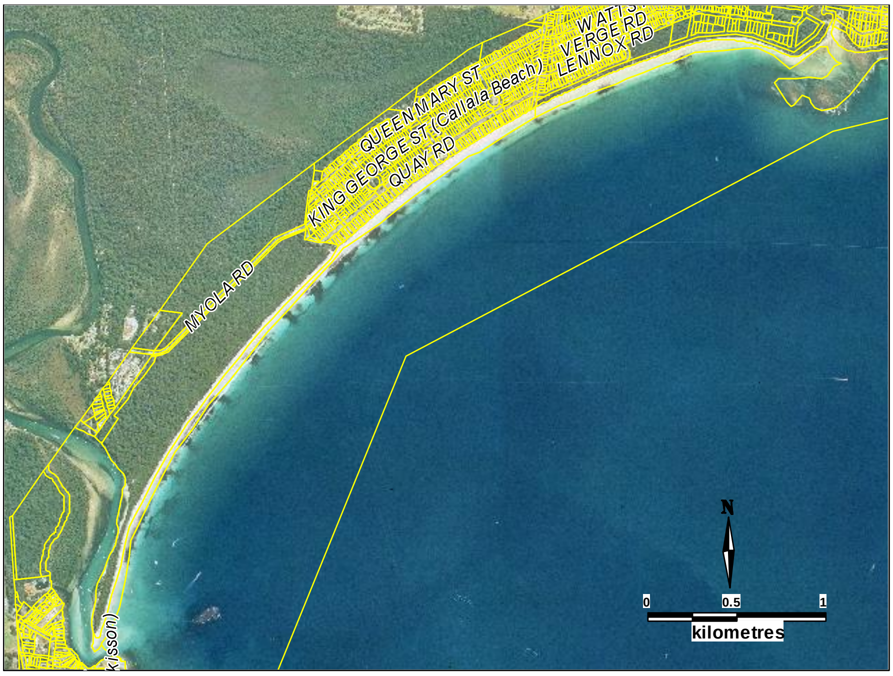


Figure 10 – Map of Callala Beach

Figure 11 – Callala Beach, looking south, 30 May 2016

2.7 Collingwood Beach

Collingwood Beach is located on the western shores of Jervis Bay, a semi-enclosed embayment on the Shoalhaven coast. It is subject to both ocean swell waves and wind waves, although the ocean swell wave climate at Collingwood Beach is much reduced compared with that which, typically, is experienced on open-coast beaches along Shoalhaven City coastline. The beach is approximately two kilometres long and is flanked by the entrance to Moona Moona Creek at the northern end and an intertidal rock shelf and Orion Beach to the south. The entire beachfront is flanked by urban development. Despite the presence of a natural dune in front of the developed area which is in relatively good condition following years of relatively calm weather, some areas of the dune have undergone severe erosion in past storms, which has threatened homes. This erosion was most pronounced at the northern end of the beach during the May-June 1974 storm event. Recently, dune vegetation along Collingwood Beach has been deliberately damaged – dune vegetation plays a significant role in dune building by altering the wind field on the beach. The destruction of dune vegetation may result in dunes becoming more susceptible to wind and wave erosion in future storms.

Since the 2009 hazard assessment, additional photogrammetry data (dated 28/11/2014) is available, as well as LiDAR ground level information and ground survey of the dune collected by Council and also by the Collingwood Beach Preservation Group dated November 2010, August 2015, September/October 2015 and March 2016. Survey data were also collected following the East Coast Low event of June 2016. These additional data have been used to update the hazard assessment for Collingwood Beach.

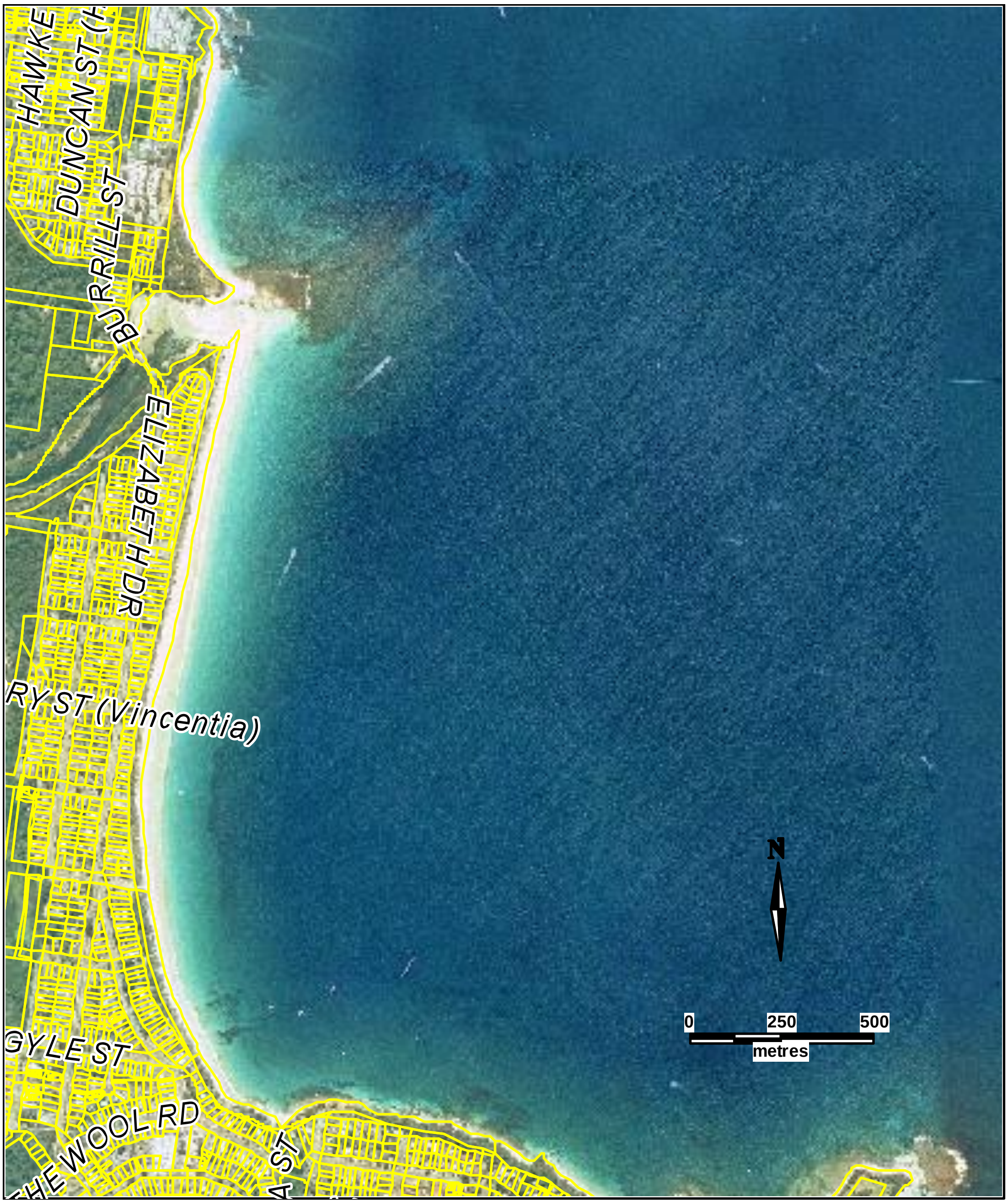


Figure 12 – Collingwood Beach

Figure 13 – Collingwood Beach, looking south, May 30, 2016. Note destruction of dune vegetation in the centre of the photograph.

2.8 Narrawallee

Narrawallee Beach is an open-coast beach located north of Ulladulla on the Shoalhaven coast. The beach is approximately 1.4 kilometres long and is flanked by an intertidal rock shelf at the southern end, and the sandstone headland of Preservation Rock and Narrawallee inlet at the northern end. The entrance to Narrawallee inlet is currently located to the north of Preservation Rock, and there is a prominent rock outcrop near the centre of the beach that has resulted in the formation of a salient. The southern end of the beach is flanked by a steep escarpment or bluff, and urban development, located behind a vegetated dune, flanks the northern half of the beach.

Since the 2009 hazard assessment, additional photogrammetry data (dated 27/11/2014) is available, as well as LiDAR ground level information, bathymetric soundings dated December 2010 and ground survey of the dune dated April 2010. These additional data have been used to update the hazard assessment for Narrawallee Beach.

Figure 14 – Narrawallee Beach

Figure 15 – Narrawallee Beach, looking north (30 May 2016)

2.9 Mollymook

Mollymook Beach is an open-coast beach located north of Ulladulla on the Shoalhaven coast. The beach is approximately two kilometres long and is flanked by a rocky sandstone headland of Bannisters Point at the northern end and an intertidal rock shelf to the south. Two small creeks cross the beach, one towards the southern end and another near the northern end. The entire beach is flanked by urban development and in some areas, the frontal dune has been interfered with, reshaped and denuded of natural vegetation, especially at the southern end where the Golf Club and Surf Club are located. Here, seawall structures have been constructed on the dune to protect property from erosion.

A dune has been recently constructed (April 2016) using sand sourced from dredging at Lake Conjola, on the northern side of Blackwater Creek, as well as a revetment constructed of rock and geobags. These works would be likely to reduce the coastal erosion and inundation hazard for the properties immediately north of the creek entrance, as well as reduce the propensity for the creek to break out to the north following a heavy rainfall event (thus decreasing the estuary entrance instability hazard for this area).

The presence of the works, as well as additional data collected since the 2009 hazard assessment, have been taken into account in updating the hazard assessment for Mollymook Beach. Since 2009, additional photogrammetry data (dated 27/11/2014) is available, as well as LiDAR ground level information, bathymetric soundings dated December 2010 and ground survey of the dune dated March 2010, April 2013, March 2015 and December 2015. Further survey of the beach was undertaken following the East Coast Low of June 2016, allowing an assessment of storm erosion demand from that event. These additional data have been used to update the hazard assessment for Mollymook.

Figure 16 – Mollymook Beach

Figure 17 – Mollymook Beach, looking north, with newly constructed dune at left (May 30 2016)

2.10 Collers Beach

Collers Beach is located on the northern side of Ulladulla Head south of Mollymook Beach. The beach is approximately 150 metres long and is flanked by rocky headlands. The nearshore seabed comprises mainly rock reef.

The beach is backed by the Mollymook Golf Course and there is a small residential subdivision on an elevated bluff to the north. On the northern side also are a car park and the start of a coastal walkway around to a local swimming hole (the Bogey Hole) and Mollymook Beach. There are some properties located behind the dune at the southern end of the beach.

Since the 2009 hazard assessment, additional photogrammetry data (dated 27/11/2014) is available, as well as LiDAR ground level information and ground survey of the dune dated April 2010. These additional data have been used to update the hazard assessment for Collers Beach.

Figure 18 – Collers Beach

Figure 19 – Collers Beach, looking north (30 May 2016). Note rock platform below subaerial beach

3 Coastal Hazard Assessment Methodology

The principal hazards induced by the coastal processes that are relevant for a coastal hazard risk assessment of the beaches in the study area include:

- short-term coastal erosion from severe storms and consequent slope instability;
- long term coastline recession resulting from imbalances in the sediment budget, such as aeolian (wind-driven) sand transport, climate change and beach rotation; and
- oceanic inundation of low lying areas.

The hydrodynamic forcing controlling the rate of these processes and hazards comprise the prevailing wave climate and water levels.

A summary of the relevant processes and coastal hazard parameters and the methodology adopted for undertaking the hazard assessment is presented below.

3.1 Short Term Coastal Erosion

Typically a beach comprises unconsolidated sands that can be mobilised under certain meteorological conditions. The dynamic nature of beaches is witnessed often during storms when waves remove the sand from the beach face and the beach berm and transport it, by a combination of longshore and rip currents, beyond the breaker zone where it is deposited in the deeper waters as sand bars. During severe storms, comprising long durations of severe wave conditions, the erosion continues into the frontal dune, which is attacked, and a steep erosion escarpment is formed. This erosion process usually takes place over several days to a few weeks.

Dune vegetation has an important role to play in the stabilisation of the beach dune prior to a storm event. Where significant human disturbance is absent, distinctive zonation of plants in the dune system may be observed, reflecting the increasingly protected / sheltered environment which is created with increasing distance from the shoreline (Figure 20). Three plant zones are usually recognised, extending landward from the backbeach: primary, secondary and tertiary. Primary zone species (grasses and creepers) colonise lower parts of the beach and trap abrasive sand particles forming a “foundation’’. Transient beach vegetation is generally dominated by grasses (e.g. *Spinifex sericus* and *Festuca littoralis*) which aid in the creation of incipient foredunes. The foredune represents an elevated “wall” that can be colonised by secondary zone species (semi-permanent populations of herbs, shrubs and trees) to provide a wind deflecting “shutter” near the shoreline. These stabilise the foredune sand mass. Finally a “roof” forms from the growth of tertiary species (taller shrubs and trees), further elevating the wind and providing increased shelter to vegetation further inland.

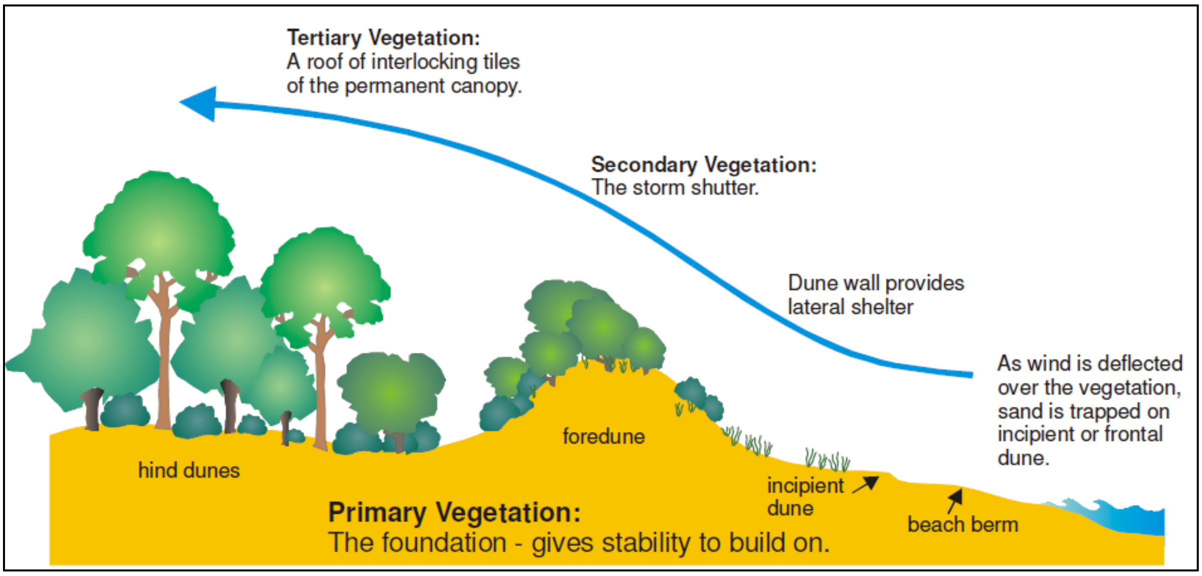


Figure 20 - Typical zonation of dune vegetation (DLWC 2001).

The amount of sand eroded from the beach during a severe storm will depend on many factors including the state of the beach when the storm begins, the storm intensity (wave height, period and duration), direction of wave approach, the tide levels during the storm and the occurrence of rips. Storm cut is the volume of beach sand that can be eroded from the subaerial (visible) part of the beach and dunes during a design storm. Usually, it has been defined as the volume of eroded sand as measured above mean sea level (~ 0 m AHD datum). For a particular beach, the storm cut (or storm erosion demand) may be quantified empirically with data obtained from photogrammetric surveys, or it may be quantified analytically using a verified numerical model.

For the beaches in the study area, the storm cut (or storm erosion demand) has been quantified empirically with data obtained photogrammetrically or through ground survey. An equivalent storm erosion volume has been derived based on the schema presented in Nielsen et al. (1992) and storm erosion volumes derived from photogrammetry data encompassing the effect of the May-June 1974 storms, using available data from before and after the storm. Other storm events that were able to be assessed at some of the beaches included the August 1986 storm, the April 2015 storm and June 2016 East Coast Low.

The storm erosion demand estimates have been based on values derived from the particular storms described above. It should be noted that it is difficult to ascribe a probability of exceedance to the storm erosion demand values presented in this report, as storm erosion depends on multiple variables including wave height, water level at the time of the storm, wave direction, beach slope and rip locations. However, it is noted in SMEC (2009) that the storm that results in the design value of storm erosion demand at each beach is estimated to have less than 5% risk of being exceeded over the next 50 years.

Following storm cut the dune face dries out and may slump. This results from the dune sediments losing their apparent cohesive properties that come from the negative pore pressures induced by the water in the soil mass (Nielsen *et al.* 1992). This subsequent slumping of the dune face causes further dune recession.

Dune slumping is treated as a slope instability hazard and can be quantified with stability computations, which can serve as a guide to determining safe setback distances on frontal dunes that are prone to wave attack and slumping during storms.

Assuming that the subsurface material in the beach dunes is composed entirely of sand, based on Nielsen et al (1992), a number of coastline hazard zones can be delineated at the beaches in the study area as shown in .

The *Zone of Wave Impact* delineates an area where any structure or its foundations would suffer direct wave attack during a severe coastal storm. It is that part of the beach that is seaward of the beach erosion escarpment.

A *Zone of Slope Adjustment* is delineated to encompass that portion of the seaward face of the beach that would slump to the natural angle of repose of the beach sand following removal of sand by wave erosion.

A *Zone of Reduced Foundation Capacity* for building foundations is delineated to take account of the reduced bearing capacity of the sand adjacent to the storm erosion escarpment. Nielsen *et al.* (1992) recommended that structural loads should only be transmitted to soil foundations outside of this zone (i.e., landward or below), as the factor of safety within the zone is less than 1.5 during extreme scour conditions at the face of the escarpment.

In general (without the protection of a terminal structure such as a seawall), dwellings/structures not piled[2] (or otherwise founded to an adequate depth) and located with the *Zone of Reduced Foundation Capacity* would be considered to have an inadequate factor of safety.

The schema for calculating the various zones is shown in Figure 21.

[2] A pile is a structural member that is driven, screwed, jacked, vibrated, drilled or otherwise installed in the ground so as to transmit loads to the surrounding soil or rock (refer to Australian Standard AS 2159–1995, “Piling – Design and installation”).

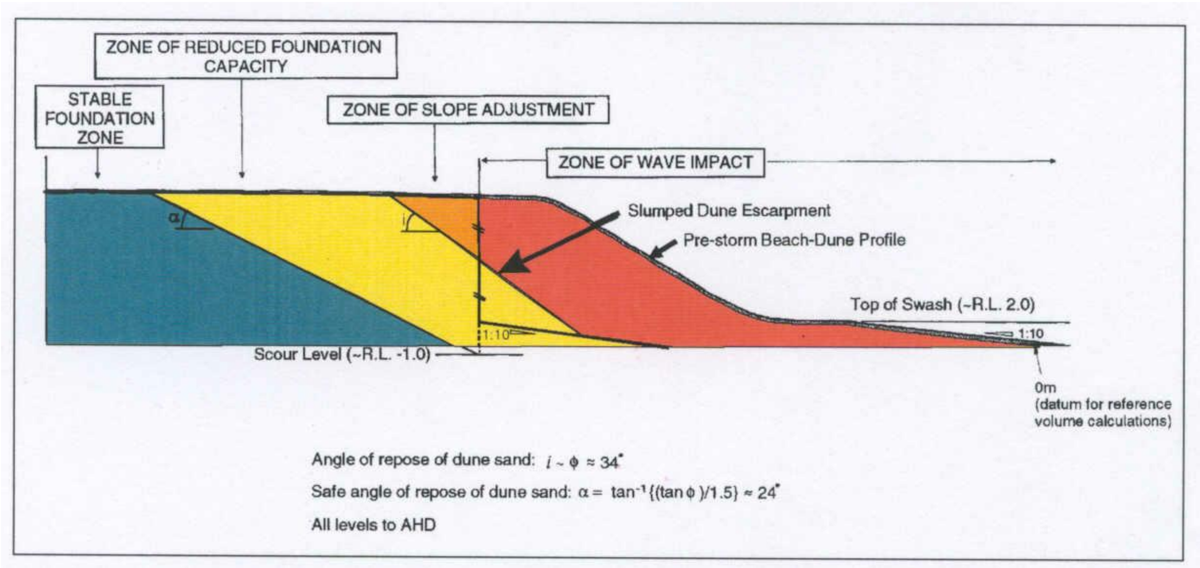


Figure 21 - Schematic representation of coastline hazard zones (after Nielsen et al, 1992)

The storm demand at a particular beach can be estimated by comparing "pre-storm" and "post-storm" beach volumes obtained from analysis of photogrammetry data. Volume change (above 0 m AHD and landward of the 2 m AHD contour) has been assessed for the analysis periods before and after known major storm events to estimate the storm erosion demand at each of the beaches attributable to major storm events. Results of this analysis are presented in Section 0 and Appendix A.

It should be noted that the photography used to generate this data is in most cases separated by several years and, therefore, does not necessarily reflect precise volume changes during the respective storm events. As the "post-storm" data was captured in some cases up to a few years after each storm event, some beach recovery would have occurred prior to the photography being taken. Further, the "pre-storm" data was in some cases captured several months or years prior to the storm events and is likely to be somewhat different from the actual pre-storm beach profiles. As such, the actual storm erosion experienced at the beaches during the 1974, 1978, 1986 and 2015 storm events may have been higher or lower than the results provided herein. Survey data have been collected shortly following an East Coast Low in June 2016, which has allowed a more accurate comparison of pre and post-storm beach volumes.

To estimate the position of the *Zone of Reduced Foundation Capacity*, a Digital Terrain Map was created based on LiDAR data provided by Shoalhaven Council. It was assumed that the natural angle of repose of the dune sand was 33°, defining the landward limit of the *Zone of Slope Adjustment*. The landward limit of the *Zone of Reduced Foundation Capacity* was defined by a line at slope of 23°, that is $\{\tan^{-1}(\tan 33°/1.5)\}$, where 1.5 is the Factor of Safety.

The top of the swash zone for the open coast beaches at low tide was assumed to be at a level of 2.0 m AHD, with a scour level of -1.0 m AHD (as per , Nielsen et al, 1992). These values are typical of those commonly adopted for open coast beaches.

3.1.1 Creek entrance instability

Short term beach fluctuations can be enhanced at natural estuary entrances. Natural entrances tend to migrate along the beach in response to freshwater flooding and coastal storm effects (NSW Government, 1990). This phenomenon has been seen at some of the beaches in the Shoalhaven, including Mollymook, with the creek entrance location migrating in response to the severe coastal storms of May 1974.

Where applicable, this extent of this hazard has been quantified empirically, with the fluctuation in sand volumes due to the 1974 storm event estimated from the photogrammetric data. The creek entrance instability hazard is applicable only in the zones around creek entrances, and has been calculated using an empirical method based on the photogrammetric data. The creek entrance instability hazard, where applicable, has been added to the short term erosion hazard. The combined hazard has been applied using the same protocol that was used for the design storm erosion (Nielsen et. al. 1992). At Mollymook, works have been carried out to reduce the estuary entrance instability hazard – these works have been taken into account in the reassessment of the coastal hazards at Mollymook.

3.2 Long Term Coastline Recession

Processes such as sea level rise, aeolian processes and the differential transport of littoral drift are natural loss components of the sediment budget of a beach. Biogenic production of sand from the shells of benthic fauna, and sediment transported into the littoral zone from nearby estuaries are natural sources of sediment for a beach. If, in the long term, the losses of sediment from a beach are greater than the gains, then a gradual beach recession will result.

An assessment of the long term beach recession rate has been made empirically using photogrammetric data from the 1940's to 2014. As the natural fluctuations of a beach and dune are large compared with any underlying long term trend in beach change, sometimes it can be difficult to quantify an accurate rate of erosion or accretion. Often it can be more accurate to measure beach recession by mapping the response of the dune erosion escarpment over time. This can be done by measuring the location of the dune face along each profile, for example, by measuring the chainage along each profile of the toe or the crest of the dune.

3.3 Future Beach Recession - Sea Level Rise

A progressive rise in sea level may result in shoreline recession through two mechanisms: first, by drowning low lying coastal land and, second, by shoreline readjustment to the new coastal water levels. The second mechanism is the more important since deeper offshore waters expose the coast to attack by larger waves, the nearshore refraction and diffraction behaviour of waves may change and a significant volume of sediment may move offshore as the beach seeks a new equilibrium profile (NSW Government 1990).

(Bruun 1962; 1983) proposed a methodology to estimate shoreline recession due to sea level rise, the so-called Bruun Rule. Bruun (1962, 1983) investigated the long term erosion along Florida's beaches, which was assumed to be caused by a long term sea level rise. 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.

illustrates the concept of the Bruun Rule. The Bruun Rule equation is given by:

$$R = \frac{S}{(h_c + B)/L}$$

where:	R	= shoreline recession due to sea level rise;
	S	= sea level rise (m)
	hc	= closure depth
	B	= berm height; and
	L	= length of the active zone.

The Bruun model assumes that the beach profile is in equilibrium with the prevailing wave climate.

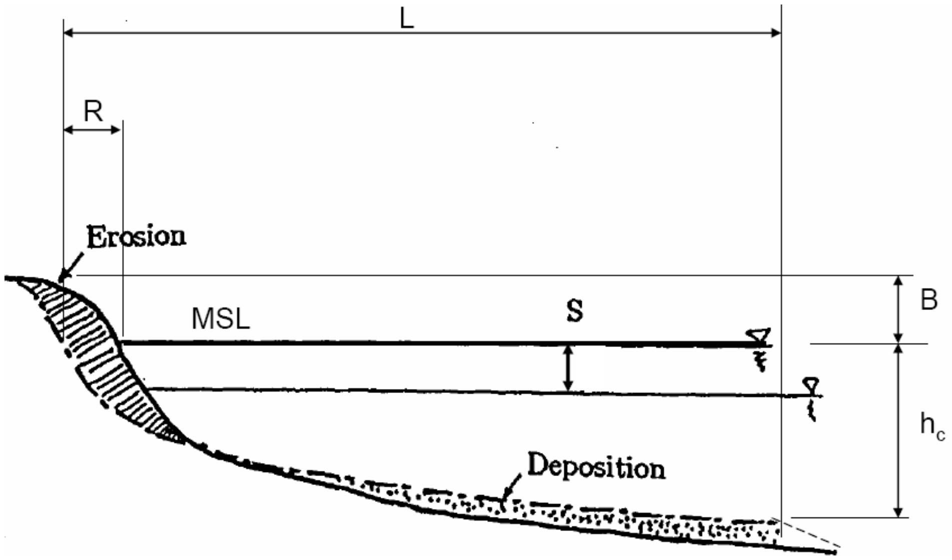


Figure 22 – Concept of shoreline recession due to sea level rise

Berm height (B) is taken to be the level of wave runup on the dune and closure depth is the depth at the seaward extent of measurable cross-shore sand transport. The length of the active zone is the distance offshore along the profile in which cross-shore sand transport occurs.

3.3.1 Estimation of Closure Depth

Bruun (1962) states that the depth of closure is "*the outer limit for the nearshore littoral drift and exchange zone of littoral material between the shore and the offshore bottom area*". According to Bruun, the depth of closure is the water depth beyond which repetitive profile surveys (collected over several years) do not detect vertical sea bed changes, generally considered to be the seaward limit of littoral transport. According to Bruun & Schwartz (1985), the depth can be determined from repeated cross-shore profile surveys, changes in sediment characteristics or estimated using formulas based on wave statistics. It is noted that the depth of closure does not imply the lack of sediment motion beyond this depth.

Several methods have been used in this assessment to estimate the depth of closure for use in the Bruun Rule. These include:

- Analytical methods based on wave characteristics and sediment grain size characteristics
- Field methods based on survey data
- Field methods based on sedimentological data.

3.3.1.1 Analytical Methods

Bruun (1988) suggested a depth of closure of $3.5H_b$, where H_b is actual breaker height of the highest waves within a certain time period, namely 50 to 100 years according to Dubois (1992). However, Bruun (1988) also noted that a closure depth of $2H_b$ was appropriate for a Danish case study. For a 100 year ARI significant wave height of 7.2 m, this is equivalent to closure depths of 14 m to 25 m.

Hallermeier (1981, 1983) defined three profile zones, namely the littoral zone, shoal or buffer zone[3], and offshore zone. These zones were defined by two depths, namely:

- an "inner" (closer to shore) depth at the seaward limit of the littoral zone, termed d_l by Hallermeier (1981) and d_s by Hallermeier (1983), and d_{inner} herein; and,
- an "outer" or "lower" (further from shore) depth at the seaward limit of the shoal/buffer zone, termed d_i by Hallermeier (1981) and d_o by Hallermeier (1983), and d_{outer} herein.

From Hallermeier (1983):

$$d_{inner} = \frac{2.9H_e}{\sqrt{S-1}} - 110\left(\frac{{H_e}^2}{(S-1)g{T_e}^2}\right) \qquad (1)$$

[3] Shoal zone in Hallermeier (1981) and buffer zone in Hallermeier (1983).

where H_e is the effective significant wave height exceeded for 12 hours per year (that is, the significant wave height with a probability of exceedance of 0.137%) and T_e is similarly defined for wave period. Based on measured Sydney wave data, H_e is about 5.6 m and T_e is about 17 s. The wave refraction coefficient for the open coast beaches is around 0.75. From Equation 1 the inner closure depth is thus about 9 m.

From Hallermeier (1983):

$$d_{outer} = 0.018 H_m T_m \sqrt{\frac{g}{D(s-1)}} \tag{2}$$

where H_m and T_m are the median wave heights and periods respectively, D is the median sediment diameter and S is the specific gravity of sand (about 2.65). Based on measured Sydney offshore wave data, H_m is about 1.6 m, T_m is about 9.6 s and the wave refraction coefficient for the open coast beaches is around 0.75. For a grain size of around 0.3 mm, from Equation 2 the depth to the outer shoal zone is around 29 m.

In the *Coastal Risk Management Guide*, DECCW (2010) recommended the use of the depth to the outer shoal zone (termed by OEH the lower limit of profile closure) when using the Bruun Rule in the absence of readily available information on active profile slopes at a location under consideration. However, according to Hallermeier (1981), "The middle zone is a buffer region where surface wave effects on a sand bed have an intermediate significance. This region is named the shoal zone primarily because the sand transport processes considered here result in deposition of sand from the flanking zones: extreme waves can carry some littoral-zone sand into the landward section of the shoal zone and common waves can carry some offshore-zone sand into the seaward section". That is, the limit of cross-shore transport of littoral sand does not extend far past the inner limit of the shoal zone.

Rijkswaterstaat (1987), approximating the work of Hallermeier (1978, 1981, 1983), found the following simplified estimate for the effective depth of closure, d_c, namely:

$$d_c = 1.75 H_e \tag{3}$$

Therefore, the predicted closure depth from Equation 3 is about 9.1 m.

3.3.1.2 Field Methods

McGrath (1968) compared various beach and nearshore profiles undertaken on Gold Coast beaches prior to and following severe cyclones that occurred there in 1967. The surveys showed that maximum accretion occurred at the 9 m water depth with the profiles closing out at 12 m depth.

Nielsen (1994) presented a data set on beach fluctuations on the Australian south-eastern seaboard that had been derived from field measurements taken from some six different sites including stakes that had been driven into the seabed at Palm Beach and repeat hydrographic surveys following large beach erosion events on the Gold Coast, Stockton and Gosford beaches (Figure 23). The data showed that there was insignificant cross-shore sand transport beyond 15 m water depth.

Nielsen (1994) presented over 20 references to sedimentological data that showed consistent distinct changes in the characteristics of sediments with water depth offshore of NSW. These changes include variations in grain size, sorting, carbonate content and colour.

There are two distinctive sediment units immediately offshore of NSW, namely *Nearshore Sand*, and (further offshore and coarser) *Inner Shelf Sand* (also known as *Shelf Plain Relict* or *Palimpsest Sand*). Nearshore Sand is further subdivided into Inner and Outer Nearshore Sand units.

The boundary between Inner and Outer Nearshore Sand is found typically at about 11 m to 15 m depth (relative to AHD), while the boundary to the nearshore Inner Shelf Sand is found usually at 18 m to 26 m depth. The boundary between Nearshore Sands and Inner Shelf Sands corresponds to those parts of the seabed considered to be active and relict. That is, there is no exchange of beach sediments with those of the Inner Shelf.

Based on a synthesis of field and laboratory data and analytical studies (particularly offshore of SE Australia), there were consistent limits of subaqueous beach fluctuations, namely water depths (relative to AHD) of:

- 12 m ± 4 m being the limit of significant wave breaking and beach fluctuations (consistent with the inner/outer nearshore sand boundary and inner Hallermeier depth)
- 22 m ± 4 m being the absolute limit of offshore sand transport under cyclonic or extreme storm events (consistent with the nearshore Inner Shelf Sand boundary)
- 30 m ± 5 m being the limit of reworking and onshore transport of beach sized sand under wave action (consistent with the outer Hallermeier depth)

For a risk-averse approach to hazard mapping, it is considered appropriate to adopt the deeper boundary between the Nearshore Sand and Inner Shelf Sand for use in the Bruun Rule for equilibrium (or steeper) profiles. This is a consistent geological indicator of the limit of cross-shore transport of littoral drift, it lies near the calculated outer limit of the Hallermeier Shoal Zone (28 m) and is well beyond any measured profile fluctuations (15 m) as recommended by Bruun & Schwartz (1985). The berm height has been taken as the limit of wave runup in extreme events.

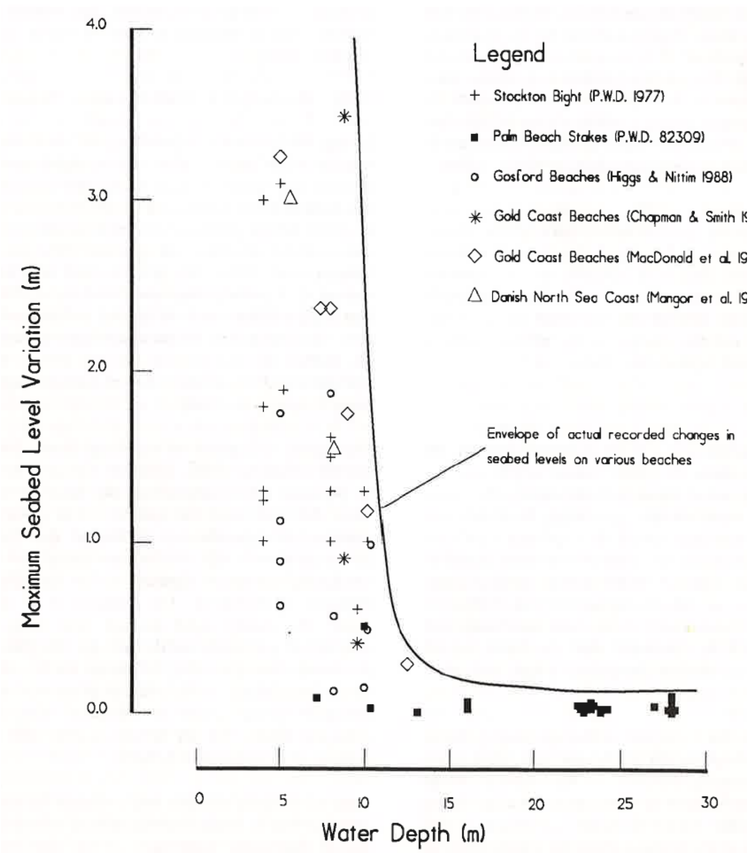


Figure 23 - Measured beach and nearshore seabed fluctuations on the south-eastern Australian seaboard (after Nielsen, 1994)

The beach profiles at all the beaches in the study area have been examined against the basic Bruun Rule assumption of the *wave-equilibrium* profile. Where beach profiles are steeper than the *equilibrium profile* (the characteristic beach profile shape formed in response to the prevailing wave climate) then the profile slope to the limit of littoral drift transport has been adopted for the application of the Bruun Rule. Where the beach profile generally is flatter than the equilibrium profile then the profile slope to the point of profile diversion has been adopted for the application of the Bruun Rule. Since the 2009 hazard assessments, additional bathymetric data has been collected at some of the beaches, which has allowed the sea level rise recession estimates to be refined.

The Bruun rule assumes that the beach profile is in an equilibrium state with the prevailing wave climate. A beach that is in equilibrium with the wave climate will develop a beach profile that has been described variously by Bruun (1954, 1962) and Dean (1991) as:

$$h = Ax^{2/3}$$

where h is the water depth at a distance x offshore.

The parameter, *A*, is dependent on the sediment fall velocity, w, thus (Dean, 1987):

$$A = 0.067w^{0.44}$$

And the fall velocity, *w*, can be related to the sediment grain size diameter, *d*, thus (Hallermeier, 1981):

$$w = 14d^{1.1}$$

Note that the relationship between sediment grain size diameter and fall velocity is not very well defined because this depends on factors including, *inter alia*, the shape of the sand grains and proportion of shell in the profile. For this reason, the value of the parameter A was varied slightly (taking account of the sediment grain size which was adopted to be around 0.3 mm) to achieve a fit to the nearshore beach profile which is most likely to be in equilibrium with the wave climate.

Since 2012, the NSW Sea Level Rise Policy no longer applies. Council has adopted the following sea level rise projections on 10 February 2015, which will apply to this assessment:

- 100mm for 2030;
- 230mm for 2050 and
- 350mm for 2100.

It should be noted that, for the assessment of long term recession due to sea level rise, it is necessary to discount long term recession attributable to sea level rise that has already occurred from the measured long term recession rates, where this was observed at a particular beach. Sea level rise trends at Fort Denison as reported by Wainwright and Lord (2014) show that approximately 0.06 m of sea level rise has occurred since 1950.

However, it should be noted that there is considerable uncertainty regarding these values, and future sea level rise could be smaller or larger than predicted.

Sea level rise recession at each of the beaches is derived in Appendix A.

3.3.2 Discussion on application of the Bruun Rule

The Bruun Rule is based on rational coastal engineering principles and has been applied in the 2009 hazard assessment (and subsequently in this re-assessment) in cognizance of the fundamental assumptions upon which it was based, to estimate projected long-term recession due to sea level rise. The methodology is in common use and has been applied in numerous other coastal hazard assessments throughout NSW in recent years.

It is noted that the Bruun Rule has been questioned in the scientific literature. However, no alternative tool for practical application in the engineering community has yet been presented and few widely-accepted alternatives to the Bruun Rule are available for assessing the impact of sea level rise on shoreline recession. Sea level rise recession has been assessed using techniques accepted by the scientific community, taking into account careful interpretation of the offshore active beach slopes, local wave climate at each beach and sedimentology of the seabed.

With additional bathymetry data, changes in sea level rise projections and known locations of rocky reefs available since the assessment done in 2009, the best available data has been used to calculate the nearshore equilibrium slope for a correct and careful application of the Bruun Rule.

It is acknowledged that the Bruun rule has several limitations but these limitations have been considered in its application to the beaches of the Shoalhaven. While the rule does not account for longshore interactions, this limitation does not necessarily apply for many of the beaches in the study area due to the beach compartments being a ‘closed system’ and not subject to significant longshore sediment transport. A further limitation is that the Bruun Rule assumes the wave climate is steady and hence the equilibrium profile remains the same - simply translated the beach profile will move landwards and upwards with the rise in mean sea level. The rule has been applied only to the portion of the beach profiles shown by bathymetric and sedimentological data to be in equilibrium with the wave climate and therefore a rise in sea level (under current coastal processes) will result in a corresponding recession relative to that rise and in maintaining the equilibrium.

It is noted that the Bruun Rule is one tool used to address prediction of coastal response due to sea level rise and that the current coastal hazard assessment also includes the incorporation of historical beach behaviour information, knowledge of local coastal processes and local geomorphology.

3.4 Inundation

3.4.1 Coastal Inundation

Coastal inundation is the flooding of coastal lands by ocean waters, which is caused by large waves and elevated water levels associated with severe storms. Severe inundation is an infrequent event and, normally, is of short duration, but it can result in significant damage to both public and private property (NSW Government 1990).

The components that give rise to elevated still water levels at times of storms include storm surge (including wind setup and barometric setup) and wave setup. This increased water level may persist for several hours to days and can inundate low lying beach areas and coastal creeks.

Wave runup relates to the rush of water up the beach on the breaking of a wave. The amount of run-up is the vertical height above still water level to which the rush of water reaches. Wave runup is site specific but, typically, reaches a maximum level of about 7 m AHD on the open NSW coast at present. The height of wave runup on beaches depends on many factors, including:

- wave height and period;
- the slope, shape and permeability of the beach;

- the roughness of the foreshore area (i.e. whether the foreshore area comprises a smooth sandy beach or a rocky foreshore with boulders); and
- wave regularity.

Wave runup can be difficult to predict accurately due to the many factors involved. Anecdotal evidence and the surveying of debris lines following a storm event usually provide the best information on wave runup levels.

Hanslow & Nielsen (1995) plotted the field experiments by Holman (1986) together with their own data (Figure 24), which showed that, for exposed sites, the near maximum wave runup limit, $R_{2\%}$, on natural beaches can be given by:

$$R_{2\%} = [25.273 \tan\beta^3 - 12.547 \tan\beta^2 + 2.2674 \tan\beta] \times (H_s L_o)^{0.5} + SWL \quad (1)$$

where:

	$R_{2\%}$	is the 2% exceedance run-up height;
	H_s	is the incident significant wave height in 6m depth;
	ß	is the beach face slope near the still water line;
	SWL	is the still water level (excluding wave setup).

Wave runup has been re-calculated using aerial LIDAR survey data provided by Shoalhaven Council and the results of the two-dimensional SWAN wave transformation modelling undertaken by SMEC for the 2009 hazard assessment (which takes into account the effects of wave refraction and the degree of exposure of the site to waves from different offshore directions). Runup has been determined at each beach using the wave height coefficient calculated from the offshore-to-nearshore SWAN wave transformation analysis as documented in the previous hazard assessment (SMEC 2009) for each offshore wave direction, using the 100 year ARI significant wave height from that direction (refer Figure 25 for offshore significant wave heights at the Sydney Waverider buoy). The 6 hour duration wave height was chosen for this analysis, to ensure that it had a high chance of occurring on the high tide. The maximum level of runup was adopted.

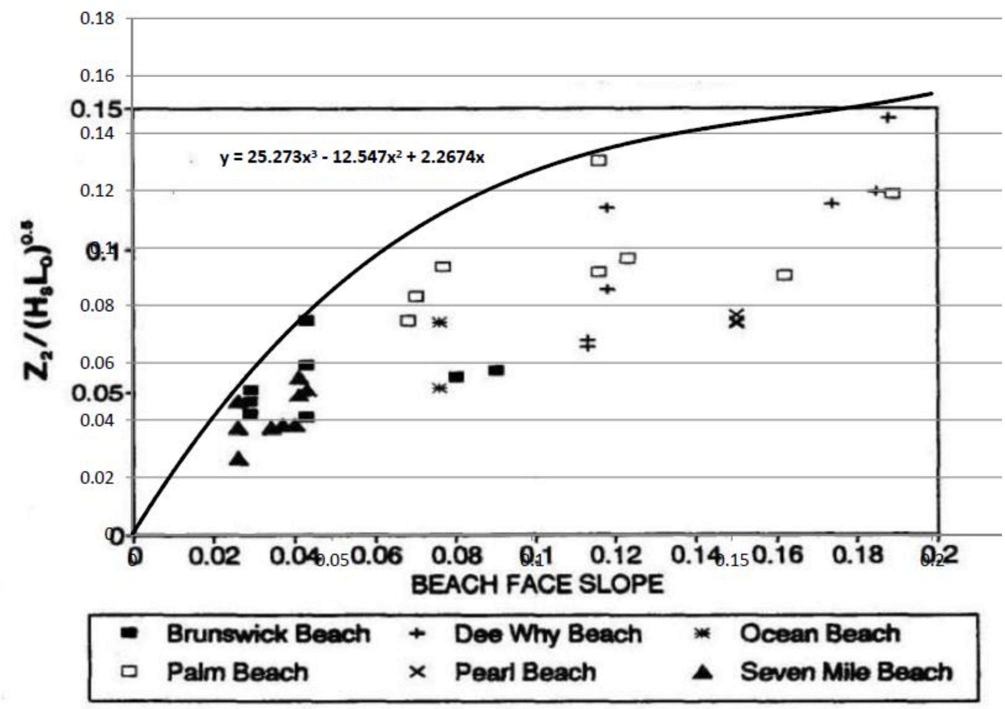


Figure 24 – Beach runup as a function of beach slope (modified after Hanslow & Nielsen, 1995)

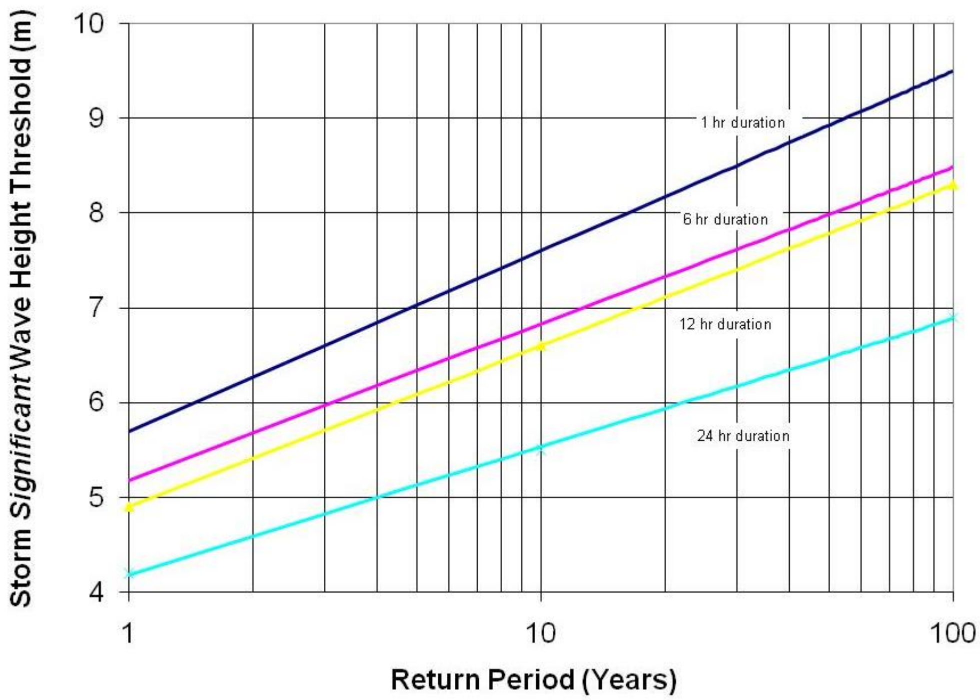


Figure 25 - Storm Wave Height Duration return periods for all directions (modified from Kulmar et al., 2005)

4 Coastal Hazard Assessment Results

The results of the coastal hazard assessment for each beach in the study area are documented below, including short term erosion, long term recession, recession due to sea level rise and coastal inundation. Differences between the latest assessment and the 2009 assessment, and reasons for these differences are summarised below. Details of the analysis at each beach are provided in Appendix A.

The coastal hazard results have been mapped using the most recent available LiDAR data as a base for the mapping. Hazard maps for each precinct in the study area are provided in Appendix B.

4.1 Shoalhaven Heads

Since the 2009 hazard assessment, additional photogrammetry data (dated 9/8/2014) is available, as well as LiDAR ground level information from 2010, bathymetric survey from 2011 and ground survey transects through the beach berm at the Surf Club dated March 2010, February 2013 and February 2014. In addition, a sediment compartment study undertaken by Carvalho and Woodroffe (2014) examining factors influencing the sediment budget of Shoalhaven Heads, Culburra, Warrain and Currarong beaches is available. These additional data have been used to update the hazard assessment for Shoalhaven Heads.

4.1.1 Summary

The results of the updated coastal hazard assessment for Shoalhaven Heads, when compared with the SMEC 2009 assessment, are provided in Table 1, below.

Table 1 – Comparison of SMEC (2009) hazard assessment with current hazard assessment at Shoalhaven Heads.

Coastal Hazard Parameter	SMEC (2009) assessment	Updated assessment
Short term storm erosion/river entrance instability hazard	350 m^3/m	350 m^3/m
Long term beach recession	Zero	Zero
Sea level rise recession 2030	Not assessed	7.6 m
Sea level rise recession 2050	21.3 m	17.4 m
Sea level rise recession 2100	48.0 m	26.4 m
Maximum wave runup level (present day)	5.9 m AHD	6.3 m AHD

4.2 Culburra Beach

Since the 2009 hazard assessment, additional photogrammetry data (dated 9/8/2014) is available, as well as LiDAR ground level information, bathymetric survey from July 2010 and ground survey of the dune dated July 2010. In addition, a sediment compartment study undertaken by Carvalho and Woodroffe (2014) examining factors influencing the sediment budget of Shoalhaven Heads, Culburra, Warrain and Currarong beaches is available. These additional data have been used to update the hazard assessment for Culburra Beach.

4.2.1 Summary

The results of the updated coastal hazard assessment for Culburra, when compared with the SMEC 2009 assessment, are provided in Table 2, below.

Table 2 – Comparison of SMEC (2009) hazard assessment with current hazard assessment at Culburra.

Coastal Hazard Parameter	SMEC (2009) assessment	Updated assessment
Short term storm erosion hazard	250 m^3/m	100 m^3/m (south); 160 m^3/m (central); 280 m^3/m (north)
Long term beach recession	0.09 – 0.19 m/y (south-central); Zero (north)	0.025 m/y (south-central); Zero (north)
Sea level rise recession 2030	Not assessed	3.3 m (south); 5.0 m (central-north)
Sea level rise recession 2050	15.8 m	7.7 m (south); 11.5 m (central-north)
Sea level rise recession 2100	35.6 m	11.7 m (south); 17.5 m (central-north)
Maximum wave runup level (present day)	8.4 m AHD	7.6 m AHD (south-central) 7.1 m AHD (north)

4.3 Warrain Beach

Since the 2009 hazard assessment, LiDAR ground level information and recent bathymetric survey and ground survey of the dune were available for analysis. In addition, a sediment compartment study undertaken by Carvalho and Woodroffe (2014) examining factors influencing the sediment budget of Shoalhaven Heads, Culburra, Warrain and Currarong beaches is available. These additional data have been used to update the hazard assessment for the northern end of Warrain Beach.

4.3.1 Summary

The results of the updated coastal hazard assessment for Warrain, when compared with the SMEC 2009 assessment, are provided in Table 3, below.

Table 3 – Comparison of SMEC (2009) hazard assessment with current hazard assessment at Warrain Beach (north of Lake Woolumboola).

Coastal Hazard Parameter	SMEC (2009) assessment	Updated assessment
Short term storm erosion hazard	250 m^3/m (north of Lake entrance) 300 m^3/m (adjacent to Lake entrance)	220 m^3/m (north of Lake entrance) 400 m^3/m at lake entrance
Long term beach recession	Zero	Zero
Sea level rise recession 2030	Not assessed	3.1 m
Sea level rise recession 2050	14.9 m	7.1 m
Sea level rise recession 2100	33.5 m	10.8 m
Maximum wave runup level (present day)	7.5 m AHD	6.4 m AHD

4.4 Currarong Beach

Since the 2009 hazard assessment, LiDAR ground level information and recent bathymetric survey and ground survey of the dune were available for analysis. Dune survey was commissioned by Council following an East Coast Low event in June 2016 and this was able to be used to accurately estimate storm erosion demand at Currarong. In addition, a sediment compartment study undertaken by Carvalho and Woodroffe (2014) examining factors influencing the sediment budget of Shoalhaven Heads, Culburra, Warrain and Currarong beaches is available. These additional data have been used to update the hazard assessment for Currarong Beach.

4.4.1 Summary

The results of the updated coastal hazard assessment for Currarong, when compared with the SMEC 2009 assessment, are provided in Table 4, below.

Table 4 – Comparison of SMEC (2009) hazard assessment with current hazard assessment at Currarong

Coastal Hazard Parameter	SMEC (2009) assessment	Updated assessment
Short term storm erosion hazard	60 m^3/m	60 m^3/m
Long term beach recession	0.17 – 0.25 m/y	0.10 – 0.29 m/y
Sea level rise recession 2030	Not assessed	4.7 m west of Cambewarra Rd 2.5 m east of Cambewarra Rd
Sea level rise recession 2050	5.2 m	10.9 m west of Cambewarra Rd 5.8 m east of Cambewarra Rd
Sea level rise recession 2100	11.7 m	16.6 m west of Cambewarra Rd 8.8 m east of Cambewarra Rd
Maximum wave runup level (present day)	3.9 – 4.6 m AHD	4.8 m AHD (east) – 5.5 m AHD (west)

It is noted that the values for sea level rise recession are slightly increased for the area west of Cambewarra Road when compared with the 2009 assessment, despite the reduction in sea level rise projections. This is due to improved bathymetric information and insight into the location of offshore reefs, which has allowed an improved estimate of beach recession due to sea level rise. Appendix A documents the assessment in full for sea level rise for Currarong.

4.5 Callala Beach

Since the 2009 hazard assessment, additional photogrammetry data (dated 2014) is available, as well as LiDAR ground level information and ground survey of the dune dated March 2010 and May 2015. These additional data have been used to update the hazard assessment for Callala Beach.

4.5.1 Summary

The results of the updated coastal hazard assessment for Callala, when compared with the SMEC 2009 assessment, are provided in Table 5, below.

Table 5 – Comparison of SMEC (2009) hazard assessment with current hazard assessment at Callala

Coastal Hazard Parameter	SMEC (2009) assessment	Updated assessment
Short term storm erosion hazard	120 m^3/m	120 m^3/m (north and south); 180 m^3/m (central)
Long term beach recession	0.05 m/y	Zero (south); 0.1 – 0.15 m/y (central – north)
Sea level rise recession 2030	Not assessed	3.0 m (south); 2.5 m (north)
Sea level rise recession 2050	9.6 m	6.9 m (south); 5.8 m (north)
Sea level rise recession 2100	21.6 m	10.5 m (south); 8.8 m (north)
Maximum wave runup level (present day)	6.0 m AHD	4.0 m AHD (north) 5.2 m AHD (south-central)

4.6 Collingwood Beach

Since the 2009 hazard assessment, additional photogrammetry data (dated 28/11/2014) is available, as well as LiDAR ground level information and ground survey of the dune dated November 2010, August 2015, September/October 2015, March 2016 and June 2016 (capturing the impact of the June 2016 East Coast Low). These additional data have been used to update the hazard assessment for Collingwood Beach.

4.6.1 Summary

The results of the updated coastal hazard assessment for Collingwood, when compared with the SMEC 2009 assessment, are provided in Table 6, below.

Table 6 – Comparison of SMEC (2009) hazard assessment with current hazard assessment at Collingwood

Coastal Hazard Parameter	SMEC (2009) assessment	Updated assessment
Short term storm erosion hazard	110 m^3/m	100 m^3/m (south); 120 m^3/m (central - north)
Long term beach recession	Zero	Zero
Sea level rise recession 2030	Not assessed	1.5 m (south) 3.0 m (north)
Sea level rise recession 2050	16.3 m	3.5 m (south) 6.9 m (north)
Sea level rise recession 2100	36.6 m	5.3 m (south) 10.5 m (north)
Maximum wave runup level (present day)	5.0 – 5.5 m AHD	5.0 m AHD (south - central) 5.7 m AHD (north)

4.7 Narrawallee Beach

Since the 2009 hazard assessment, additional photogrammetry data (dated 27/11/2014) is available, as well as LiDAR ground level information, bathymetric soundings dated December 2010 and ground survey of the dune dated April 2010. These additional data have been used to update the hazard assessment for Narrawallee Beach.

4.7.1 Summary

The results of the updated coastal hazard assessment for Narrawallee, when compared with the SMEC 2009 assessment, are provided in Table 7, below.

Table 7 – Comparison of SMEC (2009) hazard assessment with current hazard assessment at Narrawallee

Coastal Hazard Parameter	SMEC (2009) assessment	Updated assessment
Short term storm erosion hazard	110 m^3/m	110 m^3/m
Long term beach recession	Zero	Zero
Sea level rise recession 2030	Not assessed	5.4 m
Sea level rise recession 2050	18.2 m	12.4 m
Sea level rise recession 2100	41.1 m	18.8 m
Maximum wave runup level (present day)	5.1 – 7.0 m AHD	5.9 m AHD

4.8 Mollymook Beach

At Mollymook, a dune has been recently constructed (April 2016) using sand sourced from dredging at Lake Conjola, on the northern side of Blackwater Creek, as well as a geobag revetment. These works would be likely to reduce the coastal erosion and inundation hazard for the properties immediately north of the creek entrance, as well as reduce the propensity for the creek to break out to the north following a heavy rainfall event (thus decreasing the estuary entrance instability hazard for this area).

The presence of the works, as well as additional data collected since the 2009 hazard assessment, have been taken into account in updating the hazard assessment for Mollymook Beach. Since 2009, additional photogrammetry data (dated 27/11/2014) is available, as well as LiDAR ground level information, bathymetric soundings dated December 2010 and ground survey of the dune dated March 2010, April 2013, March 2015 and December 2015. These additional data have been used to update the hazard assessment for Mollymook.

4.8.1 Summary

The results of the updated coastal hazard assessment for Mollymook, when compared with the SMEC 2009 assessment, are provided in Table 8, below.

Table 8 – Comparison of SMEC (2009) hazard assessment with current hazard assessment at Mollymook

Coastal Hazard Parameter	SMEC (2009) assessment	Updated assessment
Short term storm erosion hazard	70 m^3/m – south (Golf Club) 140 m^3/m – Surf Club 170 m^3/m – between two creek entrances 100 m^3/m – northern end >200 m^3/m – on both sides of creek entrances	90 m^3/m – south (Golf Club) 150 m^3/m – Surf Club 130 m^3/m – north of Blackwater Creek in area behind nourished dune 170 m^3/m – north of nourished dune 100 m^3/m – northern end 230 m^3/m – immediately south of Blackwater Creek entrance
Long term beach recession	Zero	Zero
Sea level rise recession 2030	Not assessed	4.4 m
Sea level rise recession 2050	18.8 m	10.1 m
Sea level rise recession 2100	42.3 m	15.4 m
Maximum wave runup level (present day)	5.0 – 7.4 m AHD	5.5 - 6.0 m AHD

4.9 Collers Beach

Since the 2009 hazard assessment, additional photogrammetry data (dated 27/11/2014) is available, as well as LiDAR ground level information and ground survey of the dune dated April 2010. These additional data have been used to update the hazard assessment for Collers Beach.

4.9.1 Summary

The results of the updated coastal hazard assessment for Collers Beach, when compared with the SMEC 2009 assessment, are provided in Table 9, below.

Table 9 – Comparison of SMEC (2009) hazard assessment with current hazard assessment at Collers Beach

Coastal Hazard Parameter	SMEC (2009) assessment	Updated assessment
Short term storm erosion hazard	105 m^3/m	105 m^3/m
Long term beach recession	Zero	Zero
Sea level rise recession 2030	Not assessed	0.9 m
Sea level rise recession 2050	3.1 m	1.8 m
Sea level rise recession 2100	6.9 m	2.8 m
Maximum wave runup level (present day)	6.4 – 7.4 m AHD	6.5 m AHD

5 Conclusion

This report has presented an updated coastal hazard assessment at the beaches in the Shoalhaven. The previous assessment used photogrammetry data available at that time to derive trends in long term beach change and storm erosion demand, as well as sea level rise projections provided by the NSW Government through the NSW Sea Level Rise Policy.

Since the previous assessment in 2009, the NSW Sea Level Rise Policy no longer applies, and Council has adopted new sea level rise projections. In addition, further photogrammetry data was collected in 2014 for all the beaches, and Council has embarked on a program of ground survey collection at key locations. A major storm event occurred in June 2016 which impacted on the beach at Currarong – the effect of this storm event on inundation and storm erosion was captured by ground survey at several of the beaches in the study area, and this has been included in the analysis.

Bathymetric soundings have been collected in the nearshore at various beaches, which has improved understanding of the active beach profiles at each of the beaches and enabled an improved assessment of the response of the beach to future sea level rise.

Works to reduce coastal hazards have been carried out in some areas since the 2009 assessment, including at Blackwater Creek in Mollymook to reduce hazards from inundation, estuary entrance instability and short term storm erosion. The presence of these works have been taken into account in updating the coastal hazard mapping.

Future data collection including post-storm LiDAR data collection to assess the impact of the June 2016 East Coast Low and other future storms is recommended, to further refine the coastal hazard assessments in the future and assess the future impact of measures taken to reduce the coastal hazards.

6 References

Bruun, P.M. (1954). "Coast erosion and the development of beach profiles", Technical Memorandum 44, US Army Beach Erosion Board, June 1954.

Bruun, P.M. (1962). "Sea-Level rise as a cause of shore erosion", Jnl. Waterways, Harbour & Coastal Engg. Div., ASCE, Vol. 88, No. WW1, pp 117-130.

Bruun, P.M. (1983). "Review of conditions for uses of the Bruun Rule of erosion", Jnl. Coastal Engg., Vol 7, No. 1, pp 77-89.

Bruun, P.M. (1988), "The Bruun Rule of Erosion by Sea-Level Rise: A Discussion on Large-Scale Two- and Three-Dimensional Usages", *Journal of Coastal Research*, Volume 4 No. 4, pp. 627-648

Bruun, P.M. & M.L. Schwartz (1985), "Analytical predictions of beach profile change in response to a sea level rise", *Z. Geomorph. N.F.*, Suppl. Bd. 57, Berlin-Stuttgart, Dec., 33-50.

Carvalho, R. C. and C D Woodroffe (2014). "The Sediment Budget as a Management Tool: The Shoalhaven Coastal Compartment, Southeastern NSW, Australia". Proceedings 2014 NSW Coastal Conference.

Carvalho, R. C. and C D Woodroffe (2015). "From Catchment to Inner Shelf: Insights into NSW Coastal Compartments". Proceedings 2015 NSW Coastal Conference.

Coastal Engineering Solutions (2003). "Currarong Beach Foreshore Erosion and Management Options Study", Final Report, August 2003.

DECCW (2010), *Coastal Risk Management Guide: Incorporating sea level rise benchmarks in coastal risk assessments*, Department of Environment, Climate Change and Water 2010/760, August, ISBN 978 1 74232 922 2

Dean, R. G. (1987) "Coastal sediment processes: toward engineering solutions." In Nicholas C. Kraus, editor, Coastal Sediments '87, volume 1, pp 1 – 24, New Orleans, Louisiana, May 1987. ASCE. Proceedings of a Specialty Conference on Advances in Understanding of Coastal Sediment Processes.

Dean, R. (1991). Equilibrium beach profiles: characteristics and applications. Journal of Coastal Research 7(1):53-84.

Department of Environment and Climate Change NSW (2009). "Draft Sea Level Rise Policy Statement".

Department of Environment, Climate Change and Water (2010). "Seabed habitat mapping of the continental shelf of NSW", December.

NSW Department of Land and Water Conservation: DLWC (2001). Coastal Dune Management: A Manual of Coastal Dune Management and Rehabilitation Techniques, Coastal unit, DLWC, Newcastle.

Hallermeier, R.J. (1978), "Uses for a Calculated Limit Depth to Beach Erosion", *Proceedings of the 16th International Conference on Coastal Engineering*, Hamburg, American Society of Civil Engineers, pp 1493-1512

Hallermeier, R. J. (1981) "A profile zonation for seasonal sand beaches from wave climate" Coastal Engg., Vol. 4, pp 253-277.

Hallermeier, R. J. (1983) "Sand Transport limits in coastal structure design", Proc. Coastal Structures '83, ASCE, pp 703-716

Hanslow, DJ & Nielsen, P (1995). "Field measurements of runup on natural beaches". Proc. 12th Australasian Coastal and Ocean Engineering Conference, IEAust., Melbourne, 1995.

Holman, RA (1986). "Extreme value statistics for runup on a natural beach". Coastal Eng. Vol. 9, pp 527-544.

IPCC (2013). Working Group 1 Contribution to the IPCC Fifth Assessment Report Climate Change 2013: The Physical Science Basis (Final Draft). Intergovernmental Panel on Climate Change, Stockholm.

Kulmar, Mark; Lord, Doug and Brian Sanderson (2005), "Future Directions for Wave Data Collection in New South Wales", *Proceedings of the 17th Australasian Conference on Coastal and Ocean Engineering and the 10th Australasian Port and Harbour Conference, 2005 Coasts and Ports Australasian Conference*, edited by M Townsend and D Walker, conference held from 20-23 September at Adelaide, South Australia, Institution of Engineers, Australia, ISBN 0 646 45130 8, pp. 167-172

McPherson, A., Hazelwood, M., Moore, D., Owen, K., Nichol, S. & Howard, F. (2015). The Australian Coastal Sediment Compartments Project: methodology and product development. Record 2015/25. Geoscience Australia, Canberra. http://dx.doi.org/10.11636/Record.2015.025

McGrath. B.L. (1968) Erosion of Gold Coast Beaches, 1967. Proc. Institution of Engineers, Australia, Annual Conference, Brisbane July-Aug 1968, p155-166

Nielsen, A.F., D.B. Lord & H.G. Poulos (1992). "Dune Stability Considerations for Building Foundations", IEAust., Aust. Civ. Eng. Trans., Vol. CE 34, No. 2, 167-173.

Nielsen, A. F. (1994) "Subaqueous Beach Fluctuations on the Australian South-Eastern Seaboard", in Australian Civil Engineering Transactions, Vol. CE36 No.1 January 1994, pp 57-67.

NSW Government (1990), "Coastline Management Manual", ISBN 0730575063, September

Rijkswaterstaat 1987, *Manual on Artificial Beach Nourishment*, document prepared by the Netherlands Department of Public Works Rijkswaterstaat, August, ISBN 9021260786

SMEC Australia (2004), "Coastline Definition and Risk Rating", Report No. 31434-001 prepared by SMEC Australia for Shoalhaven City Council, July 2004

SMEC (2009) "Shoalhaven Coastal Hazard Study – Summary Report", Report no. 3001209, July.

Umwelt Australia (2012) "Shoalhaven Coastal Zone Management Plan", Draft.

Wainwright, D. and D. Lord (2014), "South Coast Regional Sea-level Rise Planning and Policy Response Framework", October.

WP Geomarine (1995). "Warrain Beach Coastal Process Overview", Final Report, March 1995.

Appendix A: Detailed assessment

1 Detailed Coastal Hazard Assessment

This Appendix documents the updated coastal hazard analysis and derivation of the results for each of the beaches in the study area.

1.1 Shoalhaven Heads

Since the 2009 hazard assessment, additional photogrammetry data (dated 9/8/2014) is available, as well as LiDAR ground level information, bathymetric survey from 2011 and ground survey transects through the beach berm at the Surf Club dated March 2010, February 2013 and February 2014. OEH collected survey data in the vicinity of the Surf Club in 2013 and following the East Coast Low of June 2016. In addition, a sediment compartment study undertaken by Carvalho and Woodroffe (2014) examining factors influencing the sediment budget of Shoalhaven Heads, Culburra, Warrain and Currarong beaches is available. These additional data have been used to update the hazard assessment for Shoalhaven Heads.

The location of available photogrammetry data at Shoalhaven Heads is shown in Figure 26, below.

Figure 26 – Location of photogrammetry data, Shoalhaven Heads

1.1.1 Short Term Erosion

Short term erosion at Shoalhaven Heads was assessed with reference to available photogrammetry data and ground survey information. The area of beach assessed includes approximately 2 km length of beach north of the entrance to the Shoalhaven River. This stretch of beach is influenced by the state of the Shoalhaven River entrance. Since the previous assessment, the largest recorded combined storm/river entrance instability at this location has been the 1978 storm/flood event, with a combined storm/river entrance instability erosion demand of 350 m^3/m. This value was calculated in the 2009 coastal hazard assessment and has been confirmed by the latest assessment, with no additional storms of such magnitude having been confirmed in the historical record. For the storm of May-June 1974, storm erosion demand was generally lower than 150 m^3/m except near the entrance to the Shoalhaven River, where values up to 200 m^3/m were measured.

Storm erosion demand from the 1974 storm event was determined from photogrammetry data between 1970 and 1974, with erosion demand for the 1978 storm/flood event determined from photogrammetry data between 1974 and 1984. Survey data at the surf club dated March 2010, February 2013 and February 2014 has been analysed but it was found that beach fluctuations over this time were largely restricted to the beach berm, with a storm erosion demand from the relatively small storms over this period restricted to around 40 m^3/m. For the East Coast Low of June 2016, a storm erosion demand of 106 m^3/m was recorded at the Surf Club, based on survey data collected by OEH in 2013 and June 2016.

The updated storm erosion analysis for Shoalhaven Heads is provided in Figure 27, below.

1.1.2 Long Term Recession

With additional photogrammetry data available for 9/8/2014 and additional ground survey data, the trend in long term recession or accretion of the beach has been examined and compared with the previously assessed (SMEC 2009) trend in beach change at Shoalhaven Heads. This was done using a volumetric technique, where the trend in beach volume over time has been examined at each beach profile, as well as tracking of the dune face or beach escarpment chainage over time.

Using both of these techniques, the beach has been assessed to be prograding over time – i.e. the beach volume has been increasing on average and the dune has been prograding seaward. This is in line with the observed geomorphological features of Shoalhaven Heads as described in Carvalho and Woodroffe (2014), with the Holocene beach barrier generally having prograded by 1,350 m since the most recent sea-level still stand around 6,640 years ago (Carvalho and Woodroffe, 2014). It is postulated that the continuing progradation of this barrier has occurred because of sediment supply provided by the Shoalhaven River.

Based on the photogrammetric assessment and analysis of survey data, long term recession is not occurring at Shoalhaven Heads, so the long term recession rate has been conservatively estimated to be **zero** for Shoalhaven Heads. This is consistent with the previous assessment undertaken by SMEC (2009).

The updated beach change analysis for Shoalhaven Heads is provided in Figure 28, below.

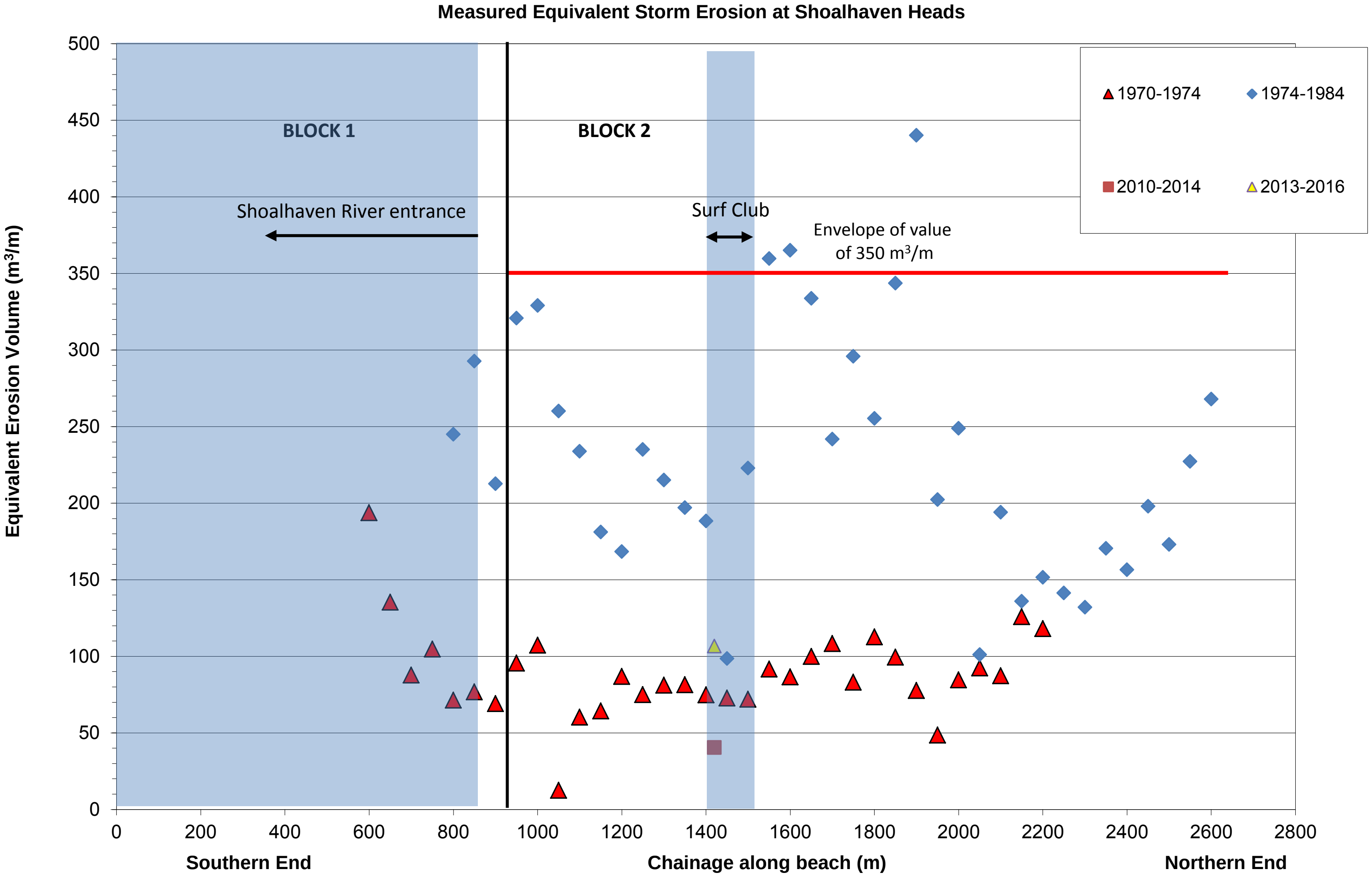
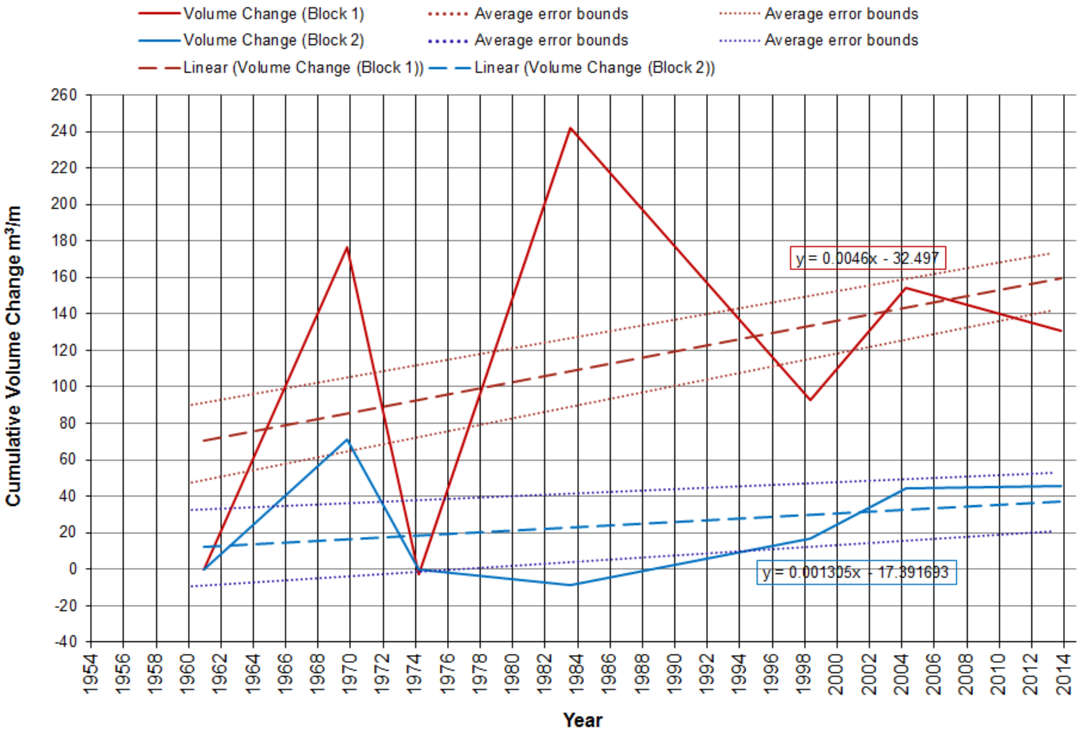


Figure 27 – Measured equivalent storm/river entrance instability erosion hazard at Shoalhaven Heads



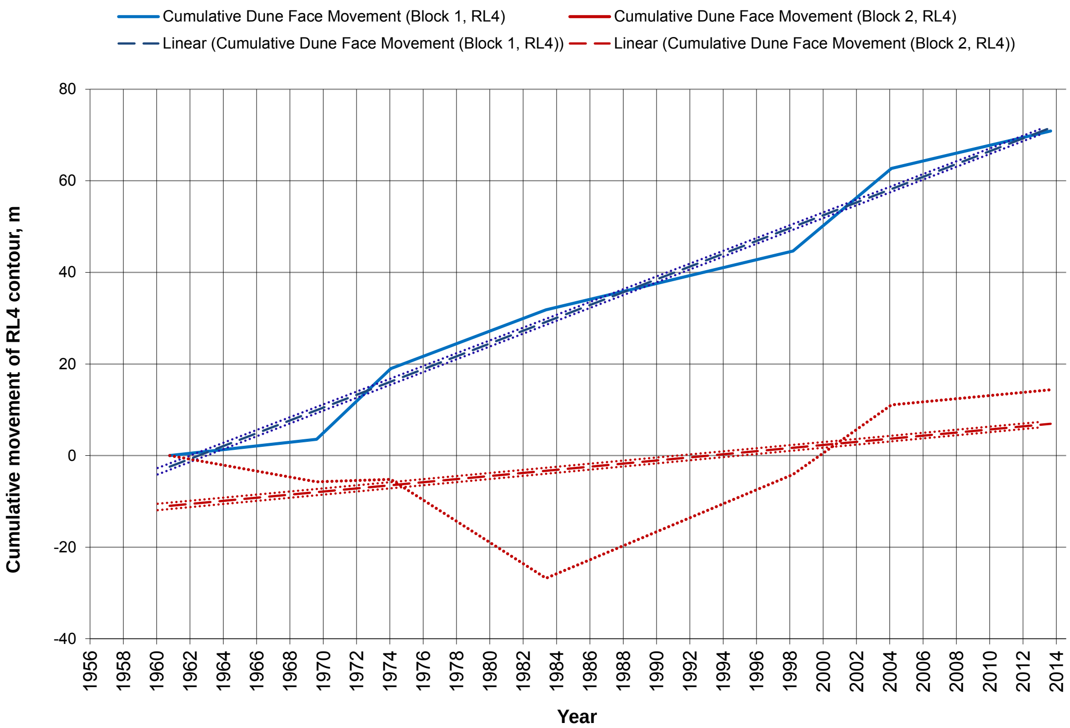


Figure 28 – Beach change over time, Shoalhaven Heads. Top: Volumetric analysis, Bottom: Dune face analysis (average for Block 1 and Block 2)

1.1.3 Future Beach Recession due to Sea Level Rise

Since the previous hazard assessment (SMEC 2009), bathymetric soundings have been collected at Shoalhaven Heads. These bathymetric soundings have enabled an updated assessment of future beach recession due to sea level rise to be carried out. The previous assessment relied on navigation chart data to determine nearshore beach slope, and had found that the measured beach slope lay above the estimated equilibrium beach profile. However, with the updated bathymetric soundings, it was found that the beach profile at Shoalhaven Heads closely approximated the equilibrium profile, down to approximately 20 m depth, which is approximately the absolute limit of offshore sand transport under extreme storm events as documented by Nielsen (1994).

A characteristic beach profile and the wave-equilibrium beach profile for Shoalhaven Heads is presented in Figure 29. A sea level rise is projected to cause erosion of Shoalhaven Heads Beach. As shown in Figure 29, the beach slope is fairly constant and a value of 1V:75H has been adopted. For this slope and for sea level rises of 0.10 m (2030), 0.23 m (2050) and 0.35 m (2100), shoreline recession of 7.6 m, 17.4 m and 26.4 m (respectively) are projected for Shoalhaven Heads Beach.

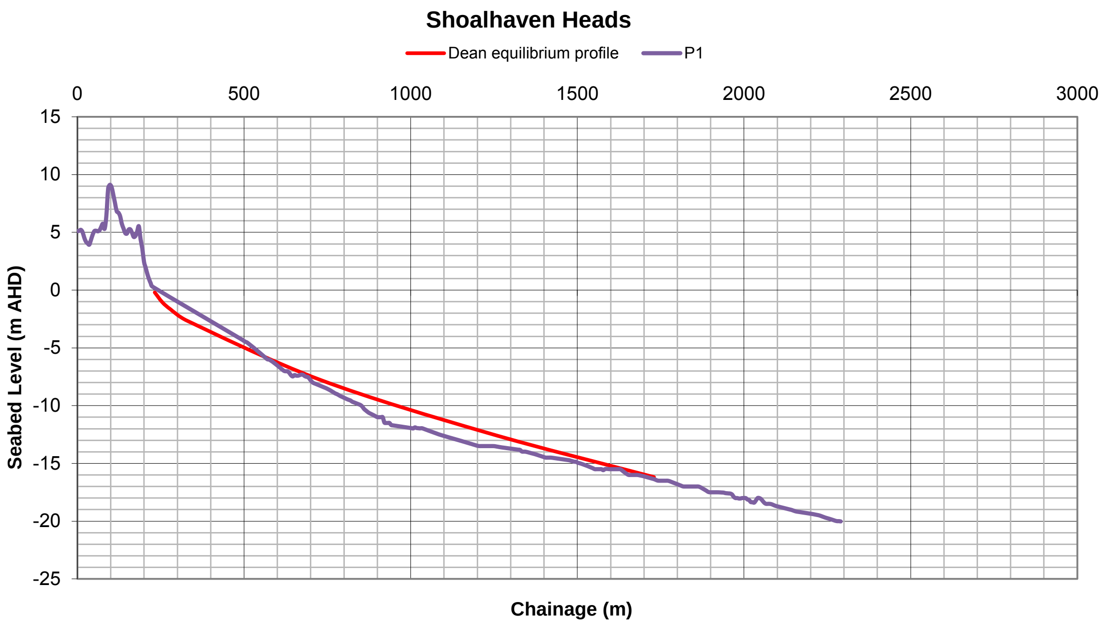


Figure 29 – Characteristic beach profile (P1) vs. wave equilibrium profile, Shoalhaven Heads

1.1.4 Wave Runup

The previous hazard assessment (SMEC 2009) found a maximum wave runup level of 5.9 m AHD, based on nearshore beach slope and ACES algorithms. Based on the procedure described in Section 3.4, the present day wave runup level for a 100 year ARI storm event at the location of the Surf Club was assessed to be 6.3 m AHD, which is slightly higher than that provided in the previous assessment. The calculation of wave runup for Shoalhaven Heads is shown in Figure 30. Sea level rise would be expected to increase this value by approximately the quantum of the sea level rise, i.e. 0.35 m by 2100. The most recent dune survey indicates that the dune crest is at around 8 m AHD, which indicates that the dune crest is not likely to be subject to wave overtopping.

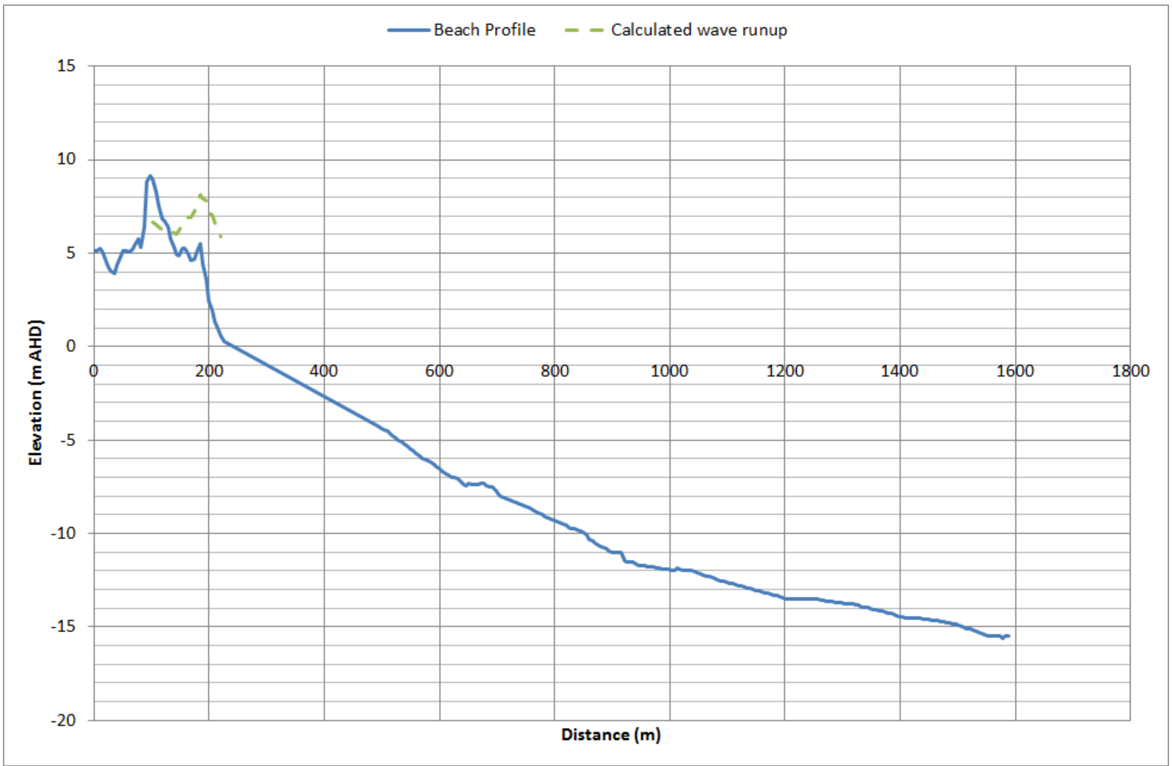


Figure 30 – Wave runup calculation for Shoalhaven Heads

1.2 Culburra Beach

Since the 2009 hazard assessment, additional photogrammetry data (dated 9/8/2014) is available, as well as LiDAR ground level information, bathymetric survey from July 2010 and ground survey of the dune dated July 2010. Ground survey of a section of dune near the southern end of the beach was undertaken by OEH in 2013 and again following the East Coast Low of June 2016. In addition, a sediment compartment study undertaken by Carvalho and Woodroffe (2014) examining factors influencing the sediment budget of Shoalhaven Heads, Culburra, Warrain and Currarong beaches is available. These additional data have been used to update the hazard assessment for Culburra Beach.

The location of photogrammetric data blocks along the beach, as referred to in the analysis below, is provided in Figure 31.

Figure 31 – Location of photogrammetric blocks at Culburra

1.2.1 Short Term Erosion

Short term erosion at Culburra was assessed with reference to available photogrammetry data and ground survey information. The area of beach assessed includes the entire length of beach from Penguin Head to Greenwell Point. Since the previous assessment, the largest recorded storm erosion demand at this location has been as a combined result of the 1974 and 1978 storm events, with a combined storm erosion demand varying along the beach from south to north. A storm erosion demand of 100 m^3/m has been adopted for the southern end of the beach (Blocks 1 and 2), 160 m^3/m for Block 3, and 280 m^3/m for the central-northern end of the beach. These values are similar to those derived in the 2009 coastal hazard assessment but have been varied slightly with the inclusion of additional calculation points in the analysis. No additional storms of similar magnitude to the 1974 and 1978 storms have occurred in the historical record, or since the previous (2009) assessment.

Storm erosion demand from the 1974 and 1978 storm events were determined from photogrammetry data between 1969 and 1978. Unfortunately, photogrammetry data were not available to allow the effects of the individual storm events to be evaluated separately. Survey data of the dune dated July 2010 was analysed and it was found that the dune profiles were largely consistent with the 2014 photogrammetry and most recent LiDAR data. No storms significant enough to leave a signature of erosion in the most recent survey or photogrammetry data were recorded. However, survey of the dune near the southern end of the beach between 2013 and following the East Coast Low in June 2016 recorded a storm erosion demand of 70 m^3/m.

The updated storm erosion analysis for Culburra is provided in Figure 32, below.

1.2.2 Long Term Recession

With additional photogrammetry data available for 9/8/2014 and additional ground survey data, the trend in long term recession or accretion of the beach has been examined and compared with the previously assessed (SMEC 2009) trend in beach change at Culburra. This was done using a volumetric technique, where the trend in beach volume over time has been examined at each beach profile, as well as tracking of the dune face or beach escarpment chainage over time.

Using both of these techniques, the northern end of the beach has been assessed to be prograding over time since the storms of 1974-78 – i.e. the beach volume has been increasing on average and the dune has been prograding seaward, having regained most of the pre-1970 beach volume. The south-central portion of the beach has been assessed to be receding at a very low rate, lower than what was measured from the SMEC (2009) assessment, with the beach volume increasing when compared with the 2005 photogrammetry data. This is in line with the observed geomorphological features of Culburra as described in Carvalho and Woodroffe (2014), with the Holocene beach barrier being much narrower than that at Shoalhaven Heads, indicating that the beach has been generally stable since the most recent sea-level still stand around 6,640 years ago (Carvalho and Woodroffe, 2014).

Based on the photogrammetric assessment and analysis of survey data, long term recession along the northern section of the beach has been assessed to be zero, and 0.025 m/year for the south-central portion of the beach. This long term recession rate is on top of that which would be expected due to sea level rise that has already occurred over the period of available photogrammetry. The long term recession rate has therefore been slightly reduced when compared with the previous assessment undertaken by SMEC (2009). The updated beach change analysis for Culburra is provided in Figure 33, below.

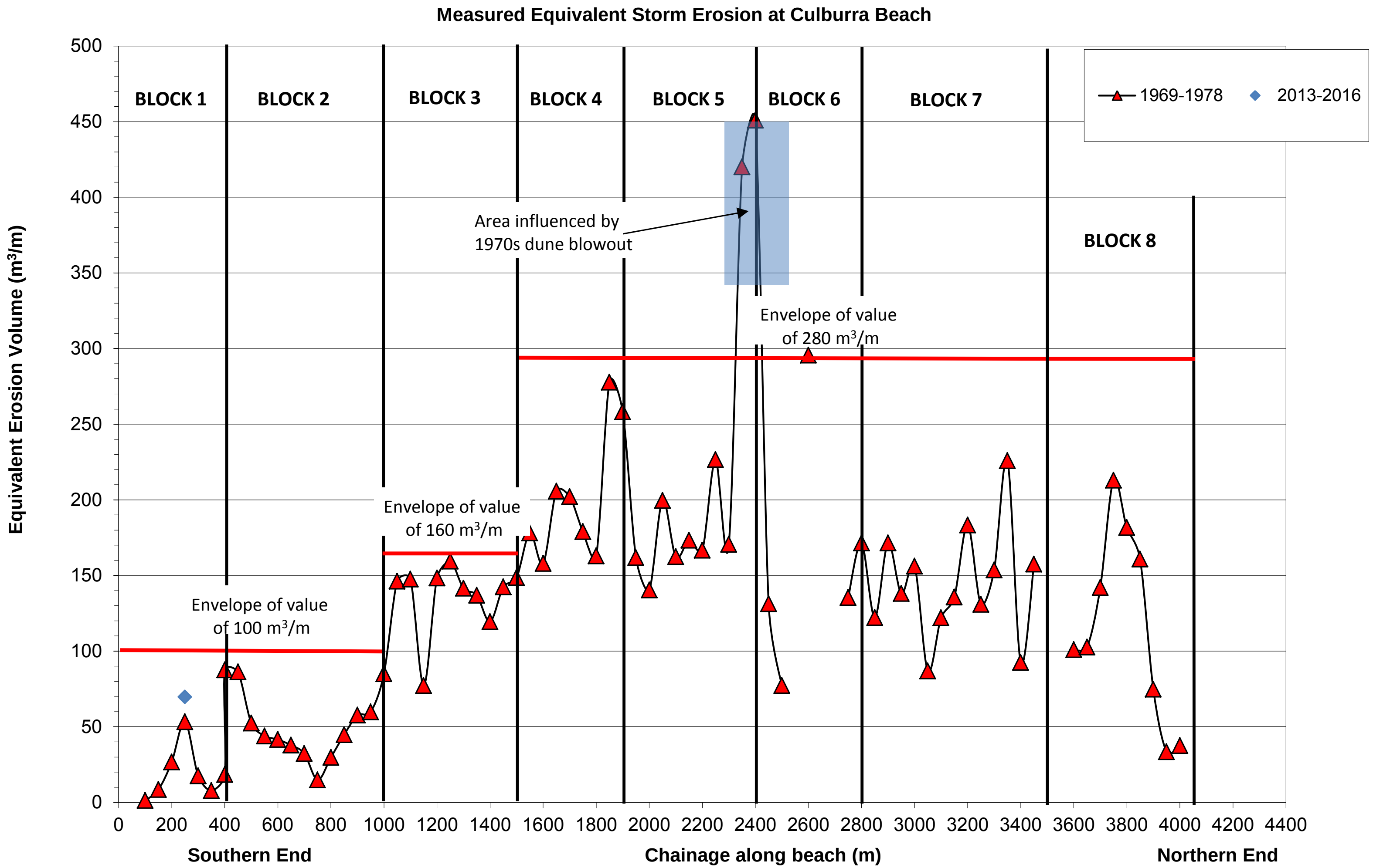


Figure 32 – Measured equivalent storm erosion hazard at Culburra, combined 1974 and 1978 storm events

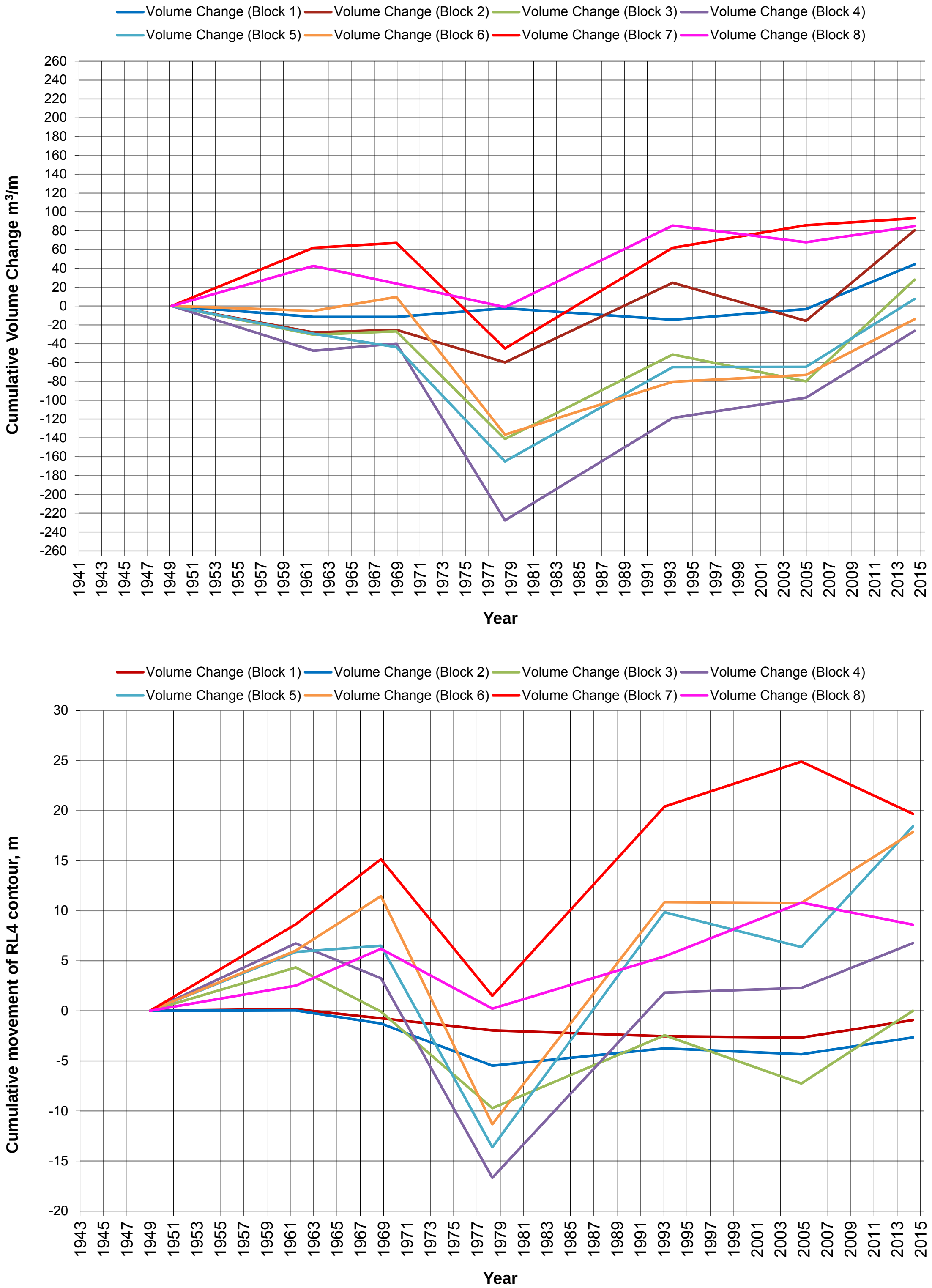


Figure 33 – Beach change over time, Culburra. Top: Volumetric analysis, Bottom: Dune face analysis

1.2.3 Future Beach Recession due to Sea Level Rise

Since the previous hazard assessment (SMEC 2009), bathymetric soundings have been collected at Culburra. These bathymetric soundings have enabled an updated assessment of future beach recession due to sea level rise to be carried out. The previous assessment relied on navigation chart data to determine nearshore beach slope, and had applied a nearshore active beach slope of 1V:40H. However, with the updated bathymetric soundings, it was found that the beach profile at Culburra varied according to the location along the beach. At the southern end of the beach, the measured beach profile matched the equilibrium profile down to a depth of 10 m, with the measured profile being above the equilibrium profile beyond this depth, yielding a beach slope of 1V:33H. At the central and northern end of the beach, the measured beach profiles were below the equilibrium profile, so the depth of the active profile was taken to be 20 m, which is approximately the absolute limit of offshore sand transport under extreme storm events as documented by Nielsen (1994). Based on the updated information, the slope of the active beach for the central and northern portions of the beach was taken to be 1V:50H.

A characteristic beach profile and the wave-equilibrium beach profile for Culburra is presented in Figure 34. A sea level rise is projected to cause erosion of Culburra. For the southern end of the beach (slope 1V:33H), and for sea level rises of 0.10 m (2030), 0.23 m (2050) and 0.35 m (2100), shoreline recession of 3.3 m, 7.7 m and 11.7 m (respectively) are projected. For the central and northern ends of the beach (slope 1V:50H), and for sea level rises of 0.10 m (2030), 0.23 m (2050) and 0.35 m (2100), shoreline recession of 5.0 m, 11.5 m and 17.5 m (respectively) are projected. These values are reduced when compared with the 2009 assessment.

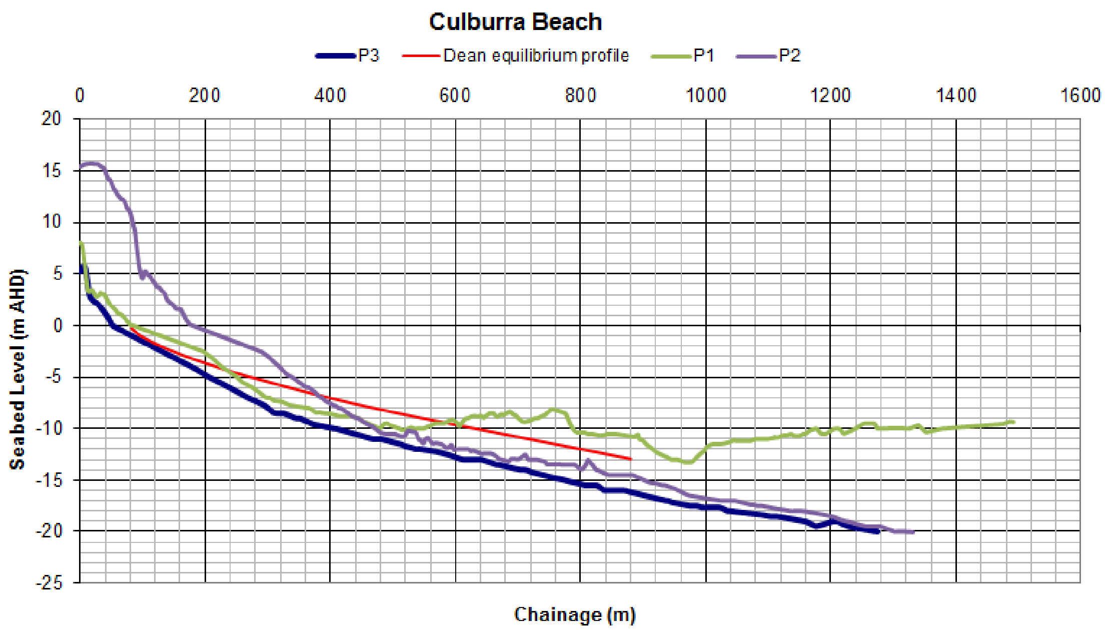


Figure 34 – Characteristic beach profile vs. wave equilibrium profile, Culburra (P1 = south, P2 = central, P3 = north)

1.2.4 Wave Runup

The previous hazard assessment (SMEC 2009) found a maximum wave runup level of 8.4 m AHD, based on nearshore beach slope and ACES algorithms. Based on the procedure described in Section 3.4, the present day maximum wave runup level for a 100 year ARI storm event at the dune at Culburra was assessed to be 7.1 - 7.6 m AHD, which is slightly lower than that provided in the previous assessment. The calculation of wave runup for Culburra is shown in Figure 35. Sea level rise would be expected to increase this value by approximately the quantum of the sea level rise, i.e. 0.35 m by 2100. The most recent dune survey indicates that the dune crest at the central and southern portions of the beach is around 8 m AHD, which indicates that the dune crest is not likely to be subject to wave overtopping. However, at the northern end of the beach, dune crests are around 7 m AHD and minor dune overtopping is possible at some locations.

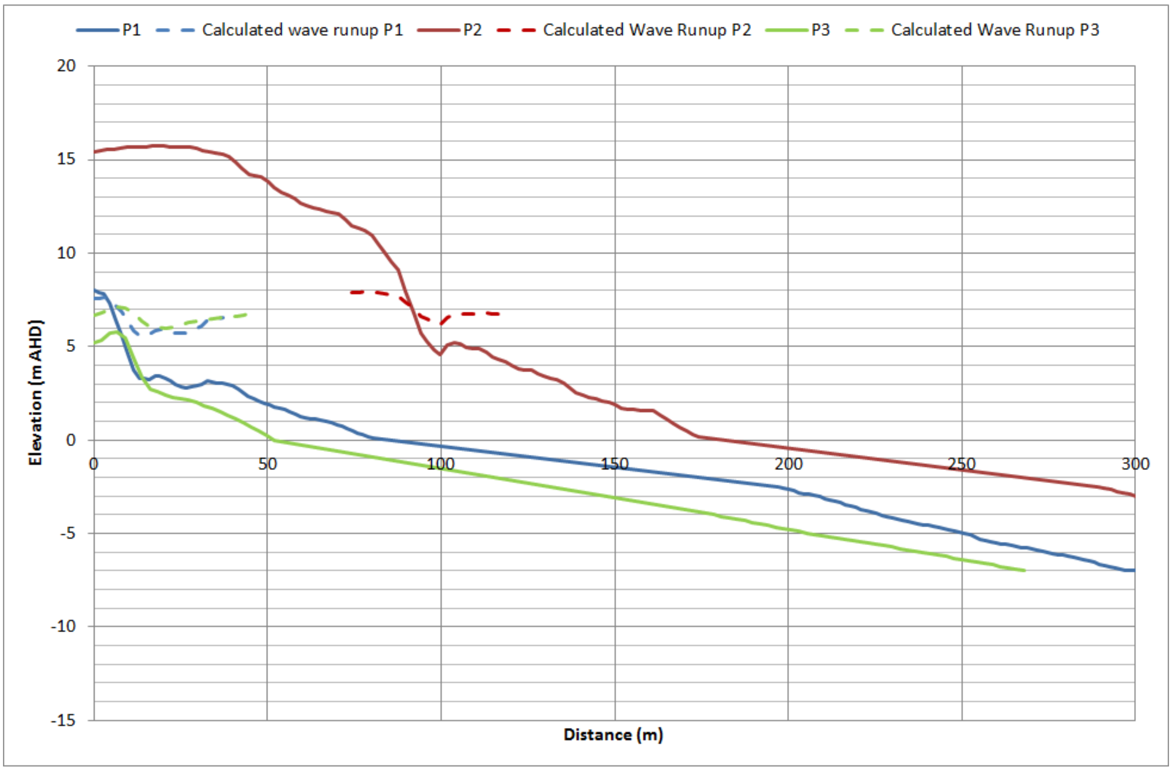


Figure 35 – Wave runup calculation for Culburra

1.3 Warrain Beach

Since the 2009 hazard assessment, LiDAR ground level information and recent bathymetric survey and ground survey of the dune were available for analysis. In addition, a sediment compartment study undertaken by Carvalho and Woodroffe (2014) examining factors influencing the sediment budget of Shoalhaven Heads, Culburra, Warrain and Currarong beaches is available. These additional data have been used to update the hazard assessment for the northern end of Warrain Beach.

1.3.1 Short Term Erosion

Short term erosion at Warrain Beach was assessed with reference to available photogrammetry data and ground survey information. The area of beach assessed includes the length of beach north from the entrance at Lake Woolumboola to Penguin Head. Since the previous assessment, the largest recorded storm erosion demand at this location has been as a combined result of the 1974 storm event, with a storm erosion demand of 220 m^3/m measured for the section of beach north of the entrance to Lake Woolumboola. These values are in line with those derived in the 2009 coastal hazard assessment. No additional storms of similar magnitude to the 1974 storms have occurred in the historical record, or since the previous (2009) assessment.

Storm erosion demand from the 1974 storm events were determined from photogrammetry data between 1961 and 1974. Unfortunately, pre-storm photogrammetry data nearer to the storm of 1974 were not available to allow the effects of the storm to be evaluated with great certainty. Survey data of the dune dated July 2010 was analysed and it was found that the dune profiles were largely consistent with the 2005 photogrammetry and most recent LiDAR data. No storms significant enough to leave a signature of erosion in the most recent survey or photogrammetry data were recorded.

The updated storm erosion analysis for Warrain is provided in Figure 36, below.

1.3.2 Long Term Recession

With additional ground survey data, the trend in long term recession or accretion of the beach has been examined and compared with the previously assessed (SMEC 2009) trend in beach change at Warrain. This was done using a volumetric technique, where the trend in beach volume over time has been examined at each beach profile, as well as tracking of the dune face or beach escarpment chainage over time.

Using both of these techniques, the northern end of the beach has been assessed to be prograding over time since the storms of 1974 – i.e. the beach volume has been increasing on average and the dune has been prograding seaward at a rate of approximately 0.8 m/year.

Based on the photogrammetric assessment and analysis of survey data, long term recession along the northern section of the beach has been assessed to be zero. This is in line with the previous assessment undertaken by SMEC (2009). The updated beach change analysis for Warrain Beach is provided in Figure 37, below.

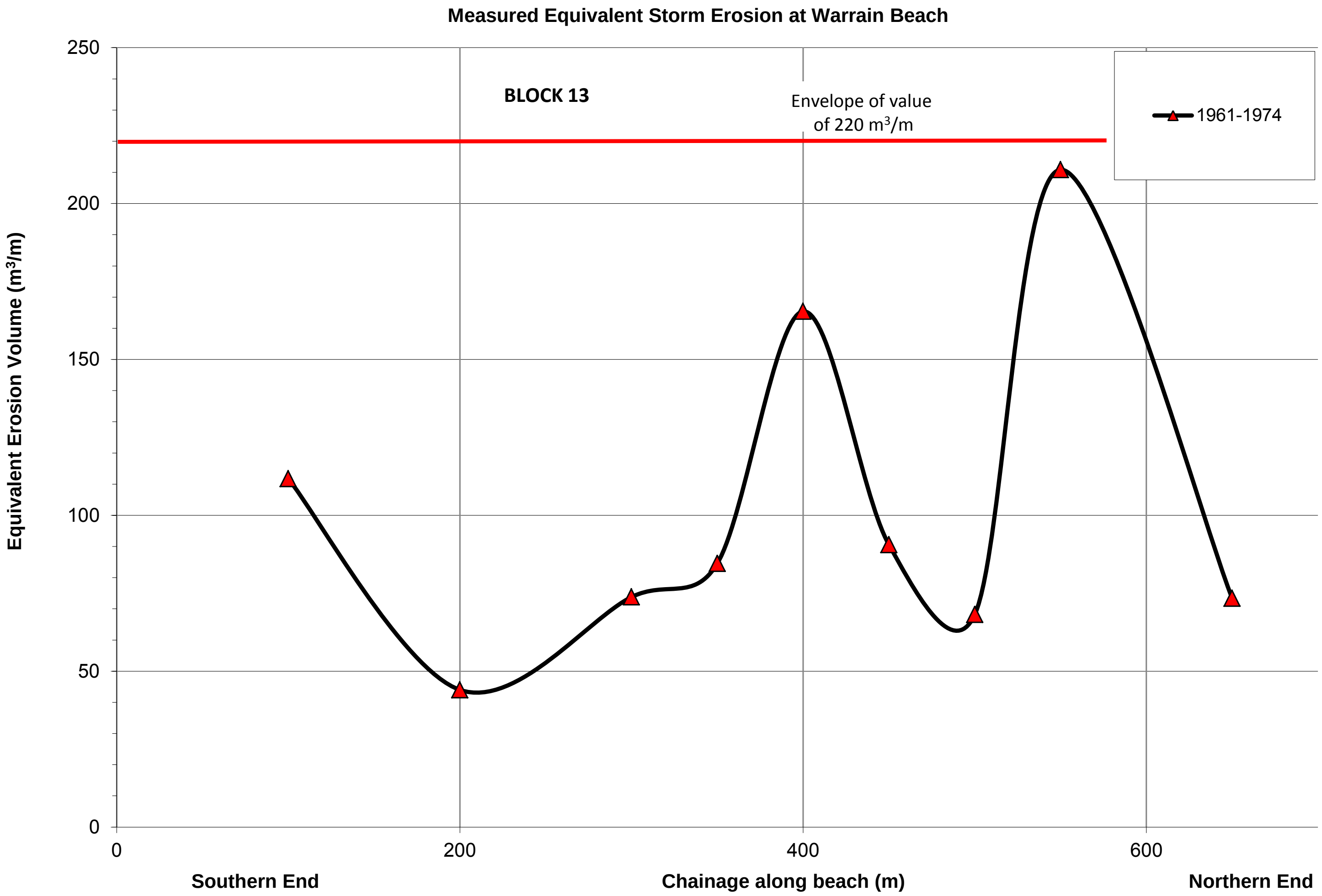
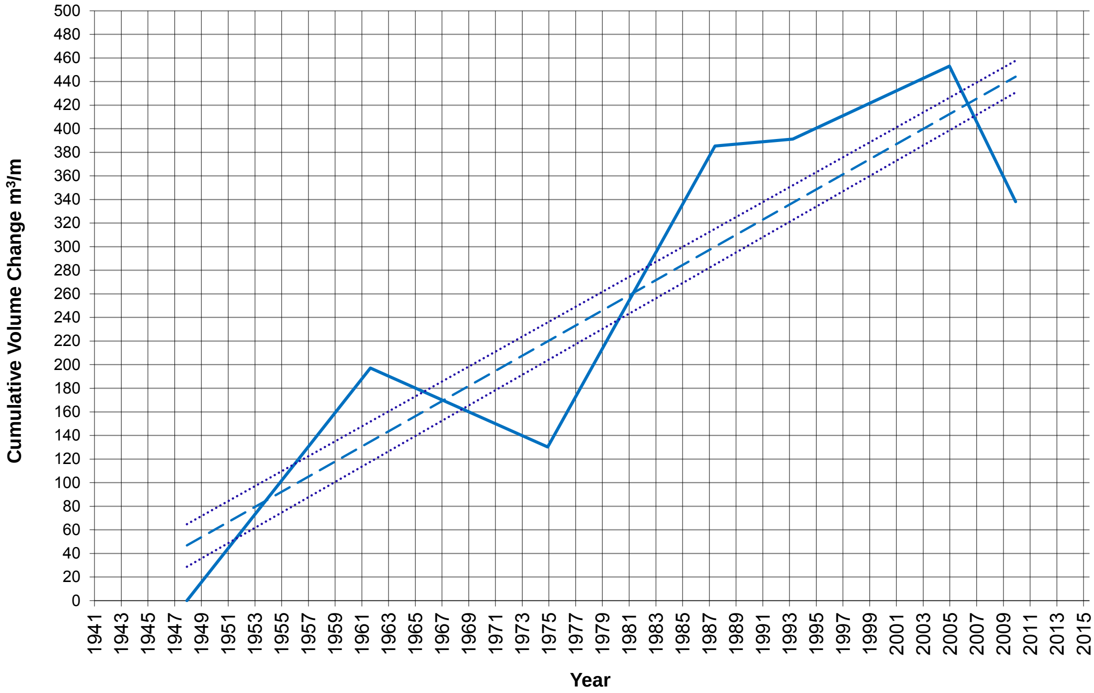


Figure 36 – Measured equivalent storm erosion hazard at Warrain, 1961 – 1974 (1974 storm event)



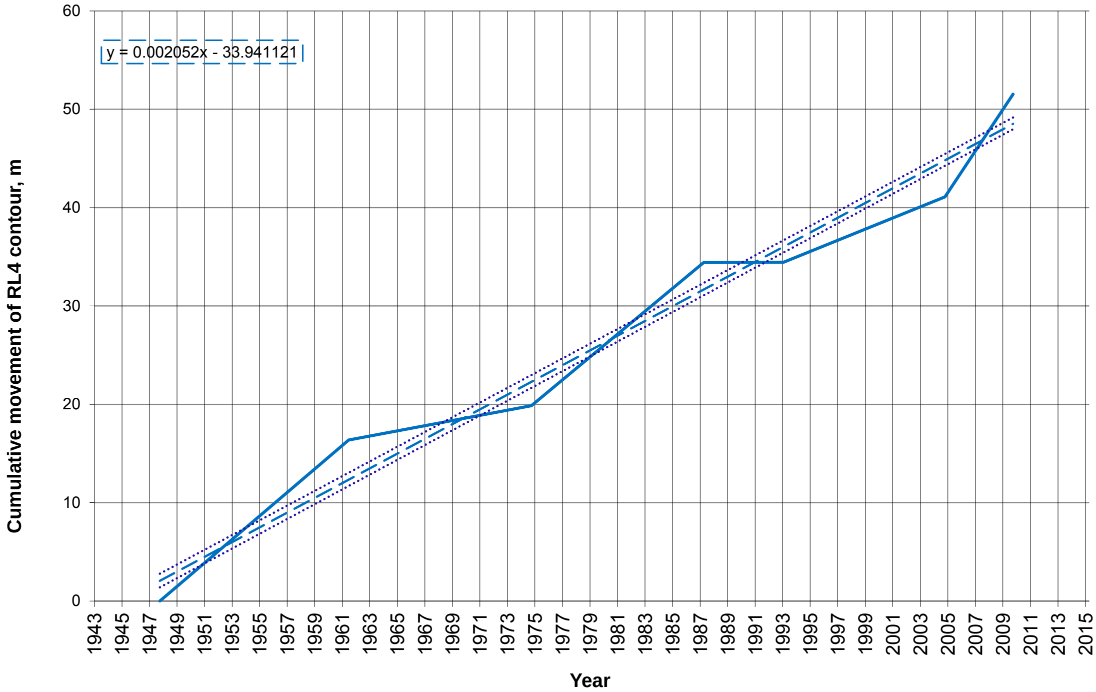


Figure 37 – Beach change over time, Warrain Beach (north of Lake Woolumboola). Top: Volumetric analysis, Bottom: Dune face analysis

1.3.3 Future Beach Recession due to Sea Level Rise

Since the previous hazard assessment (SMEC 2009), bathymetric soundings have been collected at Warrain Beach. These bathymetric soundings have enabled an updated assessment of future beach recession due to sea level rise to be carried out. The previous assessment relied on navigation chart data to determine nearshore beach slope, and had applied a nearshore active beach slope of 1V:46H. With the updated bathymetric soundings, and the presence of rock reef below -8 m AHD, the beach slope applied in the previous studies was re-assessed to be 1V:30H.

A characteristic beach profile and the wave-equilibrium beach profile for North Warrain Beach is presented in Figure 38. While the beach has been accreting in recent times as indicated in Figure 37, a sea level rise is projected to cause erosion of North Warrain Beach in the long term. For sea level rises of 0.10 m (2030), 0.23 m (2050) and 0.35 m (2100), shoreline recession of 3.1 m, 7.1 m and 10.8 m (respectively) are projected. These values are reduced when compared with the 2009 assessment, due to the reduction in sea level rise projections.

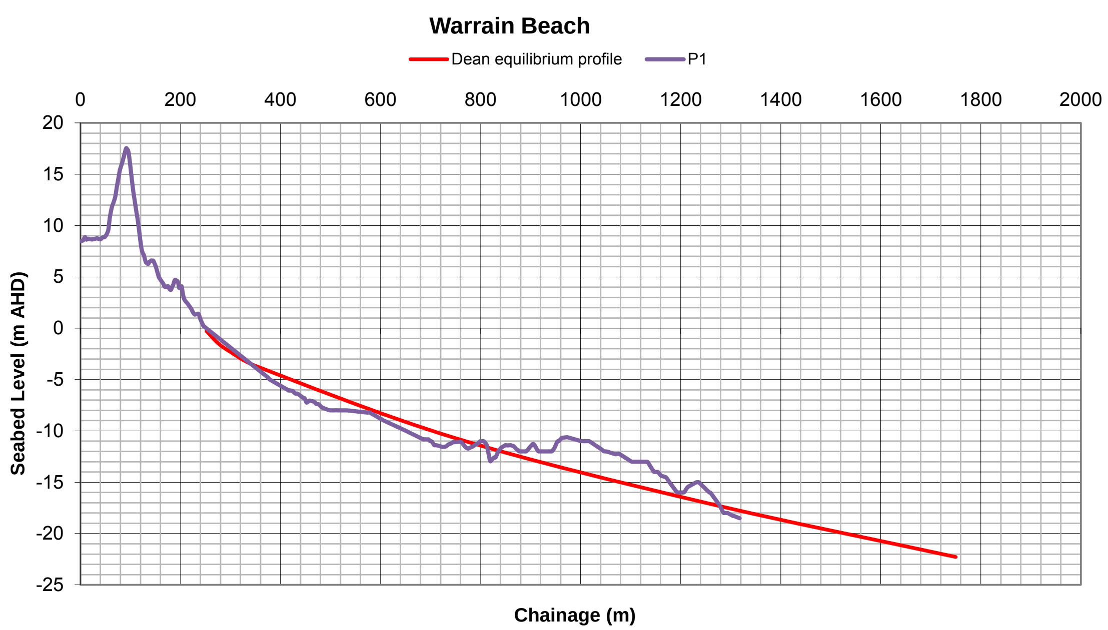


Figure 38 – Characteristic beach profile vs. wave equilibrium profile, Warrain Beach (north of Lake Woolumboola)

1.3.4 Wave Runup

The previous hazard assessment (SMEC 2009) found a maximum wave runup level of 7.5 m AHD, based on nearshore beach slope and ACES algorithms. Based on the procedure described in Section 3.4, the present day maximum wave runup level for a 100 year ARI storm event at the dune at North Warrain was assessed to be 6.4 m AHD, which is slightly lower than that provided in the previous assessment. The calculation of wave runup for Warrain Beach is shown in Figure 39. Sea level rise would be expected to increase this value by approximately the quantum of the sea level rise, i.e. 0.35 m by 2100. The most recent dune survey indicates that the dune crest at the central is generally higher than this, indicating that the dune crest is not likely to be subject to wave overtopping. From LiDAR and dune survey data, dune crests are approximately 7.0 m at the Surf Club and nearby carpark. However, adjacent to no. 42 Eastbourne Avenue, LIDAR data indicates that the dune crest is 5.3 m AHD and wave overtopping is possible at this location.

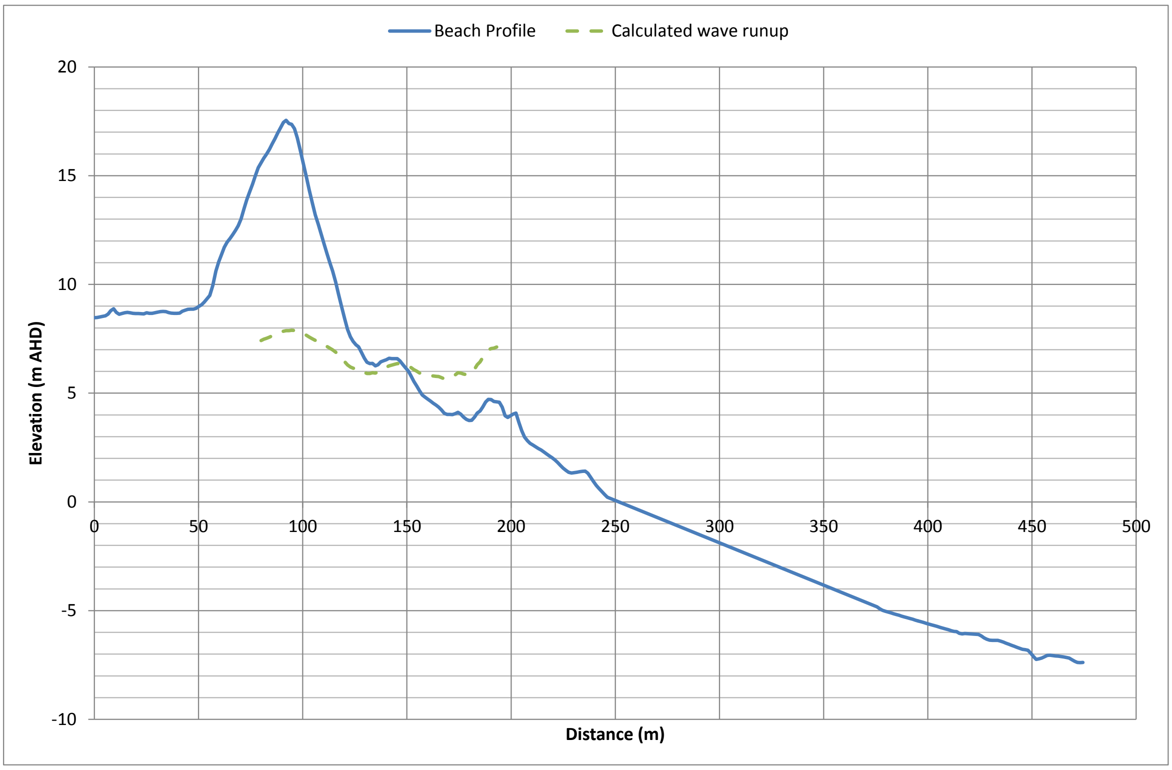


Figure 39 – Wave runup calculation for Warrain Beach

1.4 Currarong Beach

Since the 2009 hazard assessment, LiDAR ground level information and recent bathymetric survey and ground survey of the dune were available for analysis. Dune survey was commissioned by Council following an East Coast Low event in June 2016 and this was able to be used to accurately estimate storm erosion demand at Currarong. In addition, a sediment compartment study undertaken by Carvalho and Woodroffe (2014) examining factors influencing the sediment budget of Shoalhaven Heads, Culburra, Warrain and Currarong beaches is available. These additional data have been used to update the hazard assessment for Currarong Beach.

The location of photogrammetric profiles for assessment of Currarong Beach is provided in Figure 40, below.

Figure 40 – Location of photogrammetric profiles for Currarong

1.4.1 Short Term Erosion

Short term erosion at Currarong Beach was assessed with reference to available photogrammetry data and ground survey information. The previous assessment considered photogrammetry data between 1969 and 1978, as well as between 1981 and 1987, to assess the impact of the May 1974 and August 1986 storm events. However, these photogrammetry dates were several years before and after the storm events and so may not provide an accurate estimate of the storm erosion demand. A well-documented storm event, the East Coast Low of June 2016, has since occurred with ground survey available pre and post-storm to enable an accurate assessment of the storm erosion demand. The previous assessment (SMEC 2009) estimated 60 m^3/m of storm erosion demand at Currarong – analysis of the survey data for June 2016 has resulted in an estimated storm erosion demand of 40 m^3/m for the June 2016 storm. This value is in line with that derived in the 2009 coastal hazard assessment. The June 2016 storm event is notable for its approach direction of north-east, being the critical direction resulting in erosion at Currarong.

The updated storm erosion analysis for Currarong is provided in Figure 41, below.

1.4.2 Long Term Recession

With additional ground survey data, the trend in long term recession or accretion of the beach has been examined and compared with the previously assessed (SMEC 2009) trend in beach change at Currarong. This was done using a volumetric technique, where the trend in beach volume over time has been examined at each beach profile, as well as tracking of the dune face or beach escarpment chainage over time.

Using both of these techniques, the northern end of the beach has been assessed to be receding over time consistently since the start of the photographic record in 1944 – i.e. the beach volume has been decreasing on average and the dune has been receding landward.

Based on the photogrammetric assessment and analysis of survey data, long term recession along Currarong Beach east of Cambewarra Road has been assessed to be 0.29 m/year, with a recession rate of 0.1 m/ year between Peel Street and Cambewarra Road, including the impact of the June 2016 East Coast Low. This long term recession rate is on top of that which would be expected due to sea level rise that may have already occurred over the period of available photogrammetry. This is similar to the previous assessment undertaken by SMEC (2009). The updated beach change analysis for Currarong Beach is provided in Figure 42, below.

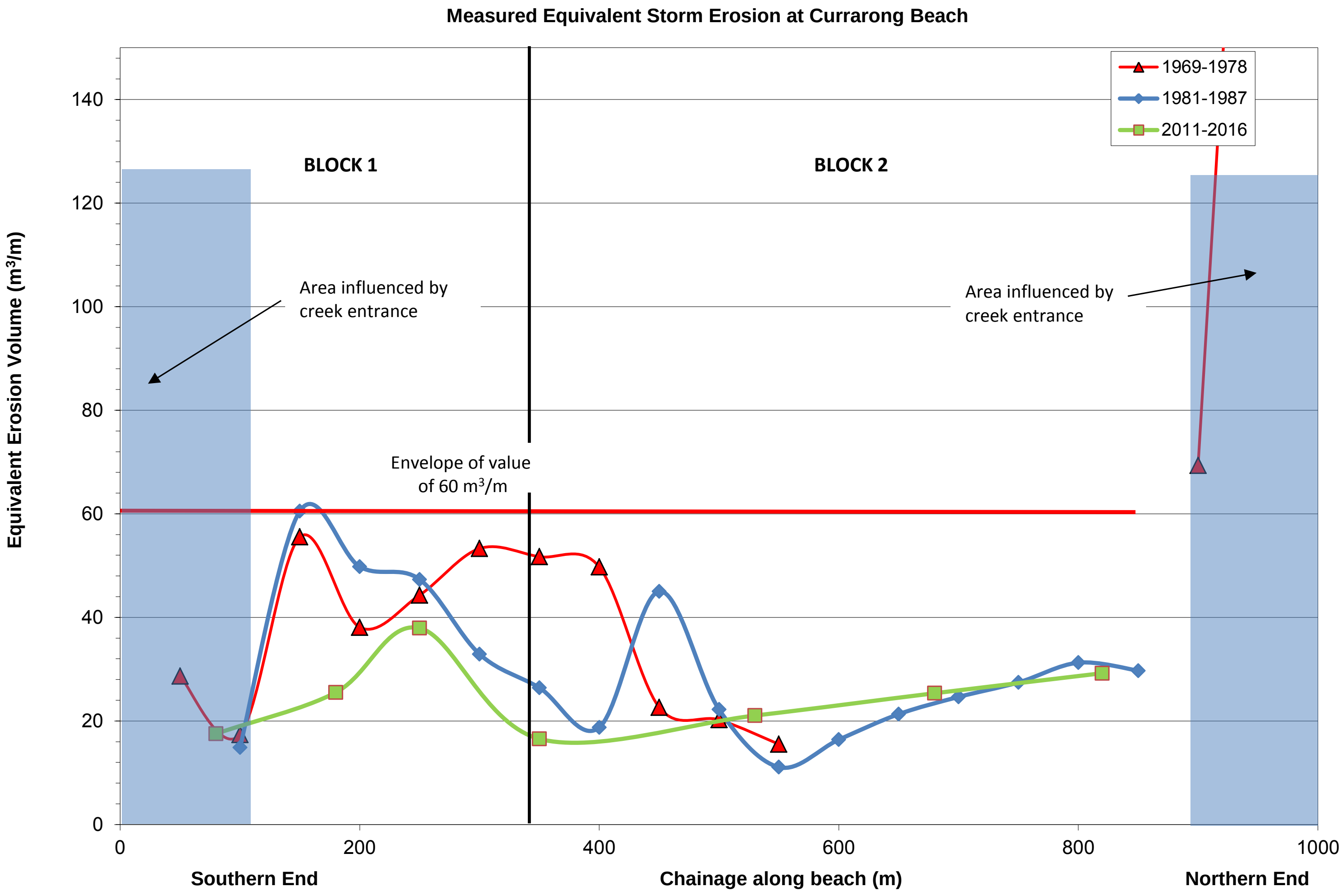


Figure 41 – Measured equivalent storm erosion hazard at Currarong including June 2016 East Coast Low

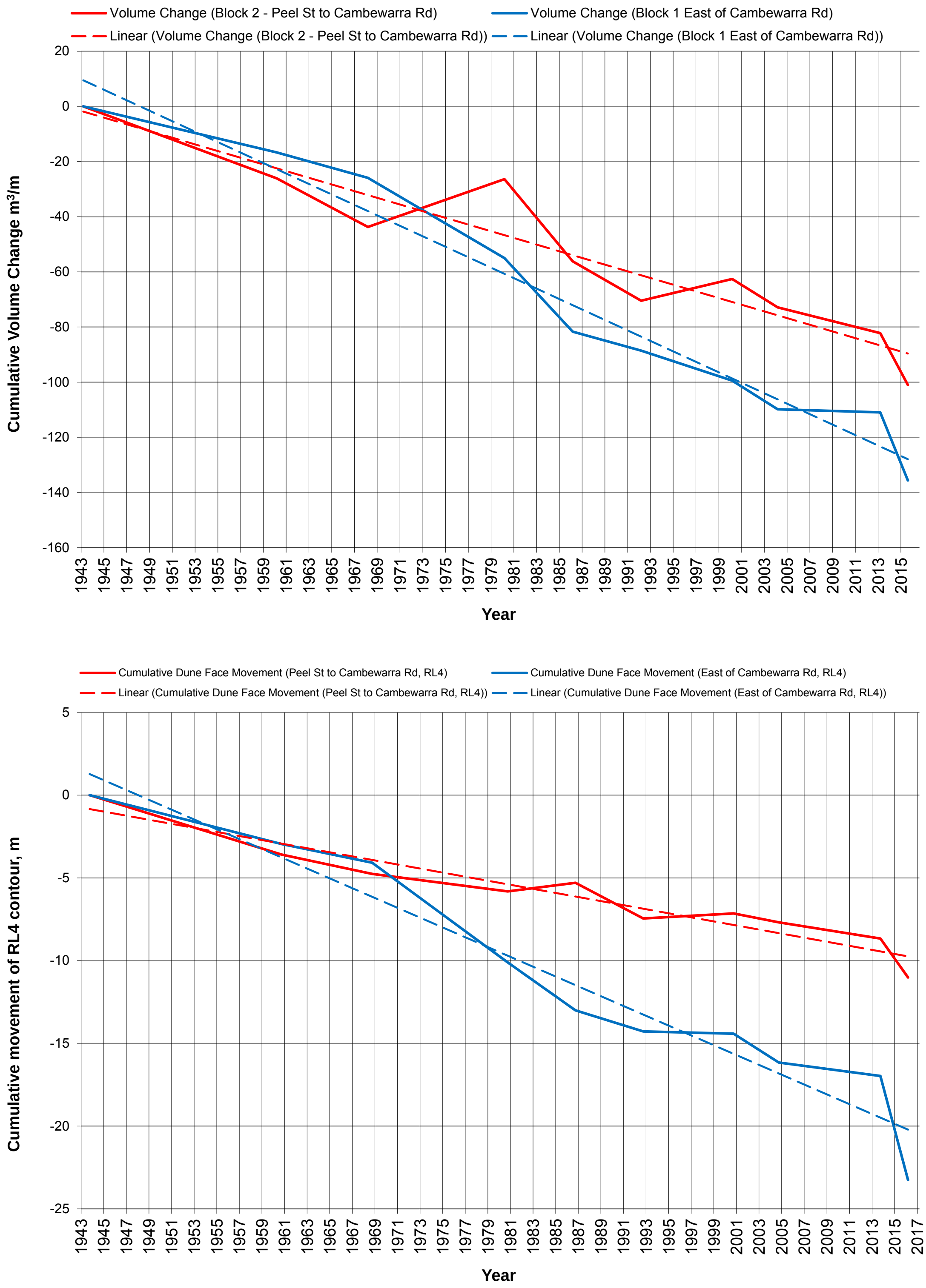


Figure 42 – Beach change over time, Currarong Beach. Top: Volumetric analysis, Bottom: Dune face analysis

1.4.3 Future Beach Recession due to Sea Level Rise

Since the previous hazard assessment (SMEC 2009), bathymetric soundings have been collected at Currarong Beach. These bathymetric soundings have enabled an updated assessment of future beach recession due to sea level rise to be carried out. The previous assessment relied on navigation chart data to determine nearshore beach slope. With the updated bathymetric soundings and information regarding the location of areas offshore rock reef and sandy seabed (DECCW 2010, Figure 43), the beach slope was found to correspond with the Dean equilibrium profile down to a depth of 10 m, which is approximately the offshore limit of sediment transport as assessed using the Hallermeier schema (1981, 1983). Based on the updated information, the slope of the active beach for the portion of the beach west of Cambewarra Road was taken to be 1V:47H. East of Cambewarra Road, rock reef exists below 5 m depth. For this portion of the beach, the rock reef would not be available for sediment transport so the active beach profile slope was assessed to be 1V:25H.

A characteristic beach profile and the wave-equilibrium beach profile for Currarong Beach is presented in Figure 44. A sea level rise is projected to cause erosion of Currarong Beach. For sea level rises of 0.10 m (2030), 0.23 m (2050) and 0.35 m (2100), shoreline recession of 4.8 m, 10.9 m and 16.6 m (respectively) are projected for the area west of Cambewarra Road. East of Cambewarra Road, for sea level rises of 0.10 m (2030), 0.23 m (2050) and 0.35 m (2100), shoreline recession of 2.5 m, 5.8 m and 8.8 m (respectively) are projected. These values are slightly increased for the area west of Cambewarra Road when compared with the 2009 assessment, despite the reduction in sea level rise projections. Improved bathymetric information and insight into the location of offshore reefs has allowed an improved estimate of beach recession due to sea level rise.

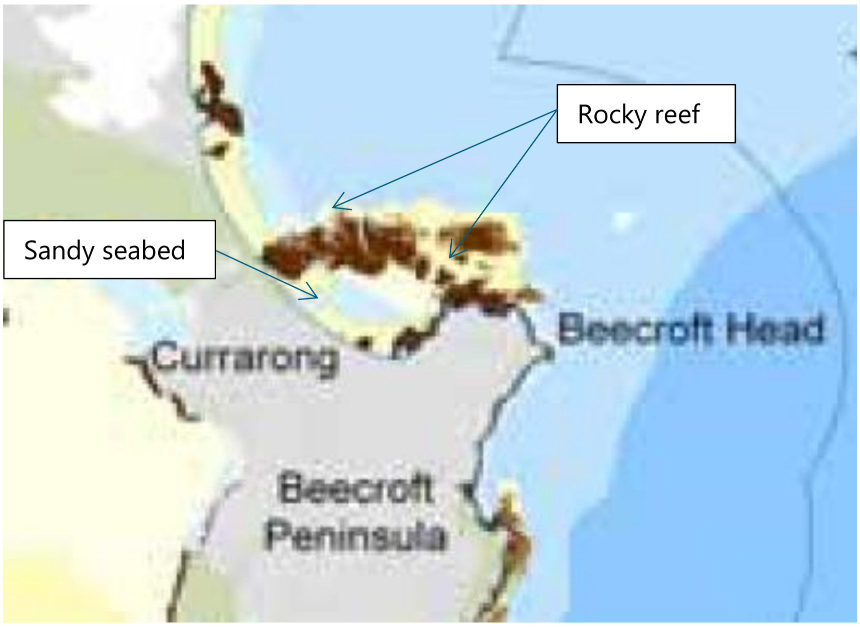


Figure 43 – Locations of rocky reef and sandy seabed, DECCW (2010)

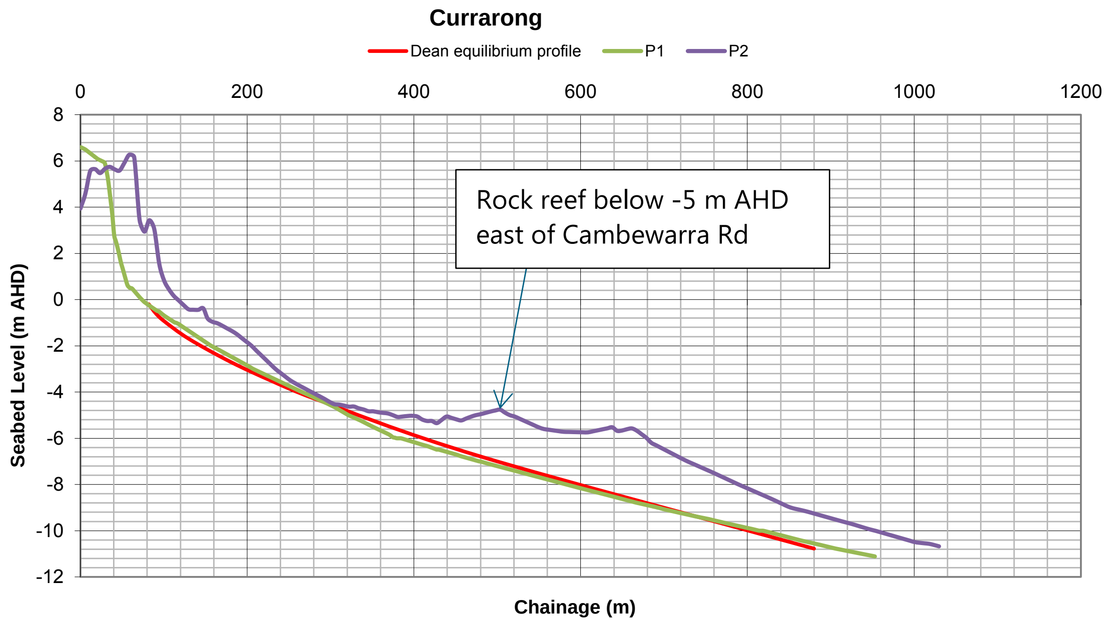


Figure 44 – Characteristic beach profile vs. wave equilibrium profile, Currarong (P1 = west of Cambewarra Road, P2 = east of Cambewarra Road)

1.4.4 Wave Runup

The previous hazard assessment (SMEC 2009) found a maximum wave runup level of 3.9 m to 4.6 m AHD depending on the beach location, based on nearshore beach slope, SWAN wave transformation modelling and ACES algorithms. Based on the procedure described in Section 3.4, the present day maximum wave runup level for a 100 year ARI storm event at the dune for the western end of the beach was assessed to be 5.5 m AHD, and 4.8 m AHD for the eastern end of the beach, which is slightly higher than that provided in the previous assessment. The calculation of wave runup for Currarong Beach is shown in Figure 45. Note that Council survey of debris lines for wave runup at Currarong east of Currarong Creek found wave runup levels of 3.7 m AHD for this area, for the East Coast Low of June 2016.

Sea level rise would be expected to increase this value by approximately the quantum of the sea level rise, i.e. 0.35 m by 2100. The most recent dune survey indicates that the dune crest is generally higher than this, indicating that the dune crest is not likely to be subject to wave overtopping. However, areas east of Currarong Creek are below the maximum wave runup level and some wave overtopping could be expected there.

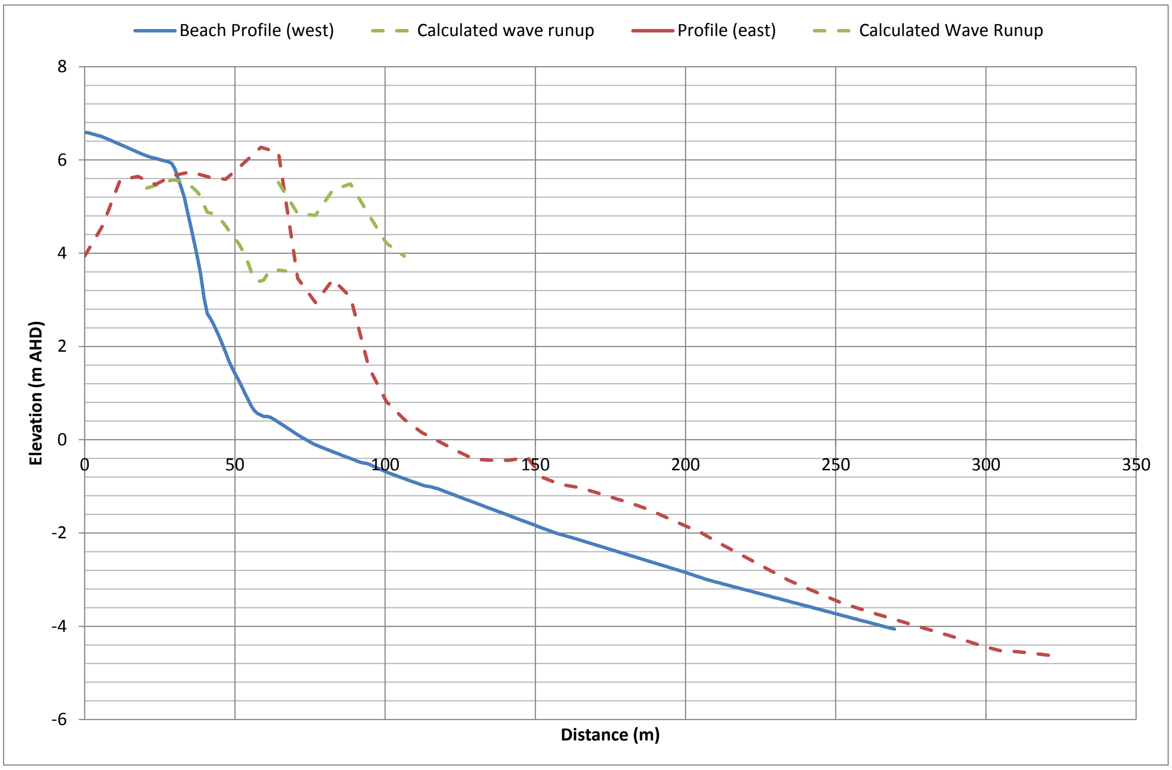


Figure 45 – Wave runup calculation for Currarong Beach

1.5 Callala Beach

Since the 2009 hazard assessment, additional photogrammetry data (dated 2014) is available, as well as LiDAR ground level information and ground survey of the dune dated March 2010 and May 2015. These additional data have been used to update the hazard assessment for Callala Beach.

The locations of photogrammetric profiles at Callala Beach are provided in Figure 46.

Figure 46 – Locations of photogrammetric profile blocks at Callala Beach

1.5.1 Short Term Erosion

Short term erosion at Callala Beach was assessed with reference to available photogrammetry data and ground survey information. The previous assessment considered photogrammetry data between 1969 and 1975, to assess the impact of the May 1974 storm event. Since this time, ground survey has captured the impacts of a smaller storm event in April 2015, and storm erosion demand from that event has been able to be assessed. The previous assessment (SMEC 2009) estimated 120 m^3/m of storm erosion demand. Further analysis of the storm erosion demand from 1974 with measurement at every available beach profile has revealed some locally higher values of storm erosion demand near the centre of the beach, with the maximum storm erosion demand measured at 180 m^3/m. Analysis of the dune survey data for May 2015 has resulted in an estimated storm erosion demand of 45 m^3/m for the April 2015 storm. While most of the beach had a storm erosion demand of 120 m^3/m in line with the 2009 assessment, locally near the centre of the beach the storm erosion demand was found to be higher than that determined in the previous assessment.

The updated storm erosion analysis for Callala is provided in Figure 47, below.

1.5.2 Long Term Recession

With additional photogrammetry data, the trend in long term recession or accretion of the beach has been examined and compared with the previously assessed (SMEC 2009) trend in beach change at Callala. This was done using a volumetric technique, where the trend in beach volume over time has been examined at each beach profile, as well as tracking of the dune face or beach escarpment chainage over time.

Using both of these techniques, the northern end of the beach has been assessed to be receding over time at a low rate since the start of the photographic record in 1949 – i.e. the beach volume has been decreasing on average and the dune has been receding landward, with the southern end of the beach assessed to be relatively stable. If the photographic record since the 1974 storm event is considered, then the dune volume has been recovering in volume consistently since that time. However, for the northern end of the beach, the recovered volume has not yet replaced the volume lost in the 1974 storm event.

Based on the photogrammetric assessment and analysis of survey data, long term recession along Callala Beach north of Centre Street has been assessed to be 0.10 – 0.15 m/year, with a rate of zero south of Centre Street. This is slightly higher than the previous assessment undertaken by SMEC (2009) for the northern end of the beach, but lower for the southern end.

The updated beach change analysis for Callala Beach is provided in Figure 48 and Figure 49, below.

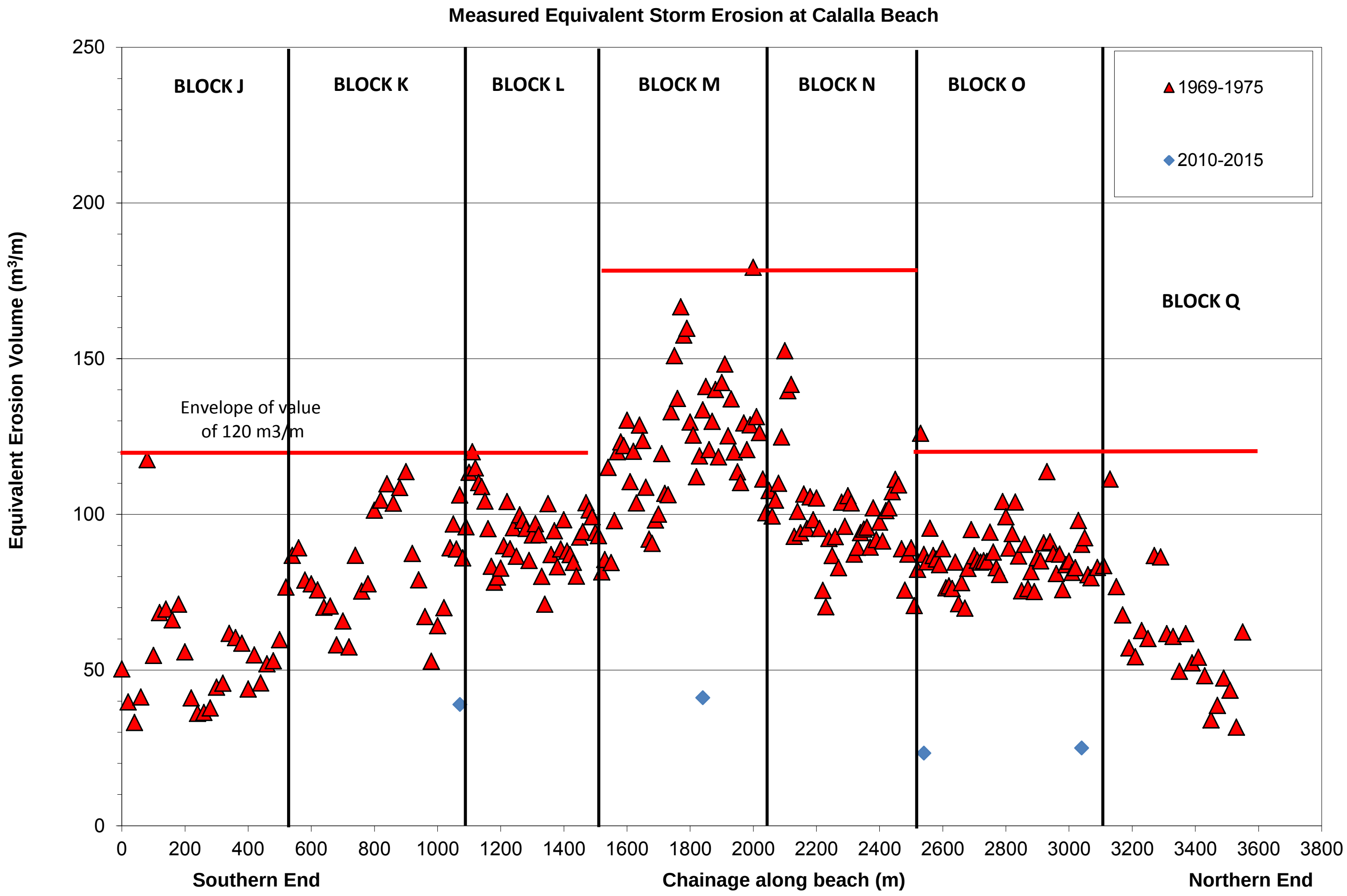
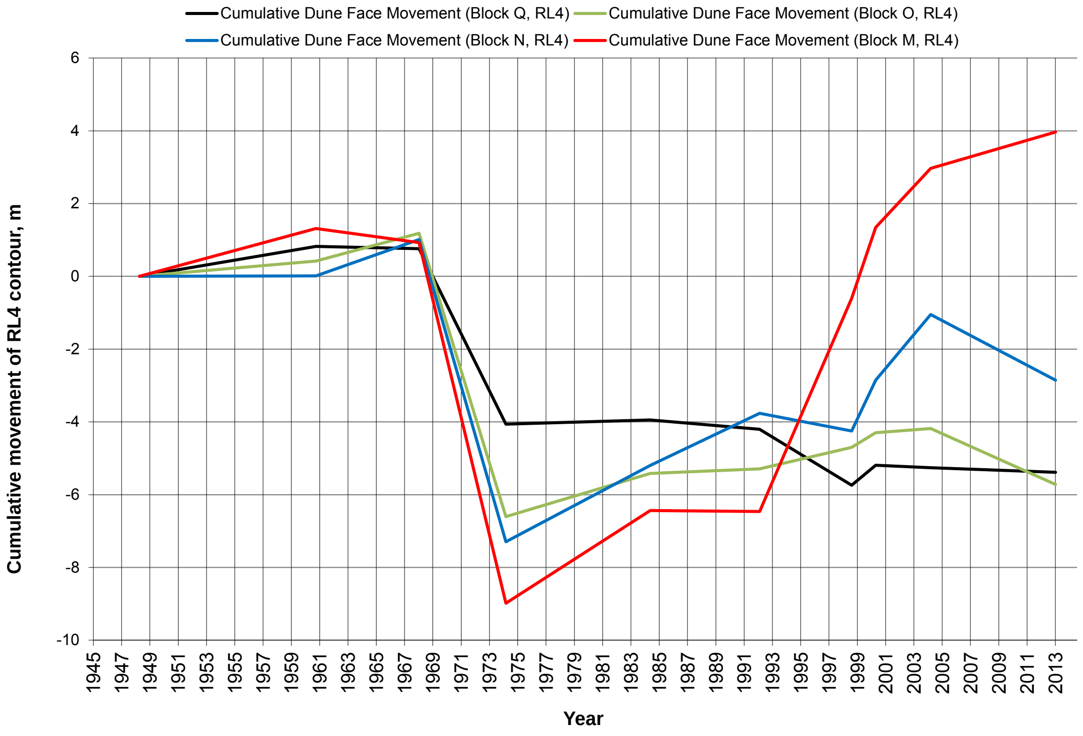


Figure 47 – Measured equivalent storm erosion hazard at Callala including April 2015 East Coast Low



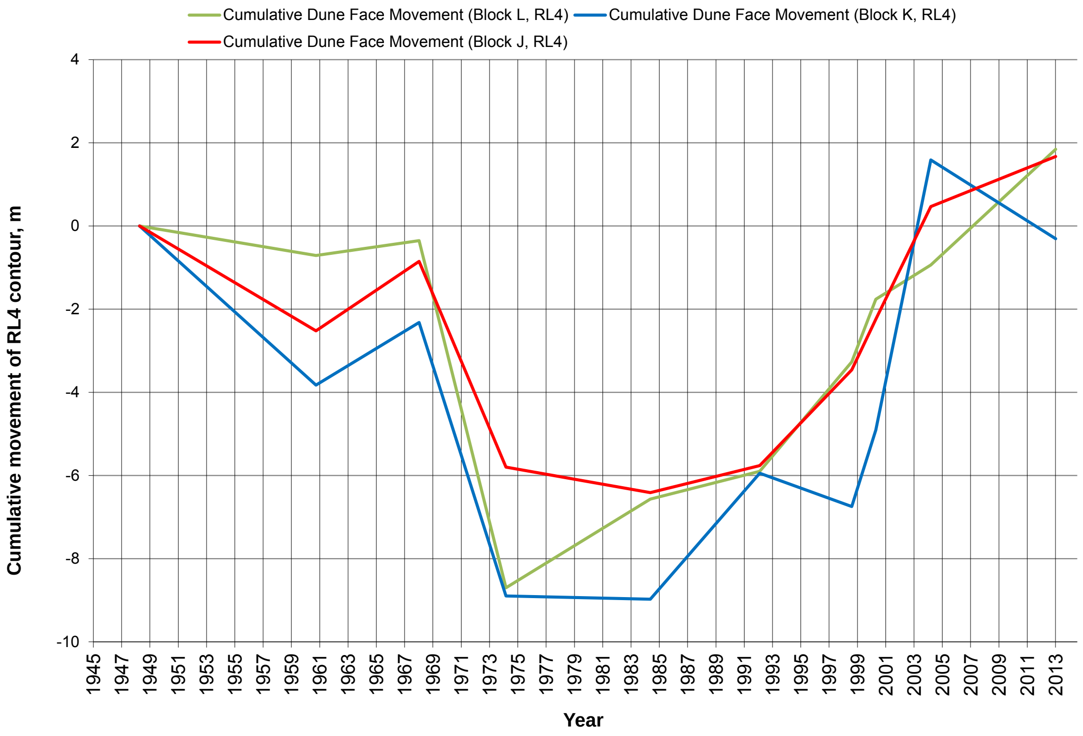


Figure 48 – Beach change over time, Callala. Top: Dune face analysis, northern end of beach; Bottom: Dune face analysis, southern end of beach

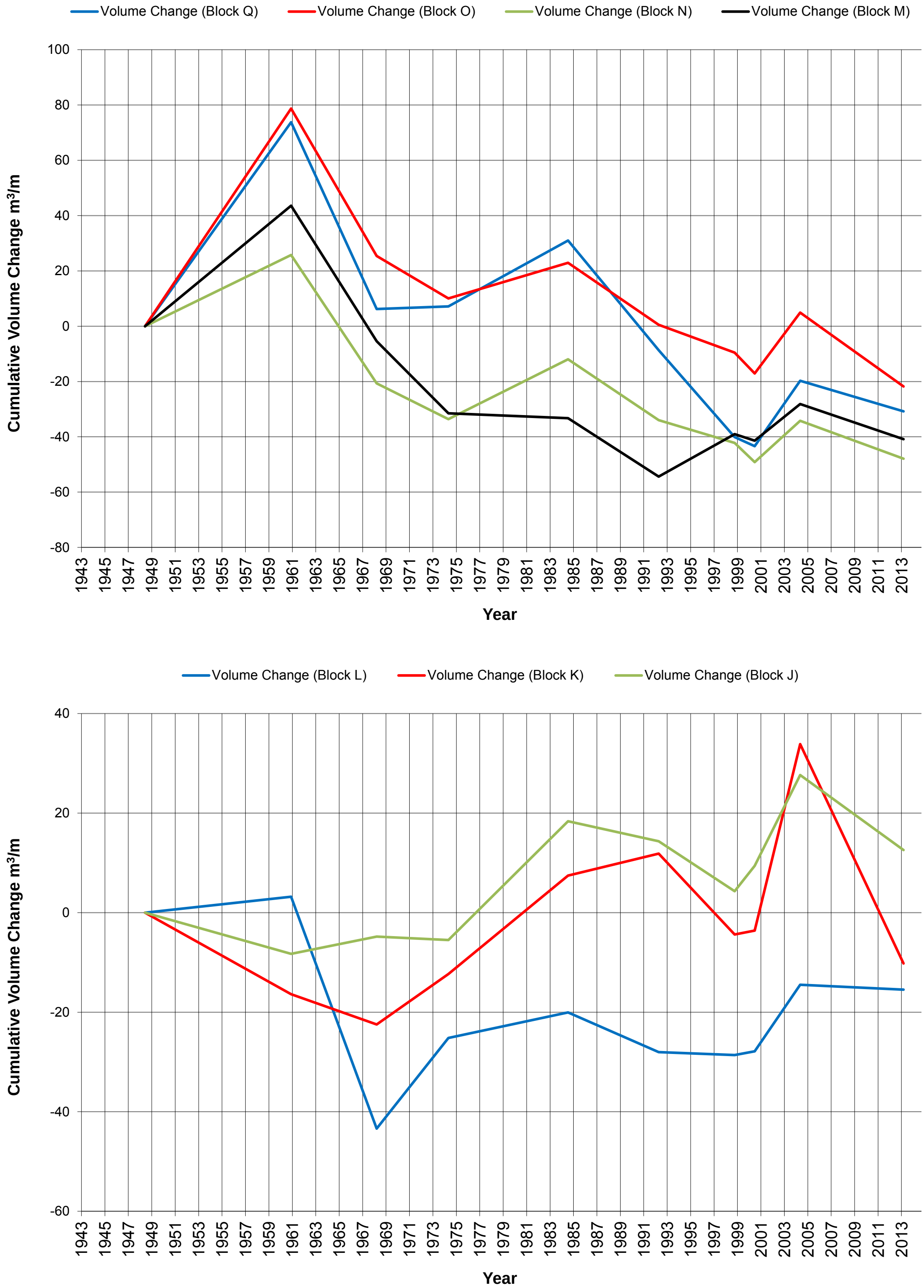


Figure 49 – Beach change over time, Callala. Top: Volumetric analysis, northern end of beach; Bottom: Volumetric analysis, southern end of beach

1.5.3 Future Beach Recession due to Sea Level Rise

Since the previous hazard assessment (SMEC 2009), an improved assessment of the impact of sea level rise on Callala Beach has been carried out, through the use of additional bathymetric profiles along the beach. This has enabled the effect of varying bathymetry along the beach to be included in the analysis. The previous assessment relied on a single bathymetric profile to determine nearshore beach slope. The beach slope was found to correspond with the Dean equilibrium profile down to a depth of 7 m – 9 m for the southern end of the beach. At the northern end of the beach, the beach slope corresponds with the Dean equilibrium profile to a depth of less than 5 m. Beyond these depths, the beach profile lies above the Dean equilibrium profile, indicating that sand would be transported onshore at this location. Based on the updated information, the slope of the active beach was taken to be as follows:

- 1V:30H for the southern half of the beach;
- 1V:25H for the northern half of the beach.

A characteristic beach profile and the wave-equilibrium beach profile for Callala Beach is presented in Figure 50. A sea level rise is projected to cause erosion of Callala Beach. For sea level rises of 0.10 m (2030), 0.23 m (2050) and 0.35 m (2100), shoreline recession of 3.0 m, 6.9 m and 10.5 m (respectively) are projected for the southern half of the beach; and 2.5 m, 5.8 m and 8.8 m for the northern half of the beach. These values are slightly reduced for 2100 when compared with the 2009 assessment. While there has been a reduction in sea level rise projections since the 2009 assessment, improved insight into the active beach slope and its variation along the beach has allowed a better estimate of sea level rise recession.

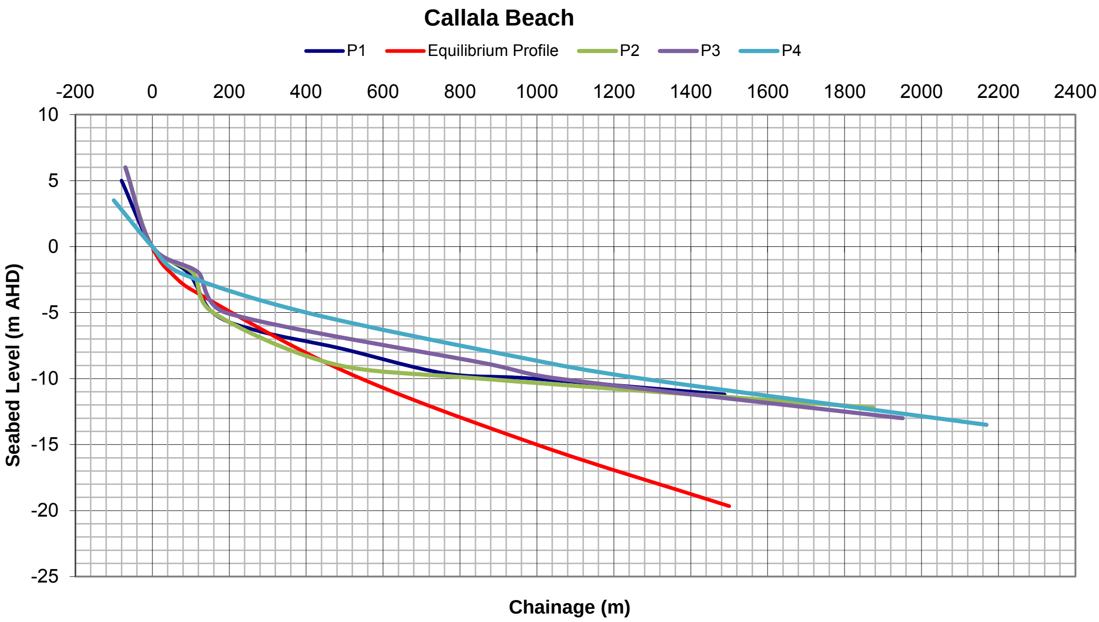


Figure 50 – Characteristic beach profile vs. wave equilibrium profile, Callala (P1 = southern end, P2 = south-centre, P3 = centre-north, P4 = northern end)

1.5.4 Wave Runup

The previous hazard assessment (SMEC 2009) found a maximum wave runup level of 6.0 m AHD, based on nearshore beach slope, SWAN wave transformation modelling and ACES algorithms. Based on the procedure described in Section 3.4, the present day maximum wave runup level for a 100 year ARI storm event at the dune for the southern and central portions of the beach was assessed to be 5.2 m AHD, and 4.0 m AHD for the northern end of the beach, which is slightly below than that provided in the previous assessment. The calculation of wave runup for Callala Beach is shown in Figure 51. Sea level rise would be expected to increase this value by approximately the quantum of the sea level rise, i.e. 0.35 m by 2100. The most recent dune survey indicates that the dune crest is generally around 6 m AHD in the developed area of the beach, but areas north urban area have a crest level of around 5 m AHD, and the southernmost lots along the beachfront also have a crest level of around 5 m AHD. This indicates that wave overtopping is possible in a large storm event, particularly for the southern portion of the urban area.

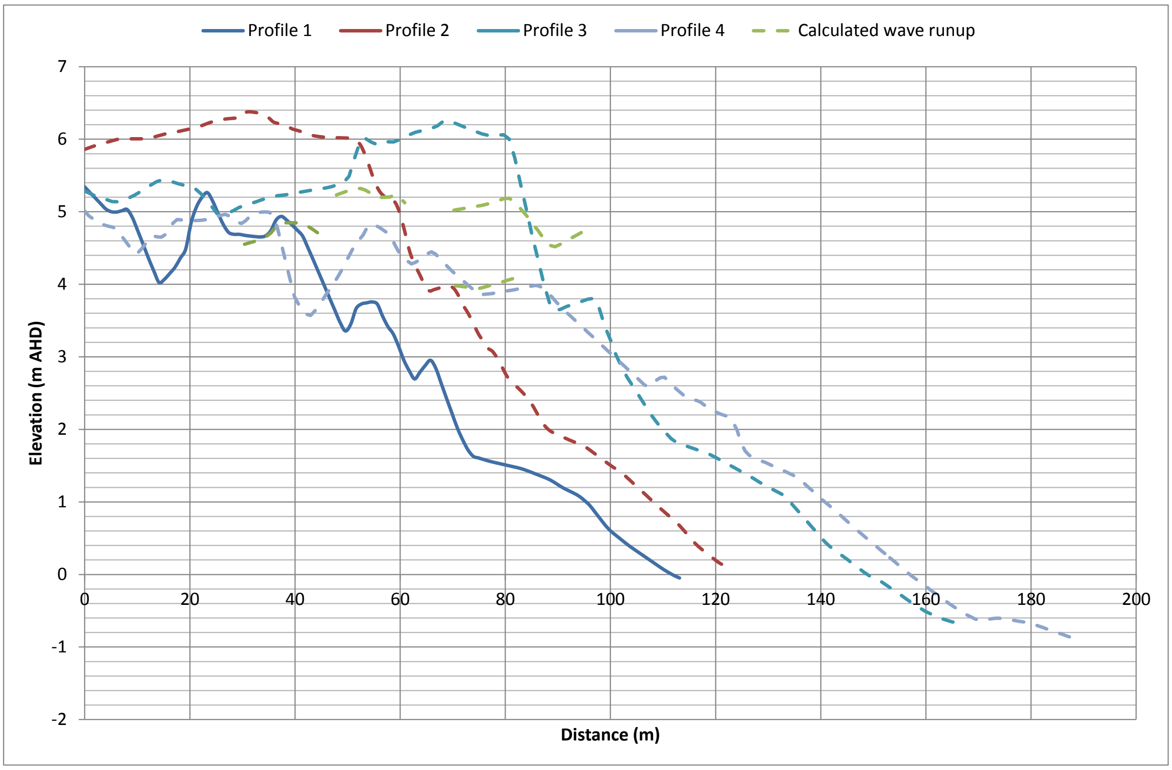


Figure 51 – Wave runup calculation for Currarong Beach

1.6 Collingwood Beach

Since the 2009 hazard assessment, additional photogrammetry data (dated 28/11/2014) is available, as well as LiDAR ground level information and ground survey of the dune dated November 2010, August 2015, September/October 2015, March 2016 and June 2016 (capturing the effect of the June East Coast Low). These additional data have been used to update the hazard assessment for Collingwood Beach.

Locations of the photogrammetric profile blocks at Collingwood Beach are provided in Figure 52.

1.6.1 Short Term Erosion

Short term erosion at Collingwood Beach was assessed with reference to available photogrammetry data and ground survey information. The previous assessment considered photogrammetry data between 1969 and 1975, to assess the impact of the May 1974 storm event. Since this time, ground survey has captured the impacts of a smaller storm event in April 2015, and storm erosion demand from that event has been able to be assessed. The previous assessment (SMEC 2009) estimated 110 m^3/m of storm erosion demand. Further analysis of the storm erosion demand from 1974 with measurement at every available beach profile has revealed some locally higher values of storm erosion demand near the centre of the beach, with the maximum storm erosion demand measured at 120 m^3/m, but with generally lower storm erosion demand values at the southern end of the beach. Analysis of the dune survey data for September/October 2015 has resulted in an estimated storm erosion demand of 40 m^3/m for the April 2015 storm. The June 2016 East Coast Low resulted in a storm erosion demand of 30 m^3/m, but this affected the southern end of the beach more greatly than the April 2015 or June 1974 events, due to the direction of approach of the June 2016 storm.

The updated storm erosion analysis for Collingwood is provided in Figure 53, below.

Figure 52 – Location of photogrammetric profile blocks, Collingwood Beach

1.6.2 Long Term Recession

With additional photogrammetry data and beach survey data, the trend in long term recession or accretion of the beach has been examined and compared with the previously assessed (SMEC 2009) trend in beach change at Collingwood. This was done using a volumetric technique, where the trend in beach volume over time has been examined at each beach profile, as well as tracking of the dune face or beach escarpment chainage over time.

Using both of these techniques, the beach south of Moona Moona Creek and north of Church Street (photogrammetric Blocks 2 to 6) has been assessed to be stable or accreting over time since the start of the photographic record in 1969 – i.e. the beach volume has been increasing or has remained relatively stable on average.

Based on the photogrammetric assessment and analysis of survey data, long term recession along Collingwood Beach has been assessed to be zero when taking into account recession that would be expected due to sea level rise that has already occurred over the period of available photogrammetry. This is in line with the previous assessment undertaken by SMEC (2009) for Collingwood Beach.

The updated beach change analysis for Collingwood Beach is provided in Figure 54, below.

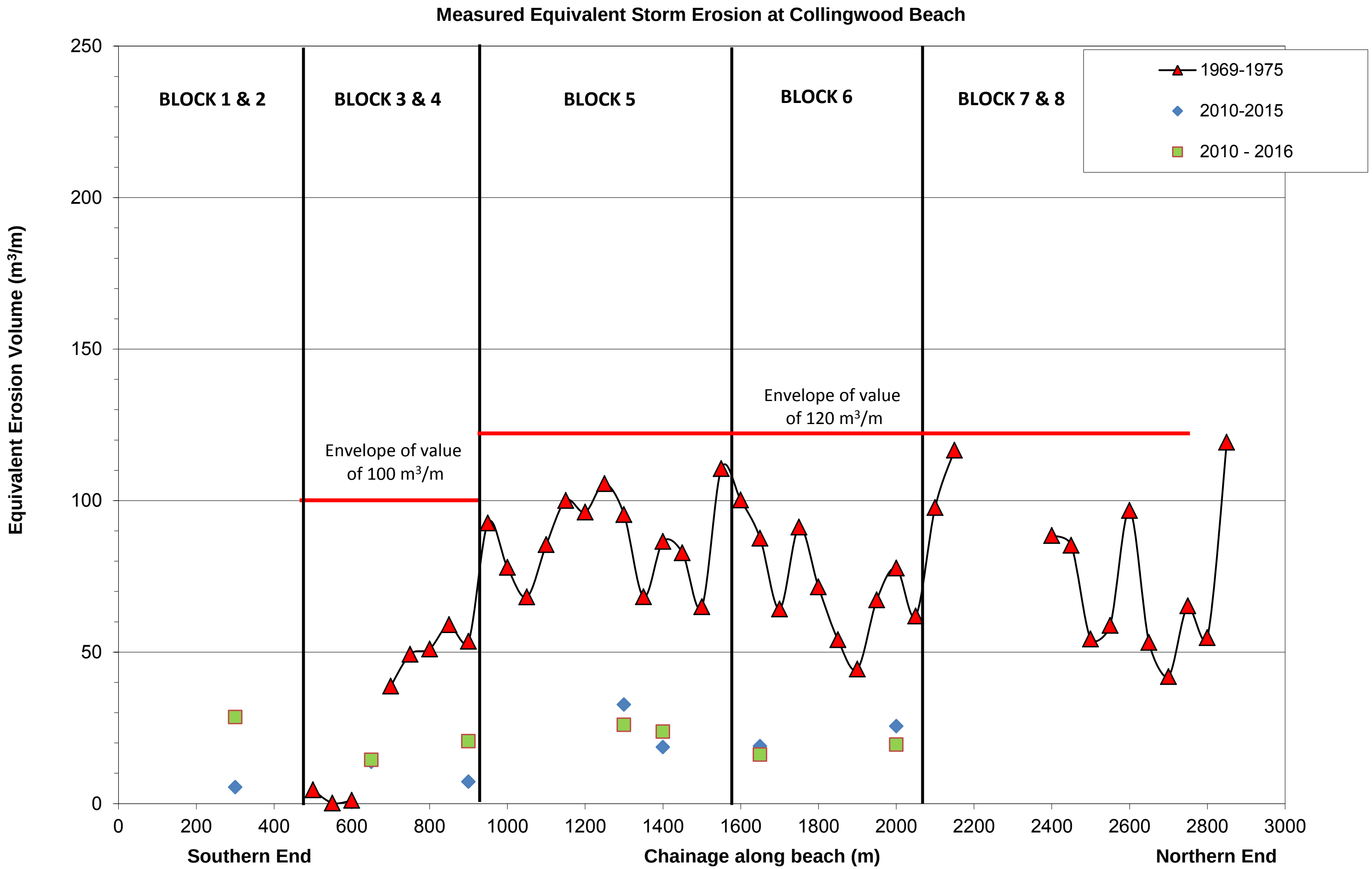
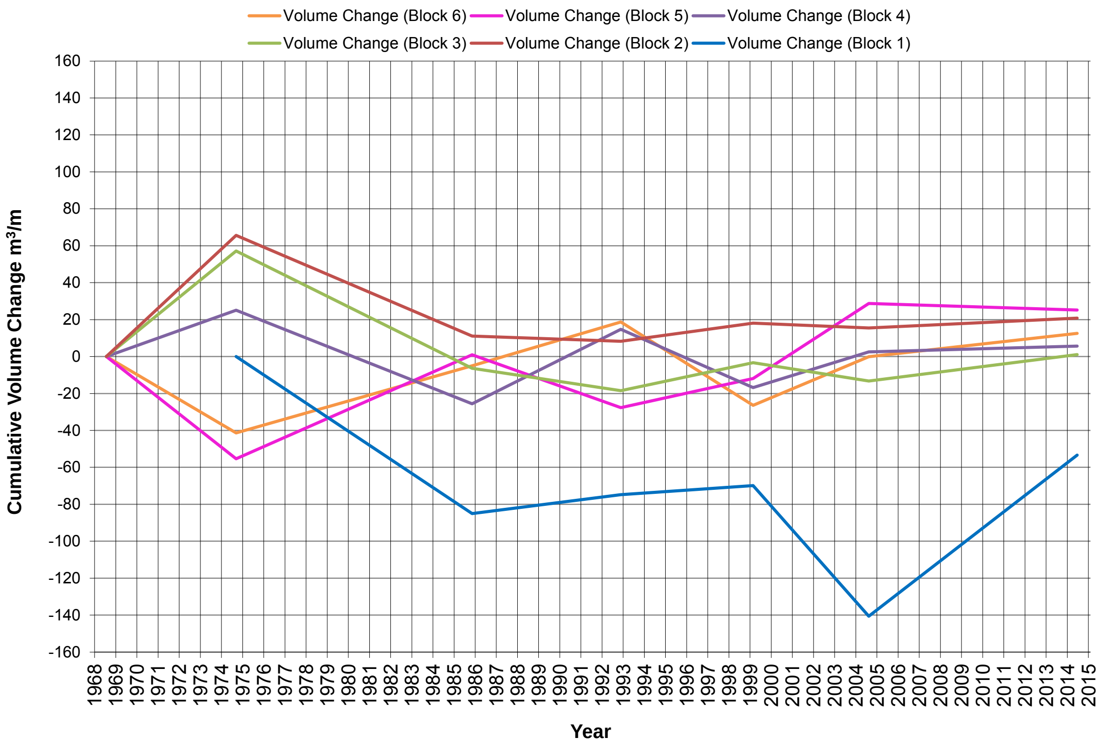


Figure 53 – Measured equivalent storm erosion hazard at Collingwood including April 2015 and June 2016 East Coast Low



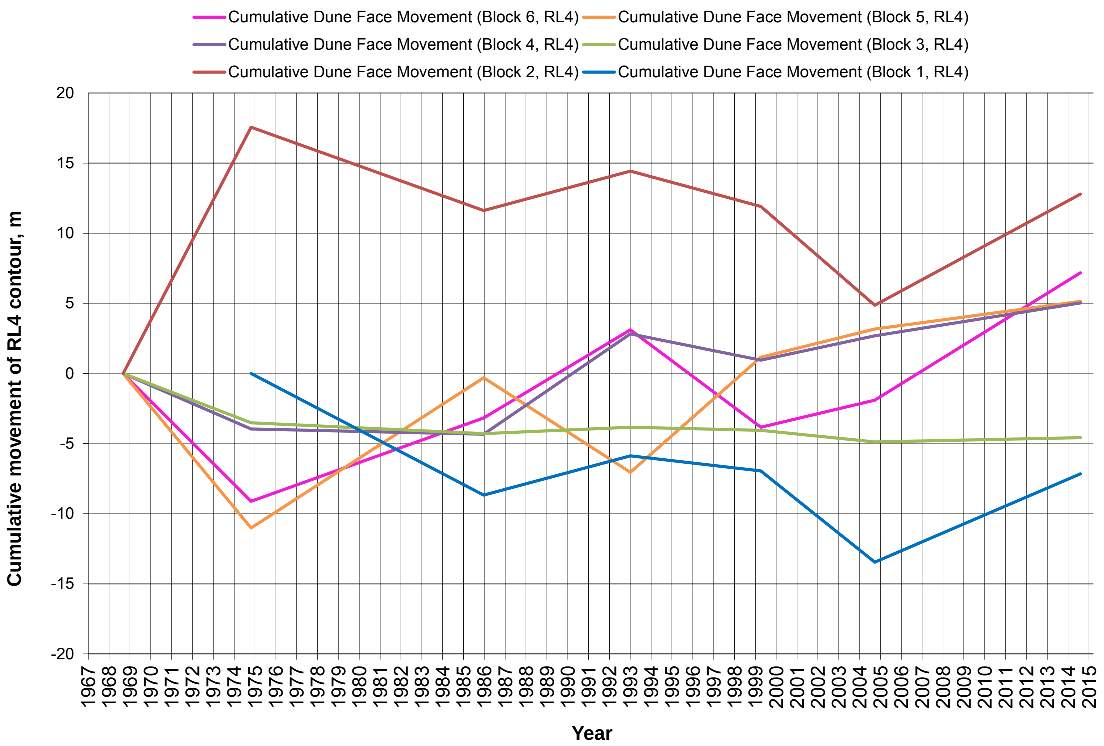


Figure 54 – Beach change over time, Collingwood Beach. Top: Volumetric face analysis; Bottom: Dune face analysis

1.6.3 Future Beach Recession due to Sea Level Rise

Since the previous hazard assessment (SMEC 2009), an improved assessment of the impact of sea level rise on Collingwood Beach has been carried out, through the use of bathymetric soundings collected in 2010. This has enabled the effect of varying bathymetry along the beach to be included in the analysis. The previous assessment relied on a single bathymetric profile to determine nearshore beach slope. The beach slope was found to lie below or correspond with the Dean equilibrium profile down to a depth of 7 m – 9 m. Beyond these depths, the beach profile lies above the Dean equilibrium profile, indicating that sand would be transported onshore at this location. Based on the updated information, the slope of the active beach was taken to be 1V:15H, for the southern end of the beach, grading to 1V:30H for the northern end of the beach. Rock reef is known to exist in the nearshore at the southern end of the beach; however, the nearshore area along most of the beach has been shown by recent DECCW mapping (2010) to be sandy and therefore the seabed would be able to respond to changes in sea level rise.

A characteristic beach profile and the wave-equilibrium beach profile for Collingwood Beach is presented in Figure 55. Based on this, a sea level rise is projected to cause recession of Collingwood Beach. For sea level rises of 0.10 m (2030), 0.23 m (2050) and 0.35 m (2100), shoreline recession of 1.5 – 3.0 m, 3.5 – 6.9 m and 5.3 - 10.5 m (respectively) are projected. These values are reduced when compared with the 2009 assessment, as there has been a reduction in the adopted sea level rise projections.

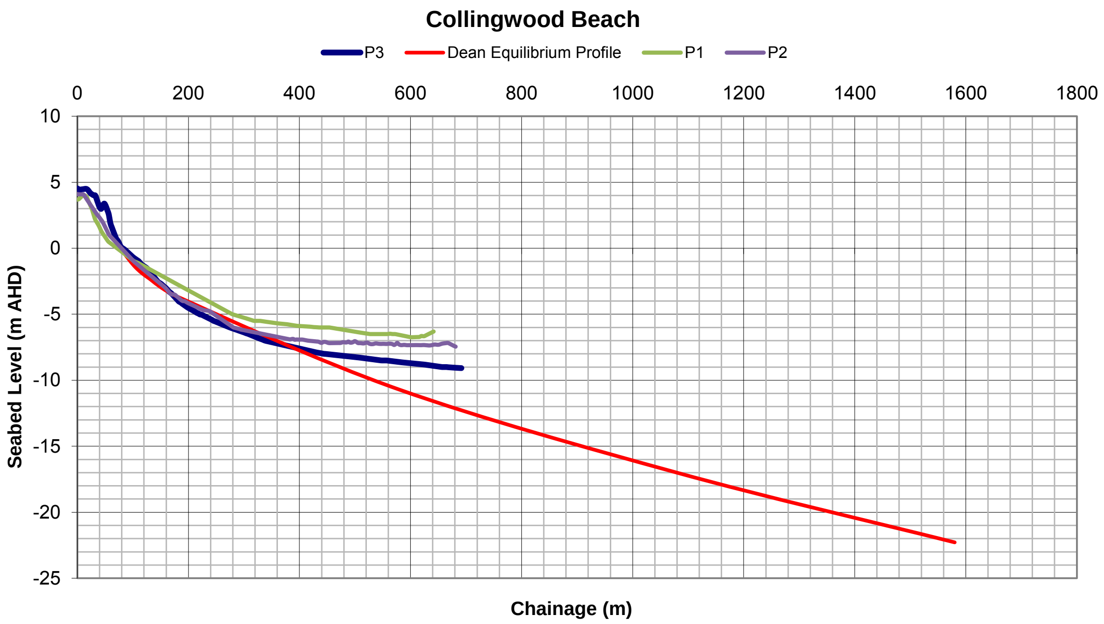


Figure 55 – Characteristic beach profile vs. wave equilibrium profile, Collingwood (P1 = southern end, P2 = centre, P3 = northern end)

1.6.4 Wave Runup

The previous hazard assessment (SMEC 2009) found a maximum wave runup level of 5.0 m to 5.5 m AHD, based on nearshore beach slope, SWAN wave transformation modelling and ACES algorithms. Based on the procedure described in Section 3.4, the present day maximum wave runup level for a 100 year ARI storm event at the dune for the southern and central portions of the beach was assessed to be 5.0 m AHD, and 5.7 m AHD for the northern end of the beach, which is similar to that provided in the previous assessment. The calculation of wave runup for Collingwood Beach is shown in Figure 56. Sea level rise would be expected to increase this value by approximately the quantum of the sea level rise, i.e. 0.35 m by 2100. The most recent dune survey indicates that the dune crest is generally around 4.5 m to 5.0 AHD in the developed area of the beach, indicating that wave overtopping of the dune onto the cycleway is possible in a large storm event. Indeed, wave overtopping onto the cycleway occurred during the June 2016 East Coast Low (pers. Comm., Shoalhaven City Council).

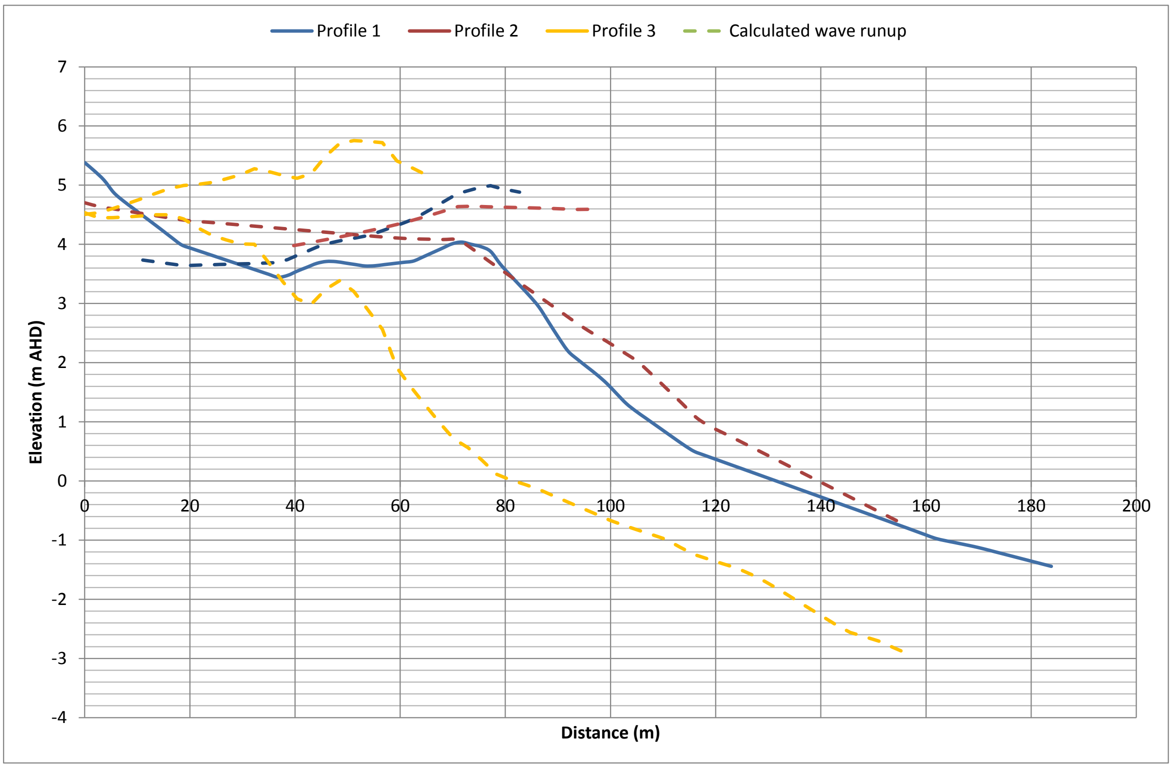


Figure 56 – Wave runup calculation for Collingwood Beach

1.7 Narrawallee Beach

Since the 2009 hazard assessment, additional photogrammetry data (dated 27/11/2014) is available, as well as LiDAR ground level information, bathymetric soundings dated December 2010 and ground survey of the dune dated April 2010. These additional data have been used to update the hazard assessment for Narrawallee Beach.

Locations of the photogrammetric profile blocks at Narrawalle Beach are shown in Figure 57.

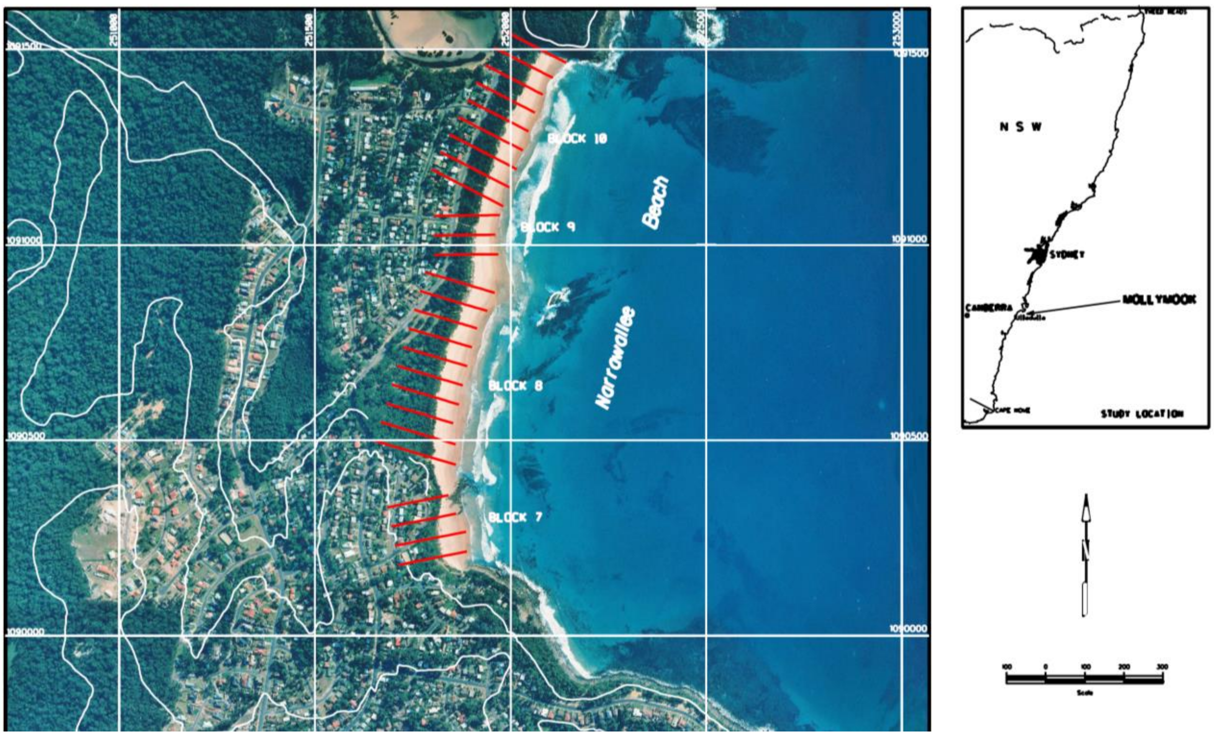


Figure 57 – Photogrammetric blocks at Narrawallee Beach

1.7.1 Short Term Erosion

Short term erosion at Narrawallee Beach was assessed with reference to available photogrammetry data and ground survey information. The previous assessment considered photogrammetry data between 1971 and 1975, to assess the impact of the May 1974 storm event. Since this time, no additional storm events have been captured in the available data to enable storm erosion demand to be re-assessed. The previous assessment (SMEC 2009) estimated 110 m^3/m of storm erosion demand. Re-analysis of the maximum storm erosion demand found a maximum storm erosion demand of 110 m^3/m at the northern end of the beach, concurring with the 2009 assessment.

The updated storm erosion analysis for Narrawallee is provided in Figure 58, below.

1.7.2 Long Term Recession

With additional photogrammetry data from 2014 and beach survey data, the trend in long term recession or accretion of the beach has been examined and compared with the previously assessed (SMEC 2009) trend in beach change at Narrawallee. This was done using a volumetric technique, where the trend in beach volume over time has been examined at each beach profile, as well as tracking of the dune face or beach escarpment chainage over time.

Using both of these techniques, the beach has been assessed to be stable over time since the start of the photographic record in 1944.

Based on the photogrammetric assessment and analysis of survey data, long term recession along Narrawallee has been assessed to be zero. This is in line with the previous assessment undertaken by SMEC (2009) for Narrawallee.

The updated beach change analysis for Narrawallee Beach is provided in Figure 59, below.

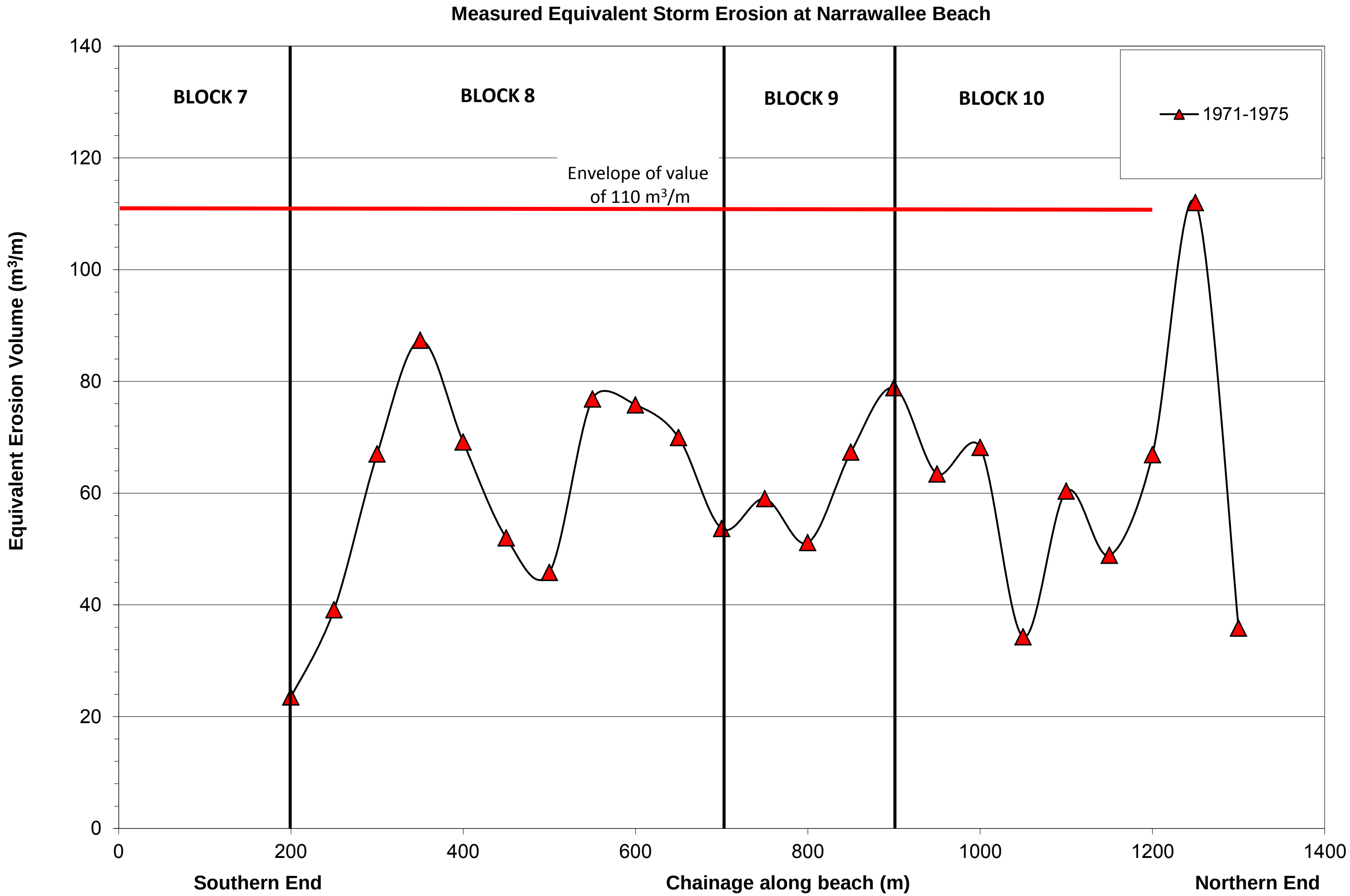


Figure 58 – Measured equivalent storm erosion hazard at Narrawallee

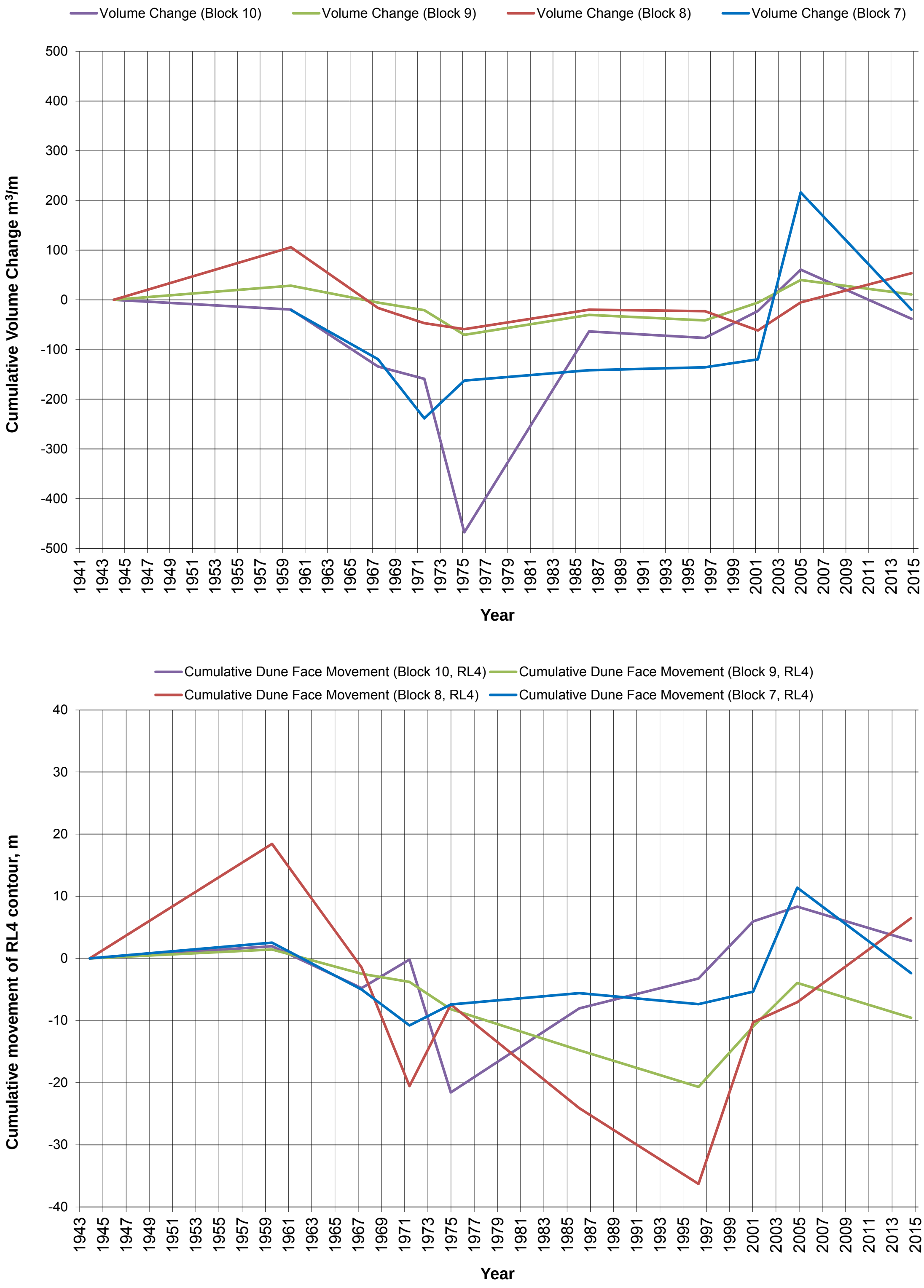


Figure 59 – Beach change over time, Narrawallee. Top: Volumetric face analysis; Bottom: Dune face analysis

1.7.3 Future Beach Recession due to Sea Level Rise

Since the previous hazard assessment (SMEC 2009), an improved assessment of the impact of sea level rise on Narrawallee Beach has been carried out, through the consideration of bathymetric soundings collected in 2010. This has enabled a more accurate assessment of the nearshore beach slope, which had previously been determined using bathymetry estimated from local Admiralty charts. The beach slope was found to lie below or correspond with the Dean equilibrium profile down to a depth of 20 m, indicating that the beach is likely to recede with sea level rise. Based on the updated information, the slope of the active beach was taken to be 1V:54H for the entire length of beach.

A characteristic beach profile and the wave-equilibrium beach profile for Narrawallee Beach is presented in Figure 60. Based on this, a sea level rise is projected to cause recession of Narrawallee Beach. For sea level rises of 0.10 m (2030), 0.23 m (2050) and 0.35 m (2100), shoreline recession of 5.4 m, 12.4 m and 18.8 m (respectively) are projected. These values are reduced when compared with the 2009 assessment, as there has been a reduction in the adopted sea level rise projections.

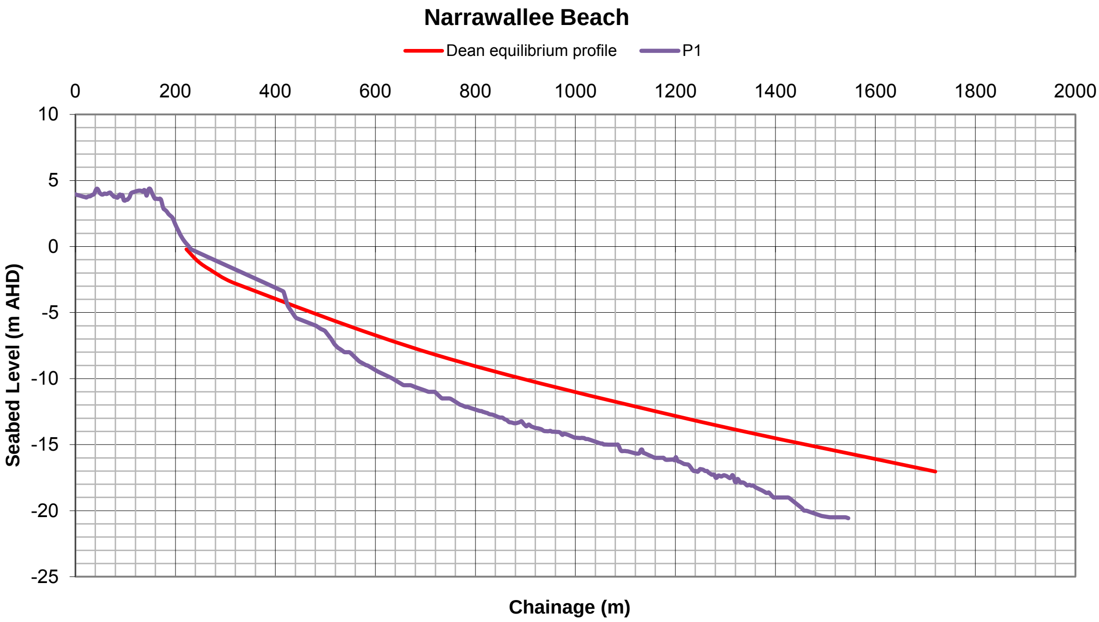


Figure 60 – Characteristic beach profile vs. wave equilibrium profile, Narrawallee

1.7.4 Wave Runup

The previous hazard assessment (SMEC 2009) found a maximum wave runup level of 5.1 m to 7.0 m AHD depending on location along the beach, based on nearshore beach slope, SWAN wave transformation modelling and ACES algorithms. Based on the procedure described in Section 3.4, the present day maximum wave runup level for a 100 year ARI storm event was assessed to be 5.9 m AHD, which is similar to that provided in the previous assessment. The calculation of wave runup for Narrawallee Beach is shown in Figure 61. Sea level rise would be expected to increase this value by approximately the quantum of the sea level rise, i.e. 0.35 m by 2100. The most recent dune survey indicates that the dune crest is generally around 4.5 m along the southern end of the beach, increasing to approximately 6.0 m AHD along Marton Porter Drive and 5.5 m AHD near the tombolo at the northern end of the beach. Wave overtopping of the dune is therefore possible in a large storm event, including wave overwash of the tombolo at the northern end of the beach. However, the wave overtopping volume is likely to diminish rapidly with distance inland from the dune crest.

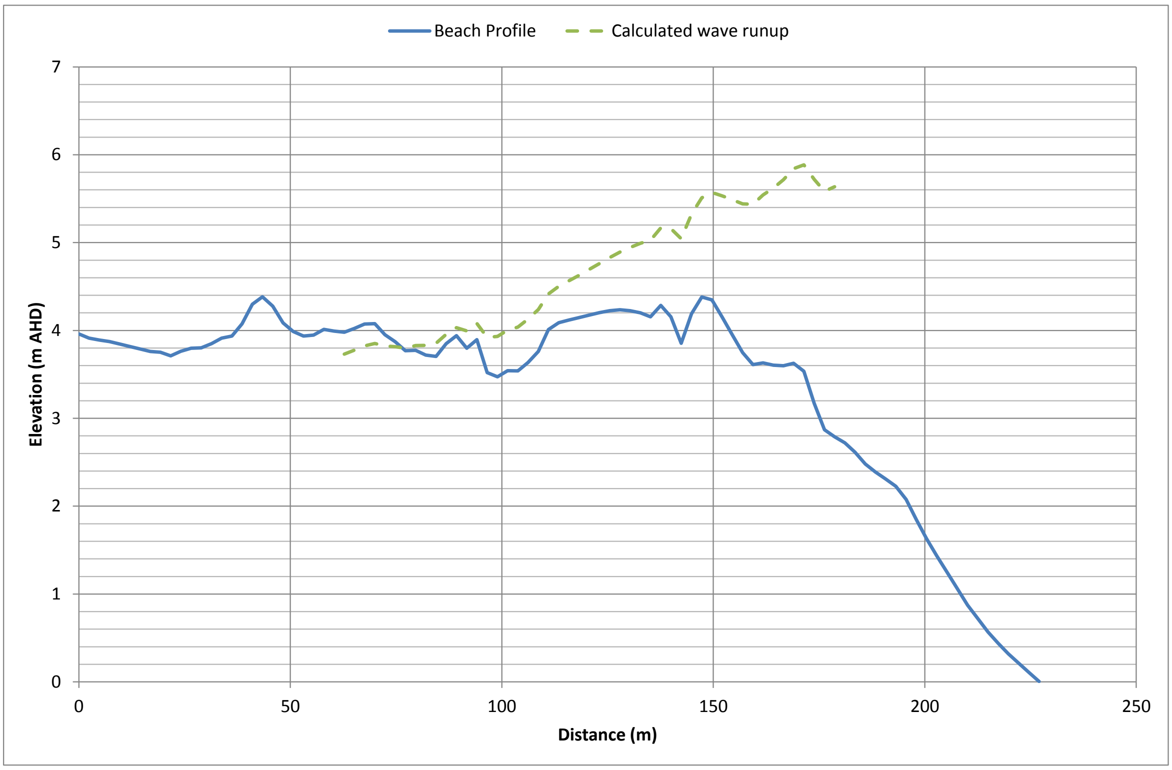


Figure 61 – Wave runup calculation for Narrawallee Beach

1.8 Mollymook Beach

At Mollymook, a dune has been recently constructed (April 2016) using sand sourced from dredging at Lake Conjola, on the northern side of Blackwater Creek, as well as a geobag revetment. These works would be likely to reduce the coastal erosion and inundation hazard for the properties immediately north of the creek entrance, as well as reduce the propensity for the creek to break out to the north following a heavy rainfall event (thus decreasing the estuary entrance instability hazard for this area).

The presence of the works, as well as additional data collected since the 2009 hazard assessment, have been taken into account in updating the hazard assessment for Mollymook Beach. Since 2009, additional photogrammetry data (dated 27/11/2014) is available, as well as LiDAR ground level information, bathymetric soundings dated December 2010 and ground survey of the dune dated March 2010, April 2013, March 2015 and December 2015. Survey data collected following the June 2016 East Coast Low allowed the storm erosion demand from that event to be assessed also. These additional data have been used to update the hazard assessment for Mollymook.

The locations of the photogrammetric profile data at Mollymook are provided in Figure 62, below.

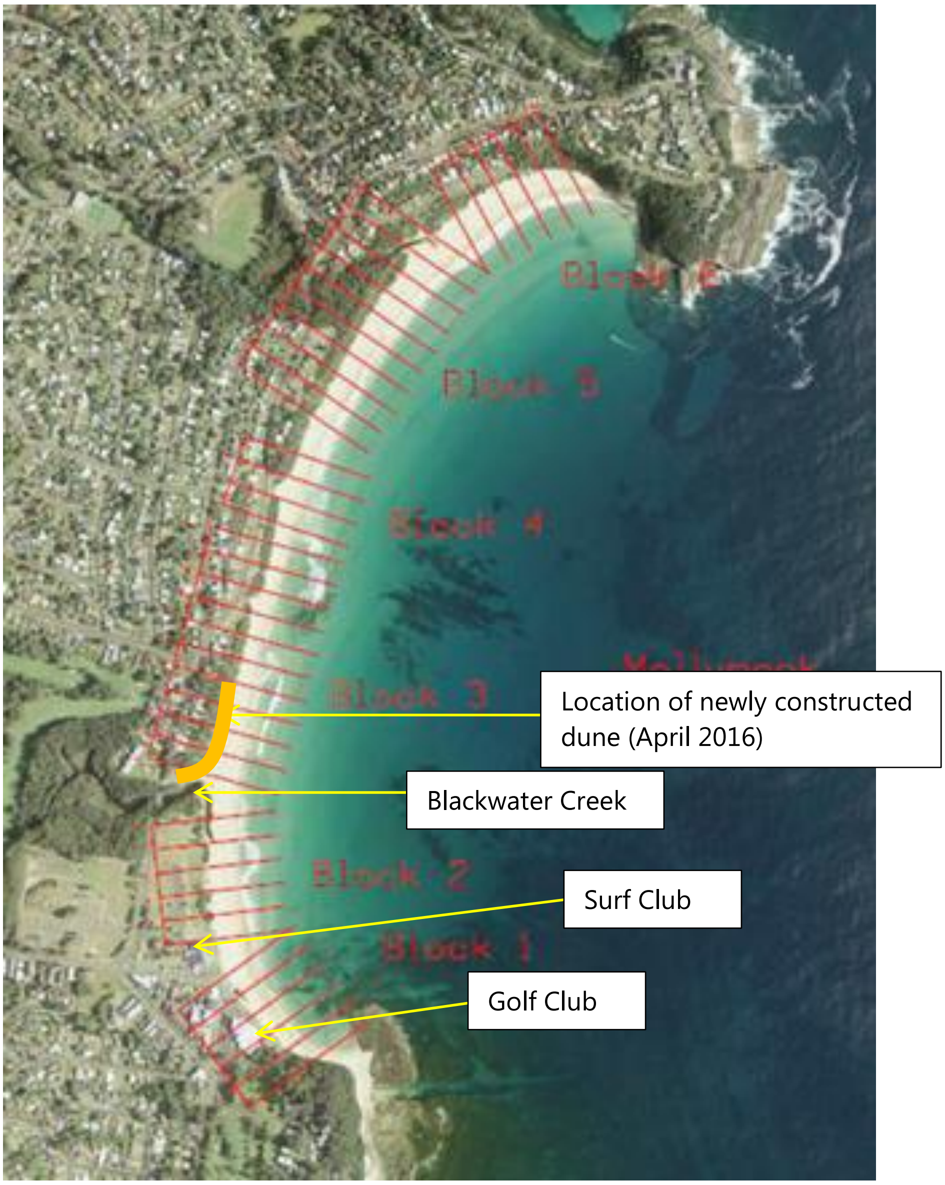


Figure 62 – Locations of photogrammetric profiles, Mollymook

1.8.1 Short Term Erosion

Short term erosion at Mollymook Beach was assessed with reference to available photogrammetry data, ground survey information and construction drawings for the recently constructed dune on the northern side of Blackwater Creek. The previous assessment considered photogrammetry data between 1971 and 1975, to assess the impact of the May 1974 storm event. Since this time, no additional storm events have been captured in the available data to enable storm erosion demand to be re-assessed. However, works have been carried out in accordance with recommendations in the Draft Coastal Zone Management Plan to reduce the coastal hazard due to estuary entrance dynamics at the northern end of Blackwater Creek. The previous assessment (SMEC 2009) estimated 70 m^3/m of storm erosion demand for the area fronting the Golf Club, 140 m^3/m for the area fronting the Surf Club, 170 m^3/m for the area between the two creek entrances and 100 m^3/m for the northern end of the beach, with higher values immediately adjacent to the creek entrances.

Drawings of the recent works at Mollymook show that 3,680 m^3 of sand have been placed along a 280 m long dune at Mollymook, immediately north of Blackwater Creek. Assuming that this sand is compatible with the native sand at Mollymook, this introduces an additional 13 m^3/m of dune sand available to feed the storm erosion demand. This additional 13 m^3/m has been taken into account in the hazard mapping for the section of the beach which includes the new dune. In addition, the crest level of the dune has been raised to 6.0 m AHD, and a geotextile revetment has been constructed immediately adjacent to Blackwater Creek entrance which would enable the creek to break out toward the south in a large storm event. This eliminates the creek entrance instability hazard for the area immediately north of the creek entrance. Including the effect of the new works, re-analysis of the maximum storm erosion demand found the following:

- A storm erosion demand of 90 m^3/m for the area fronting the Golf Club (this is limited to the beach berm only due to the presence of a protective revetment);
- A storm erosion demand of 150 m^3/m for the area fronting the Surf Club (limited, however, by the presence of the vertical concrete seawall immediately south of the Surf Club);
- A storm erosion demand immediately south of the entrance to Blackwater Creek of 230 m^3/m, which takes into account estuary entrance fluctuations;
- A storm erosion demand of 130 m^3/m for 300 m north of the entrance to Blackwater Creek, taking into account the presence of the entrance tripping structure and beach nourishment works;
- A storm erosion demand of 170 m^3/m for the central-north portion of the beach, south of the northern creek entrance; and
- A storm erosion demand of 100 m^3/m for the northern end of the beach.

The updated storm erosion analysis for Mollymook is provided in Figure 63, below.

1.8.2 Long Term Recession

With additional photogrammetry data from 2014 and beach survey data, the trend in long term recession or accretion of the beach has been examined and compared with the previously assessed (SMEC 2009) trend in beach change at Mollymook. This was done using a volumetric technique, where the trend in beach volume over time has been examined at each beach profile, as well as tracking of the dune face or beach escarpment chainage over time.

Using both of these techniques, the beach has been assessed to be stable over time since the start of the photographic record in 1944. This trend is confirmed when removing the less accurate 1944 photography from the analysis.

Based on the photogrammetric assessment and analysis of survey data, long term recession along Mollymook Beach has been assessed to be zero. This is in line with the previous assessment undertaken by SMEC (2009).

The updated beach change analysis for Mollymook Beach is provided in Figure 64, below.

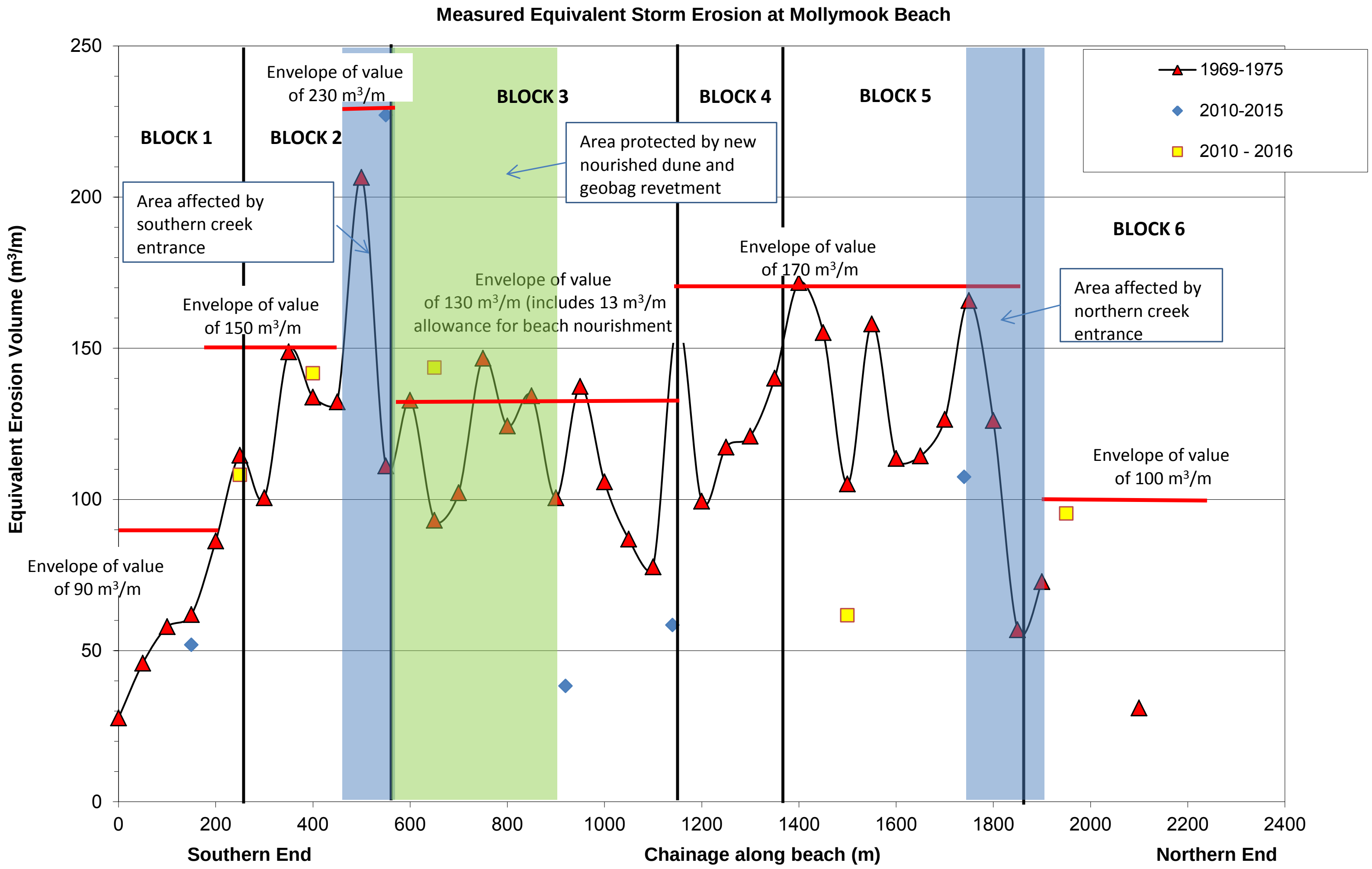
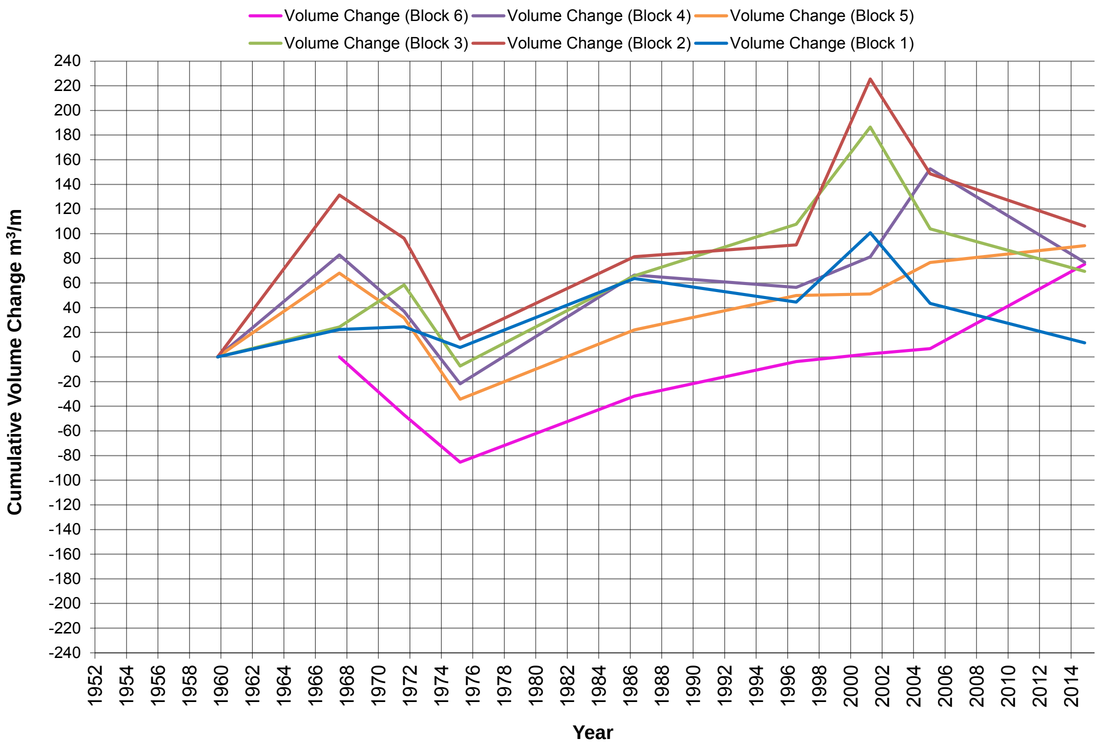


Figure 63 – Measured equivalent storm erosion hazard at Mollymook



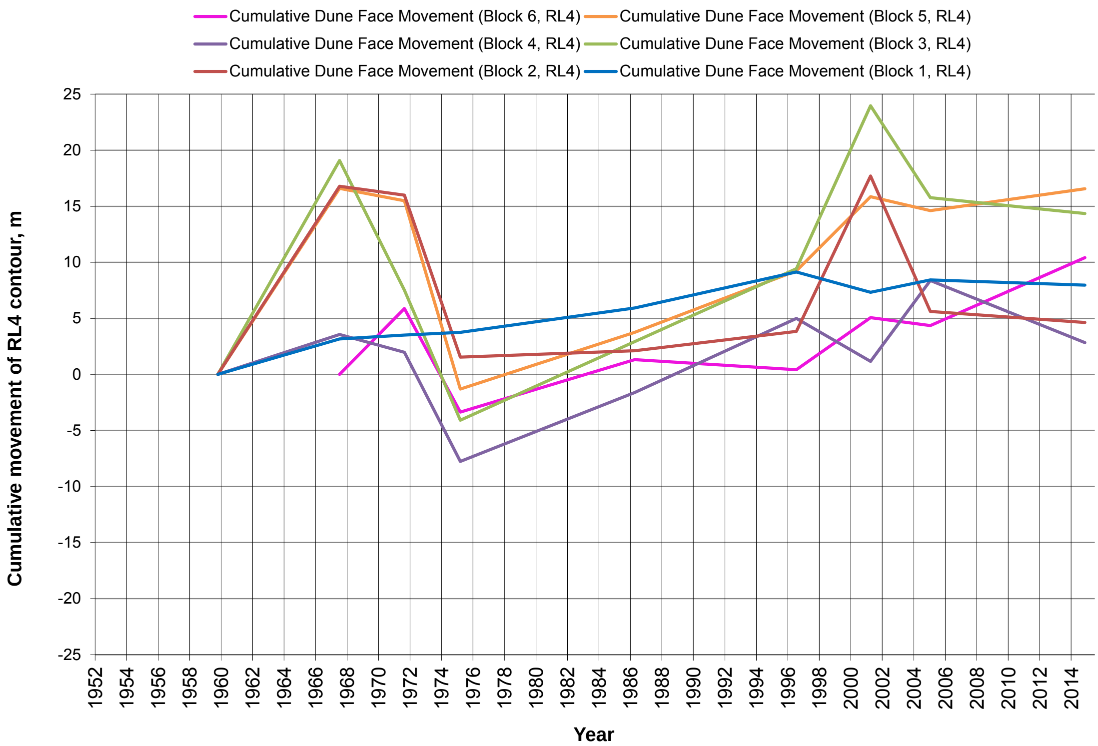


Figure 64 – Beach change over time, Mollymook. Top: Volumetric face analysis; Bottom: Dune face analysis

1.8.3 Future Beach Recession due to Sea Level Rise

Since the previous hazard assessment (SMEC 2009), an improved assessment of the impact of sea level rise on Mollymook Beach has been carried out, through the consideration of bathymetric soundings collected in 2010. This has enabled a more accurate assessment of the nearshore beach slope, which had previously been determined using bathymetry estimated from local Admiralty charts. The beach slope was found to lie below or correspond with the Dean equilibrium profile down to a depth of 20 m, indicating that the beach is likely to recede with sea level rise. Based on the updated information, the slope of the active beach was taken to be 1V:45H for the entire length of beach.

A characteristic beach profile and the wave-equilibrium beach profile for Mollymook Beach is presented in Figure 65. Based on this, a sea level rise is projected to cause recession of Mollymook Beach. For sea level rises of 0.10 m (2030), 0.23 m (2050) and 0.35 m (2100), shoreline recession of 4.4 m, 10.1 m and 15.4 m (respectively) are projected. These values are reduced when compared with the 2009 assessment, as there has been a reduction in the adopted sea level rise projections.

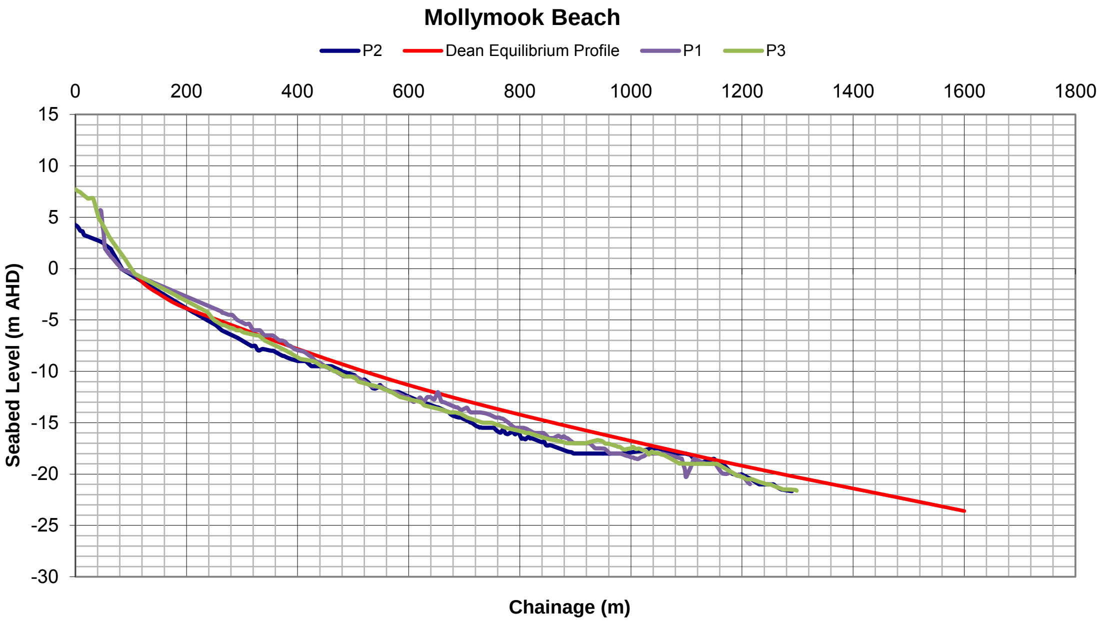


Figure 65 – Characteristic beach profile vs. wave equilibrium profile, Mollymook

1.8.4 Wave Runup

The previous hazard assessment (SMEC 2009) found a maximum wave runup level of 5.0 m to 7.4 m AHD depending on location along the beach, based on nearshore beach slope, SWAN wave transformation modelling and ACES algorithms. Based on the procedure described in Section 3.4, the present day maximum wave runup level for a 100 year ARI storm event was assessed to be 6.0 m AHD, which is similar to that provided in the previous assessment. Immediately north of the creek entrance, the wave runup is estimated to be 5.5 m AHD, which is in line with the previous assessment and is equivalent to the crest level of the constructed dune.

The calculation of wave runup for Mollymook Beach is shown in Figure 66. Sea level rise would be expected to increase this value by approximately the quantum of the sea level rise, i.e. 0.35 m by 2100. The most recent dune survey indicates that the dune crest is generally above the wave runup level along most of the beach length, but that overtopping is possible onto the road immediately north of the Golf Club.

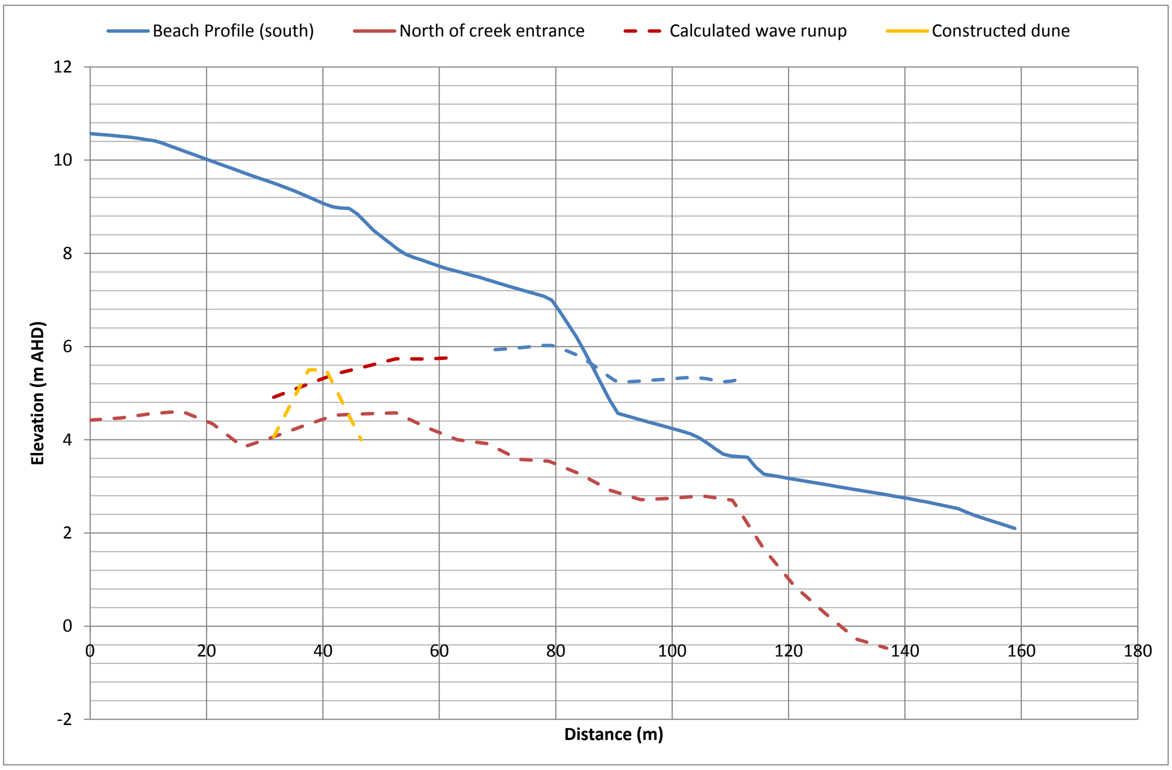


Figure 66 – Wave runup calculation for Mollymook Beach

1.9 Collers Beach

Since the 2009 hazard assessment, additional photogrammetry data (dated 27/11/2014) is available, as well as LiDAR ground level information and ground survey of the dune dated April 2010. These additional data have been used to update the hazard assessment for Collers Beach.

1.9.1 Short Term Erosion

Short term erosion at Collers Beach was assessed with reference to available photogrammetry data and ground survey information. The previous assessment considered the full range of photogrammetry data between 1967 and 2005, to assess the available sand store on the beach and the historical beach fluctuations over the photographic record. A storm erosion demand of 105 m^3/m was estimated using this technique. Photogrammetry data for Collers Beach were not suitable for isolating the impact of a particular storm, as the available data were several years after the storm event of May 1974. Since 2009, no additional storm events have been captured in the available data to enable storm erosion demand to be re-assessed. With the additional photogrammetry data and dune survey data, storm erosion demand has been re-assessed and found to be unchanged from the SMEC 2009 assessment.

The updated storm erosion analysis for Collers Beach is provided in Figure 67, below.

1.9.2 Long Term Recession

With additional photogrammetry data from 2014 and beach survey data, the trend in long term recession or accretion of the beach has been examined and compared with the previously assessed (SMEC 2009) trend in beach change at Collers Beach. This was done using a volumetric technique, where the trend in beach volume over time has been examined at each beach profile, as well as tracking of the dune face or beach escarpment chainage over time.

Using both of these techniques, the beach has been assessed to be stable over time since the start of the photographic record in 1967. This trend is confirmed when removing the less accurate 1944 photography from the analysis.

Based on the photogrammetric assessment and analysis of survey data, long term recession along Collers Beach has been assessed to be zero. This is in line with the previous assessment undertaken by SMEC (2009).

The updated beach change analysis for Collers Beach is provided in Figure 68, below.

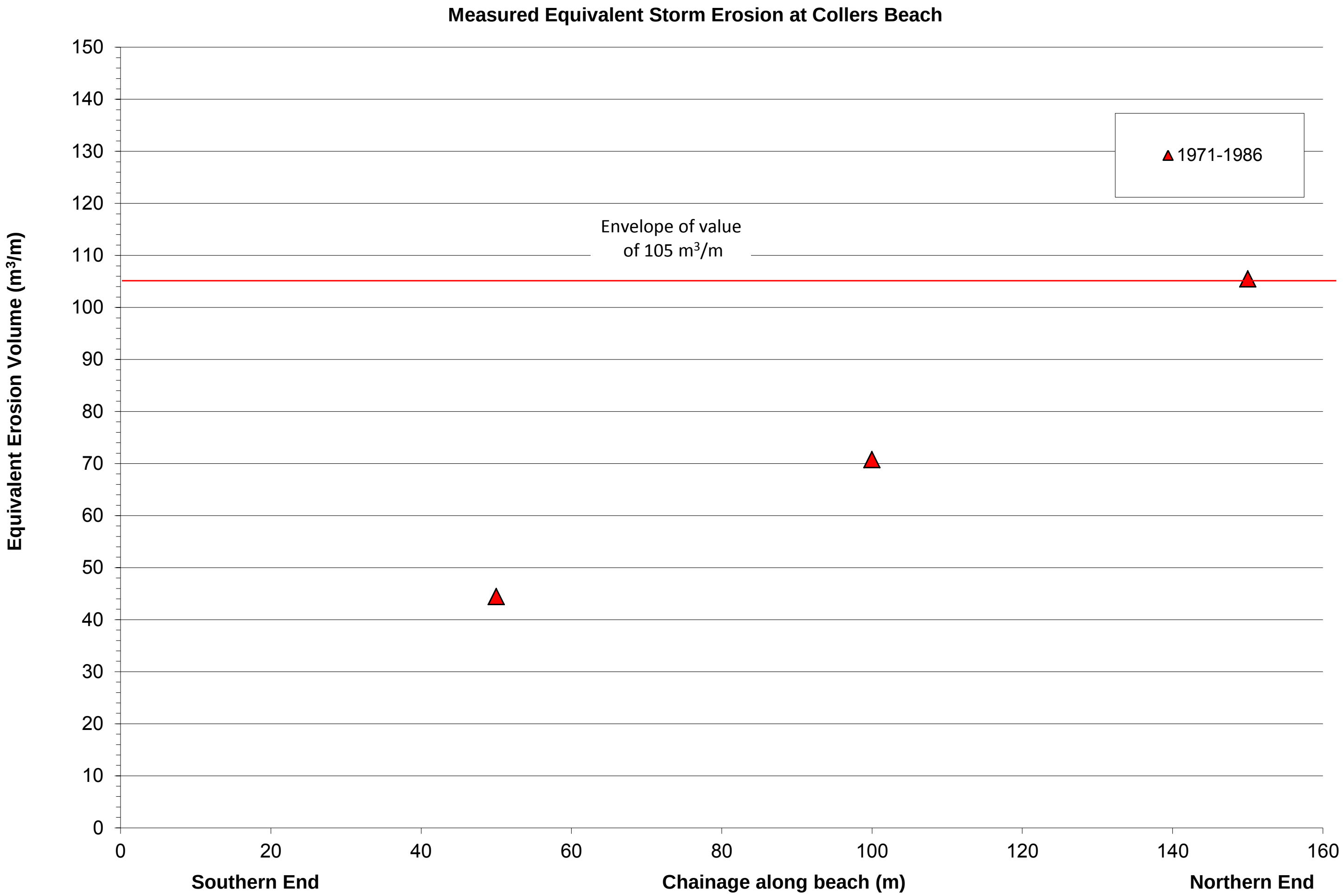
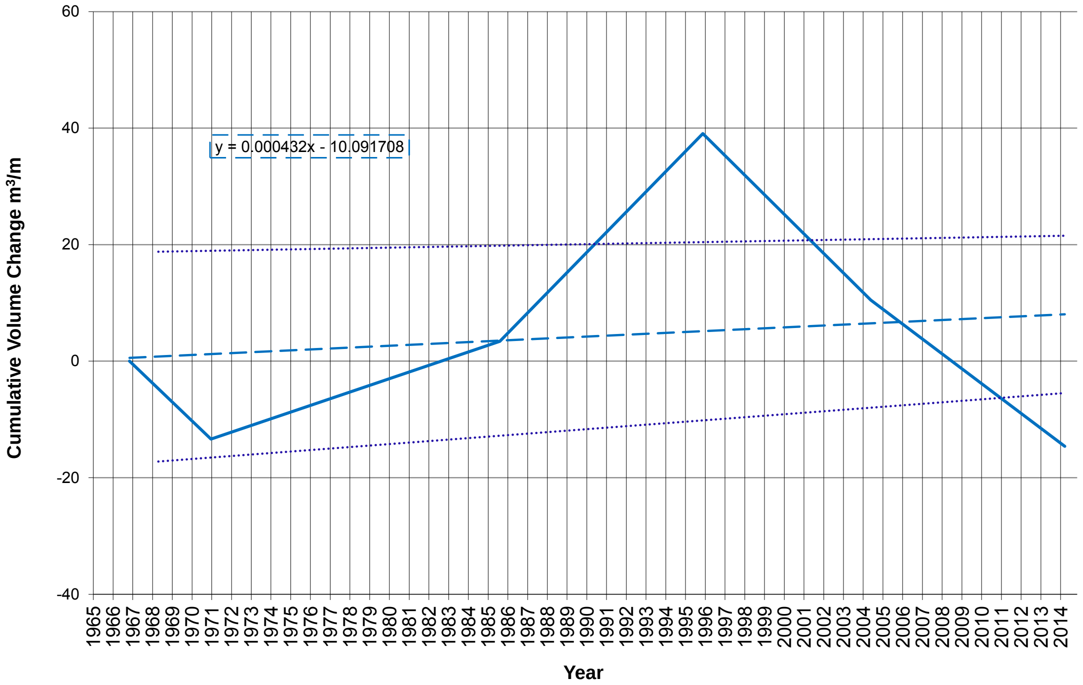


Figure 67 – Measured equivalent storm erosion hazard at Collers Beach

Advisian
WorleyParsons Group



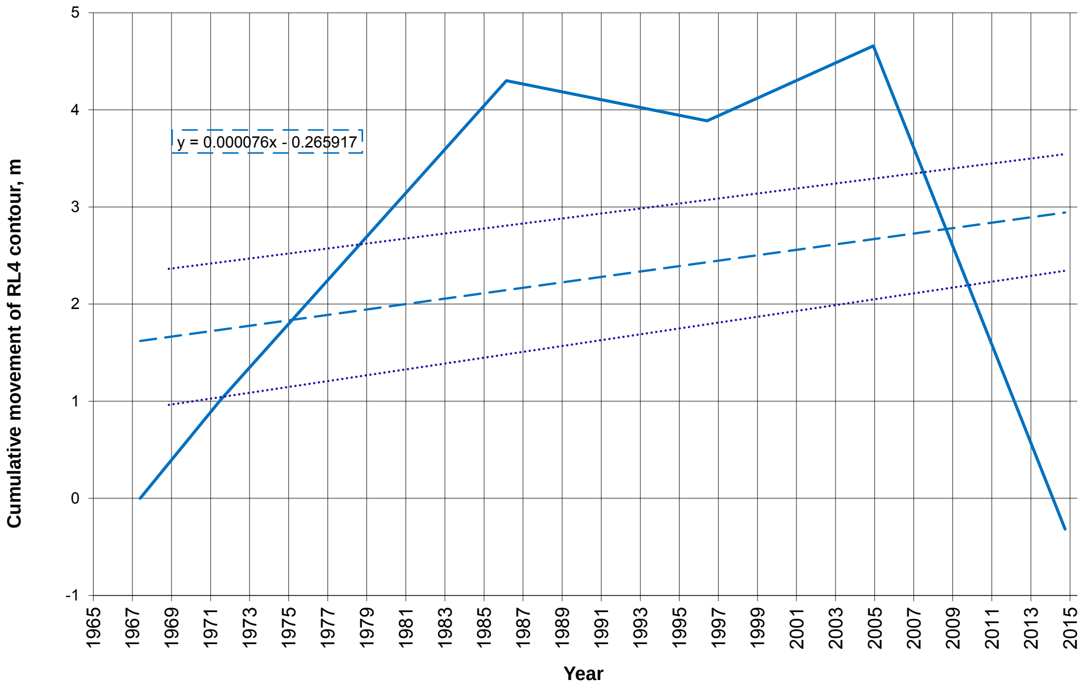


Figure 68 – Beach change over time, Collers Beach. Top: Volumetric face analysis; Bottom: Dune face analysis

1.9.3 Future Beach Recession due to Sea Level Rise

The previous hazard assessment (SMEC 2009) allowed for an active beach slope covering only the area above 0 m AHD, due to the presence of a rock shelf in the nearshore below this level. This gave an active beach slope of 1V:8H for the assessment of beach recession due to sea level rise. Analysis of LiDAR information and beach dune survey confirms this beach slope, as shown in Figure 69 below.

Sea level rise is projected to cause recession of only the active portion of the profile of Collers Beach. For sea level rises of 0.10 m (2030), 0.23 m (2050) and 0.35 m (2100), shoreline recession of 0.9 m, 1.8 m and 2.8 m (respectively) are projected. These values are reduced when compared with the 2009 assessment, as there has been a reduction in the adopted sea level rise projections.

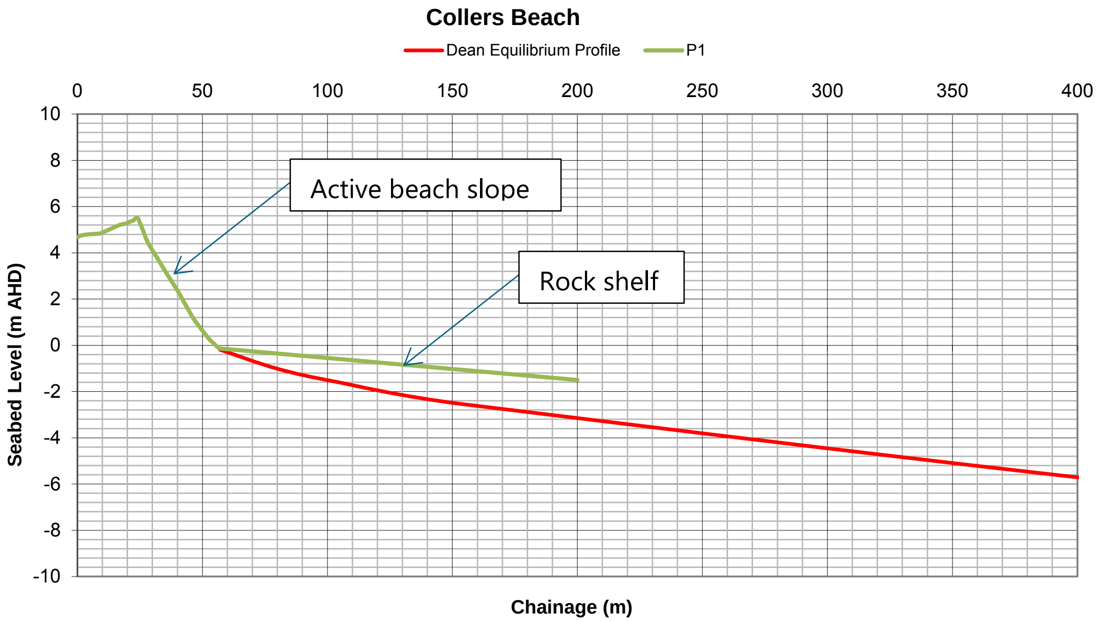


Figure 69 – Characteristic beach profile vs. wave equilibrium profile, Collers Beach

1.9.4 Wave Runup

The previous hazard assessment (SMEC 2009) found a maximum wave runup level of 6.4 m to 7.4 m AHD depending on location along the beach, based on nearshore beach slope, SWAN wave transformation modelling and ACES algorithms. Based on the procedure described in Section 3.4, the present day maximum wave runup level for a 100 year ARI storm event was assessed to be 6.5 m AHD, which is similar to that provided in the previous assessment.

The calculation of wave runup for Collers Beach is shown in Figure 70. Sea level rise would be expected to increase this value by approximately the quantum of the sea level rise, i.e. 0.35 m by 2100. The most recent dune survey indicates that the dune crest is generally below wave runup level along most of the beach length and that overtopping of the dune crest is possible, impacting on the residence immediately behind the dune crest.

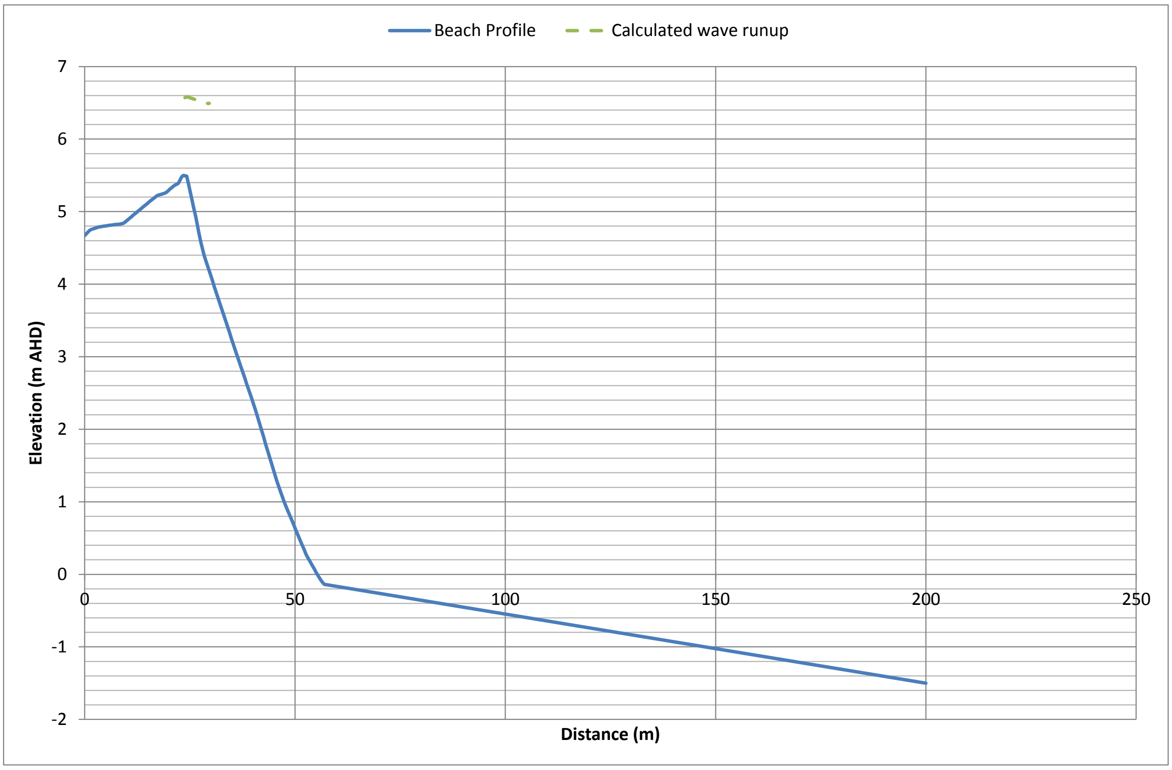


Figure 70 – Wave runup calculation for Collers Beach

Appendix B: Hazard Maps

DATE 02/08/16	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Shoalhaven Heads 2016 Coastal Hazard Zones	Shoalhaven City Council
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping	**CREATED BY** C. Adamantidis	Advisian WorleyParsons Group
		FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment	

DATE 02/08/16	0 50 100 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Shoalhaven Heads 2030 Coastal Hazard Zones
PROJECT NO. 301311-13501	PROJECT TITLE Shoalhaven Coastal Hazard Mapping		CREATED BY C. Adamantidis
			FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council
Advisian WorleyParsons Group

DATE 02/08/16	0 50 100 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Shoalhaven Heads 2050 Coastal Hazard Zones
PROJECT NO. 301311-13501	PROJECT TITLE Shoalhaven Coastal Hazard Mapping		CREATED BY C. Adamantidis	FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

Advisian
WorleyParsons Group

DATE 02/08/16	0 50 100 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Shoalhaven Heads 2100 Coastal Hazard Zones
PROJECT NO. 301311-13501	PROJECT TITLE Shoalhaven Coastal Hazard Mapping	CREATED BY C. Adamantidis	FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

Advisian
WorleyParsons Group

DATE 02/08/16	0 100 200 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Culburra 2016 Coastal Hazard Zones
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping	**CREATED BY** C. Adamantidis	**FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

Advisian WorleyParsons Group

DATE 02/08/16	0 100 200 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Culburra 2030 Coastal Hazard Zones
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping	**CREATED BY** C. Adamantidis	**FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

Advisian WorleyParsons Group

DATE 02/08/16

0 100 200 metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Culburra 2050 Coastal Hazard Zones

PROJECT NO. 301311-13501

PROJECT TITLE Shoalhaven Coastal Hazard Mapping

CREATED BY C. Adamantidis

FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

Advisian WorleyParsons Group


LEGEND
2100 Zone of Slope Adjustment
2100 Zone of Reduced Foundation Capacity
Lots where site specific geotechnical assessment required
NOTES
1. It is recommended that hazard line positions be specified from the GIS version of this map (i.e. do not scale hazard line positions off this Figure).
N
DATE 02/08/16
0 100 200
metres
COORDINATE SYSTEM MGA Zone 56
FIGURE TITLE Culburra 2100 Coastal Hazard Zones
PROJECT NO. 301311-13501
PROJECT TITLE Shoalhaven Coastal Hazard Mapping
CREATED BY C. Adamantidis
FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment
Shoalhaven City Council
Advisian
WorleyParsons Group

DATE 02/08/16	0 25 50 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Warrain 2016 Coastal Hazard Zones
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping	**CREATED BY** C. Adamantidis	**FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council — Advisian WorleyParsons Group

DATE 02/08/16	0 25 50 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Warrain 2030 Coastal Hazard Zones
PROJECT NO. 301311-13501		**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping	**CREATED BY** C. Adamantidis
FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment			

Shoalhaven City Council

Advisian WorleyParsons Group

DATE 02/08/16 | 0 25 50 metres | **COORDINATE SYSTEM** MGA Zone 56 | **FIGURE TITLE** Warrain 2050 Coastal Hazard Zones

PROJECT NO. 301311-13501 | **PROJECT TITLE** Shoalhaven Coastal Hazard Mapping | **CREATED BY** C. Adamantidis | **FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council | Advisian WorleyParsons Group

DATE 02/08/16	0 25 50 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Warrain 2100 Coastal Hazard Zones
PROJECT NO. 301311-13501	PROJECT TITLE Shoalhaven Coastal Hazard Mapping	CREATED BY C. Adamantidis	FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council
Advisian WorleyParsons Group

DATE 2/08/2016	0 50 100 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Currarong 2016 Coastal Hazard Zones
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Mapping		**CREATED BY** C. Adamantidis **FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

Advisian
WorleyParsons Group

DATE 2/08/2016

0 50 100
metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Currarong 2030 Coastal Hazard Zones

PROJECT NO. 301311-13501

PROJECT TITLE Shoalhaven Coastal Mapping

CREATED BY C. Adamantidis

FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

Advisian
WorleyParsons Group

DATE 2/08/2016	0 50 100 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Currarong 2050 Coastal Hazard Zones
PROJECT NO. 301311-13501		**PROJECT TITLE** Shoalhaven Coastal Mapping	**CREATED BY** C. Adamantidis **FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

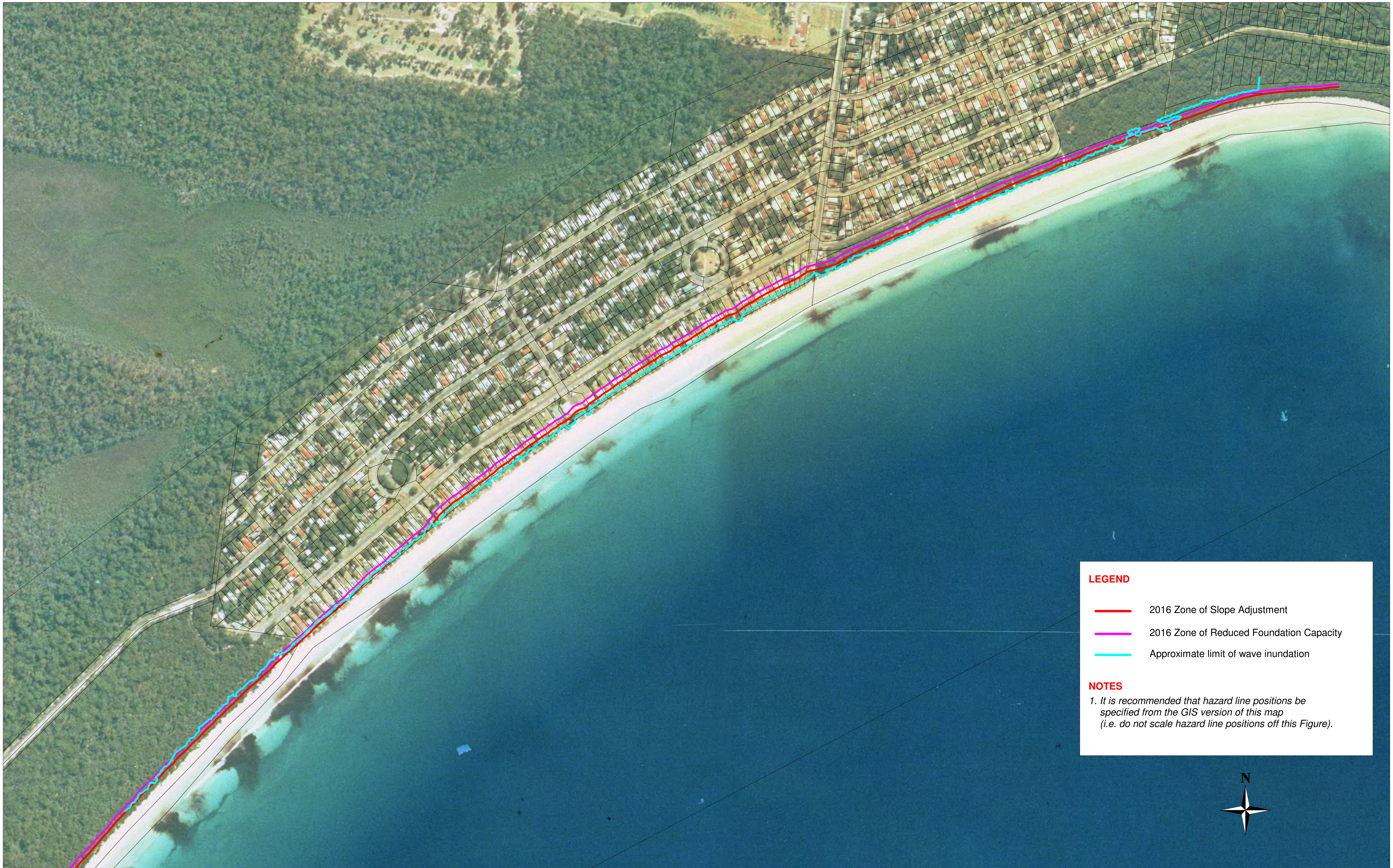
Shoalhaven City Council

Advisian WorleyParsons Group

DATE	2/08/2016	0 50 100 metres	**COORDINATE SYSTEM**	MGA Zone 56	
FIGURE TITLE	Currarong 2100 Coastal Hazard Zones				
PROJECT NO.	301311-13501	**PROJECT TITLE**	Shoalhaven Coastal Mapping		
CREATED BY	C. Adamantidis	**FILE REFERENCE**	P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment		

Shoalhaven City Council

Advisian WorleyParsons Group



DATE	2/08/2016	0 100 200 metres	**COORDINATE SYSTEM**	MGA Zone 56	**FIGURE TITLE** Callala 2016 Coastal Hazard Zones
PROJECT NO.	301311-13501	**PROJECT TITLE**	Shoalhaven Coastal Mapping	**CREATED BY** C. Adamantidis	**FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

Advisian WorleyParsons Group

DATE 2/08/2016	0 100 200 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Callala 2030 Coastal Hazard Zones
PROJECT NO. 301311-13501		**PROJECT TITLE** Shoalhaven Coastal Mapping	**CREATED BY** C. Adamantidis **FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

Advisian WorleyParsons Group

DATE	2/08/2016	0 100 200 metres	**COORDINATE SYSTEM**	MGA Zone 56	
FIGURE TITLE	Callala 2050 Coastal Hazard Zones				
PROJECT NO.	301311-13501	**PROJECT TITLE**	Shoalhaven Coastal Mapping		
CREATED BY	C. Adamantidis	**FILE REFERENCE**	P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment		

Shoalhaven City Council

Advisian
WorleyParsons Group

DATE	2/08/2016	**COORDINATE SYSTEM**	MGA Zone 56
PROJECT NO.	301311-13501	**PROJECT TITLE**	Shoalhaven Coastal Mapping
FIGURE TITLE	Callala 2100 Coastal Hazard Zones		
CREATED BY	C. Adamantidis	**FILE REFERENCE**	P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

0 100 200
metres

Shoalhaven City Council

Advisian
WorleyParsons Group

DATE 02/08/16	0 100 200 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Collingwood 2016 Coastal Hazard Zones
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping	**CREATED BY** C. Adamantidis	**FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council
Advisian WorleyParsons Group

DATE 02/08/16	0 100 200 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Collingwood 2030 Coastal Hazard Zones
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping		**CREATED BY** C. Adamantidis
			FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

Advisian WorleyParsons Group

DATE 02/08/16

0 100 200 metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Collingwood 2050 Coastal Hazard Zones

PROJECT NO. 301311-13501

PROJECT TITLE Shoalhaven Coastal Hazard Mapping

CREATED BY C. Adamantidis

FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

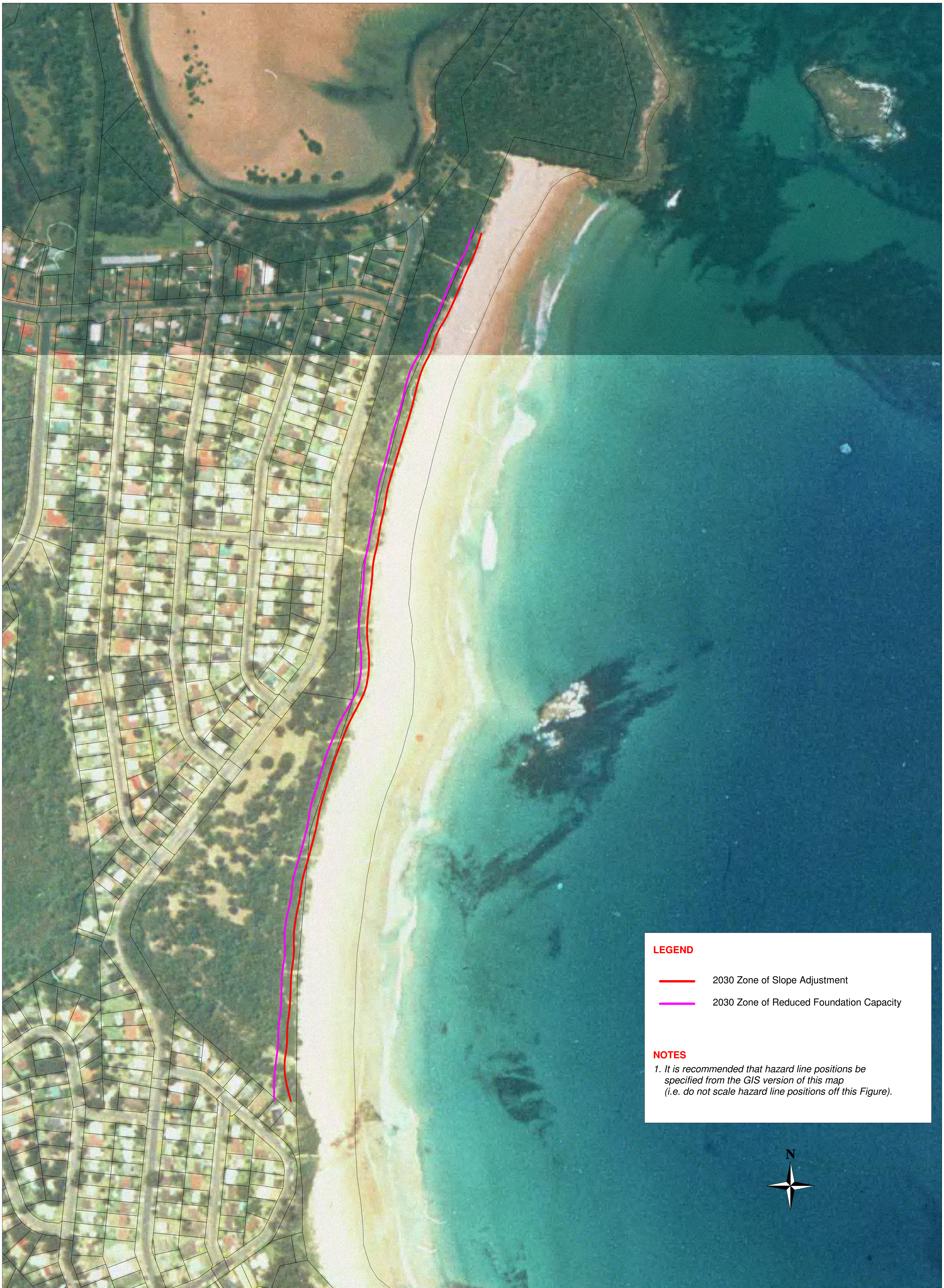
Shoalhaven City Council

Advisian WorleyParsons Group

DATE 02/08/16	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Collingwood 2100 Coastal Hazard Zones	Shoalhaven City Council
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping	**CREATED BY** C. Adamantidis	Advisian WorleyParsons Group
		FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment	

DATE 02/08/16	0 50 100 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Narrawallee 2016 Coastal Hazard Zones
PROJECT NO. 301311-13501	PROJECT TITLE Shoalhaven Coastal Hazard Mapping		CREATED BY C. Adamantidis	FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council
Advisian WorleyParsons Group



LEGEND

2030 Zone of Slope Adjustment

2030 Zone of Reduced Foundation Capacity

NOTES

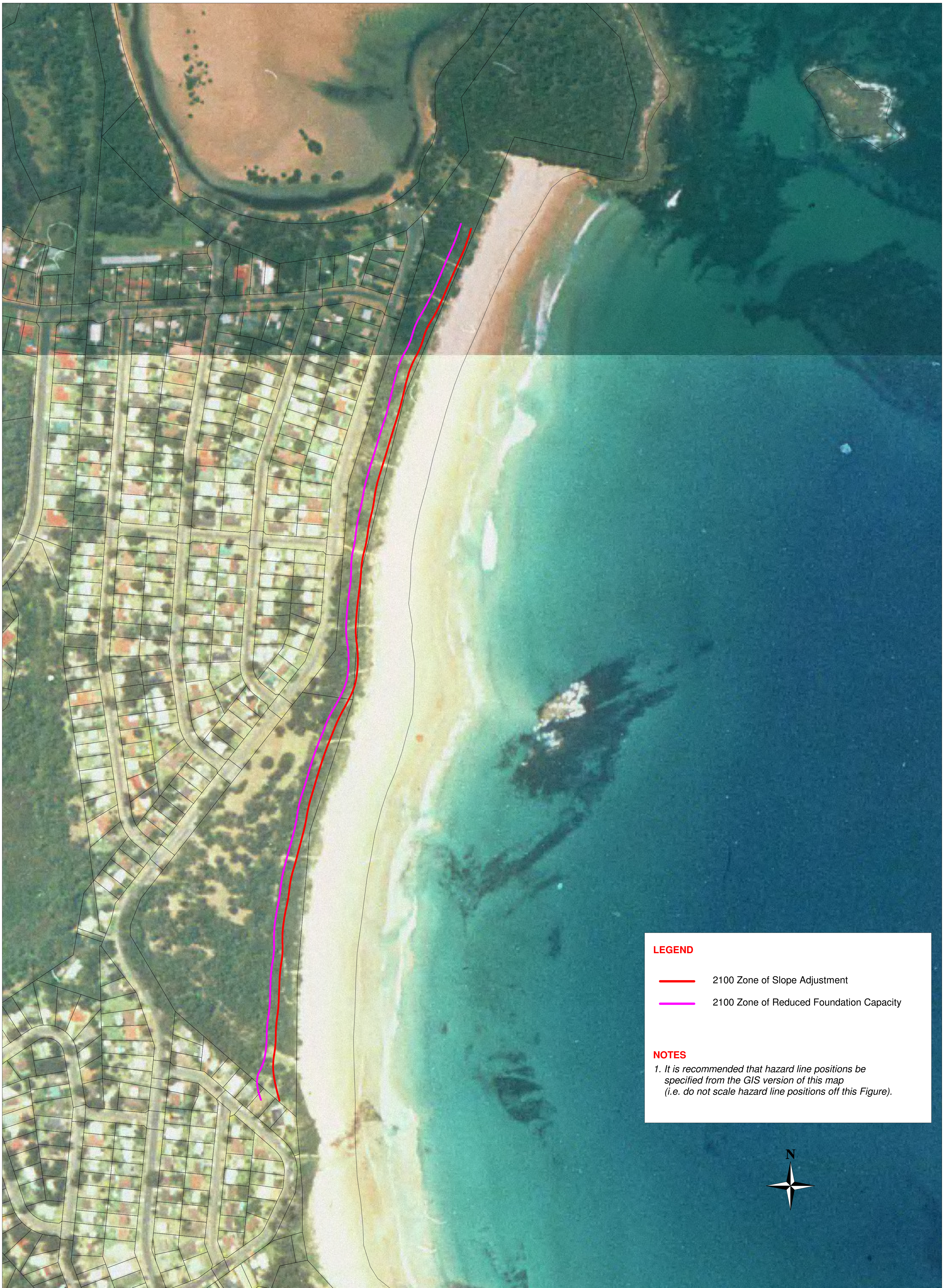
1. *It is recommended that hazard line positions be specified from the GIS version of this map (i.e. do not scale hazard line positions off this Figure).*

DATE 02/08/16	0 50 100 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Narrawallee 2030 Coastal Hazard Zones		Shoalhaven City Council / Advisian WorleyParsons Group
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping		**CREATED BY** C. Adamantidis	**FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment	

DATE 02/08/16	0 50 100 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Narrawallee 2050 Coastal Hazard Zones
PROJECT NO. 301311-13501		**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping	**CREATED BY** C. Adamantidis
			FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

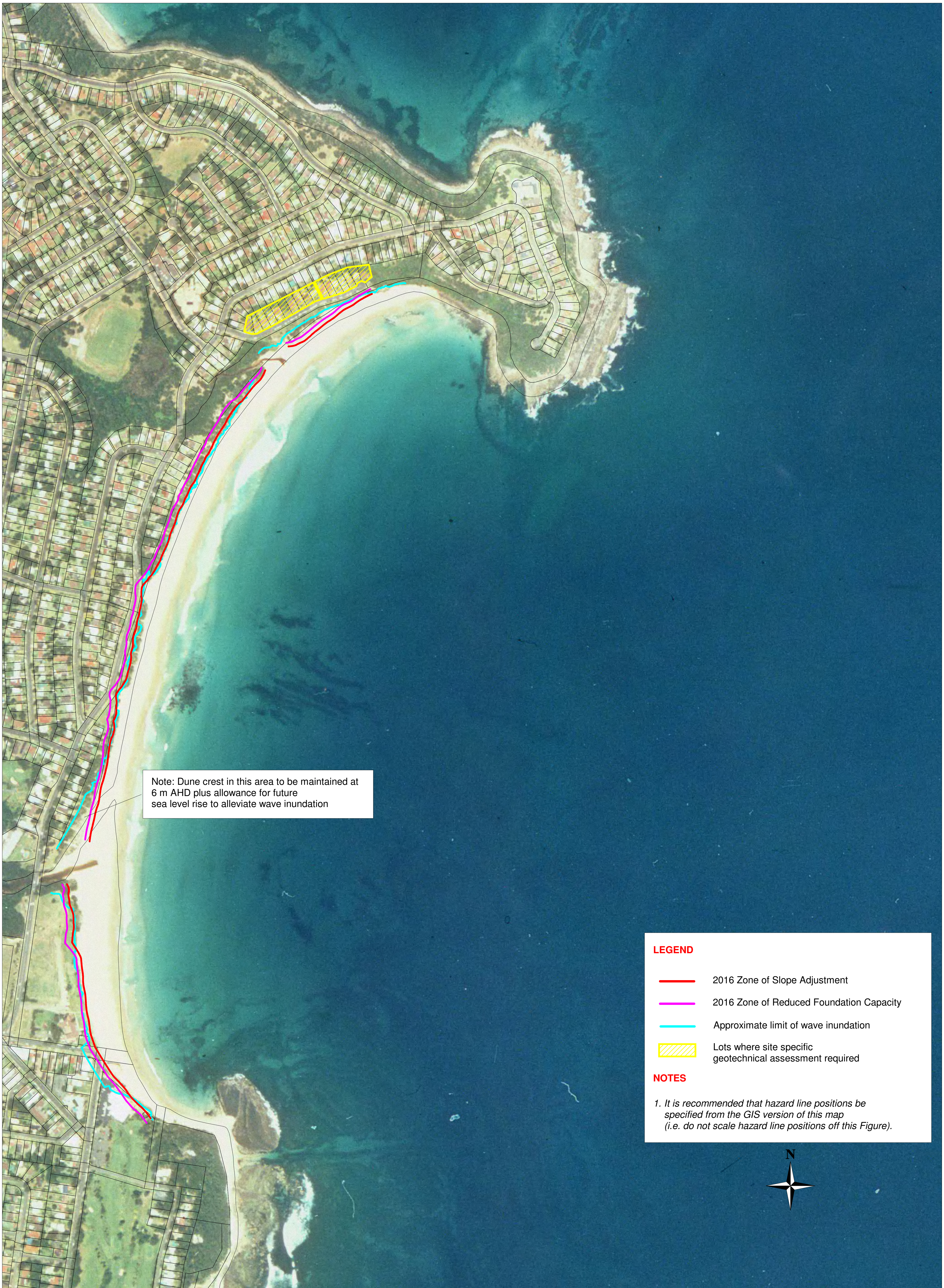
Advisian WorleyParsons Group



DATE 02/08/16	0 50 100 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Narrawallee 2100 Coastal Hazard Zones
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping	**CREATED BY** C. Adamantidis	**FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

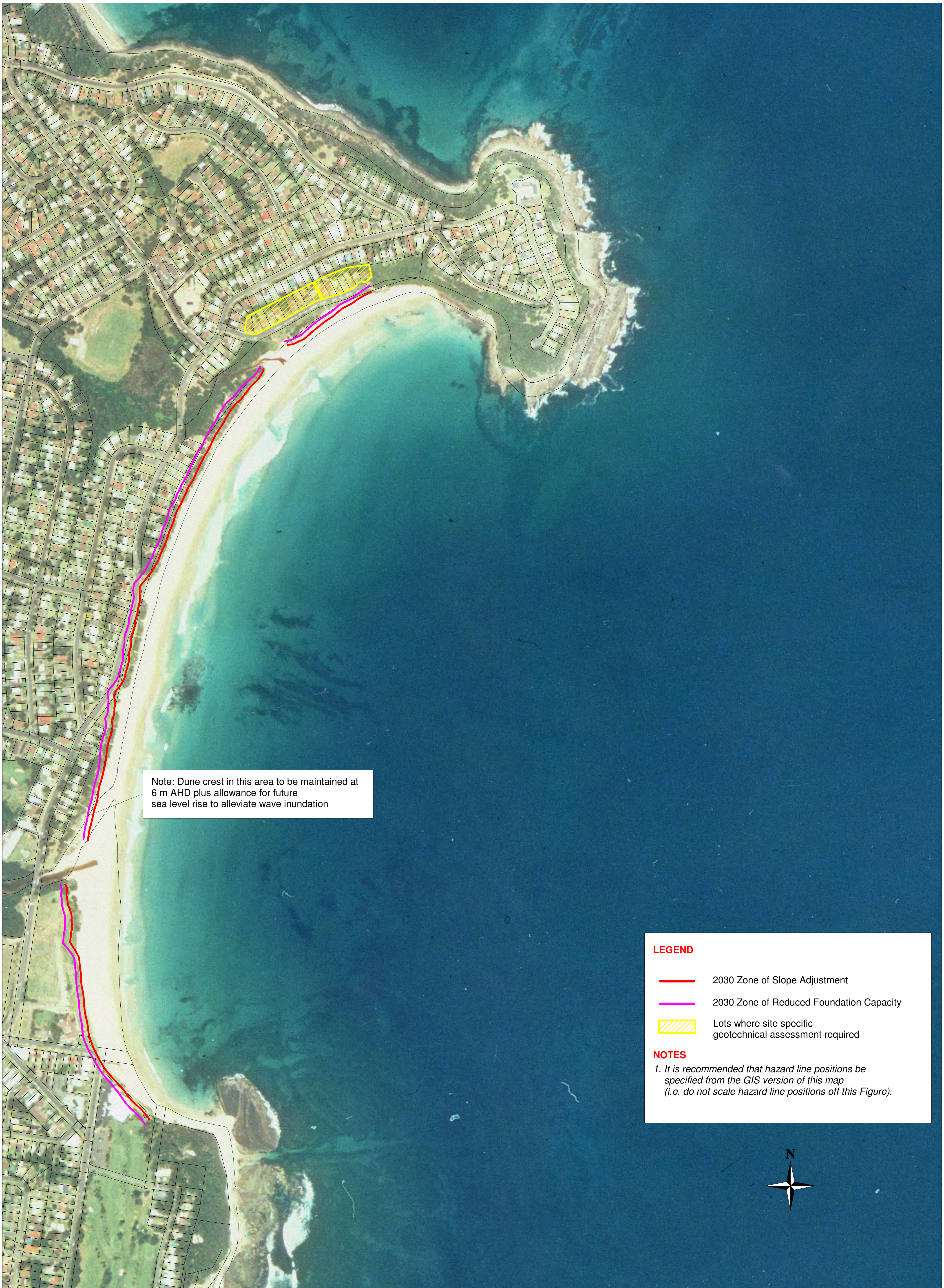
Advisian WorleyParsons Group



DATE 02/08/16	0 100 200 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Mollymook 2016 Coastal Hazard Zones
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping	**CREATED BY** C. Adamantidis	**FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

Advisian WorleyParsons Group



DATE 02/08/16

0 50 100
metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Mollymook 2030 Coastal Hazard Zones

PROJECT NO. 301311-13501

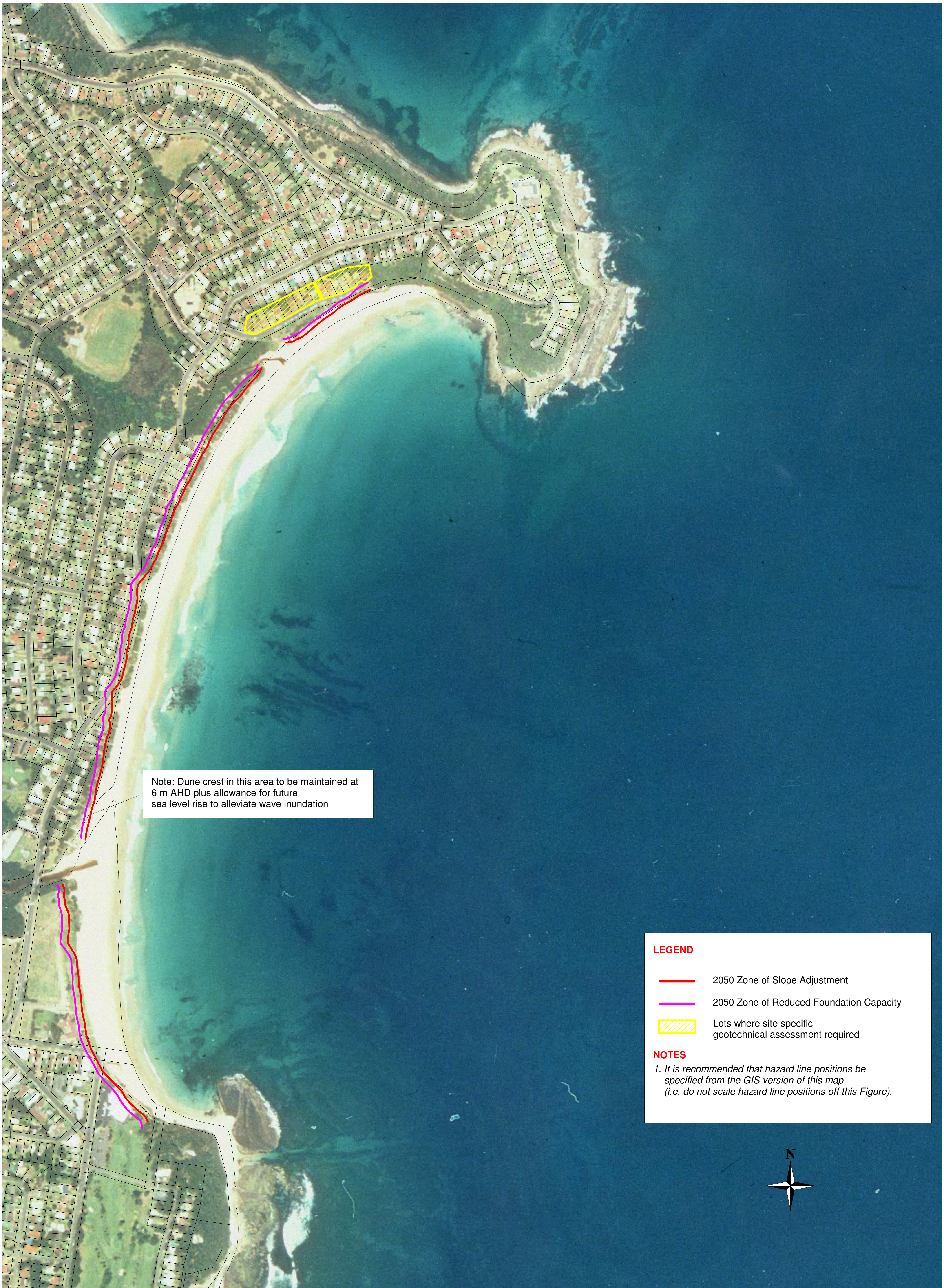
PROJECT TITLE Shoalhaven Coastal Hazard Mapping

CREATED BY C. Adamantidis

FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

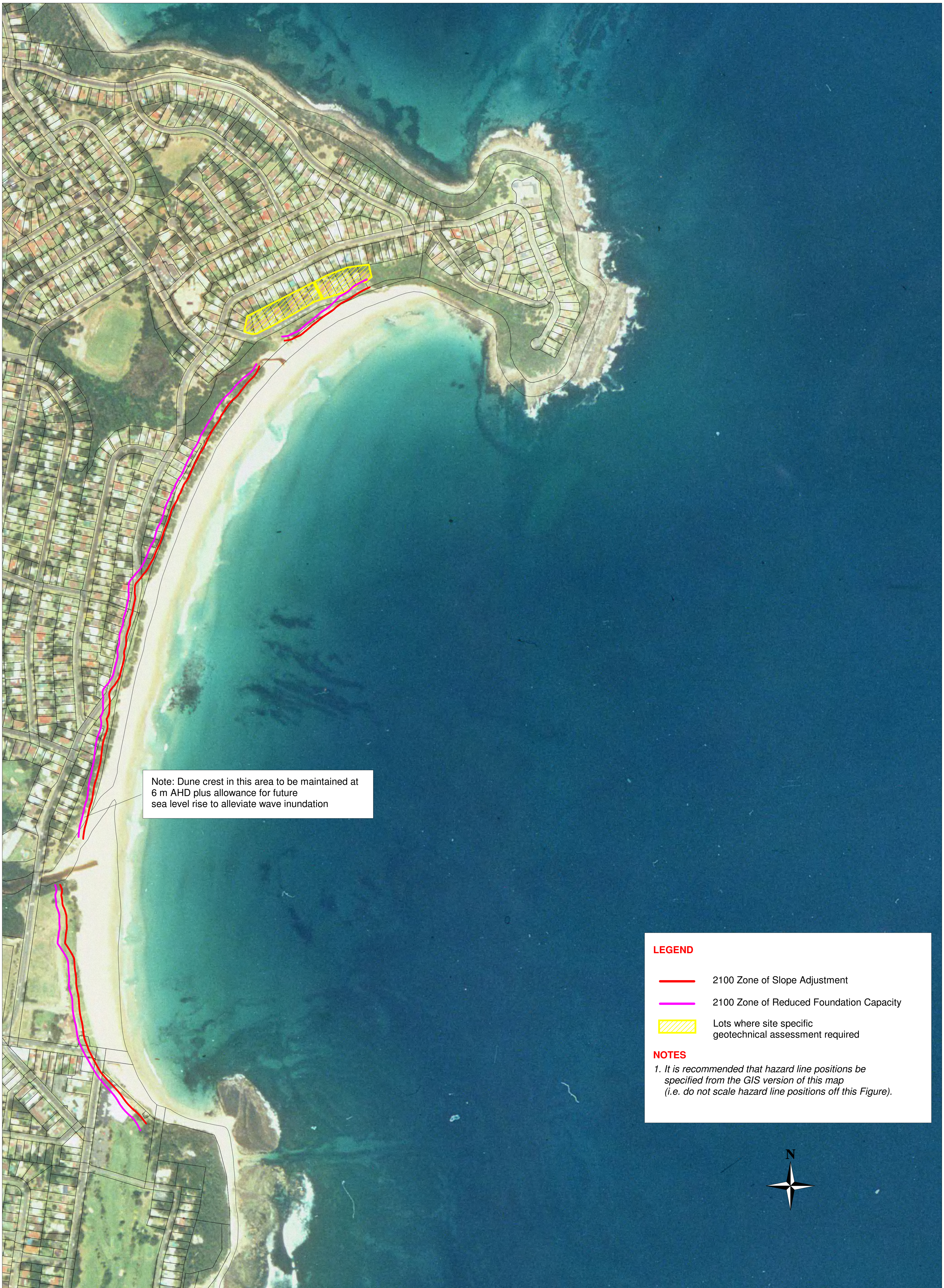
Shoalhaven City Council

Advisian
WorleyParsons Group



DATE 02/08/16	0 100 200 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Mollymook 2050 Coastal Hazard Zones	
PROJECT NO. 301311-13501	PROJECT TITLE Shoalhaven Coastal Hazard Mapping		CREATED BY C. Adamantidis	FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council Advisian WorleyParsons Group



DATE 02/08/16	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Mollymook 2100 Coastal Hazard Zones	Shoalhaven City Council
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping	**CREATED BY** C. Adamantidis	**FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Advisian
WorleyParsons Group

DATE 02/08/16	0 25 50 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Collers 2016 Coastal Hazard Zones	Shoalhaven City Council / Advisian WorleyParsons Group
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping		**CREATED BY** C. Adamantidis	**FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

DATE 02/08/16 | 0 25 50 metres | COORDINATE SYSTEM MGA Zone 56 | FIGURE TITLE Collers 2030 Coastal Hazard Zones

PROJECT NO. 301311-13501 | PROJECT TITLE Shoalhaven Coastal Hazard Mapping | CREATED BY C. Adamantidis | FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council | Advisian WorleyParsons Group

DATE 02/08/16	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Collers 2050 Coastal Hazard Zones	Shoalhaven City Council
PROJECT NO. 301311-13501	PROJECT TITLE Shoalhaven Coastal Hazard Mapping	CREATED BY C. Adamantidis	FILE REFERENCE P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Advisian
WorleyParsons Group

DATE 02/08/16	0 25 50 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Collers 2100 Coastal Hazard Zones
PROJECT NO. 301311-13501	**PROJECT TITLE** Shoalhaven Coastal Hazard Mapping	**CREATED BY** C. Adamantidis	**FILE REFERENCE** P:\JOBS CURRENT\301311-13501 Shoalhaven\GIS\Hazard assessment

Shoalhaven City Council

Advisian WorleyParsons Group

Shoalhaven Coastal Zone Management Plan

Risk Assessment

June 2018

Level 17, 141 Walker St
North Sydney NSW 2060
Australia

301015-03933-001

Advisian
WorleyParsons Group

www.**advisian**.com

Synopsis

This Coastal Hazards Risk Assessment provides a quantitative assessment of coastal hazard risks to the public assets within the Shoalhaven LGA, for the 2050 and 2100 timeframe, in accordance with the process described in the NSW Coastal Management Manual 2018. The outcome of this report is a list of the public assets at highest risk and an action plan to include in the updated Coastal Zone Management Plan.

Disclaimer

This report has been prepared on behalf of and for the exclusive use of Shoalhaven City Council, and is subject to and issued in accordance with the agreement between Shoalhaven City Council and Advisian.

Advisian accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party.

Copying this report without the permission of Shoalhaven City Council and Advisian is not permitted.

Project No: 301015-03933-001 – Shoalhaven Coastal Zone Management Plan: Risk Assessment

Rev	Description	Author	Review	Advisian Approval	Date
A	Draft for Internal Review	C.Adamantidis	A.Nielsen		27/4/18
B	Draft for Customer Review	C.Adamantidis	A.Nielsen	C.Adamantidis	18/5/18
C	Draft Final	C.Adamantidis	A.Nielsen	C.Adamantidis	7/5/18
D	Draft Final	C.Adamantidis	A.Nielsen	C.Adamantidis	18/5/18
0	Final	C.Adamantidis	A.Nielsen	C.Adamantidis	27/6/18

Table of Contents

Executive Summary ... v
1 Introduction ... 1
1.1 Background ... 1
1.2 Study Area ... 1
2 Risk Management Assessment ... 4
2.1 Requirements under the Coastal Management Act 2016 ... 4
2.2 Establish Context ... 5
2.2.1 Coastal Hazard area and Planning Horizons ... 6
2.2.2 Assets Considered ... 7
2.3 Likelihood Scale ... 9
2.4 Consequence Scale ... 12
2.5 Exposure Type ... 16
2.6 Existing Risk Management Measures ... 16
2.7 Private Assets at Risk ... 16
3 Risk Evaluation ... 19
3.1 Risk Methodology ... 19
3.2 Results ... 19
3.2.1 Analysis ... 22
3.2.2 Discussion on Risk Assessment options for extreme and high risks ... 25
4 Conclusions and Recommendations ... 28
4.1 Conclusions ... 28
4.2 Recommendations ... 28
5 Action Plan ... 33
6 References ... 41

Appendix List

Appendix A Risk Register

Appendix B Risk Mapping

Executive Summary

This Coastal Hazards Risk Assessment provides an update of the BMT-WBM (2012) Risk Assessment with respect to coastal risk to the public assets within the Shoalhaven LGA, for the 2050 and 2100 timeframe.

The previous Risk Assessment has been updated to take account of the revised coastal hazard mapping undertaken since the previous draft CZMP, based on Shoalhaven Council's updated sea level rise projections.

The Risk Assessment has been undertaken in accordance with the process identified in the updated NSW Coastline Management Manual (2018) and has identified the public assets within the coastal zone deemed to be at medium, high or extreme risk from coastal erosion or recession by the 2050 and 2100 timeframes. The quantum of private lots or buildings within the coastal hazard areas at each of the beaches within the study area has been identified also based on the most recent coastal hazard assessment.

The purpose of this Risk Assessment is to provide guidance on the priority for management of the risks as well as guidance on appropriate management options to reduce the level of risk. Risk to assets has been quantified in terms of financial risk to Council caused by damage from beach erosion and wave inundation and taking into account both likelihood and consequence, for the 2050 and 2100 planning periods. The Risk Assessment has provided a mechanism to enable the risk to public facilities to be recognised and treatment options to be identified.

Based on the updated Risk Assessment, an action plan has been prepared to treat the priority risks and the Action Plan informs the Local Area Plans included in the revised Coastal Zone Management Plan (CZMP).

An updated Risk Register has been developed that documents the financial risk to Council from potential damage to public assets caused by coastal erosion/recession and wave inundation at the high-risk beaches identified in the CZMP. The key public assets at risk have been identified in the Register together with the financial value of those assets and have been mapped for this report.

1 Introduction

1.1 Background

As part of the 2012 Draft Shoalhaven Coastal Zone Management Plan (CZMP, Umwelt Australia 2012), BMT-WBM carried out a Risk Assessment with respect to coastal risk to the public assets within the Shoalhaven LGA, for the 2050 and 2100 timeframe. Key inputs to this Risk Assessment were the SMEC (2009) Coastal Hazard Mapping, in which coastal hazards of the Shoalhaven coastline were mapped and identified based on coastal engineering studies undertaken as part of the risk assessment for the current CZMP (Umwelt Australia, 2012). That mapping took into account sea level rise benchmarks under the previous NSW Government Sea Level Rise Policy Statement (Department of Environment Climate Change and Water, DECCW 2009), which set sea level rise benchmarks for planning purposes of 40cm above 1990 levels by 2050, and 90cm above 1990 levels by 2100.

Since 2012, the NSW Sea Level Rise Policy no longer applies. Shoalhaven Council adopted the following sea level rise projections on 10 February 2015:

- 100mm for 2030;
- 230mm for 2050 and
- 350mm for 2100.

In light of the revised sea level rise projections adopted by Council, Advisian was engaged by Shoalhaven City Council to undertake updated coastal hazard mapping using the adopted sea level rise projections. The updated mapping used advances in analysis techniques developed by Advisian since the previous assessment to build upon and refine the earlier coastal hazard mapping (SMEC, 2009). Also it incorporates additional data obtained from field surveys at each beach, bathymetric surveys and post storm survey information obtained following a severe East Coast Low event that occurred in June 2016.

In light of the updated mapping, this report provides an update of the risk profile of the public assets in the coastal zone throughout the Shoalhaven. The risk to public assets is defined in terms of the risk by 2050 and the risk by 2100 and has been used to inform the proposed Local Area Actions defined in the updated CZMP.

1.2 Study Area

The study area for this investigation includes those beaches that were analysed in the updated coastal hazard studies undertaken by Advisian (2016). The study area for this investigation is shown in Figure 1.

The beaches for which updated hazard mapping has been carried out and which are the subject of this Risk Assessment include (from north to south):

- Shoalhaven Heads
- Culburra Beach
- Warrain Beach
- Currarong
- Callala Beach
- Collingwood Beach
- Bendalong Boat Harbour
- Narrawallee
- Mollymook
- Collers Beach.

A brief description of the coastal compartments of the Shoalhaven coast, a description of each of the beaches in the study area, as well as a summary of additional data available for hazard analysis since the previous assessment in 2009 is provided in the updated Coastal Hazard Mapping report (Advisian 2016).

The risks to public assets has been based on Council's GIS database of wastewater, water supply, roads, buildings and other Council owned infrastructure, superimposed onto the updated hazard mapping GIS layers and aerial photography.

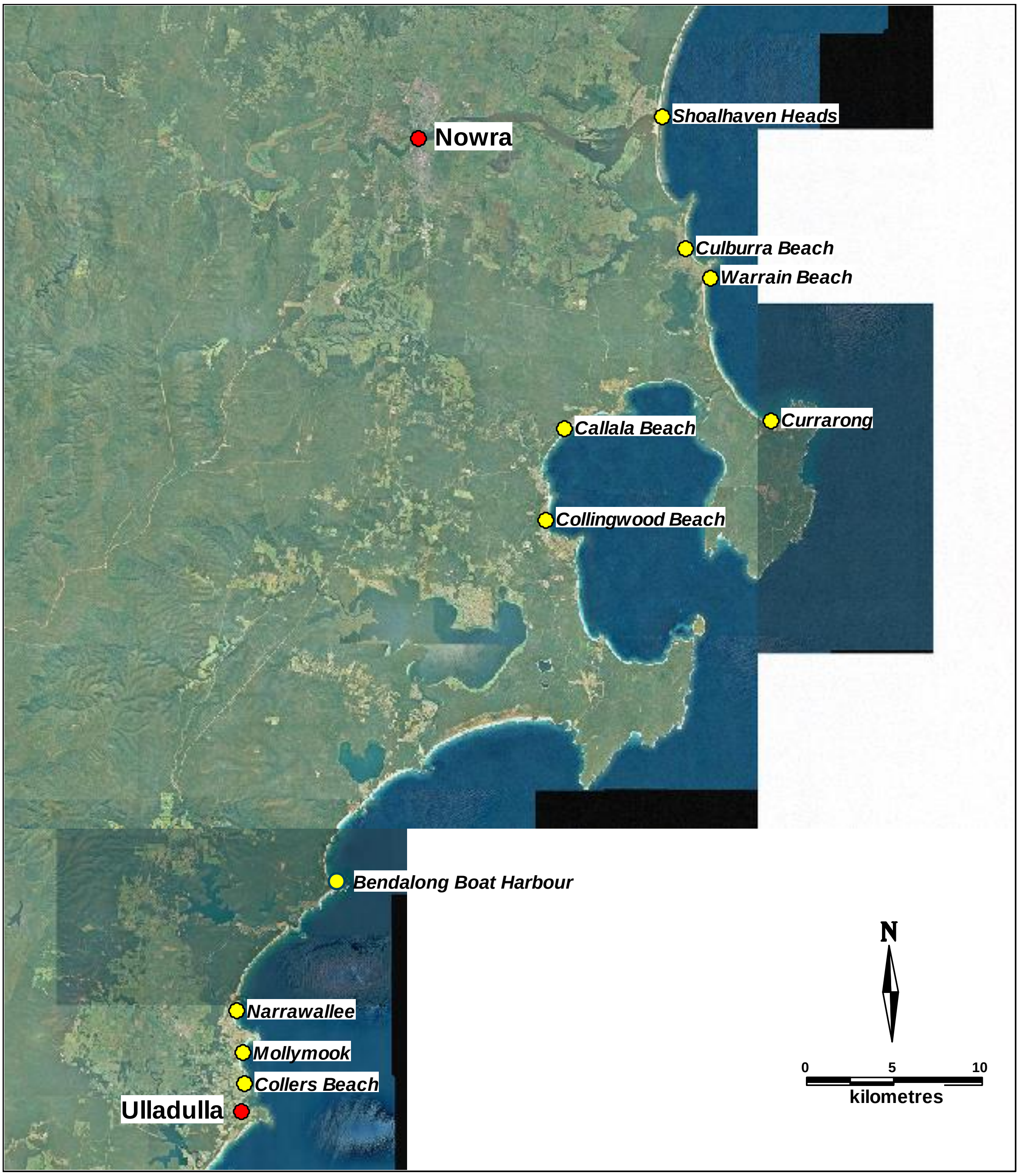


Figure 1 - Study area

2 Risk Management Assessment

2.1 Requirements under the Coastal Management Act 2016

Section 21 (3) (b) of the *Coastal Management Act* 2016 requires councils to follow a risk management process when preparing their Coastal Management Programs (CMPs) and identifying where management actions are required. This includes identifying and assessing risks and benefits to environmental, social and economic values and evaluating and selecting management actions to address those risks.

In Stage 1, councils prepare a first-pass risk assessment. This is a qualitative risk assessment using available information, to help inform the scope of the CMP.

In Stage 2, councils may refine the risk assessment through a detailed process that incorporates additional information from studies prepared in Stage 2.

In Stage 3, councils identify and evaluate management actions to address the identified risks.

It is critical that stakeholders are engaged throughout this process.

The AS/NZS ISO 31000: Risk Management – Principles and Guidelines outlines a process for risk management and defines many of the common terms associated with risk management practice.

The Risk Assessment documented in this report has been undertaken in accordance with the above process, identified in Part B of the NSW Coastal Management Manual (OEH, 2018). The purpose of this Risk Assessment, as outlined in the Manual, is to highlight priorities for management actions while recognising the uncertainties associated with natural systems and future scenarios.

Risk can be quantified as the integration of probability (i.e., frequency analysis of the hazard) and consequences. The Risk Assessment documented herein has taken into account both the "likelihood" (or probability) of the hazard occurring and the "consequence" to define the level of risk.

The steps involved in the risk management process are outlined in Figure 2.

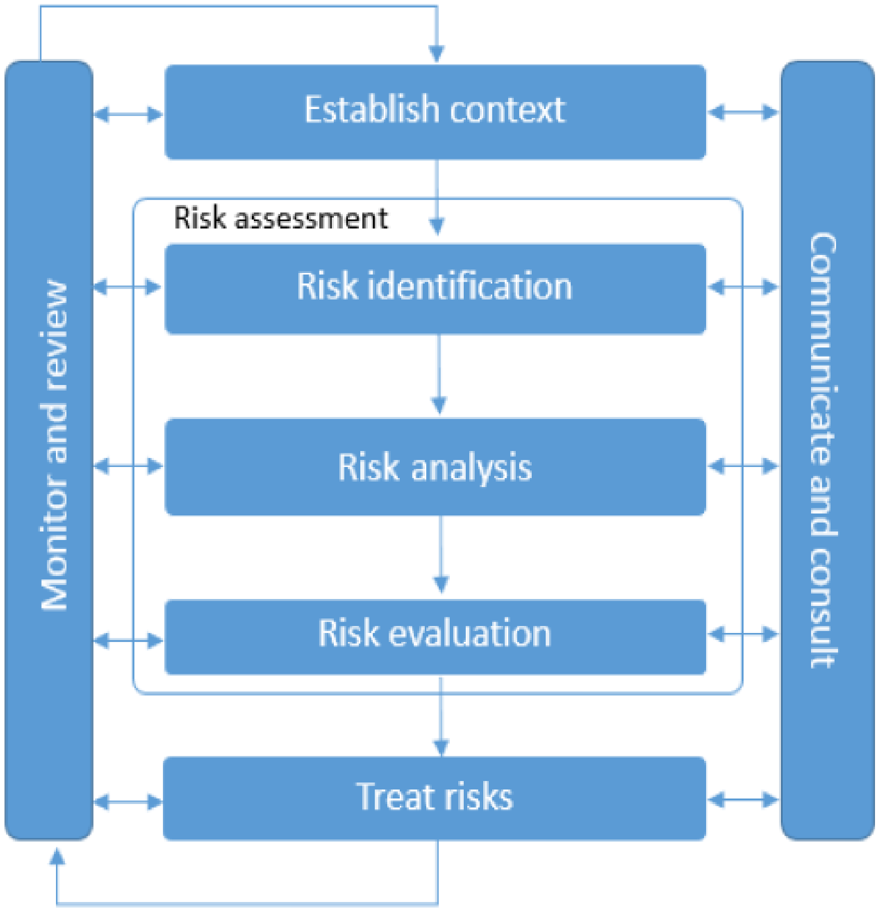


Figure 2 – Risk Management Process (AS/NZS ISO 31000: Risk Management – Principles and Guidelines, as documented in the NSW Coastal Management Manual 2018)

2.2 Establish Context

The areas deemed to be at risk from coastal hazards are those areas that have been mapped as being seaward of the coastal hazard zones, that is, seaward of the 2100 *Zone of Reduced Foundation Capacity* (Nielsen *et al*., 1992) and seaward of the limit of wave runup as identified in the coastal hazard mapping (Advisian 2016). The mapping has been undertaken for the present day, 2030, 2050 and 2100 on the basis of Council's sea level rise projections. A description of the coastal hazards captured by the mapping, and their likelihood, is provided below.

2.2.1 Coastal Hazard area and Planning Horizons

The Coastal Hazard Area has been defined in the mapping by those areas that may be subject to wave inundation, wave impact, erosion, slope adjustment or reduced foundation capacity from a design storm (nominally a 1% Annual Exceedance Probability event), for planning periods including the present day, 2030, 2050 and 2100.

The storm erosion demand estimates have been based on values derived from particular storms experienced in May-June 1974 and June 2016. It should be noted that it is difficult to ascribe a probability of exceedance to the storm erosion demand values presented in the mapping as storm erosion depends on multiple variables including antecedent beach/dune conditions, wave height, water level at the time of the storm, wave direction, beach slope and rip locations. However, based on available information, the storm that results in the design value of storm erosion demand at each beach is estimated to have an Annual Exceedance Probability of around 1% (equivalent to a 1 in 100 year Average Recurrence Interval).

Following storm cut the dune face dries out and may slump causing further dune recession.

Dune slumping is treated as a slope instability hazard and can be quantified with stability computations, which can serve as a guide to determining safe setback distances on frontal dunes that are prone to wave attack and slumping during storms.

Assuming that the subsurface material in the beach dunes is composed entirely of sand, based on Nielsen *et al.* (1992), a number of coastline hazard zones can be delineated at the beaches in the study area as shown in Figure 3.

The *Zone of Wave Impact* delineates an area where any structure or its foundations would suffer direct wave attack during a severe coastal storm. It is that part of the beach that is seaward of the beach erosion escarpment.

A *Zone of Slope Adjustment* is delineated to encompass that portion of the seaward face of the beach that would slump to the natural angle of repose of the beach sand following removal of sand by wave erosion.

A *Zone of Reduced Foundation Capacity* for building foundations is delineated to take account of the reduced bearing capacity of the sand adjacent to the storm erosion escarpment. Nielsen *et al.* (1992) recommended that structural loads should only be transmitted to soil foundations outside of this zone (*i.e.*, landward or below in the *Stable Foundation Zone*), as the factor of safety within the zone is less than 1.5 during extreme scour conditions at the face of the dune escarpment.

In general (without the protection of a terminal structure such as a seawall), dwellings/structures not piled[1] (or otherwise founded to an adequate depth) and located with the *Zone of Reduced Foundation Capacity* would be considered to have an inadequate factor of safety.

[1] A pile is a structural member that is driven, screwed, jacked, vibrated, drilled or otherwise installed in the ground so as to transmit loads to the surrounding soil or rock (refer to Australian Standard AS 2159–1995, "Piling – Design and installation").

The schema for calculating the various zones is shown in Figure 3.

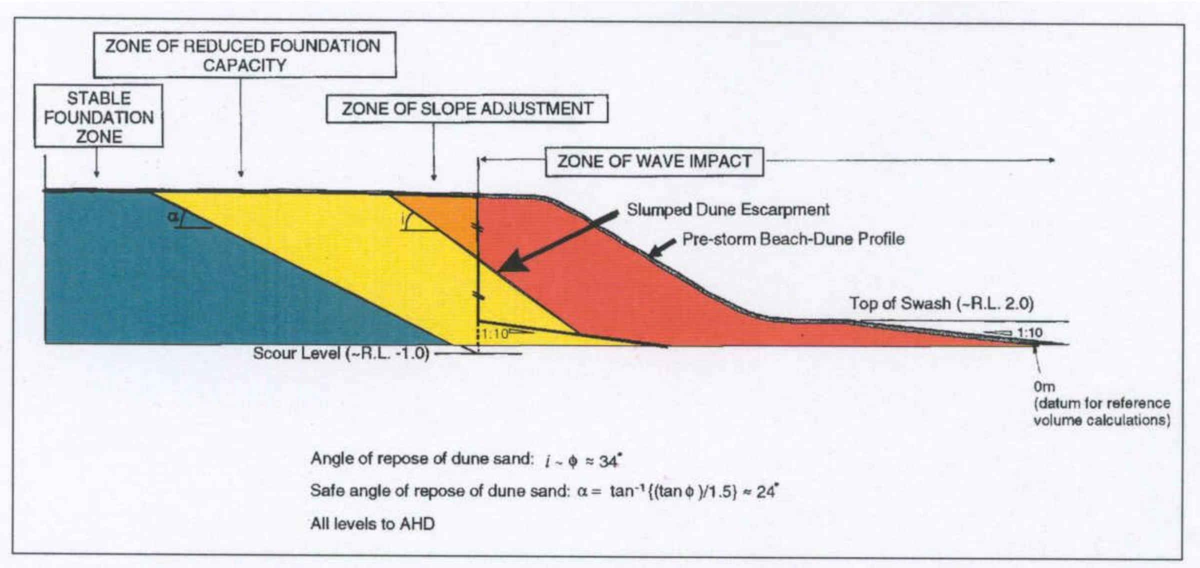


Figure 3 – Schematic representation of coastline hazard zones (after Nielsen *et al.*, 1992)

The coastal hazard zones for 2050 and 2100 take into account the documented long term changes at each beach, *that is,* if in the long term, the losses of sediment from a beach are greater than the gains, then a gradual shoreline recession will result. In addition to the long term beach recession that has been documented at some of the beaches within the study area, a progressive rise in sea level may result in shoreline recession through two mechanisms: first, by drowning low lying coastal land and second, should the beach profile be in equilibrium with the prevailing wave climate, by shoreline readjustment to the new coastal water levels. The derivation of the long-term recession of the shoreline due to sea level rise for each beach is documented in Advisian (2016).

The planning horizons considered for this risk assessment accord with those used in the previous BMT-WBM (2012) risk assessment, 2050 and 2100.

2.2.2 Assets Considered

The assets considered in this risk assessment include:

- Sewerage infrastructure, including pump stations, sewer gravity mains and rising mains;
- Water supply infrastructure mains
- Built assets, including roads, cycleways, amenity blocks, surf clubs, carparks, playgrounds, community buildings.

To quantify the consequence, a monetary value has been ascribed to each of the assets within the coastal hazard areas in accordance with the information presented in BMT-WBM (2012) and information available from the updated NSW Reference Rates Manual (Department of Primary Industry, Office of Water, 2014).

The consequences of damage to public beach accessways and stormwater infrastructure have not been evaluated in this Risk assessment, as these assets are inherently located within the coastal zone and, therefore, by their very nature are exposed to coastal hazards. It should be noted that public accessways at all of the beaches within the study area are within the immediate coastal hazard area and, therefore, are subject to high risk from coastal hazards. To this end, as a key action the CZMP identifies the development of a post storm methodology for repair or restoration of the beach accessways based on the existing Asset Management Plan and Emergency Action Plan, to guide post storm access reconstruction for each beach compartment.

The consequence scale takes into account also the vulnerability of the asset or landuse associated with the asset. The NSW Coastal Management Manual (2018) provides an example landuse vulnerability classification for areas within the coastal zone and is provided in Table 1, together with local examples. Based on Table 1 assets in the hazard areas that are among the most vulnerable therefore would be assigned a higher risk rating (*e.g.*, housing, essential sewerage or road infrastructure) than those located in the same areas but are considered to be compatible (*e.g.*, beach accessways, coastal reserves).

Table 1 – Vulnerability of assets/landuse (after NSW Coastal Management Manual, 2018)

Classification	Land use	Local Examples
Most vulnerable uses	Hospitals, police stations, command centres, ambulance stations and telecommunications used for disaster response, isolated dwellings, housing (including group homes) and residential care facilities for seniors and disabled persons, prisons, childcare facilities and accommodation associated with an educational establishment, mobile homes used for permanent residential purposes.	
Highly vulnerable uses	Multi-dwelling housing, dual occupancy, residential accommodation, residential flat building, backpackers' accommodation, boarding house, hostel, hotel accommodation, moveable dwelling, caravan park, serviced apartment, tourist and visitor accommodation	Quay Road, Callala Beach, Collingwood and Mollymook Beach residential development, Mollymook Golf Clubhouse
Less vulnerable uses	Commercial development, shops, financial and professional services, restaurants and cafes, hotels, offices, general industry, agriculture and forestry, waste treatment, short-term caravans and camping (subject	Huskisson Beach Tourist Resort, Crookhaven Heads Tourist Park

Classification	Land use	Local Examples
	to early warning and evacuation plans).	
Essential Infrastructure	Essential transport and utility infrastructure, power stations, primary substations, sewage treatment plants and water treatment works.	Mitchell Parade/Golf Avenue (Sewerage pumping stations and trunk mains)
Compatible uses	Coastal hazard and flood mitigation structures, water supply infrastructure and pumping stations, docks, marinas and wharves, shipbuilding, water-based recreation, surf clubs, amenity and open space, nature conservation and biodiversity, outdoor sports and recreation facilities and changing rooms.	Mollymook, Nowra-Culburra, Shoalhaven Heads SLSC; beach accessways, local reserves, amenities and picnic facilities, Collingwood Beach cycleway, erosion protection structures/ seawalls, Currarong and Bendalong Boat Harbour Boat Ramp

2.3 Likelihood Scale

The likelihood of the identified risks occurring is defined by the coastal hazard mapping. The *Zone of Slope Adjustment* represents the landward extent of erosion and slope adjustment that could occur with a nominal 1% Annual Exceedance Probability (AEP), equivalent to a 1 in 100 year average annual recurrence interval. The *Zone of Reduced Foundation Capacity* represents the landward extent for a nominally 1% AEP storm where the soil is subject to a reduced foundation capacity as the factor of safety within the zone is less than 1.5 during extreme scour conditions at the face of the escarpment. For buildings or structures not piled within the *Zone of Reduced Foundation Capacity*, these would be subject to an unacceptable risk of damage if they are located within this zone. However, for smaller structures that do not require substantive foundations, such as pipelines, unpaved carparking, cycleways, playgrounds or picnic shelters, the risk of damage may be tolerable if they are within the *Zone of Reduced Foundation Capacity* but a level of damage would still be expected if they are within the *Zone of Slope Adjustment*.

The 2050 and 2100 mapped zones represent the locations of these same hazard areas in 2050 and 2100, assuming long term recession of the coastline estimated based on sea level rise and the existing measured rate of long-term recession at each beach. Thus, the lines represent the landward extent of these coastal hazards for a 1% AEP storm occurring in 2050, or in 2100.

It should be noted that the probability of such a storm event occurring or being exceeded between now and 2050 is 25%, which would be deemed “Likely”, and between now and 2100 is 60%, which is "Almost Certain" (Figure 4). Therefore, the asset life should be considered in determining the likelihood that the asset will be exposed to a particular hazard within the lifetime of the asset.

The likelihood scale adopted for this risk assessment is presented in Table 2 and has been modified from the scale adopted by BMT-WBM (2012) to align with the definition of the mapped coastal hazard areas as defined by Advisian (2016). The likelihood descriptors are the same as what was adopted in the CZMP and accord with those presented in the NSW Coastal Management Manual (2018).

The likelihood of the storm event that defines the coastal hazard area corresponds to the "Possible" descriptor in Table 2 – for this reason, the present day, 2050 and 2100 landward limit of the *Zone of Reduced Foundation Capacity* have been defined as the landward extent of the zones in the present day, 2050 and 2100 where risk from coastal erosion is "Possible". Areas seaward of the respective *Zone of Slope Adjustment* lines for the present day, 2050 and 2100 have been considered to be subject to a likelihood of "Almost Certain" – that is, the likelihood of coastal erosion within these zones has been assumed to be "almost certain" to occur over the lifetime of the asset. For example, if a road has a nominal asset lifetime of 80 years, with reference to Figure 4, the risk of erosion seaward of the 2100 *Zone of Slope Adjustment* occurring between now and 2100 is approximately 60% and thus would be "almost certain" to occur within the asset lifetime.

The application of the likelihood scale to the various hazard zones is considered to be appropriately conservative given the uncertainty relating to factors such as future sea level rise, the likelihood of actual damage to assets within the *Zone of Reduced Foundation Capacity* and the relatively short asset lives of some of the more minor public assets that are within the coastal hazard areas.

Areas landward of the immediate, 2050 and 2100 coastal hazard zones and wave inundation limits have been assigned a likelihood of "unlikely".

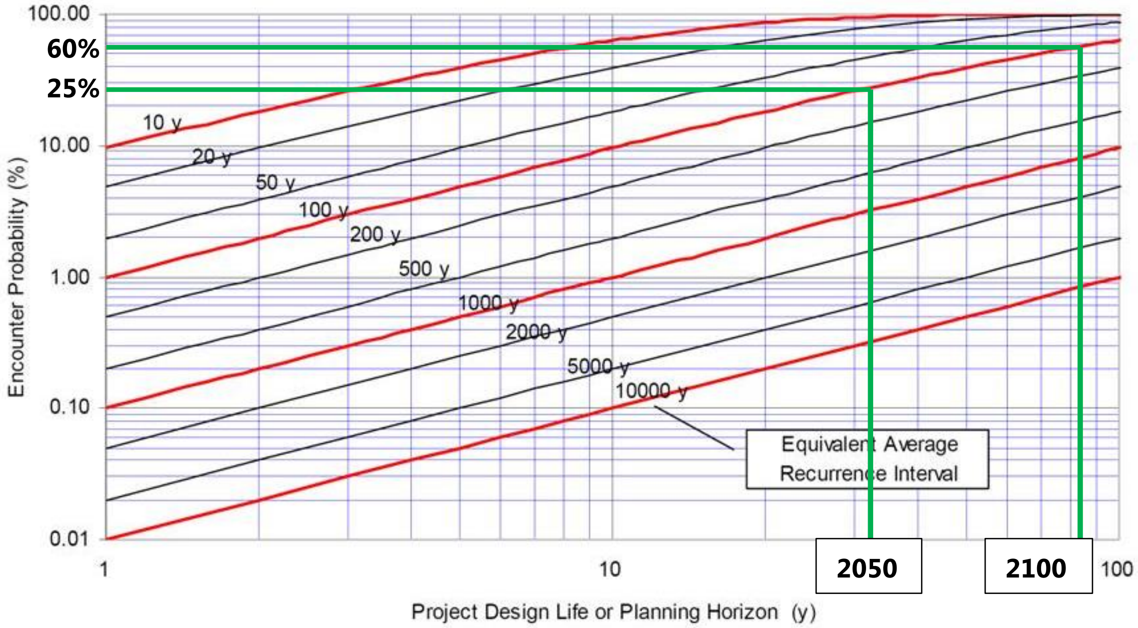


Figure 4 – Probability of exceedance of 1% AEP storm between 2018 and 2050, and between 2018 and 2100

Table 2 - Likelihood Scale for Coastal Risk Assessment for erosion, Shoalhaven Coastline

Likelihood Descriptor	Immediate	For 2050	For 2100
Almost certain Expected to occur, many recorded incidents, strong anecdotal evidence, great opportunity, reason or means to occur. May occur or be exceeded once every 1-5 years	Immediate ZSA line	2050 ZSA line	2100 ZSA line
Likely Will probably occur, consistent record of incidents and good anecdotal evidence; considerable opportunity, reason or means to occur. May occur or be exceeded once every 20 years	Immediate ZSA line	2100 ZSA line	2050 ZRFC line
Possible Might occur, a few recorded incidents in the locality and some anecdotal evidence in the community; some opportunity, reason or means to occur. May occur or be exceeded once every 100 years. Will generally be close to or exceed past records of severity.	Immediate ZRFC line	2050 ZRFC line	2100 ZRFC line
Unlikely Is not expected to occur. Isolated recorded incidents in this country with anecdotal evidence in other communities. Little opportunity, reason or means to occur. May occur or be exceeded once every 250 years. Will almost always break previous records of severity.	Landward of the Immediate ZRFC line and wave inundation limit	Landward of the 2050 ZRFC line	Landward of the 2100 ZRFC line

2.4 Consequence Scale

The consequence scale for the risk assessment takes into account financial, governance, environmental, health and safety and beach amenity consequences. Some consequences in the coastal zone can be described quantitatively (*i.e.*, assigned a dollar value), but with the currently available information and methodologies, many consequences can only be described qualitatively. The current risk assessment prepared for the Shoalhaven coast relies principally on quantitative consequence scales for built assets such as roads, pathways, water mains, sewerage systems (pipes and pump stations), car parks, bridges, surf clubs, community halls and other buildings. Over time, this risk assessment approach will be revised as new methodologies and data become available for other natural, social and cultural values.

Surf clubs are an example of an asset that has important social values as well as a financial value. Surf Life Saving Australia commissioned a study on the vulnerability of surf clubs (Coastal Zone Management, 2011) to extreme events and to climate change. The study found that surf club buildings are very vulnerable because of their location on frontal dune systems, and the financial and technical capacity of clubs and local councils to respond to erosion impacts is limited. However, storms and sea level rise also increase risks for surf clubs in other ways. Examples include:

- Loss of sand on beaches affects safety and the suitability of club areas for major competitions/events. These changes have potential social and economic impacts on the clubs and on their local communities.
- Loss of club equipment, or increased safety risks when using the equipment.
- Increased emergency response training requirements.
- Development assessment requirements for relocation or for protection works – significant cost and time requirements.
- No coordinated response strategy between clubs, local government areas, regions or states.

For the quantitative risk assessment developed in this report, the consequence matrix used in the previous risk assessment developed by BMT-WBM (2012) in conjunction with Shoalhaven Council has been applied. This matrix is presented in Table 3.

The derivation of the financial values for the consequences is described in BMT-WBM (2012) and was guided by Shoalhaven Council's internal risk assessment framework, where consequence categories are based on financial losses as a portion of Council's budget for a particular year, with these portions applied to Council's Waterways, Coastal and Floodplain capital expenditure and operating budget. Under the framework, an extensive financial loss greater than 20% of Council's operating budget for Waterways, Coastal and Floodplain was considered "Catastrophic", whereas financial losses below 1% of Council's budget are considered "Minor".

Asset financial values were defined based on the same methodology used in the previous risk assessment to allow direct comparison, including with reference to the NSW Reference Rate Manual, which has been updated since the previous assessment (DPI Office of Water 2014), and unit rates developed for asset types under the previous risk assessment (BMT-WBM 2012). The updated unit rates for particular infrastructure types within the coastal hazard areas are provided in Table 4.

As per the previous risk assessment (BMT-WBM 2012), a percentage of expected damage was estimated for the particular hazard type, hazard extent and asset type, which was then applied to the asset values. The percentage of expected damage has been estimated independently for this assessment.

Note that as per the 2012 risk assessment, the financial consequences only consider the cost of damage to the asset in today's dollars and do not consider financial costs from factors such as loss of revenue to local businesses because of the need to repair infrastructure, loss of tourism revenue due to damage to the environment or infrastructure at the beach, loss of dune vegetation, cost due to environmental impact caused by failure of the sewer infrastructure, or net present value of future losses applying annual discount rates to damage to assets that may occur in the future.

Table 3 – Consequence Scale Adopted for the Risk Assessment (BMT-WBM 2012)

Consequence Scale	Finance	Governance	Environment	Health and Safety	Beach amenity
Catastrophic	Extensive financial loss (>$1m)	Loss of asset, loss of program or business operation. Threat to viability of service or operation	Extreme and widespread devastating long term impacts. Recovery unlikely.	Multiple fatalities or permanent disability of employees, contractor or members of the public	Extreme and widespread long term impacts on the amenity – complete loss of sandy beach. No Beaches of similar amenity available nearby for use in the short term.
Major	Major financial loss ($500,000 - $1m)	major asset damage, severe impact on program or business operations	Major habitat loss and/or triggering of nuisance species proliferation, over a wide area. Recovery may take many years	Serious illness, injury or death of employee, contractor or members of the public	Major impact on the amenity, reversible only through intense management efforts. No Beaches of similar amenity available nearby for use in the short term.
Moderate	Significant financial loss ($50,000 - $500,000)	Considerable impact on program or business operations. Temporary disruption of services	Significant environmental changes isolated to a localized area. Recovery may take several years.	Medical attendance, time off work	Moderate impact on the amenity mainly reversible through management efforts. Beaches of similar amenity available nearby for use in the short term.
Minor	Minor financial loss ($10,000 - $50,000)	Minimal impact on program or business operations. Minor long-term and/or minor short term impacts (mainly reversible) on communities and their access to services	Environmental damage of a magnitude consistent with seasonal variability	Minor injury with first aid treatment required	Minor impact to beach amenity, mainly reversible through management efforts. Beaches of a similar nature available nearby
Insignificant	Little to no financial loss (<$10,000)	Little to no impact on communities and their access to services	Little to no impact on terrestrial and or aquatic ecosystems	Minor injury with no treatment required	Little to no change to beach amenity

Table 4 – Rates used for deriving asset values

Infrastructure Type	$ rate/m	Source of Rate
Sewer Infrastructure		
100 mm Gravity Main*	231	NSW Reference Rate Manual 2014
150 mm Gravity Main*	306	NSW Reference Rate Manual 2014
300 mm Gravity Main*	604	NSW Reference Rate Manual 2014
450 mm Gravity Main*	1052	NSW Reference Rate Manual 2014
100 mm Rising Main*	196	NSW Reference Rate Manual 2014
200 mm Rising Main*	352	NSW Reference Rate Manual 2014
225 mm Rising Main*	438	NSW Reference Rate Manual 2014
250 mm Rising Main*	438	NSW Reference Rate Manual 2014
375 mm Rising Main*	726	NSW Reference Rate Manual 2014
Pump Station	1000000	BMT-WBM (2012)
Pump station (small)	500000	Advisian estimate
Water Infrastructure		
100 mm Reticulation Main*	176	NSW Reference Rate Manual 2014
150 mm Reticulation Main*	271	NSW Reference Rate Manual 2014
250 mm Trunk Water Main*	403	NSW Reference Rate Manual 2014
200 mm Trunk Water Main*	322	NSW Reference Rate Manual 2014
Roads and Carparks		
Bridge	3510	BMT-WBM (2012)
Carpark	176	Per m^2, Indexed from BMT-WBM (2012)
Roads	484	Indexed from BMT-WBM (2012)
Cycleway	55	Indexed from BMT-WBM (2012)
Buildings		
Golf Club (private asset)	10000000	BMT-WBM (2012)
SLSC	3000000	BMT-WBM (2012)
Amenities	100000	Per building, Advisian estimate
Playground	50000	Per playground, Advisian estimate
Picnic Shelter	30000	each, Advisian estimate
Tennis Club	600000	BMT-WBM (2012)

* The rates for sewer and water mains were derived based on guidance in the NSW Reference Rate Manual (2014) assuming they are laid at a minimum depth and that the construction difficulty is high, i.e. a suburban site with other services, residential roads and traffic control required.

2.5 Exposure Type

The type of coastal hazard to which the asset is exposed is an important consideration in determining the severity of the consequences for a particular asset.

The previous risk assessment (BMT-WBM 2012) considered different exposure types for the different assets – for example, assets that are not expected to be severely damaged by periodic inundation were assigned a relatively low percentage damage if they are exposed only to coastal inundation hazard.

Portions of road and wastewater assets that were located within the *Zone of Reduced Foundation Capacity* were assumed to be at risk of 100% damage. Buildings that were wholly within the *Zone of Reduced Foundation Capacity* or partly within the *Zone of Slope Adjustment* and which are not known to be protected by an adequate engineered coastal protection structure or an adequate piled foundation, were assumed to be at risk of 100% damage. Carparks that were in the *Zone of Slope Adjustment* that were informal or unpaved were assigned 50% damage to reflect their lesser replacement cost than formal paved carparks with line markings and drainage, which were assumed to be subject to 100% damage in the areas seaward of the *Zone of Slope Adjustment*. Minor infrastructure such as playgrounds and amenities were considered to be subject to a lesser percentage of damage if they were within the *Zone of Reduced Foundation Capacity* or if only a portion of these assets were within the *Zone of Slope Adjustment*.

2.6 Existing Risk Management Measures

Existing risk mitigation measures were taken into account in determining the residual risk for each asset. For example, assets that are protected by an engineered erosion protection structure were assigned a lower "likelihood" rating, to take into account the effectiveness of the control on the likelihood of the hazard causing damage to the asset. For example, the Shoalhaven Heads Surf Club is protected by an engineered revetment that reduces the likelihood of damage occurring.

Recent works undertaken at Mollymook, including the tripper wall and beach nourishment, have been taken into account in redefining the coastal hazard areas and, therefore, are reflected in this updated risk assessment. However, actions that are proposed in the CZMP and Emergency Response Plans but that have not yet been implemented have not been included in defining a residual level of risk for each asset.

2.7 Private Assets at Risk

This Risk Assessment has considered public assets within the coastal hazard areas. However, at a number of the beaches in the study area, several private lots and dwellings were found to be located within the various coastal hazard areas.

The number of private lots with a portion in the *Zone of Slope Adjustment* and *Zone of Reduced Foundation Capacity*, as well as the number of residential buildings partially within these zones, has been quantified for each beach and is presented in Table 5.

From Table 5 it can be seen that the beach with the highest number of residential lots and buildings within the coastal hazard area is Callala, followed by Currarong and Collingwood beaches.

The risk to the private assets has not been quantified in monetary terms as it will vary depending on the value of each asset, the portion of the lot or building within the hazard area and the existing controls on each asset, such as whether individual buildings are on deep-piled foundations. However, Table 5 allows a qualitative assessment of the level of risk to private assets at each beach, based on the quantum of assets located within the coastal hazard area and the likelihood scale provided in Table 2.

Risk to private development in the coastal hazard areas is being managed through the application of development controls through the Shoalhaven Development Control Plan (DCP) and Local Environment Plan (LEP), including application of foreshore setbacks and deep-piled foundations for new development. This approach is feasible in the medium term, where existing building lots have sufficient area to accommodate foreshore setbacks for new development so that it can be located outside the coastal hazard area and can accommodate future erosion within an acceptable planning horizon.

Table 5 – Private Lots and Buildings within the Coastal Hazard Areas

KEY:	<5 lots	5 – 9 lots	10 -19 lots	20 – 50 lots	>50 lots

Beach	Asset Class	Immediate ZSA	Immediate ZRFC	2030 ZSA	2030 ZRFC	2050 ZSA	2050 ZRFC	2100 ZSA	2100 ZRFC	Inundation	Risk now	Risk 2050	Risk 2100	SDCP G6	SLEP	Recommended Future Strategy	Response Category (OEH 2013)[2]
Shoalhaven Heads	No. Lots	-	-	-	-	-	-	-	-	-	Low	Low	Low			• No private properties at risk. Implement CZMP actions for Shoalhaven Heads SLSC.	C
	No. Buildings	-	-	-	-	-	-	-	-	-							
Culburra	No. Lots	1	1	2	3	3	28	4	62	17	Low	Moderate	High	✓	✓	• Dune vegetation management and manage accessways to maintain dune resilience. • Apply development controls through SDCP and SLEP.	C
	No. Buildings	1	1	1	1	1	1	1	2	-							
Warrain Beach	No. Lots	-	-	-	-	-	-	2	-	1	Low	Low	Low			• Dune vegetation management and manage accessways to maintain dune resilience.	C
	No. Buildings	-	-	-	-	-	-	-	-	-							
Currarong	No. Lots	5	20	5	23	7	29	15	43	4	Moderate	Moderate	High	✓	✓	• Trial geotextile groyne, Shoreline protection works at Beecroft Parade. • Reroute Peel St access. • Regular foreshore profile surveys. • Dune vegetation management and manage accessways to maintain dune resilience • Apply development controls through SDCP and SLEP.	A (coastal protection works would also protect essential public infrastructure)
	No. Buildings	-	9	-	9	-	19	10	21	-							
Callala Beach	No. Lots	80	82	82	82	82	82	82	82	74	High	Extreme	Extreme	✓	✓	• Apply development controls through SDCP and SLEP to reduce risk as properties are redeveloped. Immediate erosion hazard affects < 25% of area of most lots, and lots have enough area to allow setback of future development. • Dune vegetation management and manage accessways to maintain dune resilience. • Obtain approval from Jervis Bay Marine Park Authority (JBMPA) to undertake post-storm NABE as a coastal protection measure.	C[3]
	No. Buildings	16	53	16	63	55	68	55	76	-							
Collingwood	No. Lots	-	1	-	13	1	34	1	42	58	Low	Moderate	High	✓	✓	• Apply development controls through SDCP and SLEP. • Monitor dune crest levels. • Options for managing dune heights include dune scraping. • Dune vegetation management and manage accessways to maintain dune resilience. • Obtain approval from JBMPA to undertake post-storm NABE as a coastal protection measure.	C
	No. Buildings	-	-	-	-	-	-	-	1	-							
Bendalong	No. Lots	-	-	-	-	-	-	-	-	-	Low	Low	Low			• Implement CZMP actions and future masterplan	C
	No. Buildings	-	-	-	-	-	-	-	-	-							
Narrawallee	No. Lots	-	-	-	-	-	2	-	2	-	Low	Low	Low			• Dune vegetation management and manage accessways to maintain dune resilience.	C
	No. Buildings	-	-	-	-	-	-	-	-	-							
Mollymook	No. Lots	-	-	-	4	-	21	1	32	-	Moderate	Moderate	Moderate	✓	✓	• Apply development controls through SDCP and SLEP. • Golf Club is a private asset at immediate risk, resilience of existing works to be assessed • Condition assessment of tripper wall at northern end of beach at creek entrance near Beach Road. • Dune vegetation management and manage accessways to maintain dune resilience. • Monitor dune nourishment and buried training wall at Blackwater creek	A (coastal protection works for Golf Club would also protect essential public infrastructure)
	No. Buildings	1 (Golf Club)	1 (Golf Club)	1 (Golf Club)	1 (Golf Club)	1 (Golf Club)	3	1 (Golf Club)	7	-							
Collers	No. Lots	1	1	1	1	1	1	1	1	1	Low	Low	Low	✓	✓	• Apply development controls through SDCP and SLEP.	C
	No. Buildings	1	1	1	1	1	1	1	1	1							

[2] Council's intended response to managing risks to property from Table 6 of NSW Guidelines for Preparing Coastal Zone Management Plans (OEH 2013). The response category considers the feasibility of Council funded coastal protection works other than temporary Coastal Protection Works.
[3] For Callala Beach, although risk to private property is high, the risk can be managed through the use of the DCP/LEP for future development. Erosion risk can be managed in the short term through temporary coastal protection works (i.e. post-storm beach scraping with approval from JBMPA). Coastal protection works other than temporary coastal protection works are not considered feasible at this stage but the need for works would be reassessed in subsequent revisions of the CZMP.

3 Risk Evaluation

3.1 Risk Methodology

The risk for each public asset within the coastal hazard areas was evaluated by applying a risk matrix combining the "likelihood" and "consequence" ratings discussed in Section 2. The risk matrix applied is the same as that used in BMT-WBM (2012), to permit a ready comparison between the updated and previous risk assessments.

This process has enabled a quantitative risk rating to be applied to each asset, and also has enabled the individual financial value and cumulative value of the public assets at risk at each beach to be quantified.

The risk matrix applied to quantify the risk to each asset is provided in Table 6.

Table 6 – Risk Matrix applied to evaluate risk to each asset (BMT-WBM 2012)

Risk Rating Matrix					
Likelihood	Consequences				
	Negligible	Minor	Moderate	Major	Severe
Almost Certain 5	M	H	H	E	E
Likely 4	M	M	H	H	E
Possible 3	L	M	H	H	H
Unlikely 2	L	L	M	M	H
Rarely 1	L	L	M	M	H

3.2 Results

The results of the risk assessment for 2050 and 2100 are summarised below for each beach, with assets identified as having a "HIGH" or "EXTREME" risk based on existing controls listed in Table 7. The full risk register, which identifies assets with a "MEDIUM" and "LOW" risk, together with their estimated financial value, is provided in Appendix A.

Table 7 – Public Assets identified as being at Extreme, High or Medium Risk in 2050 and 2100

Beach	Asset Class	Location	Asset	2050 Rating	2100 Rating
Collers Beach	Wastewater		150 mm Gravity main	MEDIUM	MEDIUM
	Wastewater		375 mm Rising Main	MEDIUM	MEDIUM
	Wastewater		Pump Station	HIGH	HIGH
Mollymook	Wastewater	Near Golf Club	300 mm Gravity main	HIGH	HIGH
	Wastewater	Mitchell Pde and near Surf Club	150 mm Gravity main	HIGH	HIGH
	Wastewater	Near Golf Club	375 mm Rising Main	HIGH	HIGH
	Wastewater	Near Golf Club	Pump Station	HIGH	HIGH
	Wastewater	Mitchell Pde	250 mm Rising Main	HIGH	HIGH
	Wastewater	Small Pump Station opposite 57 Mitchell	Pump Station small	EXTREME	EXTREME
	Wastewater	near 57 Mitchell	100 mm Rising Main	MEDIUM	MEDIUM
	Wastewater	Beach Rd	Pump Station	HIGH	EXTREME
	Water	Mitchell Ave	250 mm Trunk Water Main	MEDIUM	MEDIUM
	Water	Mitchell Ave	200 mm Trunk Water Main	MEDIUM	MEDIUM
	Private Asset	Golf Club	Golf Club	EXTREME	EXTREME
	Community Infrastructure	SLSC	SLSC	HIGH	HIGH
	Community Infrastructure	SLSC Carpark	Carpark	LOW	MEDIUM
	Roads	Golf Avenue/Ocean St	Roads	MEDIUM	MEDIUM
	Roads	Mitchell Parade	Roads	HIGH	HIGH
	Roads	Beach St	Roads	MEDIUM	MEDIUM
Narrawallee	Wastewater	Near 12 Victor Ave	200 mm Rising Main	HIGH	HIGH
	Wastewater	Near 12 Victor Ave	150 mm Gravity main	MEDIUM	MEDIUM
	Community Infrastructure	Amenities Block in park	Amenities	MEDIUM	HIGH
Bendalong	Community Infrastructure	Carpark west end		MEDIUM	HIGH
	Community Infrastructure	Playground		MEDIUM	MEDIUM
	Roads	Red Point Road		HIGH	HIGH
Collingwood	Wastewater		450 mm Gravity Main	MEDIUM	MEDIUM
	Wastewater		150 mm Gravity main	LOW	MEDIUM
	Wastewater		225 mm Rising Main	MEDIUM	HIGH
	Community Infrastructure	Carpark north of creek	Carpark	HIGH	HIGH
	Community Infrastructure	Large Picnic Shelter	Picnic Shelter	HIGH	HIGH
	Community Infrastructure		Cycleway	HIGH	HIGH
	Roads	Ilfracombe Ave, Beach St	Roads	HIGH	HIGH

Beach	Asset Class	Location	Asset	2050 Rating	2100 Rating
Callala	Community Infrastructure	Tennis Club	Tennis Club	HIGH	HIGH
	Community Infrastructure	Tennis Club	Carpark	MEDIUM	HIGH
	Community Infrastructure	Toilet Block Tennis Club	Amenities	HIGH	HIGH
	Community Infrastructure	Toilet Block Callala Beach Road	Amenities	LOW	MEDIUM
	Community Infrastructure	Calalla Beach Road	Carpark	MEDIUM	HIGH
	Roads	Greenway Road	Roads	LOW	MEDIUM
Currarong	Wastewater	Beecroft Pde	150 mm Gravity main	HIGH	HIGH
	Wastewater	Warrain Cr	150 mm Gravity main	MEDIUM	HIGH
	Water		100 mm Reticulation Main	MEDIUM	HIGH
	Community Infrastructure		Carpark	MEDIUM	HIGH
	Community Infrastructure		Amenities	HIGH	HIGH
	Community Infrastructure	Near boat ramp	Playground	HIGH	HIGH
	Roads	Warrain Cres and 20 m access to boat ramp	Roads	HIGH	HIGH
Warrain	Wastewater		150 mm Gravity Main	LOW	MEDIUM
	Community Infrastructure	SLSC	Carpark	LOW	MEDIUM
	Community Infrastructure	SLSC	SLSC	HIGH	HIGH
Culburra	Community Infrastructure	Carpark at north end of beach	Carpark	MEDIUM	HIGH
	Community Infrastructure	Carpark at east end of Allerton Ave	Carpark	LOW	MEDIUM
	Roads	Access loop road to carpark at north end	Roads	HIGH	HIGH
Shoalhaven Heads	Community Infrastructure	SLSC	SLSC	HIGH	EXTREME
	Community Infrastructure	SLSC Carpark	Carpark	HIGH	HIGH
	Community Infrastructure	Boatshed	Amenities	HIGH	HIGH
	Community Infrastructure	Viewing Platforms		HIGH	HIGH
	Community Infrastructure	Amenities Block	Amenities	MEDIUM	HIGH

3.2.1 Analysis

The breakdown of the financial costs for the public assets at risk is illustrated in Figure 5, for 2050 and 2100. It can be seen that the assets with the highest values at-risk are buildings/infrastructure, including surf clubs, sporting clubs, and community facilities, followed by wastewater infrastructure, roads and water supply infrastructure. Note that the replacement value of beach accessways and stormwater infrastructure is not included in the below, as these assets are inherently located in the coastal hazard areas and, therefore, are known to be at high risk. The locations of accessways and stormwater infrastructure in the hazard areas are shown in the Risk Maps in Appendix B.

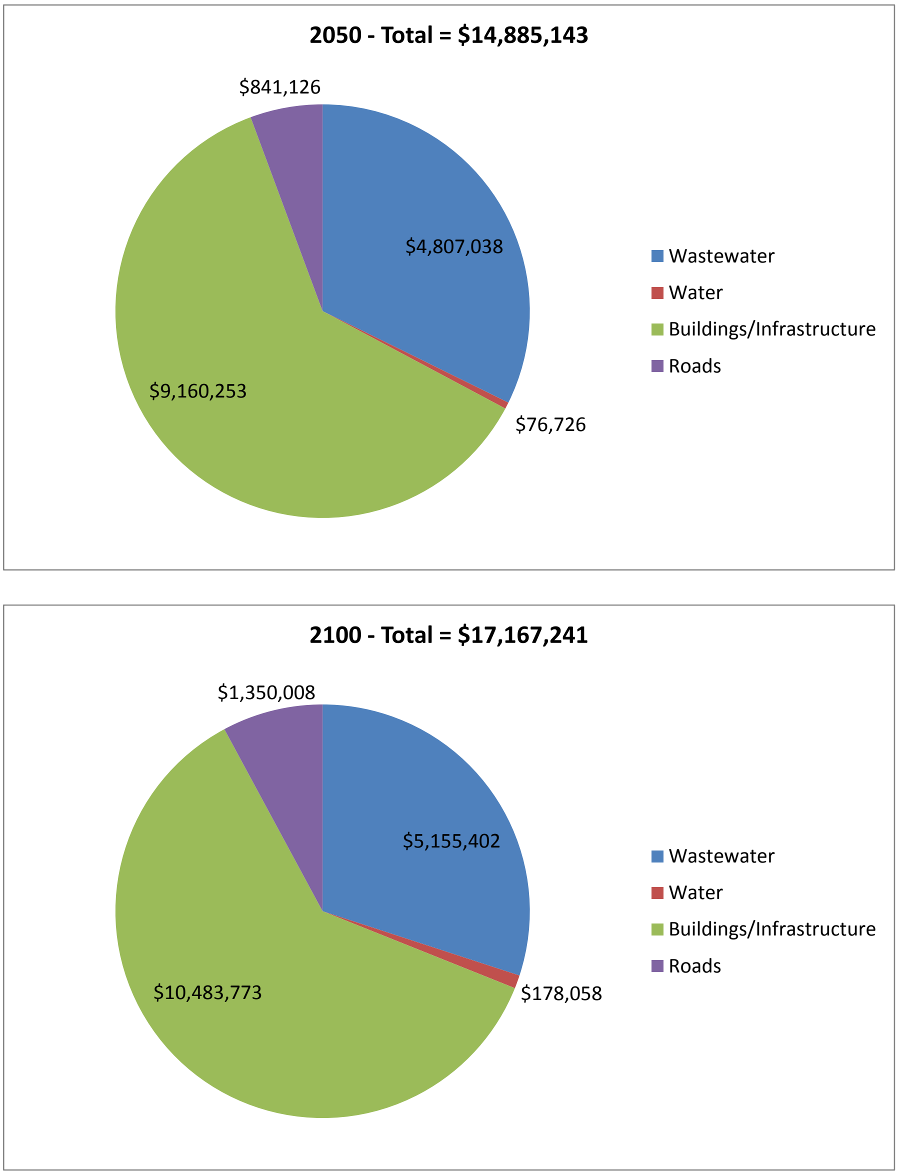


Figure 5 – Financial value of asset classes at risk, 2050 and 2100.

Figure 6 shows the total value of public assets at risk in 2050 and 2100, broken down on a beach-by-beach basis. It can be seen that Mollymook Beach has the highest value of public assets at risk, both in 2050 and 2100.

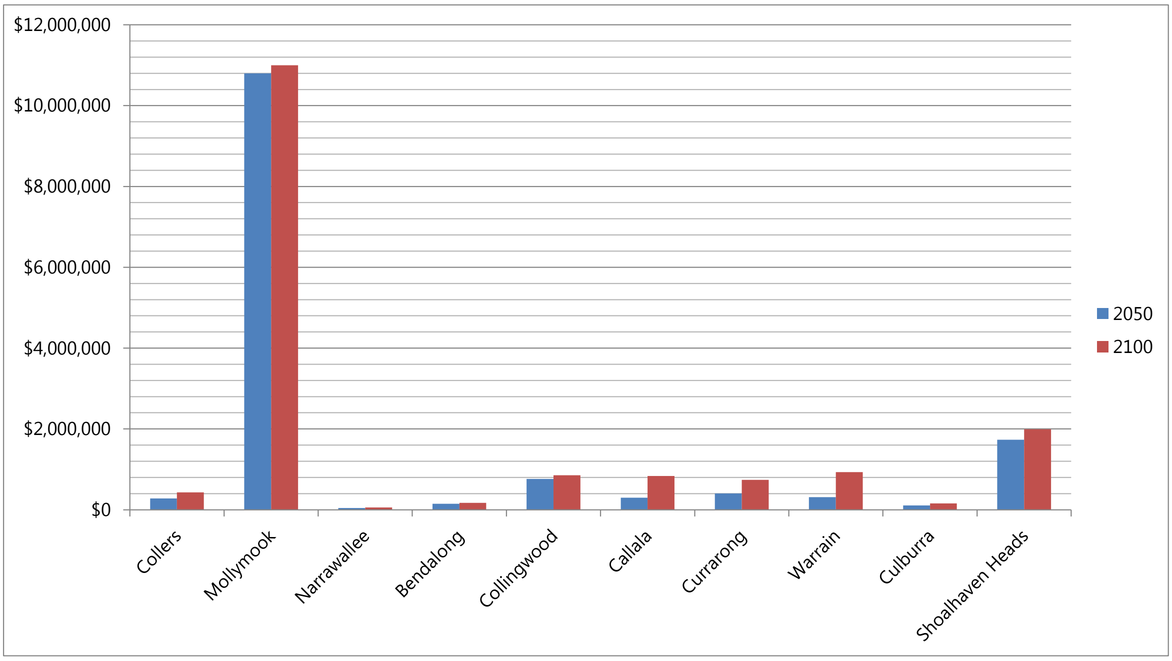


Figure 6 – Total value of public assets at risk per beach, 2050 and 2100

Table 8 and Table 9 show the financial value of public assets at risk by asset type in 2050 and 2100, on a beach by beach basis. It can be seen that Buildings/Infrastructure represents the highest value of assets at risk, followed by wastewater infrastructure at most of the beaches. The buildings deemed to be at risk include the surf lifesaving clubs, and the Mollymook Golf Club which is a private asset.

Table 8 – Financial Value of public assets at risk by asset type per beach, 2050

2050					
Beach	**Wastewater**	**Water**	**Buildings/ Infrastructure**	**Roads**	**TOTAL**
Collers	$279,000	$0	$0	$0	$279,000
Mollymook	$3,968,000	$48,000	$6,554,000	$230,000	$10,800,000
Narrawallee	$41,000	$0	$5,000	$0	$46,000
Bendalong	$0	$0	$69,000	$79,000	$148,000
Collingwood	$425,000	$0	$46,000	$290,000	$761,000
Callala	$0	$0	$298,000	$0	$298,000
Currarong	$85,000	$29,000	$86,000	$203,000	$403,000
Warrain	$9,000	$0	$301,000	$0	$310,000
Culburra	$0	$0	$69,000	$39,000	$108,000
Shoalhaven Heads	$0	$0	$1,733,000	$0	$1,733,000
TOTALS	**$4,807,000**	**$77,000**	**$9,161,000**	**$841,000**	**$14,886,000**

Table 9 – Financial value of public assets at risk by asset type per beach, 2100

2100					
Beach	**Wastewater**	**Water**	**Buildings/ Infrastructure**	**Roads**	**TOTAL**
Collers	$429,000	$0	$0	$0	$429,000
Mollymook	$4,037,000	$82,000	$6,566,000	$316,000	$11,001,000
Narrawallee	$48,000	$0	$10,000	$0	$58,000
Bendalong	$0	$0	$80,000	$90,000	$170,000
Collingwood	$479,000	$9,000	$51,000	$316,000	$855,000
Callala	$0	$0	$594,000	$242,000	$836,000
Currarong	$154,000	$87,000	$172,000	$329,000	$742,000
Warrain	$9,000	$0	$921,000	$0	$930,000
Culburra	$0	$0	$99,000	$58,000	$157,000
Shoalhaven Heads	$0	$0	$1,990,000	$0	$1,990,000
TOTALS	**$5,156,000**	**$178,000**	**$10,483,000**	**$1,351,000**	**$17,168,000**

3.2.2 Discussion on Risk Assessment options for extreme and high risks

The assets shown in Table 10 were found to be subject to extreme or high risk in the 2050 timeframe and, therefore, should be allocated priority with respect to actions to manage the risk. Specific considerations and strategies to reduce the level of risk for each of the assets are described in Table 10.

Table 10 – Assets rated as extreme or high risk in 2050 scenario and site-specific considerations

Beach	Location	Asset	2050 Risk Rating	Site Specific Considerations
Collers Beach		Pump Station	HIGH	Investigate whether localised protection for the sewerage assets at Collers Beach is required
Mollymook	Near Golf Club	300 mm Gravity main	HIGH	Design an upgrade of the revetment (designed by the Public Works Department Manly Hydraulics Lab in 1992) that protects infrastructure at the southern end of Mollymook Beach. Maintain or reconstruct the revetment as necessary to apply best practice design
	Near Golf Club	Pump Station	HIGH	
	Near Golf Club	375 mm Rising Main	HIGH	
	Golf Club	Golf Club	EXTREME	
	Mitchell Pde and near Surf Club	150 mm Gravity main	HIGH	Plan for relocation of Council owned sewer infrastructure including a pipeline and pumping stations that are located seaward of the Mollymook Beach 2050 ZSA.
	Mitchell Pde	250 mm Rising Main	HIGH	
	Small Pump Station opposite 57 Mitchell	Pump Station small	EXTREME	
	Beach Rd	Pump Station	HIGH	
	SLSC	SLSC	HIGH	Audit site constraints and foundation capacity of community buildings and infrastructure at Mollymook, including surf club & wastewater pump stations, to inform decisions about future relocation options and timing.
	Mitchell Parade	Roads	HIGH	Investigate localised protection options around the stormwater drains along Mitchell Parade as these are the locations where the Mitchell Parade roadway is at highest erosion

Beach	Location	Asset	2050 Risk Rating	Site Specific Considerations
				risk
Narrawallee	Near 12 Victor Ave	200 mm Rising Main	HIGH	Investigate whether localised protection for the sewerage assets is required and the feasibility of relocation of the sewerage infrastructure. Implement actions from the Draft Coastal Cliffs and Slopes Emergency Action Sub Plan 2018
Bendalong Boat Harbour	Red Point Road	Roads	HIGH	Implement Bendalong Boat Harbour Master Plan, Stormwater Upgrade Plan and Coastal Hazard Study recommendations
Collingwood	Carpark north of creek	Carpark	HIGH	Accept risk or investigate options for future landward relocation if required
	Large Picnic Shelter	Picnic Shelter	HIGH	
	All along beach	Cycleway	HIGH	Monitor dune crest levels to minimise wave overtopping onto shared path and road, accept risk and repair cycleway if subject to erosion. Implement recommendations of emergency action plan, undertake beach scraping and implement dune management plan to reduce likelihood of erosion.
	Ilfracombe Ave, Beach St	Roads	HIGH	
Callala	Tennis Club	Tennis Club	HIGH	Investigate future relocation of tennis club and amenities. Audit site constraints and foundation capacity of community buildings and infrastructure.
	Toilet Block Tennis Club	Amenities	HIGH	
Currarong	Beecroft Pde	150 mm Gravity main	HIGH	Investigate the feasibility of shoreline erosion protection works at Beecroft Parade. Investigate the feasibility of constructing a geotextile groyne, in conjunction with beach nourishment works, on Currarong Beach, with an anticipated life of 5 years. Prepare for medium term, to long term, relocation of water and road infrastructure along the eastern end of Warrain Crescent to the landward
	Warrain Cres and 20 m access to boat ramp	Roads	HIGH	

Beach	Location	Asset	2050 Risk Rating	Site Specific Considerations
				boundary of housing lots – currently these assets are on the seaward boundary. Similarly, where sewerage infrastructure is provided, prepare to relocate it to a more landward position.
		Amenities	HIGH	These assets can be relocated or the risk can be accepted and repaired if needed.
	Near boat ramp	Playground	HIGH	
Warrain	SLSC	SLSC	HIGH	Audit site constraints and foundation capacity of surf club to inform decisions about future relocation options and timing.
Culburra	Access loop road to carpark at north end	Roads	HIGH	Accept risk and repair if subject to erosion. Implement recommendations of emergency action plan.
Shoalhaven Heads	SLSC	SLSC	HIGH	Assess the condition of the rock revetment in front of the Shoalhaven Heads Surf Club if and when it is exposed during a major storm. Audit site constraints and foundation capacity for the Shoalhaven Heads surf club, to inform decisions about the timing of relocation. Investigate zoning, land tenure and approval processes for relocation of the Shoalhaven Heads Surf Club landward of its current position, outside the 2050 coastal erosion risk area. The move will be triggered by the asset life of the existing building, or significant storm damage to the building, and the cost/benefit of maintaining the existing rock protection.
	SLSC Carpark	Carpark	HIGH	
	Boatshed	Amenities	HIGH	
	Viewing Platforms		HIGH	Accept risk and repair or relocate if damaged.

4 Conclusions and Recommendations

4.1 Conclusions

This Risk Assessment provides an update of the BMT-WBM (2012) Risk Assessment with respect to coastal risk to the public assets within the Shoalhaven LGA, for the 2050 and 2100 timeframe. The Risk Assessment has been updated to take account of the revised coastal hazard mapping undertaken since the previous draft CZMP, based on Shoalhaven Council's updated sea level rise projections.

The Risk Assessment has been undertaken in accordance with the process identified in the updated NSW Coastline Management Manual (2018) and has identified the public assets within the coastal zone deemed to be at medium, high or extreme risk from coastal erosion or recession by the 2050 and 2100 timeframes. The quantum of private lots or buildings within the coastal hazard areas at each of the beaches within the study area has been identified also based on the most recent coastal hazard assessment.

The purpose of this Risk Assessment is to provide guidance on the priority for management of the risks as well as guidance on appropriate management options to reduce the level of risk. Risk to assets has been quantified in terms of financial risk to Council caused by damage from beach erosion. However, the overall risk is likely to be much greater than what has been identified in this report due to factors such as impacts on the local economy, urban areas and the environment from damage to essential road or sewerage infrastructure, loss of tourism income caused by long-term loss of beach amenity, and impact on the community caused by loss of community facilities. The Risk Assessment has provided a mechanism to enable the risk to public facilities to be recognised and treatment options to be identified.

The 2011 Risk Assessment (BMT-WBM, 2012) identified strategies and options to manage the risks for specific areas and specific asset types. Those strategies and options largely remain relevant for the assets identified in this updated Risk Assessment but have been modified to reflect the updated level of risk for those assets.

The Risk Register should be updated regularly in accordance with the review schedule of the CZMP as it transitions to a Coastal Management Program under the new *Coastal Management Act* 2016. Residual risks for each of the assets can be evaluated based on the adopted actions in the Local Area Plans in the CZMP and as presented in the Action Plan in Section 5, and with the ongoing collection of relevant data on coastal hazards, effectiveness of existing management measures and value of infrastructure.

4.2 Recommendations

The final step in the Risk Assessment process is to identify management options for treatment of the risks. Shoalhaven Council have a Risk Management Strategy that includes a Risk Action Table to guide action on specific risks. The Risk Action Table is provided below in Table 11.

Table 11 – Risk Rating Action Table from Council Risk Management Strategy (after BMT-WBM 2012)

Risk Rating	Explanation	Action	Review & Reporting
Low	Risk treatment not likely to be required	Managed in day to day operations at section/ local level	Biannual assessment of risk
High	Risk has significant impact on one or more departments	Managed by Group Director(s). Implementation of treatments within 6 months. Monitored by Risk Management Committee. Controls reviewed annually and tested every three years.	Half yearly reassessment of risk and when changes occur.
Extreme	Risk has serious implications to Council and cannot be justified except in extraordinary circumstances.	Risk must be approved by the General Manager. Immediate implementation of treatments. Monitored by Risk Management Committee. Controls audited annually as part of the internal audit process.	As stipulated by General Manager

Risk treatment involves selecting treatment options to further modify risks. Risk treatment options can include the following (BMT-WBM 2012):

- avoiding the risk by deciding not to start or continue with the activity that gives rise to the risk
- removing the risk source
- changing the likelihood
- changing the consequences
- transferring the risk or sharing the risk with another party (parties)
- retaining the risk with higher levels of management focus.

The NSW Coastal Management Manual (2018) outlines five broad categories for management options in coastal areas where unacceptable risks have been identified:

- *Alert* – includes coastal management actions that seek to 'watch and wait' such as monitoring change and setting thresholds, low regret responses and research to improve knowledge.
- *Avoid future impact* – includes recommending proactive land use planning and encouraging new development only in locations of low-risk.
- *Active intervention* – includes coastal management actions that seek to protect assets or accommodate change in any of the coastal management areas, while maintaining current systems and values.
- *Planning for change* – includes coastal management actions that seek to facilitate habitat migration and transformative changes to natural systems. For built areas, this includes planning to relocate or redevelop assets to consider the dynamic and ambulatory nature of the shoreline. It may be timed to commence as opportunities arise or when thresholds of exposure, impact and risk are exceeded.
- *Emergency response* – includes coastal management actions to address residual risk in emergency situations.

For the assets identified within this Risk Assessment as having a "High" or "Extreme" risk, the recommended response will involve a combination of the above strategies. For example, landward relocation of sewerage assets in the medium term once a particular trigger for action is reached falls within the *Planning for Change* strategy, whereas an *active intervention* strategy may be required in the short term to deal with the extreme risks to assets where it would be impractical for these to be relocated (*e.g.*, Mollymook Golf Club). *Avoiding Future Impact* is an overarching strategy to reduce risk to new development *via* planning controls applied through the Shoalhaven DCP and LEP. *Emergency Response* is required to address the residual risk in emergency situations, where it is not possible or practical to implement actions to remove the risk completely. The *Alert* strategy is appropriate where the risk to assets is deemed to be acceptable and where more data is needed to devise actions.

The BMT-WBM (2012) Risk Assessment discussed various options for high risk assets. These options remain valid for the updated risk assessment and include planning for relocation of assets at a future time when the risk has approached unacceptable levels, or the asset has neared the end of its design life. Such an approach applies to sewerage infrastructure and high value community buildings found to be at a high future risk. Relocation of sewer infrastructure such as pumping stations needs to be planned carefully, as these facilities by their very nature are located at the lowest point in the catchment and will need to be below the levels of the houses that they service. The available risk treatment options, the category of management option from the NSW Coastal Management Manual (2018) that they represent and further information required for their implementation are presented in Table 12.

Table 12 – Options for treating risks by risk type (after BMT-WBM 2012)

Asset	Options and Category	Further information required	Planning Recommendations	Trigger Thresholds
Water and Wastewater Infrastructure	Periodic inundation of pump stations can be accommodated by elevating electrical kiosks in the short term *(Alert)* Protection by means of a seawall to engineering standards *(Active intervention)* Retreat to a new location at the end of the design life. This may require retrofitting non-centralised technologies for some properties *(Planning for Change)*.	Life cycle asset management assessment Identification of available land for potential future relocation.	Do not locate / approve water /wastewater infrastructure in the identified hazard zones, unless adequately protected, or otherwise able to accommodate the hazards. Any major upgrading of existing infrastructure should be assessed using lifecycle cost benefit assessment and compared to relocation strategies. Reserve available and appropriate land to enable future relocation	Should be based on a measurable quantity, such as distance to existing ZRFC. This should be related to the risk, e.g, Sewerage pump station has emergency spills due to inundation or other coastal hazard less than once every 10 years for life span of asset. Adequate planning and technical studies will need to be undertaken well in advance of this trigger being reached.
Roads	Protect *(Active Intervention)* Raise *(Active Intervention)* Close *(Planning for Change)*	Traffic assessment to assess significance of at risk roads Decisions regarding residential development and public property serviced by at risk roads.	Do not locate / approve new roads in the identified hazard zones, unless adequately protected, or otherwise able to accommodate the hazards. Any major upgrading of existing infrastructure should be assessed	Should be based on a measurable quantity, such as distance to existing ZRFC. This should be related to the risk, e.g., Public roads to be inundated for no more than 2 hours, only twice a year or less.

Asset	Options and Category	Further information required	Planning Recommendations	Trigger Thresholds
		Closure impact and alternate traffic routes	using lifecycle cost benefit assessment and compared to relocation strategies. Reserve available and appropriate land to enable future relocation	Adequate planning and technical studies will need to be undertaken well in advance of this trigger being reached.
Surf Clubs/ other community sporting clubs	Accommodate periodic inundation to lower levels *(Alert)* Protect *(Active Intervention)* Relocate *(Planning for Change)*	Identify whether existing surf clubs and other community buildings in the hazard areas are on deep-piled foundations. Identify timeframes when upgrades to existing infrastructure are planned.	Do not locate / approve new surf clubs in the identified hazard zones, unless adequately protected, or otherwise able to accommodate the hazards e.g. through the use of deep piled foundations. Any major upgrading or refurbishing of existing infrastructure should be assessed using lifecycle cost benefit assessment including consideration of relocation strategies and moveable structure options. Reserve available and appropriate land to enable future relocation	Should be based on a measurable quantity, such as distance to existing ZRFC. This should be related to the risk. Adequate planning and technical studies will need to be undertaken well in advance of this trigger being reached.

Advisian
WorleyParsons Group

5 Action Plan

The following Action Plan (Table 13) has been prepared to treat the priority risks identified in this assessment. These Actions have been updated from those recommended in the previous Risk Assessment (BMT-WBM 2012) based on updated information available and actions that have since been implemented. In the table below, "Short Term" refers to 1 – 3 years, "Medium Term" refers to 3 – 10 years and "Long term" refers to longer than 10 years. These Actions should be reviewed in subsequent revisions of the CZMP.

Table 13 – Action Plan

Action	Responsibility	Timing	Indicative Cost
Collers Beach			
Investigate whether localised protection, redesign or landward relocation of the sewerage assets at Collers Beach is required	SCC Asset Management and Shoalhaven Water	Short Term	Staff time or small consultancy $5,000
Mollymook Beach			
Design an upgrade of the gabions revetment which protects infrastructure at the southern end of Mollymook Beach and undertake cost benefit analysis. Modifications should include provision for safe disabled access onto the beach.	SCC Asset Management and Environmental Services in consultation with DoI – Crown Lands & Water and other agencies	Short Term	$50,000
Implement recommendations of cost benefit analysis currently underway for southern end of Mollymook – i.e. depending on outcome of cost benefit analysis, undertake detailed design, planning and approvals of a new revetment to provide adequate protection to assets most at risk	SCC Asset Management and Environmental Services in consultation with DoI – Crown Lands & Water and other agencies	Medium Term	$150,000 design and CBA cost. $4.8 million for construction of full suite of options in Haskoning Australia (2016)
Audit site constraints and foundation capacity of community buildings and infrastructure at Mollymook, including surf club & wastewater pump stations, to inform	SCC Asset Management and Shoalhaven Water	Short Term	$10,000

Action	Responsibility	Timing	Indicative Cost
decisions about future relocation or reconstruction on deep-piled foundations and timing.			
Undertake technical studies and planning for relocation or protection of Council owned sewer infrastructure including a pipeline and pumping stations that are located seaward of the Mollymook Beach 50 year ZSA (in the areas outside the study area for the cost-benefit study currently underway).	SCC Asset Management and Shoalhaven Water	Short Term	$50,000 plus future construction/ easement acquisition costs
Undertake condition assessment of existing tripper wall at northern end of beach at creek entrance near Beach Road	SCC Asset Management	Short Term	$10,000
Investigate localised protection options consistent with the Coastal Erosion Road Stormwater Assessment 2015 around the stormwater drains along Mitchell Parade (e.g. opposite 55 Mitchell Parade) as these are the locations where the Mitchell Parade roadway is at highest erosion risk	SCC Asset Management	Short Term	$100,000
Engage with foreshore reserve property owners, residents and beach goers around the values of dune vegetation e.g. trapping wind-blown sand and maintaining dune resilience, ecological functions and buffering against coastal hazards, the importance of foreshore vegetation in providing shade and wind protection, filtering runoff, improving water quality and providing habitat.	SCC Environmental Services team	Short Term	Staff time, media resources. Allow $10,000
Consult with residents along Mollymook Beach about reducing the frequency of pedestrian access ways from private dwellings across the dunes. The aim is to reduce pressures on dune vegetation and to enhance the resilience of dune landforms.	SCC Environmental Services team	Short Term	Staff time, within existing responsibilities

Action	Responsibility	Timing	Indicative Cost
Repair and replace/relocate beach access infrastructure including viewing platforms if and when required following a large storm.	SCC Environmental Services	Long term	Allocate $10,000 p.a.
Narrawallee Beach			
Investigate whether localised protection for the sewerage assets is required and the feasibility of relocation of the sewerage infrastructure.	SCC Asset Management and Shoalhaven Water	Short Term	$20,000
At Narrawallee Beach, monitor dune crest levels. A minimum of 6.0m AHD may minimise the risk of wave overtopping. Options for managing dune heights include post-storm beach scraping.	SCC Environmental Services in consultation with DoI – Crown Lands & Water	Short Term	Staff time for survey teams, beach scraping. Allow $10,000 p.a.
Implement actions from the Draft Coastal Cliffs and Slopes Emergency Action Sub Plan 2018 to manage risk to safety and assets	SCC Environmental Services	Short Term	Staff time, within existing responsibilities
Repair and replace/relocate beach access infrastructure including viewing platforms if and when required following a large storm.	SCC Environmental Services	Long term	Allocate $10,000 p.a.
Bendalong Boat Harbour			
Implement Bendalong Boat Harbour Master Plan, Stormwater Upgrade Plan and Coastal Hazard Study recommendations	SCC Environmental Services, Recreation & Community and Asset Management	Short – Medium Term	$100,000
Collingwood Beach			
Monitor dune crest levels to minimise wave overtopping onto shared path and road, accept risk and repair cycleway if subject to erosion. A minimum of 5.0m AHD may minimise the risk of wave overtopping. Options for managing dune heights include	SCC Environmental Services team in consultation with DoI – Crown Lands & Water, OEH, JBMP and local community	Short term	Staff time for survey teams, beach scraping. Allow $20,000 p.a.

Action	Responsibility	Timing	Indicative Cost
beach scraping.			
Implement recommendations of dune management plan to reduce likelihood of erosion.	SCC Environmental Services team in consultation with DoI – Crown Lands & Water, OEH, JBMP and local community	Immediate	Staff time plus cost of new planting etc. Allow $50,000
Initiate technical studies to investigate feasibility of future relocation of sewerage infrastructure along the beach front reserve at Collingwood Beach, between Argyle Street and Berry Street	SCC Asset Management and Shoalhaven Water	Medium-long term	$50,000
Monitor beachfront area along Huskisson Beach and implement post-storm emergency action measures if required.	SCC Environmental Services team	Ongoing	Staff time, allow $5,000 p.a.
Repair and replace/relocate beach access infrastructure including viewing platforms if and when required following a large storm.	SCC Environmental Services	Long term	Allocate $10,000 p.a.
Callala Beach			
At Callala Beach, monitor dune crest levels. A minimum of 6.0m AHD may minimise the risk of wave overtopping. Options for managing dune heights include beach scraping	SCC Environmental Services team	Short term	Staff time for survey teams, beach scraping. Allow $20,000 p.a.
Monitor beachfront area and implement post-storm emergency action measures when required to repair/replace public beach access	SCC Environmental Services team	Short term	Staff time. Allow $20,000 p.a.
Investigate future relocation of tennis club and amenities. Audit site constraints and foundation capacity of community buildings and infrastructure. Apply requirements of Shoalhaven DCP to future upgrades of	SCC Environmental Services team	Short term	$10,000

Action	Responsibility	Timing	Indicative Cost
tennis club buildings and infrastructure as well as development on private lots.			
Engage with foreshore reserve property owners, residents and beach goers around the values of dune vegetation e.g. trapping wind-blown sand and maintaining dune resilience, ecological functions and buffering against coastal hazards, the importance of foreshore vegetation in providing shade and wind protection, filtering runoff, improving water quality and providing habitat.	SCC Environmental Services team	Short term	Staff time, media resources. Allow $10,000
Consult with residents along Callala Beach about reducing the frequency of pedestrian access ways from private dwellings across the dunes. The aim is to reduce pressures on dune vegetation and to enhance the resilience of dune landforms.	SCC Environmental Services team	Short Term	Staff time, within existing responsibilities
Repair and replace/relocate beach access infrastructure including viewing platforms if and when required following a large storm.	SCC Environmental Services	Long term	Allocate $10,000 p.a.
Currarong			
Undertake technical studies to investigate the feasibility of medium term, to long term, relocation of water and road infrastructure along the eastern end of Warrain Crescent to the landward boundary of housing lots – currently these assets are on the seaward boundary. Similarly, where sewerage infrastructure is provided, investigate feasibility of locating it to a more landward position.	SCC Asset Management and Shoalhaven Water	Medium-long term	$50,000, plus construction/ easement acquisition costs
Detailed design and consultation for geotextile groyne, in conjunction with beach nourishment works, on Currarong Beach, with an anticipated life of 5 years. This is to trial the effect on sand retention	SCC Environmental Services in consultation with DoI – Crown Lands & Water, OEH and JBMP	Short term	$980,000

Action	Responsibility	Timing	Indicative Cost
on the beach.			
Establish a five year monitoring program to determine the efficacy of the works to decide whether to remove or replace with a permanent structure.	SCC Environmental Services in consultation with DoI – Crown Lands & Water, OEH and JBMP	Medium term	Staff time for survey teams
Shoreline erosion protection works to protect infrastructure at Beecroft Pde.	SCC Environmental Services in consultation with DoI – Crown Lands & Water, OEH and JBMP	Short term	$780,000 including construction and detailed design/ approvals costs)
Undertake ongoing regular foreshore profile surveys to inform refinement of erosion/long term recession hazard for Beecroft Parade area.	SCC Environmental Services	Short Term, ongoing	$20,000
Re-route the Peel Street beach access to address sand loss from beach. Fence and revegetate the nourished dune and beach accesses that have been closed to stabilise the dune	SCC Environmental Services	Short Term	$50,000
Repair and replace/relocate beach access infrastructure including viewing platforms if and when required following a large storm.	SCC Environmental Services	Long term	Allocate $10,000 p.a.
Warrain Beach			
Audit site constraints and foundation capacity at Nowra Culburra Surf Club to inform decisions about future relocation or reconstruction on deep-piled foundations.	SCC Asset Management	Short term	$10,000
Investigate zoning, land tenure and approval processes for relocation of the Nowra Culburra Surf Club landward of its current position, outside the 2050 coastal erosion risk area. The move will be	SCC Asset Management	Short term	Staff time

Action	Responsibility	Timing	Indicative Cost
triggered by the asset life of the existing building or significant storm damage to the building.			
Repair and replace/relocate beach access infrastructure including viewing platforms if and when required following a large storm.	SCC Environmental Services	Long term	Allocate $10,000 p.a.
Culburra			
Implement actions from the Draft Coastal Cliffs and Slopes Emergency Action Sub Plan 2018 to manage risk to safety and assets	SCC Environmental Services	Short term	Staff time, within existing responsibilities
Develop dune vegetation management plan. Engage with foreshore reserve property owners, residents and beach goers around the values of dune vegetation e.g. trapping wind-blown sand and maintaining dune resilience, ecological functions and buffering against coastal hazards, the importance of foreshore vegetation in providing shade and wind protection, filtering runoff, improving water quality and providing habitat.	SCC Environmental Services team	Short term	Staff time, consultancy, media resources. Allow $20,000
Consult with residents along Culburra Beach about reducing the frequency of pedestrian access ways from private dwellings across the dunes. The aim is to reduce pressures on dune vegetation and to enhance the resilience of dune landforms.	SCC Environmental Services team	Short term	Staff time, within existing responsibilities
Repair and replace/relocate beach access infrastructure including viewing platforms if and when required following a large storm.	SCC Environmental Services	Long term	Allocate $10,000 p.a.
Shoalhaven Heads			
Assess the condition of the rock revetment in front of the Shoalhaven Heads Surf Club if and when exposed following a major	SCC Asset Management and Environmental Services	As required	$10,000

Action	Responsibility	Timing	Indicative Cost
storm.			
Audit site constraints and foundation capacity for the Shoalhaven Heads surf club, to inform decisions about the timing of relocation	SCC Asset Management	Short term	$10,000
Investigate zoning, land tenure and approval processes for relocation of the Shoalhaven Heads Surf Club landward of its current position, outside the 2050 coastal erosion risk area. The move will be triggered by the asset life of the existing building, or significant storm damage to the building, and the cost/benefit of maintaining the existing rock protection.	SCC Asset Management in consultation with DoI – Crown Lands & Water	Short term	Staff time plus $30,000 for cost benefit analysis
Depending on outcome of above, at end of building asset life or in the event of significant storm damage, relocate surf club landward and construct on deep piled foundations	SCC Asset Management in consultation with DoI – Crown Lands & Water	Long term	>$1m
Prepare a dune management plan for the dune at Shoalhaven Heads	SCC Environmental Services	Short term	Staff time, consultant $10,000
Repair and replace/relocate beach access infrastructure including viewing platforms if and when required following a large storm.	SCC Environmental Services	As required	Allocate $10,000 p.a.

6 References

Advisian (2016) *Shoalhaven Coastal Hazard Mapping Review*, 301311-13501-001

BMT-WBM (2012) *Shoalhaven Public Asset Coastal Risk Management Review*, R N1961 001 02, July.

Coastal Zone Management (2011) *Impact of Extreme Weather Events and Climate Change on Surf Life Saving Services: A Road Map for Adaptive Action*, report prepared by Elrick, C., Dalton, L. and Kay, R.C. for Surf Life Saving Australia.

Department of Environment and Climate Change NSW (2009). *Draft Sea Level Rise Policy Statement*.

Department of Primary Industry, Office of Water (2014) *NSW Reference Rates Manual*

Nielsen, A.F., D.B. Lord & H.G. Poulos (1992) *Dune Stability Considerations for Building Foundations*, IEAust., Aust. Civ. Eng. Trans., Vol. CE 34, No. 2, 167-173.

NSW Office of Environment and Heritage (2013) *Guidelines for Preparing Coastal Zone Management Plans*

NSW Office of Environment and Heritage (2018) *NSW Coastal Management Manual*

SMEC (2009) *Shoalhaven Coastal Hazard Study – Summary Report*, Report no. 3001209, July.

Umwelt Australia (2012) *Shoalhaven Coastal Zone Management Plan*, Draft.

Appendix A Risk Register

Table 2-2 Consequence Scale used for the Risk Assessment

Consequence Scale	Finance	Governance	Environment	Health and Safety	Beach amenity
Catastrophic	Extensive financial loss (>$1m)	Loss of asset, loss of program or business operation. Threat to viability of service or operation	Extreme and widespread devastating long term impacts. Recovery unlikely.	Multiple fatalities or permanent disability of employees, contractor or members of the public	Extreme and widespread long term impacts on the amenity – complete loss of sandy beach. No Beaches of similar amenity available nearby for use in the short term.
Major	Major financial loss ($500,000 - $1m)	major asset damage, severe impact on program or business operations	Major habitat loss and/or triggering of nuisance species proliferation, over a wide area. Recovery may take many years	Serious illness, injury or death of employee, contractor or members of the public	Major impact on the amenity, reversible only through intense management efforts. No Beaches of similar amenity available nearby for use in the short term.
Moderate	Significant financial loss ($50,000 - $500,000)	Considerable impact on program or business operations. Temporary disruption of services	Significant environmental changes isolated to a localized area. Recovery may take several years.	Medical attendance, time off work	Moderate impact on the amenity mainly reversible through management efforts. Beaches of similar amenity available nearby for use in the short term.
Minor	Minor financial loss ($10,000 - $50,000)	Minimal impact on program or business operations. Minor long-term and/or minor short term impacts (mainly reversible) on communities and their access to services	Environmental damage of a magnitude consistent with seasonal variability	Minor injury with first aid treatment required	Minor impact to beach amenity, mainly reversible through management efforts. Beaches of a similar nature available nearby
Insignificant	Little to no financial loss (<$10,000)	Little to no impact on communities and their access to services	Little to no impact on terrestrial and or aquatic ecosystems	Minor injury with no treatment required	Little to no change to beach amenity

Table 2 - Likelihood Scale for Coastal Risk Assessment for erosion, Shoalhaven Coastline

Likelihood Descriptor	Immediate	For 2050	For 2100
Almost certain Expected to occur, many recorded incidents, strong anecdotal evidence, great opportunity, reason or means to occur. May occur or be exceeded once every 1-5 years	Immediate ZSA line	2050 ZSA line	2100 ZSA line
Likely Will probably occur, consistent record of incidents and good anecdotal evidence; considerable opportunity, reason or means to occur. May occur or be exceeded once every 20 years	Immediate ZSA line	2100 ZSA line	2050 ZRFC line
Possible Might occur, a few recorded incidents in the locality and some anecdotal evidence in the community; some opportunity, reason or means to occur. May occur or be exceeded once every 100 years. Will generally be close to or exceed past records of severity.	Immediate ZRFC line	2050 ZRFC line	2100 ZRFC line

Table 3-1 Likelihood and Consequence Risk Rating Table

Risk Rating Matrix					
Likelihood	Consequences				
	Negligible	Minor	Moderate	Major	Severe
Almost Certain 5	M	H	H	E	E
Likely 4	M	M	H	H	E
Possible 3	L	M	H	H	H
Unlikely 2	L	L	M	M	H
Rarely 1	L	L	M	M	H

Sewer	$ rate/m	
150 mm Gravity Main	306	
375 mm Rising Main	726	
Pump Station	1000000	
300 mm Gravity Main	604	
250 mm Rising Main	438	
100 mm Rising Main	196	
Pump station small	500000	
100 mm Reticulation Main	176	
250 mm Trunk Water Main	403	
200 mm Trunk Water Main	322	
Bridge	3510	
Golf Club	10000000	
SLSC	3000000	
Carpark	176	/sqm
Roads	484	
200 mm Rising Main	352	
Amenities	100000	
Playground	50000	
450 mm Gravity Main	1052	
225 mm Rising Main	438	
Cycleway	55	
Picnic Shelter	30000	
Tennis Club	600000	
100 mm Gravity Main	231	
150 mm Reticulation Main	271	

Table 9 Sewer Mains (See also Table 17 on page 35 for additional costs)

	Dia (mm)	Contract Rate Min depth ($/m) 2014	Reference Rate Min depth ($/m) 2014	1.5–3m deep ($/m) 2014	3-4.5m deep ($/m) 2014	>4.5m deep ($/m) 2014
Reticulation	**100**	136	150	216	315	400
	150	159	175	248	348	440
	225	218	240	320	432	550
	300	327	360	430	570	675
	375	450	490	590	705	820
	450	586	645	738	865	970
	500	686	750	830	970	1 090
	600	855	940	1 030	1 180	1 290
Trunk Mains	**150**	150	165	253	340	420
	225	200	220	315	410	505
	300	300	330	427	520	615
	375	409	450	553	660	765
	450	518	570	670	775	880
	500	605	665	775	885	990
	600	768	845	1 000	1 110	1 220
	750	1 010	1 110	1 340	1 450	1 570
Rising Mains (DICL)	**100**	105	115			
	150	145	160			
	200	173	190			
	250	214	235			
	300	269	295			
	375	364	400			
	450	459	505			
	500	527	580			
	600	670	740			
	750	871	960			

NOTES

1. These rates are for June 2014 valuation of the capital cost of existing assets and exclude contingencies and the GST. A suitable percentage for contingencies must be included (section 2.5 on page 8) for valuation of new works.
2. Review of recent contracts shows that rates for sewer mains have increased above the capital cost inflation rate since 2003 as follows – sewer reticulation mains and trunk mains by up to 10% and sewer rising mains (DICL) up to 35%. The increases are not uniform over all sizes.
3. Reference Rate = 1.10 x Contract Rate (ie. Contract Rate plus SID of 10%).
4. Caution: Additional costs apply for mains constructed in congested urban areas (eg. in town centres), in rock or where dewatering is required (refer Table 17 on page 35).
5. The rates allow for pipe supply, excavate, lay, backfill, restoration, fittings and thrust blocks.
6. "Reticulation" rates include an allowance for access chambers (or maintenance holes), sidelines and restoration.
7. "Trunk main" rates include an allowance for access chambers (or maintenance holes).
8. Excavation is in OTR.
9. Pipe materials are VC Class Z, AC Class 50, uPVC Class SNB, Concrete Class 2. For uPVC rising mains, use the values for a water trunk main shown on page 11.
10. Note that depreciation of sewers should be based on the cost of relining or renewing a sewer, as these avoid the need for excavation and backfill and are typically about 60% of the cost of reconstructing a shallow sewer ie. an existing sewer main would be valued at 40% of its replacement cost at the end of its useful life. For deep sewers, the saving from relining is correspondingly greater.

Table 1 Water Mains – uPVC

(See also Table 17 on page 35 for additional costs)

	Diameter (mm)	Contract Rate ($/m) 2014	Reference Rate ($/m) 2014
Reticulation uPVC	**50**	56	62
	80	73	80
	100	86	95
	150	127	140
	200	173	190
	250	227	250
	300	291	320
	375	382	420
Trunk Mains uPVC	**80**	62	68
	100	77	85
	150	105	115
	200	145	160
	250	182	200
	300	227	250
	375	336	370

Table 17 Additional Costs for Construction Difficulty, Rock Excavation and Dewatering

	Dia	Contract Rate Min depth ($/m) 2014	Reference Rate Min depth ($/m) 2014	1.5m deep ($/m) 2014	3m deep ($/m) 2014	4.5m deep ($/m) 2014
Rock excavation Trench excavation (10% rock)	**100**	5	6	16	33	48
	150	6	7	18	34	51
	200	7	8	18	37	54
	250	8	9	20	39	58
	300	11	12	20	42	63
	375	14	15	24	51	77
	450	17	19	27	57	86
	500	18	20	29	63	95
	600	23	25	34	66	102
	750	34	37	42	86	136
	900	46	51	51	104	157
Construction Difficulty MODERATE Ie. suburban site with other services, residential roads and traffic control	**100**	37	42			
	150	56	61			
	200	74	81			
	250	93	102			
	300	111	122			
	375	148	162			
	450	184	203			
	500	210	231			
	600	247	271			
	750	321	353			
	900	380	407			
HIGH ie. suburban site with other services, residential roads and traffic control	**100**	74	81			
	150	119	131			
	200	148	162			
	250	184	203			
	300	222	244			
	375	296	326			
	450	380	407			
	500	413	457			
	600	487	535			
	750	641	705			
	900	740	814			
Dewatering Assuming well point Dewatering. Note this may only apply to part of the length	**150**	93	102			
	300	104	115			
	500	111	122			
	600	123	136			
	900	130	142			

NOTES

1. These rates are for June 2014 valuation of the capital cost of existing assets and exclude contingencies and the GST. A suitable percentage for contingencies must be included (section 2.5 on page 8) for valuation of new works.
2. Reference Rate = 1.10 x Contract Rate (ie. Contract Rate plus SID of 10%).
3. Caution: These are additional costs which should be added to the rates determined from Table 1 on page 11, Table 2 on page 12, Table 3 on page 13, Table 9 on page 21 and Table 18 on page 36. These additional costs should be applied with judgement and care since they may represent a significant part of the total capital cost.

Risk Register.xlsx

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Coller 1	150 mm Gravity main	27	$ 8,262	100	$ 8,262	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
	150 mm Gravity main	17	$ 5,202	100	$ 5,202	y	y	y	y	3	1	LOW		3	1	LOW	
	375 mm Rising Main	21	$ 15,246	100	$ 15,246	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
	Pump Station	1	$ 1,000,000	25	$ 250,000	y	y	y	y	3	3	HIGH		3	3	HIGH	
	TOTAL		$ 1,028,710		$ 278,710												
	Subtotal Wastewater		$ 1,028,710		$ 278,710												
	Subtotal Water																
	Subtotal Buildings/Infrastructure																
	Subtotal Roads																

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
	150 mm Gravity main	27	$ 8,262	100	$ 8,262	y	y	y	y	5	1	MEDIUM		5	1	MEDIUM	
	150 mm Gravity main	17	$ 5,202	100	$ 5,202	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
	375 mm Rising Main	21	$ 15,246	100	$ 15,246	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
	Pump Station	1	$ 1,000,000	40	$ 400,000	y	y	y	y	4	3	HIGH		4	3	HIGH	
	TOTAL		$ 1,028,710		$ 428,710												
	Subtotal Wastewater		$ 1,028,710		$ 428,710												
	Subtotal Water																
	Subtotal Buildings/Infrastructure																
	Subtotal Roads																

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Near Golf Club	300 mm Gravity main	56	$ 33,824	100	$ 33,824	y	y	y	y	5	2	HIGH		5	2	HIGH	
Mitchell Pde and near Surf Club	150 mm Gravity main	51	$ 15,606	100	$ 15,606	y	y	y	y	5	2	HIGH	Concrete retaining wall	4	2	MEDIUM	
Near Golf Club	375 mm Rising Main	93	$ 67,518	100	$ 67,518	y	y	y	y	5	3	HIGH	Gabion Revetment	4	3	HIGH	
Near Golf Club	Pump Station	1	$ 1,000,000	100	$ 1,000,000	y	y	y	y	5	5	EXTREME	Gabion Revetment	4	4	HIGH	
Mitchell Pde	250 mm Rising Main	47	$ 20,586	100	$ 20,586	y	y	y	y	5	2	HIGH		5	2	HIGH	
Pump Station north side of bridge	Pump Station	1	$ 1,000,000	100	$ 1,000,000	y	y	y	y	3	5	HIGH	Rock revetment	2	2	LOW	
Small Pump Station opposite 57 Mitchell	Pump Station small	1	$ 500,000	100	$ 500,000	y	y	y	y	5	4	EXTREME		5	4	EXTREME	
near 57 Mitchell	100 mm Rising Main	6	$ 1,176	100	$ 1,176	y	y	y	y	5	1	MEDIUM		5	1	MEDIUM	
Near Golf Club	300 mm Gravity main	83	$ 50,132	100	$ 50,132	y	y	y	y	4	3	HIGH		4	3	HIGH	
Mitchell Pde and near Surf Club	150 mm Gravity main	138	$ 42,228	100	$ 42,228	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
Near Golf Club	375 mm Rising Main	50	$ 36,300	100	$ 36,300	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
Mitchell Pde	250 mm Rising Main	91	$ 39,858	100	$ 39,858	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
near 57 Mitchell	100 mm Rising Main	7	$ 1,372	100	$ 1,372	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
Near Golf Club	300 mm Gravity main	8	$ 4,832	100	$ 4,832	y	y	y	y	3	1	LOW		3	1	LOW	
Pump Station Beach Rd	Pump Station	1	$ 1,000,000	100	$ 1,000,000	y	y	y	y	3	5	HIGH		3	5	HIGH	
Mitchell Pde and near Surf Club	150 mm Gravity main	206	$ 63,036	100	$ 63,036	y	y	y	y	3	3	HIGH		3	3	HIGH	
Near Golf Club	375 mm Rising Main	10	$ 7,260	100	$ 7,260	y	y	y	y	3	1	LOW		3	1	LOW	
Mitchell Pde	250 mm Rising Main	166	$ 72,708	100	$ 72,708	y	y	y	y	3	3	HIGH		3	3	HIGH	
near 57 Mitchell	100 mm Rising Main	61	$ 11,956	100	$ 11,956	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Water																	
Near Golf Ave	100 mm Reticulation Main	10	$ 1,760	100	$ 1,760	y	y	y	y	5	1	MEDIUM	Sandstone Seawall	3	1	LOW	
Near Golf Ave	100 mm Reticulation Main	15	$ 2,640	100	$ 2,640	y	y	y	y	4	1	MEDIUM	Sandstone Seawall	3	1	LOW	
Near Golf Ave	100 mm Reticulation Main	18	$ 3,168	100	$ 3,168	y	y	y	y	3	1	LOW	Sandstone Seawall	3	1	LOW	
Mitchell Ave	250 mm Trunk Water Main	58	$ 23,374	100	$ 23,374	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Mitchell Ave	200 mm Trunk Water Main	52	$ 16,744	100	$ 16,744	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Buildings and Other Infrastructure																	
Bridge on Mitchell Parade	Bridge	139	$ 487,890	10	$ 48,789	n	n	y	n	1	2	LOW	Rock revetment	0	2	LOW	
Golf Club	Golf Club	1	$ 10,000,000	50	$ 5,000,000	y	y	y	y	5	5	EXTREME	Gabion Revetment	4	5	EXTREME	
SLSC	SLSC	1	$ 3,000,000	50	$ 1,500,000	y	y	y	y	3	5	HIGH	Concrete retaining wall	3	5	HIGH	
SLSC Carpark	Carpark	57	$ 10,032	50	$ 5,016	y	y	y	y	3	1	LOW	Concrete retaining wall	3	1	LOW	
Roads																	
Golf Avenue/Ocean St	Roads	36	$ 17,424	100	$ 17,424	y	y	y	y	5	2	HIGH	Sandstone Seawall	3	2	MEDIUM	
Golf Avenue/Ocean St	Roads	32	$ 15,488	100	$ 15,488	y	y	y	y	3	2	MEDIUM	Sandstone Seawall	3	2	MEDIUM	
Mitchell Parade	Roads	84	$ 40,656	100	$ 40,656	y	y	y	y	5	2	HIGH		5	2	HIGH	
Mitchell Parade	Roads	98	$ 47,432	100	$ 47,432	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
Mitchell Parade	Roads	140	$ 67,760	100	$ 67,760	y	y	y	y	3	3	HIGH		3	3	HIGH	
Beach St	Roads	39	$ 18,876	100	$ 18,876	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Beach St	Roads	46	$ 22,264	100	$ 22,264	y	y	y	y	2	2	LOW		2	2	LOW	

TOTAL	$ 17,743,900	$ 10,799,783
Subtotal Wastewater	$ 3,968,392	$ 3,968,392
Subtotal Water	$ 47,686	$ 47,686
Subtotal Buildings/Infrastructure	$ 13,497,922	$ 6,553,805
Subtotal Roads	$ 229,900	$ 229,900

Risk Register.xlsx

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Near Golf Club	300 mm Gravity main	140	$ 84,560	100	$ 84,560	y	y	y	y	5	3	HIGH		5	3	HIGH	
Mitchell Pde and near Surf Club	150 mm Gravity main	120	$ 36,720	100	$ 36,720	y	y	y	y	5	2	HIGH	Concrete retaining wall	4	2	MEDIUM	
Near Golf Club	375 mm Rising Main	143	$ 103,818	100	$ 103,818	y	y	y	y	5	3	HIGH	Gabion Revetment	4	3	HIGH	
Near Golf Club	Pump Station	1	$ 1,000,000	100	$ 1,000,000	y	y	y	y	5	5	EXTREME	Gabion Revetment	4	4	HIGH	
Mitchell Pde	250 mm Rising Main	158	$ 69,204	100	$ 69,204	y	y	y	y	5	3	HIGH		5	3	HIGH	
Pump Station north side of bridge	Pump Station	1	$ 1,000,000	100	$ 1,000,000	y	y	y	y	3	5	HIGH	Rock revetment	2	2	LOW	
Small Pump Station opposite 57 Mitchell	Pump Station small	1	$ 500,000	100	$ 500,000	y	y	y	y	5	4	EXTREME		5	4	EXTREME	
near 57 Mitchell	100 mm Rising Main	11	$ 2,156	100	$ 2,156	y	y	y	y	5	1	MEDIUM		5	1	MEDIUM	
Near Golf Club	300 mm Gravity main	10	$ 6,040	100	$ 6,040	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
Mitchell Pde and near Surf Club	150 mm Gravity main	276	$ 84,456	100	$ 84,456	y	y	y	y	4	3	HIGH		4	3	HIGH	
Near Golf Club	375 mm Rising Main	9	$ 6,534	100	$ 6,534	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
Mitchell Pde	250 mm Rising Main	139	$ 60,882	100	$ 60,882	y	y	y	y	4	3	HIGH		4	3	HIGH	
near 57 Mitchell and at Beach Rd	100 mm Rising Main	62	$ 12,152	100	$ 12,152	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
Near Golf Club	300 mm Gravity main	6	$ 3,624	100	$ 3,624	y	y	y	y	3	1	LOW		3	1	LOW	
Mitchell Pde and near Surf Club	150 mm Gravity main	144	$ 44,064	100	$ 44,064	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Pump Station Beach Rd	Pump Station	1	$ 1,000,000	100	$ 1,000,000	y	y	y	y	4	5	EXTREME		4	5	EXTREME	
Near Golf Club	375 mm Rising Main	7	$ 5,082	100	$ 5,082	y	y	y	y	3	1	LOW		3	1	LOW	
Mitchell Pde	250 mm Rising Main	21	$ 9,198	100	$ 9,198	y	y	y	y	3	1	LOW		3	1	LOW	
near 57 Mitchell & Beach Rd	100 mm Rising Main	41	$ 8,036	100	$ 8,036	y	y	y	y	3	1	LOW		3	1	LOW	
Water																	
Near Golf Ave	100 mm Reticulation Main	25	$ 4,400	100	$ 4,400	y	y	y	y	5	1	MEDIUM	Sandstone Seawall	3	1	LOW	
Near Golf Ave	100 mm Reticulation Main	17	$ 2,992	100	$ 2,992	y	y	y	y	4	1	MEDIUM	Sandstone Seawall	3	1	LOW	
Near Golf Ave	100 mm Reticulation Main	16	$ 2,816	100	$ 2,816	y	y	y	y	3	1	LOW	Sandstone Seawall	3	1	LOW	
Beach Rd	100 mm Reticulation Main	29	$ 5,104	100	$ 5,104	y	y	y	y	3	1	LOW		3	1	LOW	
Mitchell Ave	250 mm Trunk Water Main	54	$ 21,762	100	$ 21,762	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
Mitchell Ave	250 mm Trunk Water Main	63	$ 25,389	100	$ 25,389	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Mitchell Ave	200 mm Trunk Water Main	7	$ 2,254	100	$ 2,254	y	y	y	y	3	1	LOW		3	1	LOW	
Mitchell Ave	200 mm Trunk Water Main	53	$ 17,066	100	$ 17,066	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
Buildings and Other Infrastructure																	
Bridge on Mitchell Parade	Bridge	139	$ 487,890	10	$ 48,789	n	n	y	n	1	2	LOW	Rock revetment	0	2	LOW	
Golf Club	Golf Club	1	$ 10,000,000	50	$ 5,000,000	y	y	y	y	5	5	EXTREME	Gabion Revetment	4	5	EXTREME	
SLSC	SLSC	1	$ 3,000,000	50	$ 1,500,000	y	y	y	y	4	5	EXTREME	Concrete retaining wall	3	5	HIGH	
SLSC Carpark	Carpark	139	$ 24,464	50	$ 12,232	y	y	y	y	3	2	MEDIUM	Concrete retaining wall	3	2	MEDIUM	
SLSC Carpark	Carpark	57	$ 10,032	50	$ 5,016	y	y	y	y	4	1	MEDIUM	Concrete retaining wall	3	1	LOW	
Roads																	
Golf Avenue/Ocean St	Roads	51	$ 24,684	100	$ 24,684	y	y	y	y	5	2	HIGH	Sandstone Seawall	3	2	MEDIUM	
Golf Avenue/Ocean St	Roads	15	$ 7,260	100	$ 7,260	y	y	y	y	4	1	MEDIUM	Sandstone Seawall	3	1	LOW	
Golf Avenue/Ocean St	Roads	15	$ 7,260	100	$ 7,260	y	y	y	y	3	1	LOW	Sandstone Seawall	3	1	LOW	
Mitchell Parade	Roads	149	$ 72,116	100	$ 72,116	y	y	y	y	5	3	HIGH		5	3	HIGH	
Mitchell Parade	Roads	253	$ 122,452	100	$ 122,452	y	y	y	y	4	3	HIGH		4	3	HIGH	
Mitchell Parade	Roads	85	$ 41,140	100	$ 41,140	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Beach St	Roads	40	$ 19,360	100	$ 19,360	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
Beach St	Roads	44	$ 21,296	100	$ 21,296	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	

	Value	Damage Cost
TOTAL	$ 17,956,263	$ 10,999,914
Subtotal Wastewater	$ 4,036,526	$ 4,036,526
Subtotal Water	$ 81,783	$ 81,783
Subtotal Buildings/Infrastructure	$ 13,522,386	$ 6,566,037
Subtotal Roads	$ 315,568	$ 315,568

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Near 12 Victor Ave	200 mm Rising Main	53	$ 18,656	100	$ 18,656	y	y	y	y	5	2	HIGH		5	2	HIGH	
Near 12 Victor Ave	150 mm Gravity main	18	$ 5,508	100	$ 5,508	y	y	y	y	5	1	MEDIUM		5	1	MEDIUM	
Near 12 Victor Ave	200 mm Rising Main	9	$ 3,168	100	$ 3,168	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
Near 12 Victor Ave	150 mm Gravity main	11	$ 3,366	100	$ 3,366	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
Near 12 Victor Ave	200 mm Rising Main	7	$ 2,464	100	$ 2,464	y	y	y	y	3	1	LOW		3	1	LOW	
Near 12 Victor Ave	150 mm Gravity main	24	$ 7,344	100	$ 7,344	y	y	y	y	3	1	LOW		3	1	LOW	
Water																	
Buildings and Other Infrastructure																	
Amenities Block in park	Amenities	1	$ 100,000	5	$ 5,000	n	n	y	n	4	1	MEDIUM		4	1	$ 45,506	
Roads																	

TOTAL	$ 140,506	$ 45,506
Subtotal Wastewater	$ 40,506	$ 40,506
Subtotal Water	$ -	$ -
Subtotal Buildings/Infrastructure	$ 100,000	$ 5,000
Subtotal Roads	$ -	$ -

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Near 12 Victor Ave	200 mm Rising Main	68	$ 23,936	100	$ 23,936	y	y	y	y	5	2	HIGH		5	2	HIGH	
Near 12 Victor Ave	150 mm Gravity main	26	$ 7,956	100	$ 7,956	y	y	y	y	5	1	MEDIUM		5	1	MEDIUM	
Near 12 Victor Ave	200 mm Rising Main	5	$ 1,760	100	$ 1,760	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
Near 12 Victor Ave	150 mm Gravity main	21	$ 6,426	100	$ 6,426	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
Near 12 Victor Ave	200 mm Rising Main	13	$ 4,576	100	$ 4,576	y	y	y	y	3	1	LOW		3	1	LOW	
Near 12 Victor Ave	150 mm Gravity main	12	$ 3,672	100	$ 3,672	y	y	y	y	3	1	LOW		3	1	LOW	
Water																	
Buildings and Other Infrastructure																	
Amenities Block in park	Amenities	1	$ 100,000	10	$ 10,000	n	n	y	n	5	2	HIGH		5	2	HIGH	
Roads																	

TOTAL	$ 148,326	$ 58,326
Subtotal Wastewater	$ 48,326	$ 48,326
Subtotal Water	$ -	$ -
Subtotal Buildings/Infrastructure	$ 100,000	$ 10,000
Subtotal Roads	$ -	$ -

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
No GIS data available												No GIS data available					
Water																	
No GIS data available												No GIS data available					
Buildings and Other Infrastructure																	
Carpark west end	Carpark	58	$ 10,208	50	$ 5,104	y	y	y	y	5	1	MEDIUM		5	1	MEDIUM	
Carpark west end	Carpark	65	$ 11,440	50	$ 5,720	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
Carpark west end	Carpark	377	$ 66,352	50	$ 33,176	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Playground	Playground	1	$ 50,000	50	$ 25,000	y	y	y	y	5	2	HIGH		3	2	MEDIUM	
Roads																	
Red Point Road	Roads	129	$ 62,436	100	$ 62,436	y	y	y	y	5	3	HIGH		5	3	HIGH	
Red Point Road	Roads	35	$ 16,940	100	$ 16,940	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	

TOTAL		$ 217,376	$ 148,376
Subtotal Wastewater		$ -	$ -
Subtotal Water		$ -	$ -
Subtotal Buildings/Infrastructure		$ 138,000	$ 69,000
Subtotal Roads		$ 79,376	$ 79,376

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
No GIS data available												No GIS data available					
Water																	
No GIS data available												No GIS data available					
Buildings and Other Infrastructure																	
Carpark west end	Carpark	123	$ 21,648	50	$ 10,824	y	y	y	y	5	2	HIGH		5	2	HIGH	
Carpark west end	Carpark	377	$ 66,352	50	$ 33,176	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
Carpark west end	Carpark	125	$ 22,000	50	$ 11,000	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Playground	Playground	1	$ 50,000	50	$ 25,000	y	y	y	y	5	2	HIGH		3	2	MEDIUM	
Roads																	
Red Point Road	Roads	142	$ 68,728	100	$ 68,728	y	y	y	y	5	3	HIGH		5	3	HIGH	
Red Point Road	Roads	43	$ 20,812	100	$ 20,812	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	

	Value	Damage Cost
TOTAL	$ 249,540	$ 169,540
Subtotal Wastewater	$ -	$ -
Subtotal Water	$ -	$ -
Subtotal Buildings/Infrastructure	$ 160,000	$ 80,000
Subtotal Roads	$ 89,540	$ 89,540

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
	450 mm Gravity Main	245	$ 257,740	100	$ 257,740	y	y	y	y	3	3	HIGH		3	3	HIGH	
	150 mm Gravity main	9	$ 2,754	100	$ 2,754	y	y	y	y	3	1	LOW		3	1	LOW	
	225 mm Rising Main	64	$ 28,032	100	$ 28,032	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
	225 mm Rising Main	312	$ 136,656	100	$ 136,656	y	y	y	y	3	3	HIGH		3	3	HIGH	
No GIS data for area north of creek												No GIS data for area north of creek					
Water																	
No GIS data for area north of creek												No GIS data for area north of creek					
Buildings and Other Infrastructure																	
Carpark north of creek	Carpark	129	$ 22,704	50	$ 11,352	n	n	y	n	5	2	HIGH		5	2	HIGH	
	Carpark	71	$ 12,496	50	$ 6,248	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
	Carpark	150	$ 26,400	50	$ 13,200	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Large Picnic Shelter	Picnic Shelter	1	$ 30,000	50	$ 15,000	y	y	y	y	5	2	HIGH		5	2	HIGH	
Roads																	
	Cycleway	350	$ 19,250	100	$ 19,250	y	y	y	y	5	2	HIGH		5	2	HIGH	
	Cycleway	960	$ 52,800	100	$ 52,800	y	y	y	y	4	3	HIGH		4	3	HIGH	
	Cycleway	440	$ 24,200	100	$ 24,200	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Ilfracombe Ave, Beach St	Roads	400	$ 193,600	100	$ 193,600	y	y	y	y	3	3	HIGH		3	3	HIGH	

TOTAL	$ 806,632	$ 760,832
Subtotal Wastewater	$ 425,182	$ 425,182
Subtotal Water	$ -	$ -
Subtotal Buildings/Infrastructure	$ 91,600	$ 45,800
Subtotal Roads	$ 289,850	$ 289,850

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
	450 mm Gravity Main	8	$ 8,416	100	$ 8,416	y	y	y	y	3	1	LOW		3	1	LOW	
	450 mm Gravity Main	245	$ 257,740	100	$ 257,740	y	y	y	y	4	3	HIGH		4	3	HIGH	
	150 mm Gravity main	9	$ 2,754	100	$ 2,754	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
	150 mm Gravity main	12	$ 3,672	100	$ 3,672	y	y	y	y	3	1	LOW		3	1	LOW	
	225 mm Rising Main	64	$ 28,032	100	$ 28,032	y	y	y	y	5	2	HIGH		5	2	HIGH	
	225 mm Rising Main	300	$ 131,400	100	$ 131,400	y	y	y	y	4	3	HIGH		4	3	HIGH	
	225 mm Rising Main	107	$ 46,866	100	$ 46,866	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
No GIS data for area north of creek												No GIS data for area north of creek					
Water																	
	100 mm Reticulation Main	106	$ 18,656	50	$ 9,328	n	n	y	n	3	1	LOW		3	1	LOW	
No GIS data for area north of creek												No GIS data for area north of creek					
Buildings and Other Infrastructure																	
Carpark north of creek	Carpark	200	$ 35,200	50	$ 17,600	n	n	y	n	5	2	HIGH		5	2	HIGH	
	Carpark	150	$ 26,400	50	$ 13,200	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
	Carpark	54	$ 9,504	50	$ 4,752	y	y	y	y	3	1	LOW		3	1	LOW	
Large Picnic Shelter	Picnic Shelter	1	$ 30,000	50	$ 15,000	y	y	y	y	5	2	HIGH		5	2	HIGH	
Roads																	
	Cycleway	1310	$ 72,050	100	$ 72,050	y	y	y	y	5	3	HIGH		5	3	HIGH	
	Cycleway	440	$ 24,200	100	$ 24,200	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
	Cycleway	30	$ 1,650	100	$ 1,650	y	y	y	y	3	1	LOW		3	1	LOW	
Ilfracombe Ave, Beach St	Roads	400	$ 193,600	100	$ 193,600	y	y	y	y	4	3	HIGH		4	3	HIGH	
Ilfracombe Ave, Beach St	Roads	50	$ 24,200	100	$ 24,200	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	

TOTAL	$ 914,340		$ 854,460
Subtotal Wastewater	$ 478,880		$ 478,880
Subtotal Water	$ 18,656		$ 9,328
Subtotal Buildings/Infrastructure	$ 101,104		$ 50,552
Subtotal Roads	$ 315,700		$ 315,700

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Water																	
Buildings and Other Infrastructure																	
Tennis Club	Tennis Club	1	$ 600,000	25	$ 150,000	y	y	y	y	5	3	HIGH		5	3	HIGH	
	Carpark	48	$ 8,448	50	$ 4,224	y	y	y	y	5	1	MEDIUM		5	1	MEDIUM	
	Carpark	250	$ 44,000	50	$ 22,000	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Toilet Block	Amenities	1	$ 100,000	100	$ 100,000	y	y	y	y	5	3	HIGH		5	3	HIGH	
Calalla Beach Road	Carpark	250	$ 44,000	50	$ 22,000	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Roads																	

TOTAL	$ 796,448	$ 298,224
Subtotal Wastewater	$ -	$ -
Subtotal Water	$ -	$ -
Subtotal Buildings/Infrastructure	$ 796,448	$ 298,224
Subtotal Roads	$ -	$ -

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Water																	
Buildings and Other Infrastructure																	
Tennis Club	Tennis Club	1	$ 600,000	60	$ 360,000	y	y	y	y	5	3	HIGH		5	3	HIGH	
	Carpark	300	$ 52,800	50	$ 26,400	y	y	y	y	5	2	HIGH		5	2	HIGH	
	Carpark	160	$ 28,160	50	$ 14,080	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Toilet Block Tennis Club	Amenities	1	$ 100,000	100	$ 100,000	y	y	y	y	5	3	HIGH		5	3	HIGH	
Toilet Block Callala Beach Road	Amenities	1	$ 100,000	50	$ 50,000	y	y	y	y	3	3	HIGH		3	3	HIGH	
Calalla Beach Road	Carpark	250	$ 44,000	50	$ 22,000	y	y	y	y	5	2	HIGH		5	2	HIGH	
	Carpark	250	$ 44,000	50	$ 22,000	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
Roads																	
Greenway Road	Roads	500	$ 242,000	100	$ 242,000	y	y	y	y	3	3	HIGH		3	3	HIGH	

	Value	Damage Cost
TOTAL	$ 1,210,960	$ 836,480
Subtotal Wastewater	$ -	$ -
Subtotal Water	$ -	$ -
Subtotal Buildings/Infrastructure	$ 968,960	$ 594,480
Subtotal Roads	$ 242,000	$ 242,000

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Beecroft Pde	150 mm Gravity main	245	$ 74,970	100	$ 74,970	y	y	y	y	5	3	HIGH		5	3	HIGH	
Warrain Cr	150 mm Gravity main	16	$ 4,896	100	$ 4,896	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
	150 mm Gravity main	17	$ 5,202	100	$ 5,202	y	y	y	y	3	1	LOW		3	1	LOW	
Water																	
	100 mm Reticulation Main	39	$ 6,864	100	$ 6,864	y	y	y	y	5	1	MEDIUM		5	1	MEDIUM	
	100 mm Reticulation Main	111	$ 19,536	100	$ 19,536	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
	100 mm Reticulation Main	15	$ 2,640	100	$ 2,640	y	y	y	y	3	1	LOW		3	1	LOW	
Buildings and Other Infrastructure																	
	Carpark	600	$ 105,600	10	$ 10,560	n	n	y	n	4	2	MEDIUM		4	2	MEDIUM	
	Amenities	1	$ 100,000	50	$ 50,000	y	y	y	y	4	3	HIGH		4	3	HIGH	
Near boat ramp	Playground	1	$ 50,000	50	$ 25,000	y	y	y	y	5	3	HIGH		5	3	HIGH	
Roads																	
Warrain Cres and 20 m access to boat ramp	Roads	170	$ 82,280	100	$ 82,280	y	y	y	y	5	3	HIGH		5	3	HIGH	
	Roads	170	$ 82,280	100	$ 82,280	y	y	y	y	4	3	HIGH		4	3	HIGH	
	Roads	80	$ 38,720	100	$ 38,720	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	

	Value	Damage Cost
TOTAL	$ 572,988	$ 402,948
Subtotal Wastewater	$ 85,068	$ 85,068
Subtotal Water	$ 29,040	$ 29,040
Subtotal Buildings/Infrastructure	$ 255,600	$ 85,560
Subtotal Roads	$ 203,280	$ 203,280

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Beecroft Pde	150 mm Gravity main	245	$ 74,970	100	$ 74,970	y	y	y	y	5	3	HIGH		5	3	HIGH	
Warrain Cr	150 mm Gravity main	16	$ 4,896	100	$ 4,896	y	y	y	y	5	1	MEDIUM		5	1	MEDIUM	
	150 mm Gravity main	217	$ 66,402	100	$ 66,402	y	y	y	y	3	3	HIGH		3	3	HIGH	
	100 mm Gravity main	10	$ 2,310	100	$ 2,310	y	y	y	y	3	1	LOW		3	1	LOW	
	150 mm Gravity main	17	$ 5,202	100	$ 5,202	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
Water																	
	100 mm Reticulation Main	176	$ 30,976	100	$ 30,976	y	y	y	y	5	2	HIGH		5	2	HIGH	
	100 mm Reticulation Main	20	$ 3,520	100	$ 3,520	y	y	y	y	4	1	MEDIUM		4	1	MEDIUM	
	100 mm Reticulation Main	278	$ 48,928	100	$ 48,928	y	y	y	y	3	2	MEDIUM		3	2	MEDIUM	
	150 mm Reticulation Main	13	$ 3,523	100	$ 3,523	y	y	y	y	3	1	LOW		3	1	LOW	
Buildings and Other Infrastructure																	
	Carpark	600	$ 105,600	50	$ 52,800	n	n	y	n	5	3	HIGH		5	3	HIGH	
	Carpark	500	$ 88,000	50	$ 44,000	n	n	y	n	4	2	MEDIUM		4	2	MEDIUM	
	Amenities	1	$ 100,000	50	$ 50,000	y	y	y	y	4	3	HIGH		4	3	HIGH	
Near boat ramp	Playground	1	$ 50,000	50	$ 25,000	y	y	y	y	5	2	HIGH		5	2	HIGH	
Roads																	
Warrain Cres and 20 m access to boat ramp	Roads	340	$ 164,560	100	$ 164,560	y	y	y	y	5	3	HIGH		5	3	HIGH	
	Roads	80	$ 38,720	100	$ 38,720	y	y	y	y	4	2	MEDIUM		4	2	MEDIUM	
	Roads	260	$ 125,840	100	$ 125,840	y	y	y	y	3	3	HIGH		3	3	HIGH	
	TOTAL		$ 913,447		$ 741,647												
	Subtotal Wastewater		$ 153,780		$ 153,780												
	Subtotal Water		$ 86,947		$ 86,947												
	Subtotal Buildings/Infrastructure		$ 343,600		$ 171,800												
	Subtotal Roads		$ 329,120		$ 329,120												

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
	150 mm Gravity Main	30	$ 9,180	100	$ 9,180	n	n	y	n	3	1	LOW		3	1	LOW	
Water																	
Buildings and Other Infrastructure																	
SLSC	Carpark	10	$ 1,760	50	$ 880	n	n	y	n	3	1	LOW		3	1	LOW	
SLSC	SLSC	1	$ 3,000,000	10	$ 300,000	y	y	n	n	3	3	HIGH		3	3	HIGH	
Roads																	

TOTAL	$ 3,010,940	$ 310,060
Subtotal Wastewater	$ 9,180	$ 9,180
Subtotal Water	$ -	$ -
Subtotal Buildings/Infrastructure	$ 3,001,760	$ 300,880
Subtotal Roads	$ -	$ -

Warrain 2100

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
	150 mm Gravity Main	30	$ 9,180	100	$ 9,180	n	n	y	n	4	1	MEDIUM		4	1	MEDIUM	
Water																	
Buildings and Other Infrastructure																	
SLSC	Carpark	10	$ 1,760	50	$ 880	n	n	y	n	4	1	MEDIUM		4	1	MEDIUM	
	Carpark	230	$ 40,480	50	$ 20,240	n	n	y	n	3	2	MEDIUM		3	2	MEDIUM	
SLSC	SLSC	1	$ 3,000,000	30	$ 900,000	y	y	n	n	4	4	HIGH		4	4	HIGH	
Roads																	

TOTAL	$ 3,051,420	$ 930,300
Subtotal Wastewater	$ 9,180	$ 9,180
Subtotal Water	$ -	$ -
Subtotal Buildings/Infrastructure	$ 3,042,240	$ 921,120
Subtotal Roads	$ -	$ -

Risk Register.xlsx

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Water																	
Buildings and Other Infrastructure																	
Carpark at north end of beach	Carpark	110	$ 19,360	50	$ 9,680	n	n	y	n	5	1	MEDIUM		5	1	MEDIUM	
Carpark at north end of beach	Carpark	256	$ 45,056	50	$ 22,528	y	y	n	n	4	2	MEDIUM		4	2	MEDIUM	
Carpark at north end of beach	Carpark	309	$ 54,384	50	$ 27,192	y	y	n	n	3	2	MEDIUM		3	2	MEDIUM	
Carpark at east end of Allerton Ave	Carpark	110	$ 19,360	50	$ 9,680	y	y	n	n	3	1	LOW		3	1	LOW	
Roads																	
Access loop road to carpark at north end	Roads	50	$ 24,200	100	$ 24,200	y	y	y	n	5	2	HIGH		5	2	HIGH	
Access loop road to carpark at north end	Roads	30	$ 14,520	100	$ 14,520	y	y	y	n	3	2	MEDIUM		3	2	MEDIUM	

TOTAL	$ 176,880	$ 107,800
Subtotal Wastewater	$ -	$ -
Subtotal Water	$ -	$ -
Subtotal Buildings/Infrastructure	$ 138,160	$ 69,080
Subtotal Roads	$ 38,720	$ 38,720

Culburra 2100

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Water																	
Buildings and Other Infrastructure																	
Carpark at north end of beach	Carpark	356	$ 62,656	50	$ 31,328	n	n	y	n	5	2	HIGH		5	2	HIGH	
Carpark at north end of beach	Carpark	309	$ 54,384	50	$ 27,192	y	y	n	n	4	2	MEDIUM		4	2	MEDIUM	
Carpark at north end of beach	Carpark	280	$ 49,280	50	$ 24,640	y	y	n	n	3	2	MEDIUM		3	2	MEDIUM	
Carpark at east end of Allerton Ave	Carpark	110	$ 19,360	50	$ 9,680	y	y	n	n	4	1	MEDIUM		4	1	MEDIUM	
Carpark at east end of Allerton Ave	Carpark	75	$ 13,200	50	$ 6,600	y	y	n	n	3	1	LOW		3	1	LOW	
Roads																	
Access loop road to carpark at north end	Roads	60	$ 29,040	100	$ 29,040	y	y	y	n	5	2	HIGH		5	2	HIGH	
Access loop road to carpark at north end	Roads	20	$ 9,680	100	$ 9,680	y	y	y	n	4	1	MEDIUM		4	1	MEDIUM	
Access loop road to carpark at north end	Roads	20	$ 9,680	100	$ 9,680	y	y	y	n	3	1	LOW		3	1	LOW	
East end of Allerton Ave	Roads	20	$ 9,680	100	$ 9,680	y	y	y	n	3	1	LOW		3	1	LOW	

	Value	Damage Cost
TOTAL	$ 256,960	$ 157,520
Subtotal Wastewater	$ -	$ -
Subtotal Water	$ -	$ -
Subtotal Buildings/Infrastructure	$ 198,880	$ 99,440
Subtotal Roads	$ 58,080	$ 58,080

Risk Register.xlsx

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Water																	
Buildings and Other Infrastructure																	
SLSC	SLSC	1	$ 3,000,000	50	$ 1,500,000	y	y	y	n	5	5	EXTREME	Revetment	3	5	HIGH	
SLSC Carpark	Carpark	280	$ 49,280	100	$ 49,280	y	y	y	n	5	2	HIGH		5	2	HIGH	
SLSC Carpark	Carpark	423	$ 74,448	50	$ 37,224	n	y	n	n	4	2	MEDIUM		4	2	MEDIUM	
SLSC Carpark	Carpark	300	$ 52,800	50	$ 26,400	n	y	n	n	3	2	MEDIUM		3	2	MEDIUM	
Boatshed	Amenities	1	$ 100,000	10	$ 10,000	n	y	n	n	5	2	HIGH		5	2	HIGH	
Viewing Platforms	Amenities	1	$ 100,000	100	$ 100,000	n	y	n	n	5	3	HIGH		5	3	HIGH	
Amenities Block	Amenities	1	$ 100,000	10	$ 10,000	y	y	n	n	4	2	MEDIUM		4	2	MEDIUM	
Roads																	

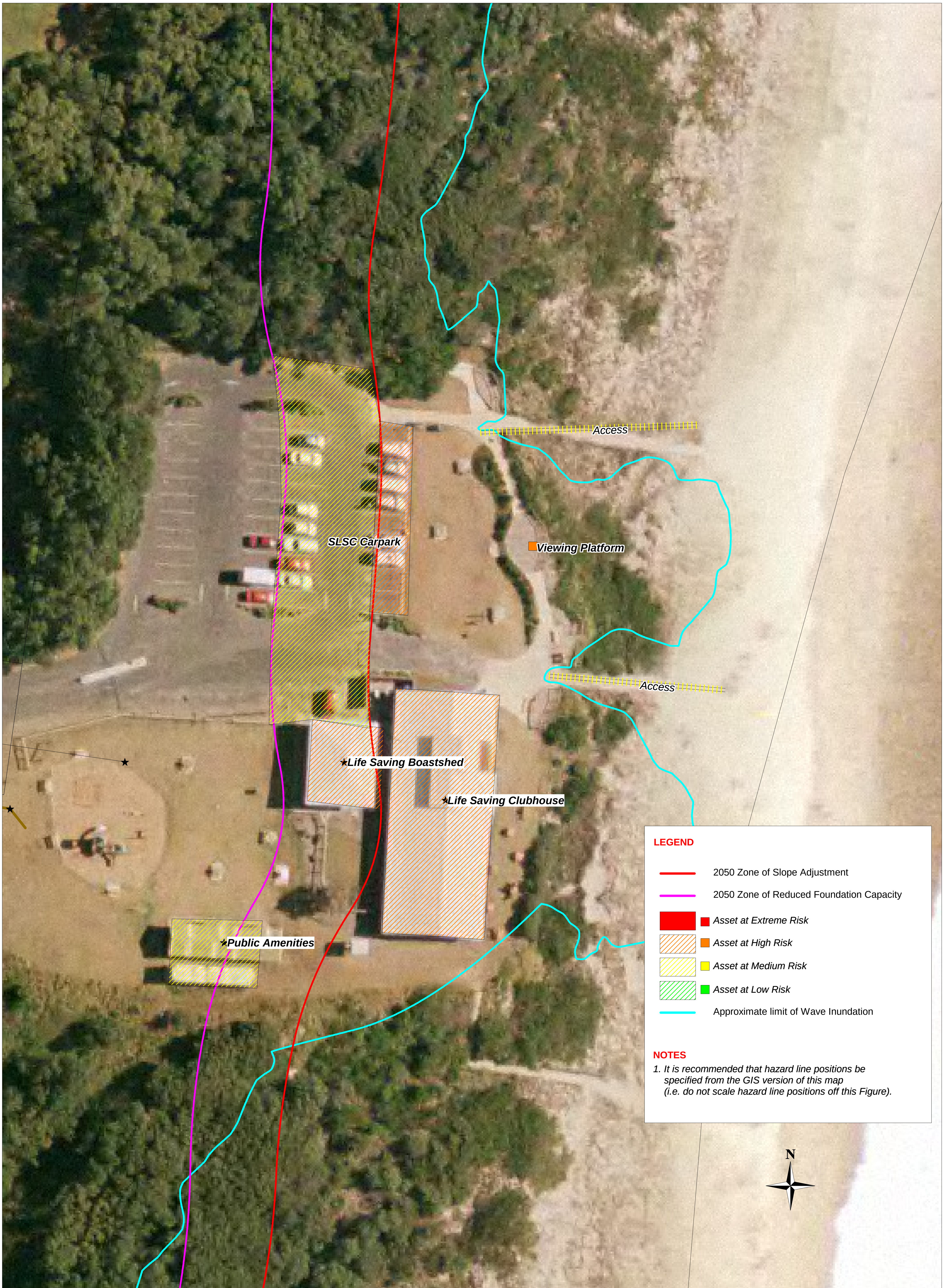
TOTAL	$ 3,476,528	$ 1,732,904
Subtotal Wastewater	$ -	$ -
Subtotal Water	$ -	$ -
Subtotal Buildings/Infrastructure	$ 3,476,528	$ 1,732,904
Subtotal Roads	$ -	$ -

Risk ID	Risk	Length/ Unit	Value	% Damage	Damage Cost	Erosion	ZRFC	Periodic Inundation	Frequent Inundation	Likelihood	Consequence	Risk Rating	Control Description (Existing Controls)	Likelihood	Consequence	Residual Risk Rating	Comments
Wastewater																	
Water																	
Buildings and Other Infrastructure																	
SLSC	SLSC	1	$ 3,000,000	50	$ 1,500,000	y	y	y	n	5	5	EXTREME	Revetment	4	5	EXTREME	
SLSC Carpark	Carpark	703	$ 123,728	100	$ 123,728	y	y	y	n	5	3	HIGH		5	3	HIGH	
SLSC Carpark	Carpark	300	$ 52,800	50	$ 26,400	n	y	n	n	4	2	MEDIUM		4	2	MEDIUM	
SLSC Carpark	Carpark	457	$ 80,432	50	$ 40,216	n	y	n	n	3	2	MEDIUM		3	2	MEDIUM	
Boatshed	Amenities	1	$ 100,000	100	$ 100,000	n	y	n	n	5	3	HIGH		5	3	HIGH	
Viewing Platforms	Amenities	1	$ 100,000	100	$ 100,000	n	y	n	n	5	3	HIGH		5	3	HIGH	
Amenities Block	Amenities	1	$ 100,000	100	$ 100,000	n	y	n	n	5	3	HIGH		5	3	HIGH	
Roads																	

TOTAL	$ 3,556,960	$ 1,990,344
Subtotal Wastewater	$ -	$ -
Subtotal Water	$ -	$ -
Subtotal Buildings/Infrastructure	$ 3,556,960	$ 1,990,344
Subtotal Roads	$ -	$ -

Risk Register.xlsx

Appendix B Risk Mapping



DATE 27/04/18	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Shoalhaven Heads 2050 Risk Map SLSC	Shoalhaven City Council
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Risk Mapping	**CREATED BY** C. Adamantidis	Advisian WorleyParsons Group

DATE 27/04/18	0 5 10 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Shoalhaven Heads 2100 Risk Map SLSC
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Risk Mapping		**CREATED BY** C. Adamantidis

Shoalhaven City Council Advisian WorleyParsons Group

DATE 27/04/18	0 50 100 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Shoalhaven Heads 2050 Risk Map showing Beach Access locations
PROJECT NO. 301015-03933	PROJECT TITLE Shoalhaven Coastal Risk Mapping		CREATED BY C. Adamantidis

Shoalhaven City Council
Advisian WorleyParsons Group

DATE 27/04/18

0 50 100 metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Shoalhaven Heads 2100 Risk Map showing Beach Access locations

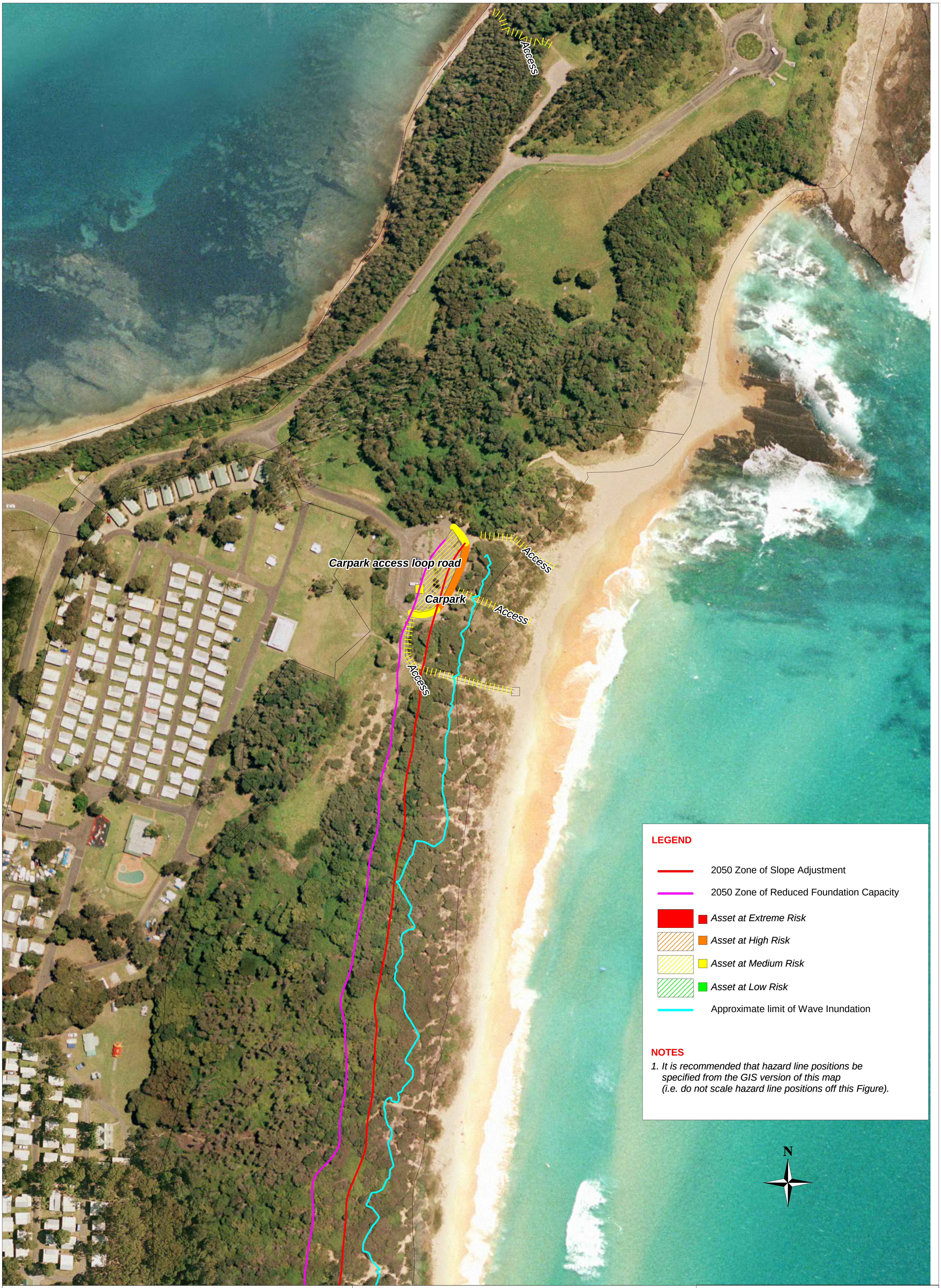
PROJECT NO. 301015-03933

PROJECT TITLE Shoalhaven Coastal Risk Mapping

CREATED BY C. Adamantidis

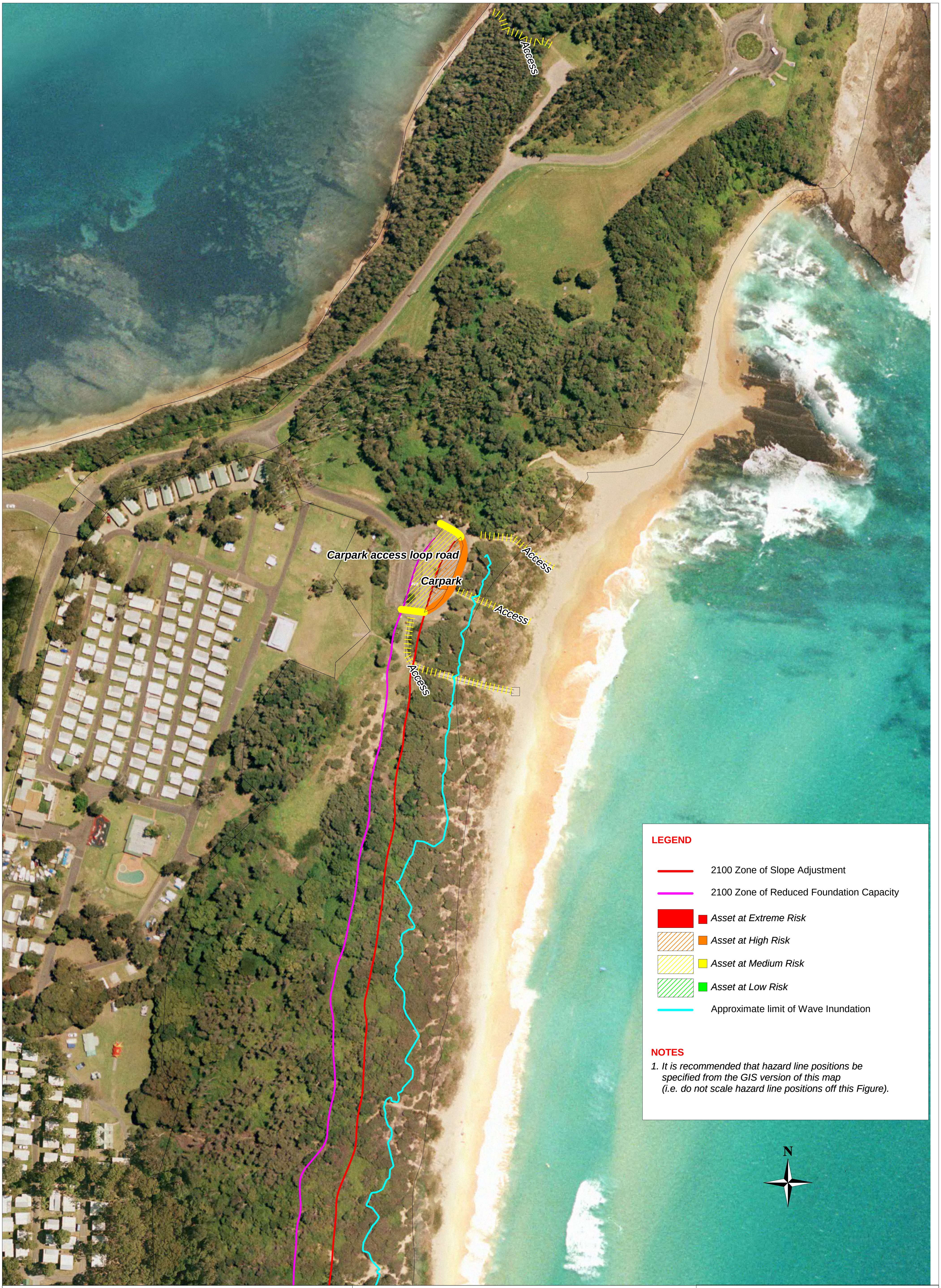
Shoalhaven City Council

Advisian WorleyParsons Group



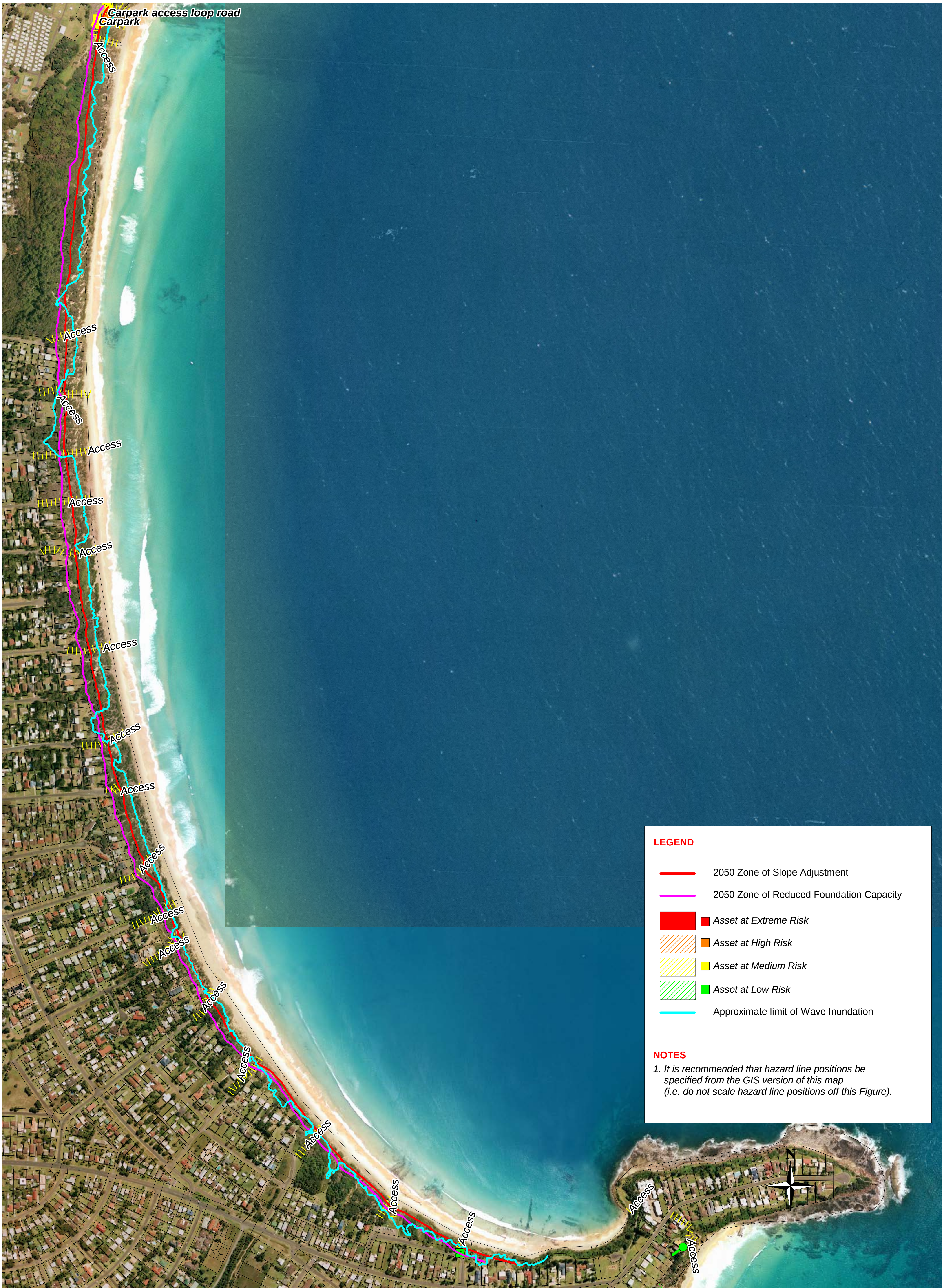
DATE 27/04/18	0 25 50 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Culburra 2050 Risk Map (North)
PROJECT NO. 301015-03933		**PROJECT TITLE** Shoalhaven Coastal Risk Mapping	**CREATED BY** C. Adamantidis

Shoalhaven City Council — Advisian WorleyParsons Group



DATE 27/04/18	0 25 50 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Culburra 2100 Risk Map (North)
PROJECT NO. 301015-03933		**PROJECT TITLE** Shoalhaven Coastal Risk Mapping	**CREATED BY** C. Adamantidis

Shoalhaven City Council
Advisian WorleyParsons Group



DATE 27/04/18

0 100 200
metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Culburra 2050 Risk Map showing Beach Access locations

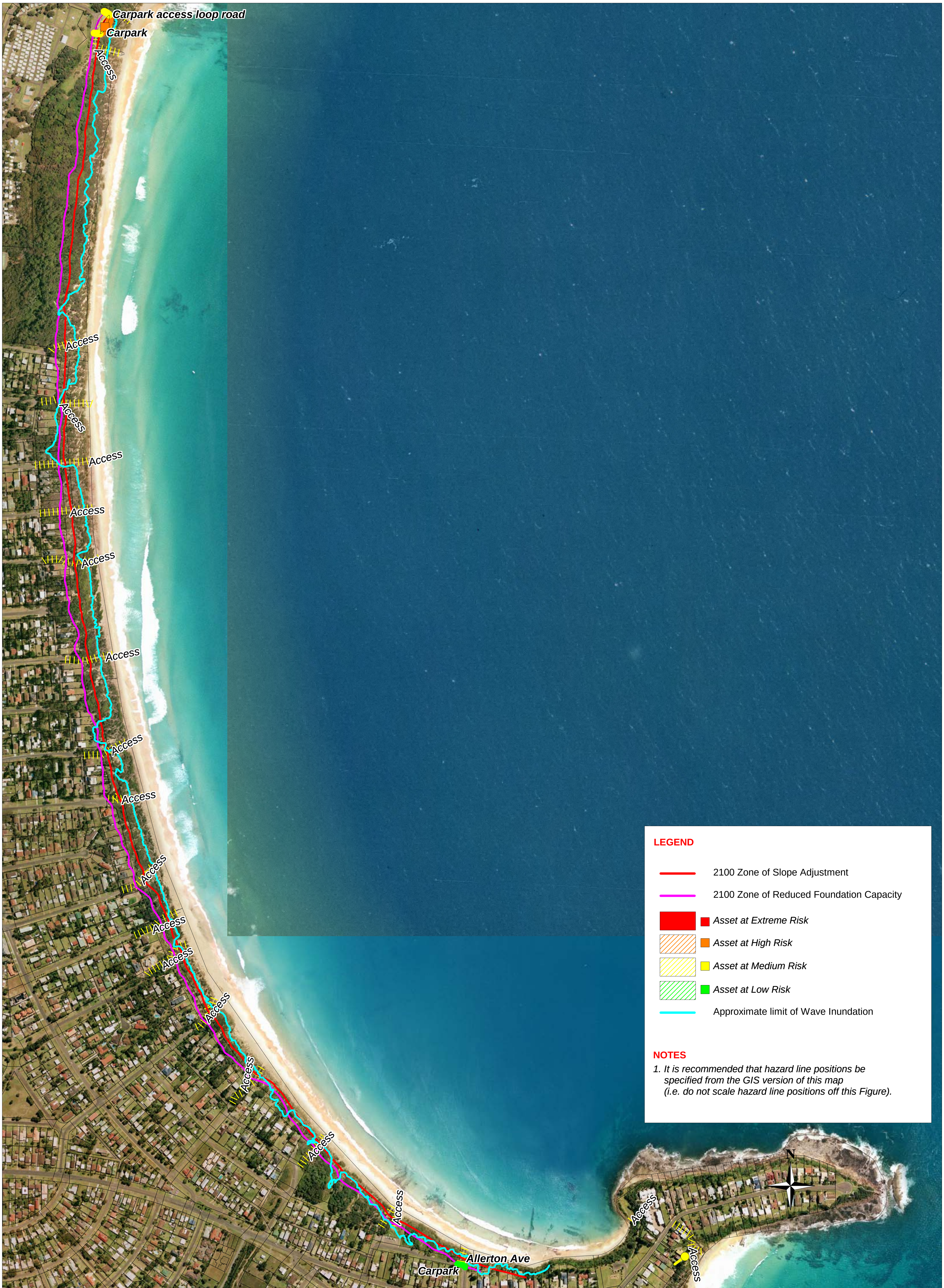
PROJECT NO. 301015-03933

PROJECT TITLE Shoalhaven Coastal Risk Mapping

CREATED BY C. Adamantidis

Shoalhaven City Council

Advisian
WorleyParsons Group



DATE 27/04/18

0 100 200 metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Culburra 2100 Risk Map showing Beach Access locations

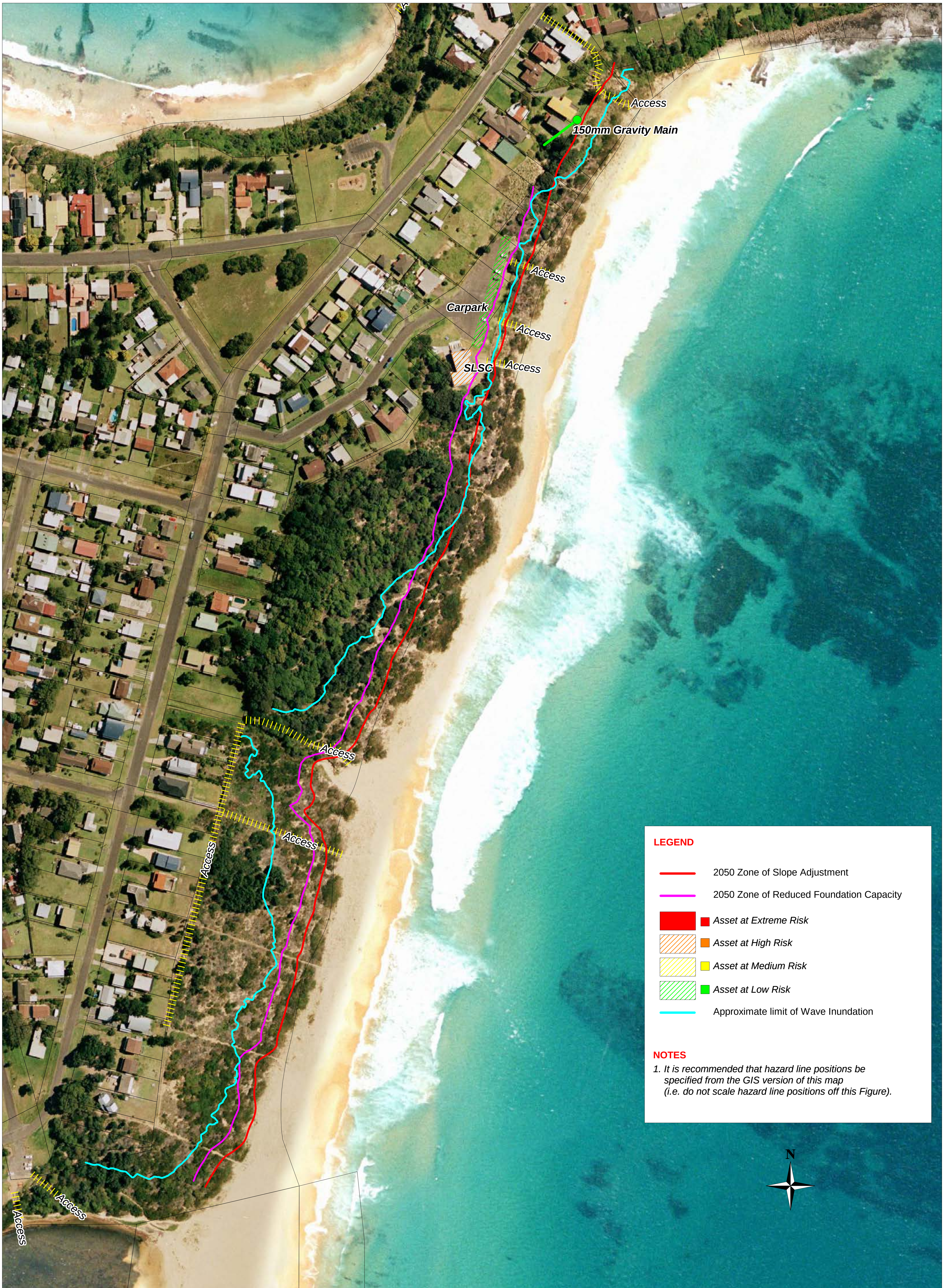
PROJECT NO. 301015-03933

PROJECT TITLE Shoalhaven Coastal Risk Mapping

CREATED BY C. Adamantidis

Shoalhaven City Council

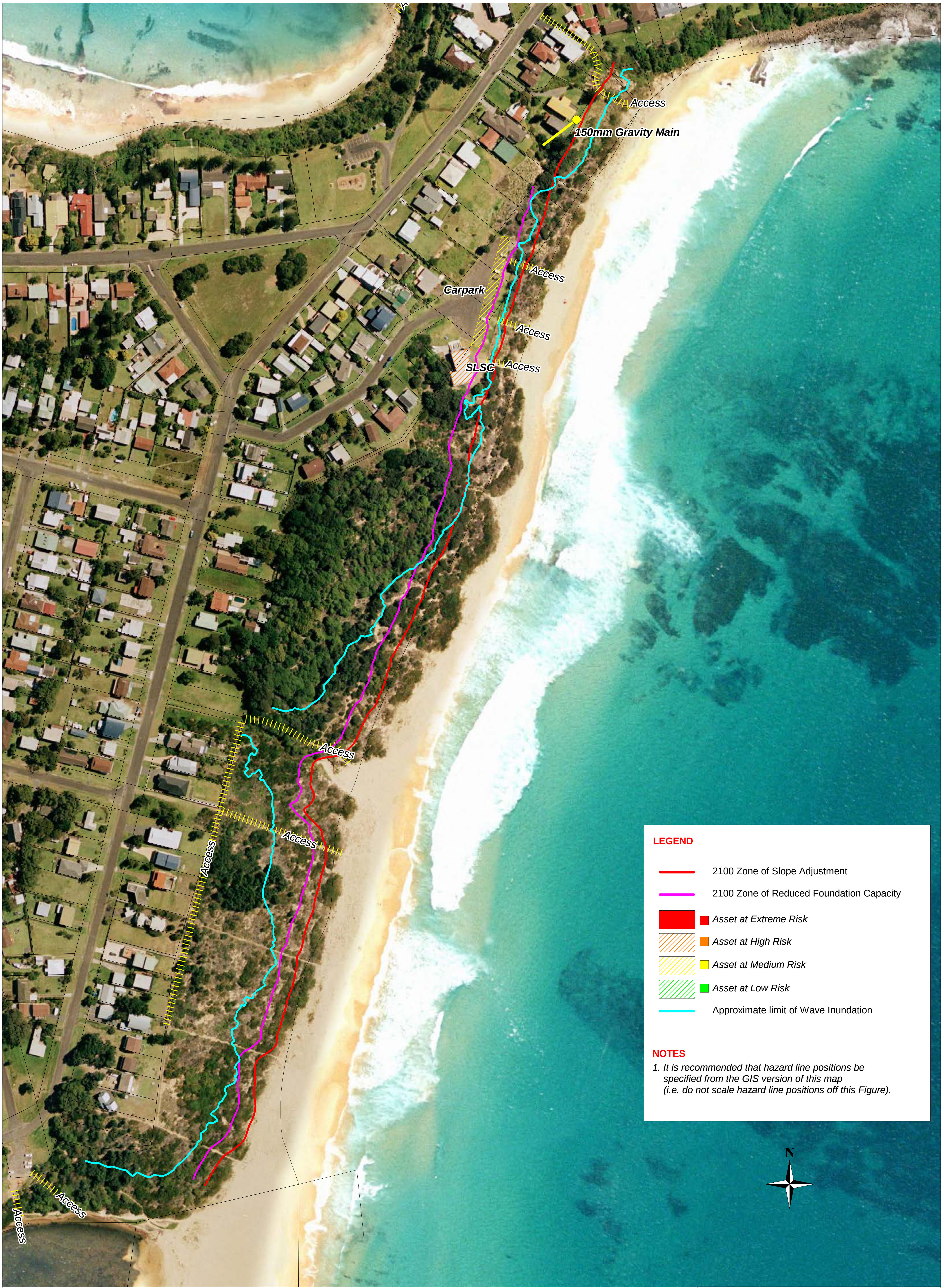
Advisian WorleyParsons Group



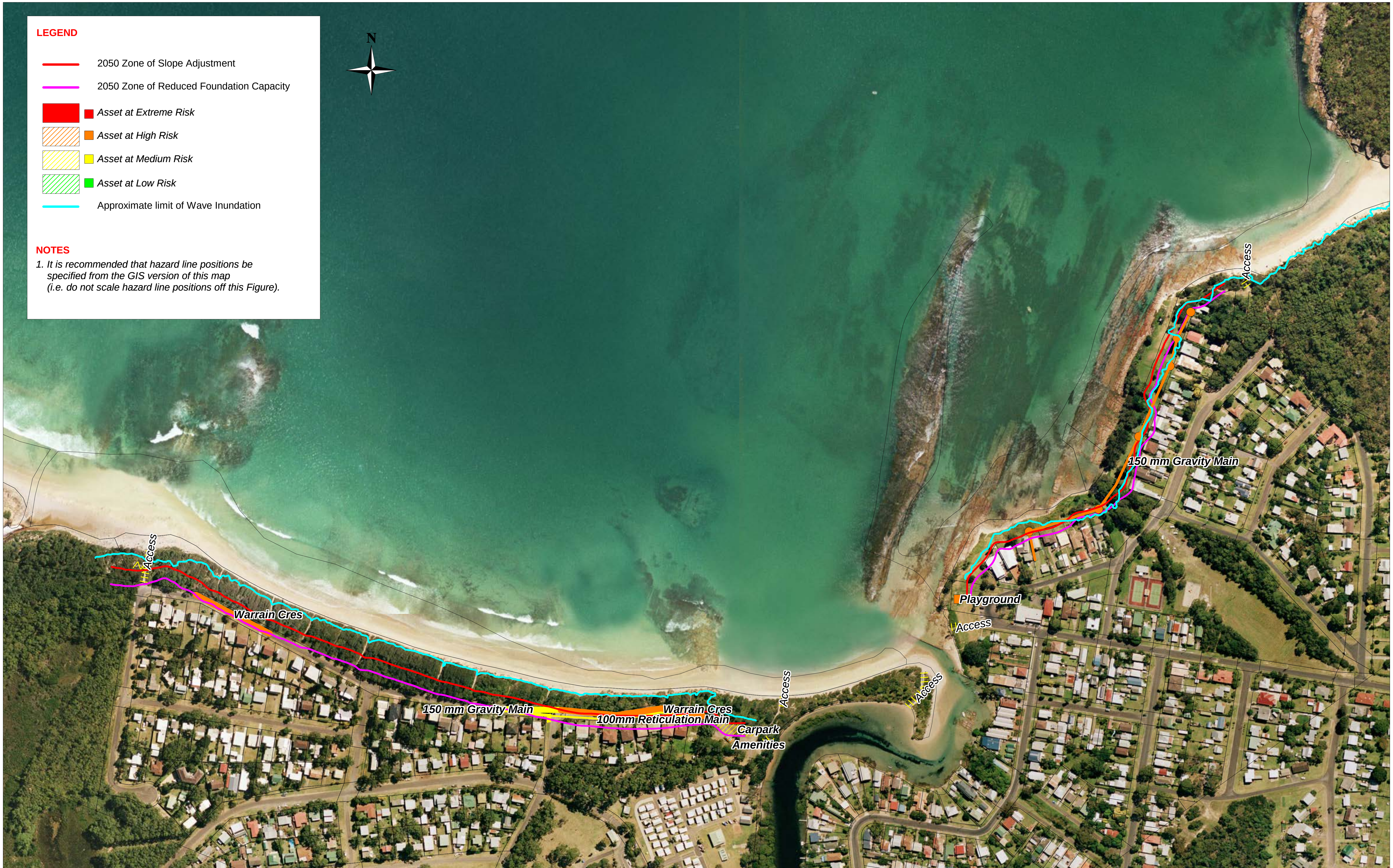
DATE 27/04/18	0 25 50 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Warrain 2050 Risk Map
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Risk Mapping		**CREATED BY** C. Adamantidis

Shoalhaven City Council

Advisian WorleyParsons Group



DATE 27/04/18	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Warrain 2100 Risk Map	Shoalhaven City Council
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Risk Mapping	**CREATED BY** C. Adamantidis	Advisian WorleyParsons Group



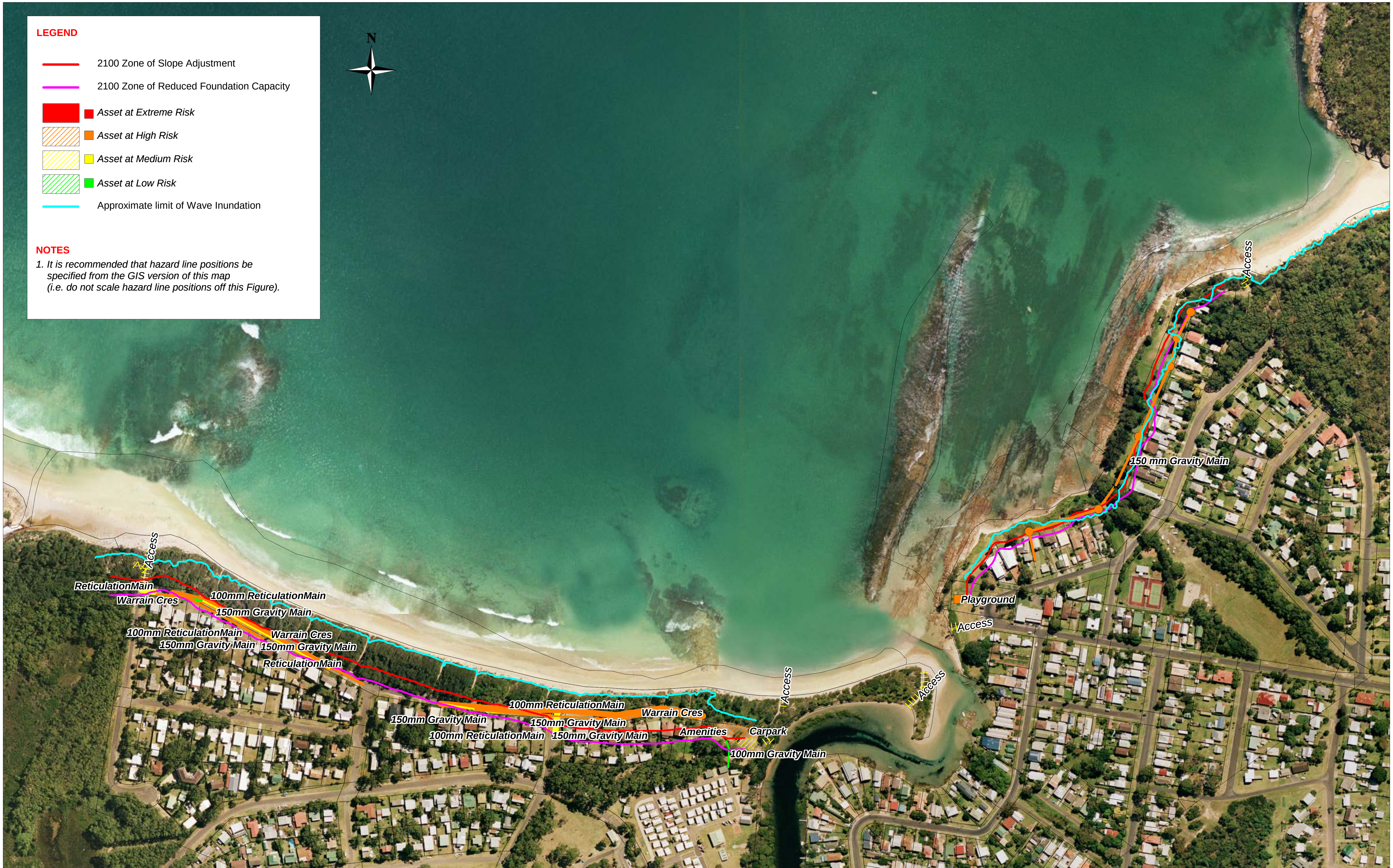
DATE	27/4/18	0 50 100 metres	COORDINATE SYSTEM MGA Zone 56
PROJECT NO.	301015-03933	PROJECT TITLE	Shoalhaven Coastal Mapping

FIGURE TITLE Currarong 2050 Risk Map

CREATED BY C. Adamantidis

Shoalhaven City Council

Advisian WorleyParsons Group



DATE	27/4/18	0 50 100 metres	**COORDINATE SYSTEM**	MGA Zone 56	
PROJECT NO.	301015-03933	**PROJECT TITLE**	Shoalhaven Coastal Mapping		

FIGURE TITLE Currarong 2100 Risk Map

CREATED BY C. Adamantidis

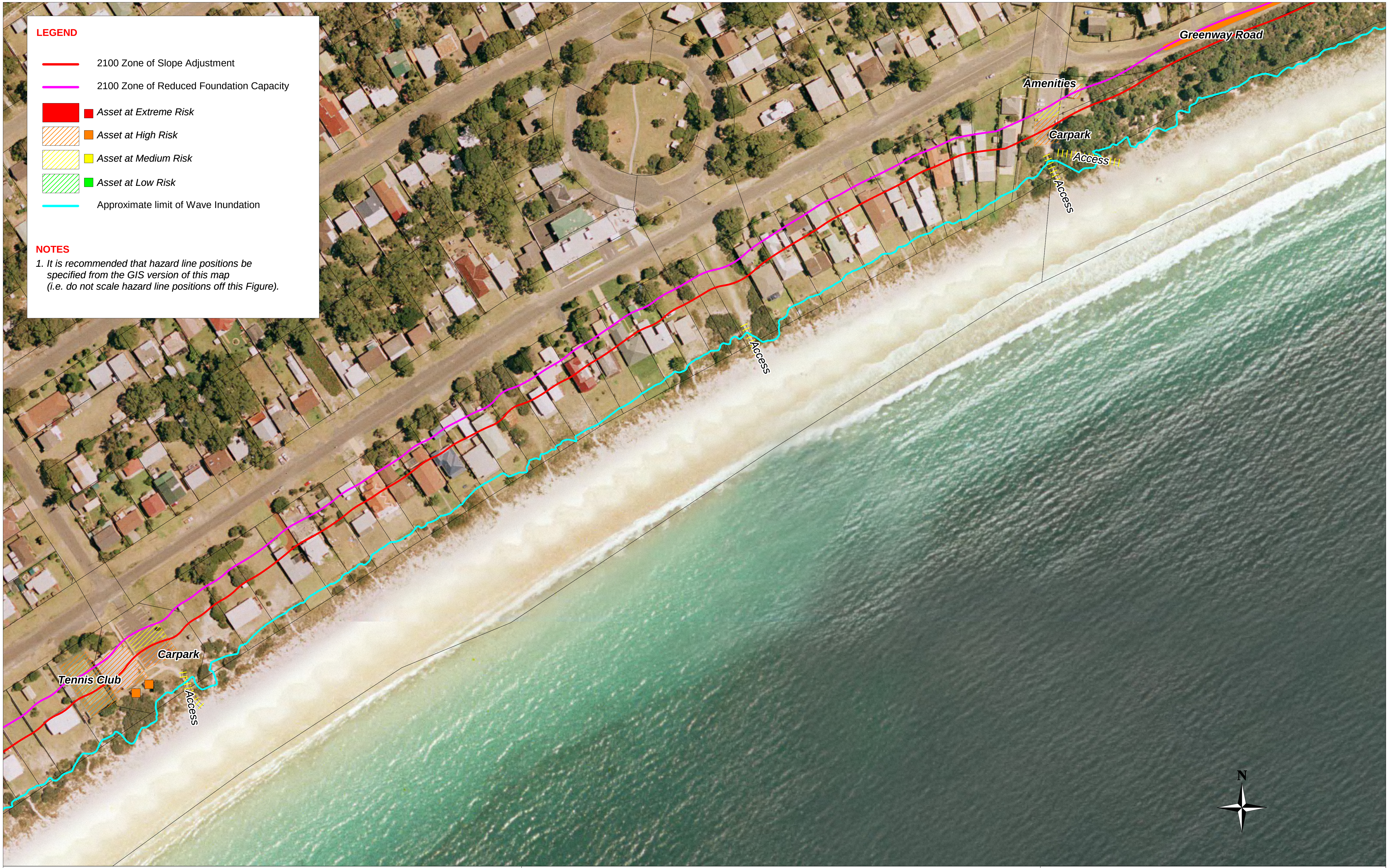
Shoalhaven City Council

Advisian WorleyParsons Group

DATE 27/4/18	0 25 50 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Callala 2050 Risk Map
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Mapping		**CREATED BY** C. Adamantidis

Shoalhaven City Council

Advisian
WorleyParsons Group



DATE	27/4/18	0 25 50 metres	COORDINATE SYSTEM	MGA Zone 56	FIGURE TITLE	Callala 2100 Risk Map
PROJECT NO.	301015-03933	PROJECT TITLE	Shoalhaven Coastal Mapping		CREATED BY	C. Adamantidis

Shoalhaven City Council

Advisian WorleyParsons Group

DATE 27/4/18	0 50 100 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Callala 2050 Risk Map - Beach Accessways
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Mapping		**CREATED BY** C. Adamantidis

Shoalhaven City Council

Advisian WorleyParsons Group

DATE 27/4/18

0 50 100 metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Callala 2100 Risk Map - Beach Accessways

PROJECT NO. 301015-03933

PROJECT TITLE Shoalhaven Coastal Mapping

CREATED BY C. Adamantidis

Shoalhaven City Council

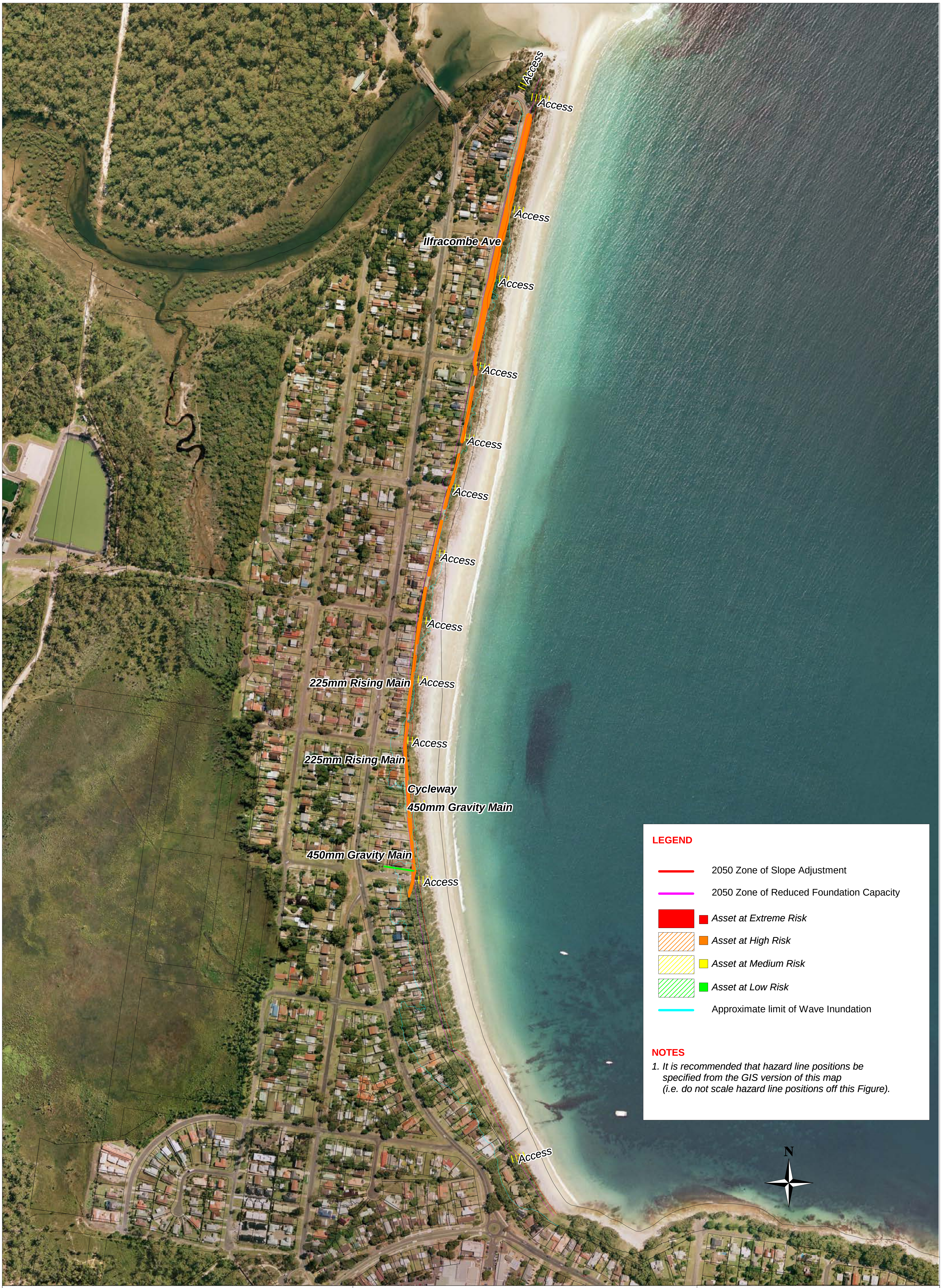
Advisian WorleyParsons Group

DATE 27/04/18	0 25 50 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Huskisson 2050 Risk Map
PROJECT NO. 301015-03933	PROJECT TITLE Shoalhaven Coastal Risk Mapping		CREATED BY C. Adamantidis

Shoalhaven City Council
Advisian WorleyParsons Group

DATE 27/04/18	0 25 50 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Huskisson 2100 Risk Map
PROJECT NO. 301015-03933		PROJECT TITLE Shoalhaven Coastal Risk Mapping	CREATED BY C. Adamantidis

Shoalhaven City Council
Advisian WorleyParsons Group



DATE 27/04/18

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Collingwood 2050 Risk Map - Beach Access

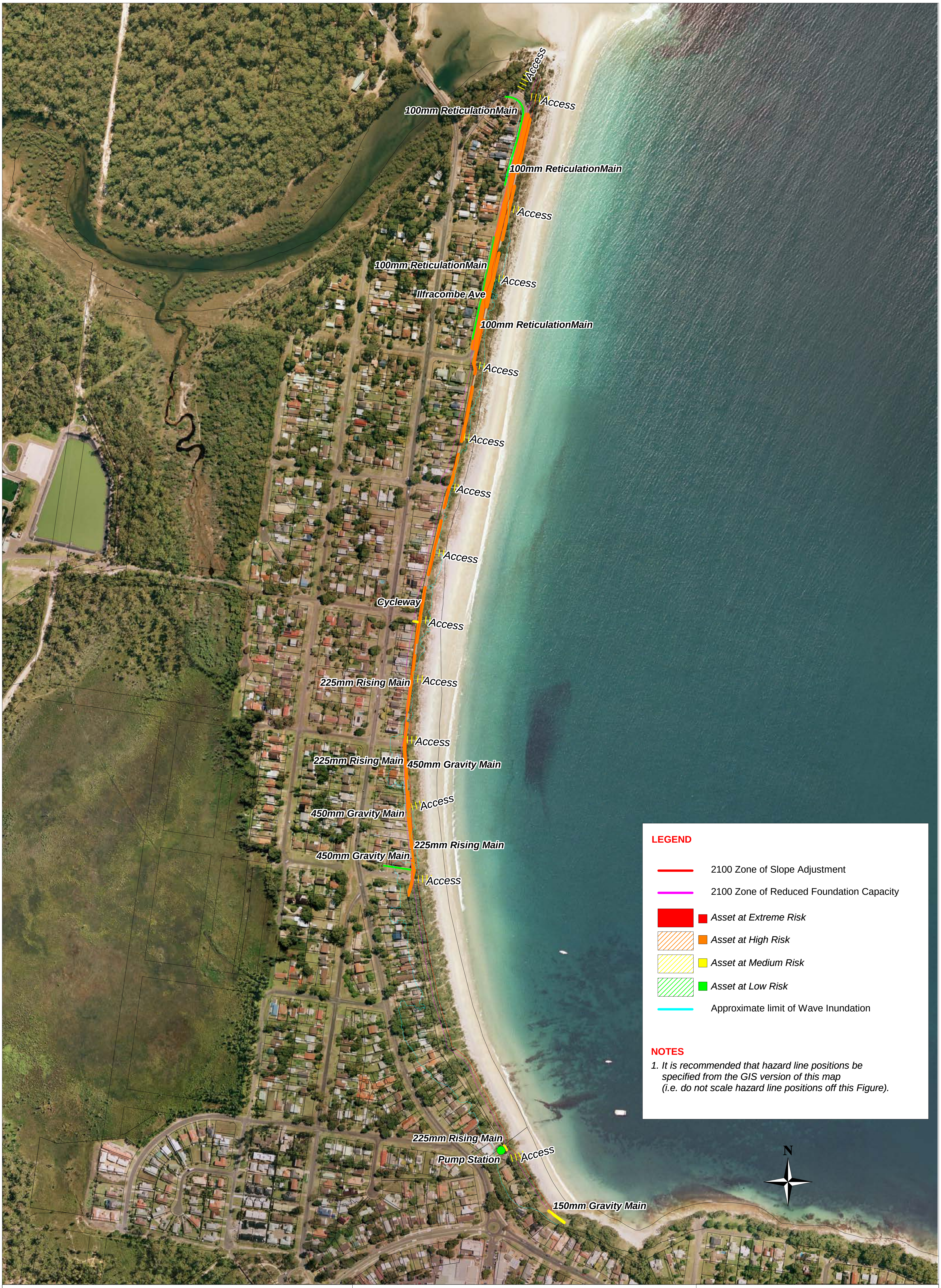
PROJECT NO. 301015-03933

PROJECT TITLE Shoalhaven Coastal Risk Mapping

CREATED BY C. Adamantidis

Shoalhaven City Council

Advisian WorleyParsons Group



DATE 27/04/18	0 50 100 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Collingwood 2100 Risk Map - Beach Access
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Risk Mapping		**CREATED BY** C. Adamantidis

Shoalhaven City Council — Advisian WorleyParsons Group

DATE 27/4/18

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Bendalong Boat Harbour - 2050 Risk Map

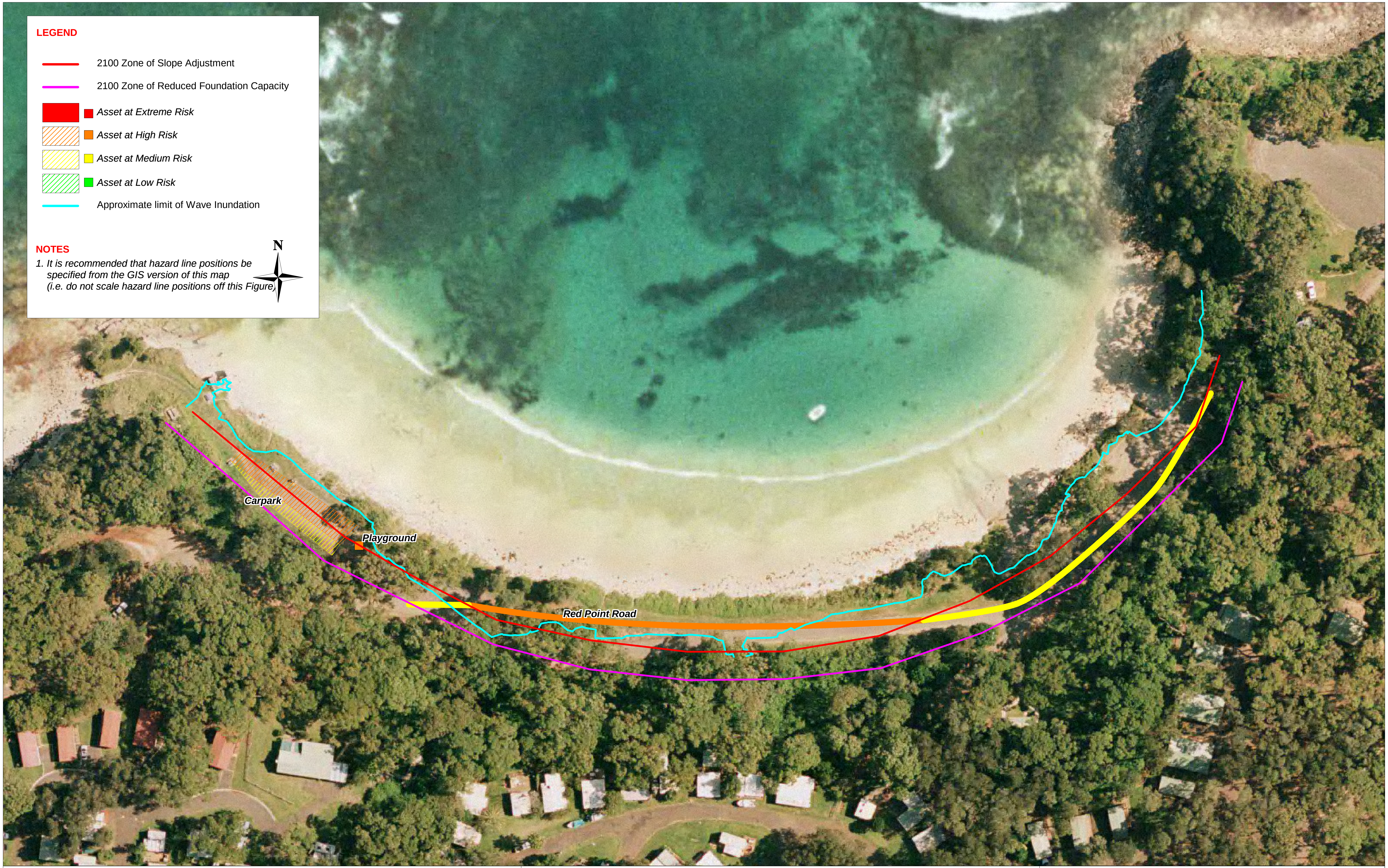
PROJECT NO. 301015-03933

PROJECT TITLE Shoalhaven Coastal Mapping

CREATED BY C. Adamantidis

Shoalhaven City Council

Advisian WorleyParsons Group

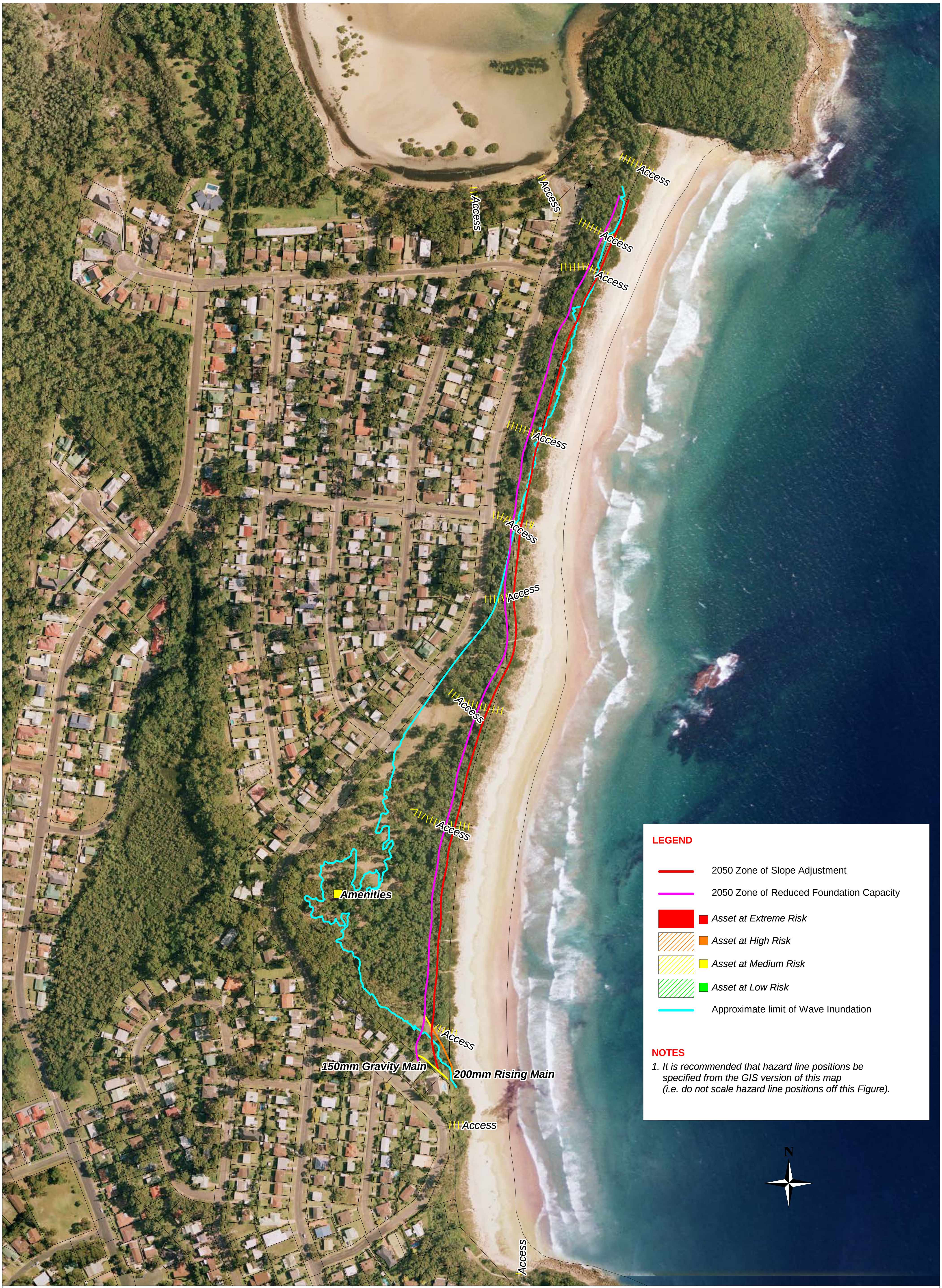


DATE	27/4/18	COORDINATE SYSTEM	MGA Zone 56	FIGURE TITLE	Bendalong Boat Harbour - 2100 Risk Map
PROJECT NO.	301015-03933	PROJECT TITLE	Shoalhaven Coastal Mapping	CREATED BY	C. Adamantidis

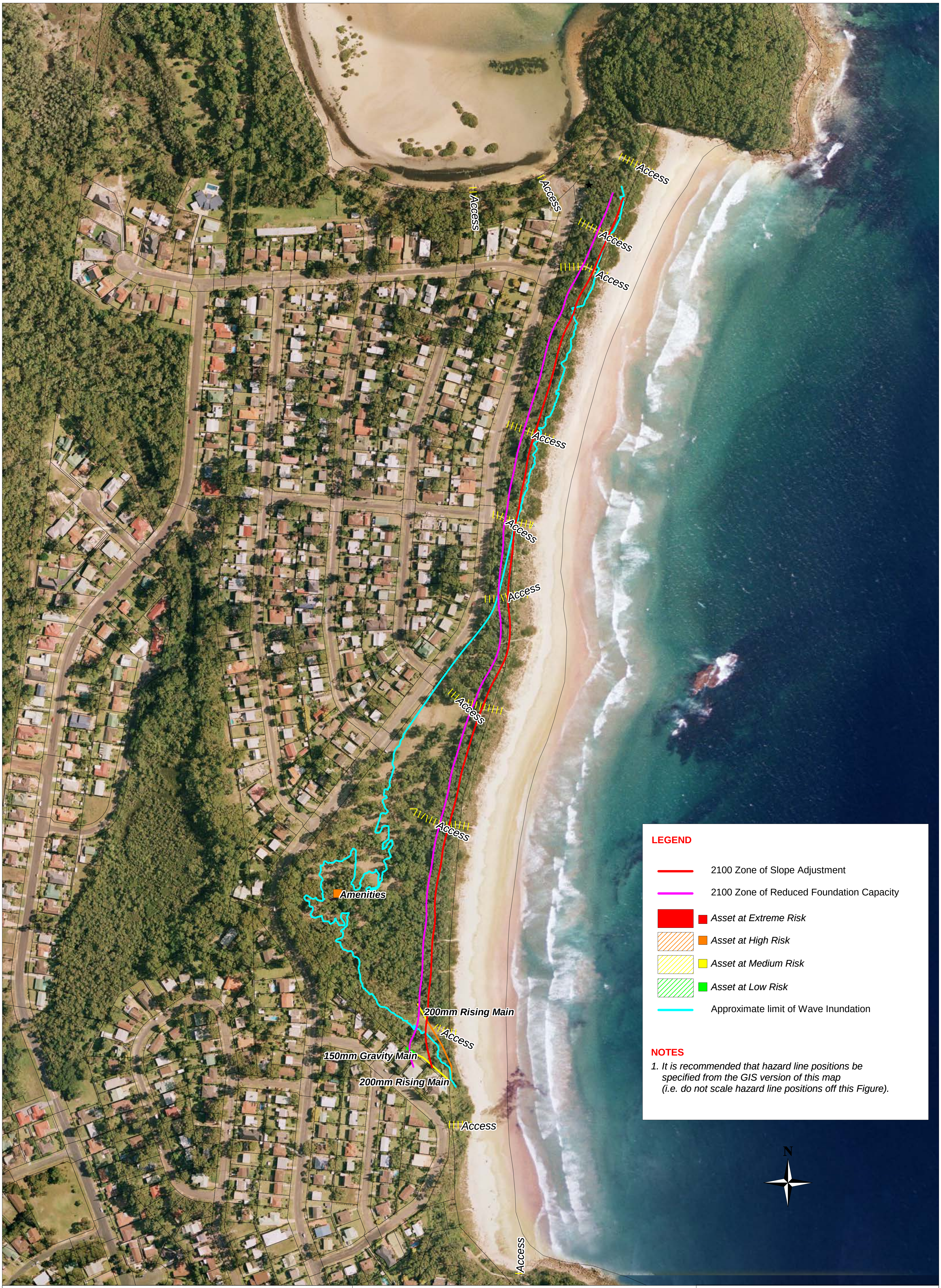
0 10 20 metres

Shoalhaven City Council

Advisian WorleyParsons Group



DATE 27/04/18	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Narrawallee 2050 Risk Map - Beach Access	Shoalhaven City Council / Advisian WorleyParsons Group
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Risk Mapping	**CREATED BY** C. Adamantidis	



DATE 27/04/18	0 50 100 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Narrawallee 2100 Risk Map - Beach Access
PROJECT NO. 301015-03933		**PROJECT TITLE** Shoalhaven Coastal Risk Mapping	**CREATED BY** C. Adamantidis

Shoalhaven City Council Advisian WorleyParsons Group

DATE 27/04/18	0 5 10 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Mollymook North 2050 Risk Map
PROJECT NO. 301015-03933		**PROJECT TITLE** Shoalhaven Coastal Risk Mapping	**CREATED BY** C. Adamantidis

Shoalhaven City Council · Advisian WorleyParsons Group

DATE 27/04/18

0 5 10
metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Mollymook North 2100 Risk Map

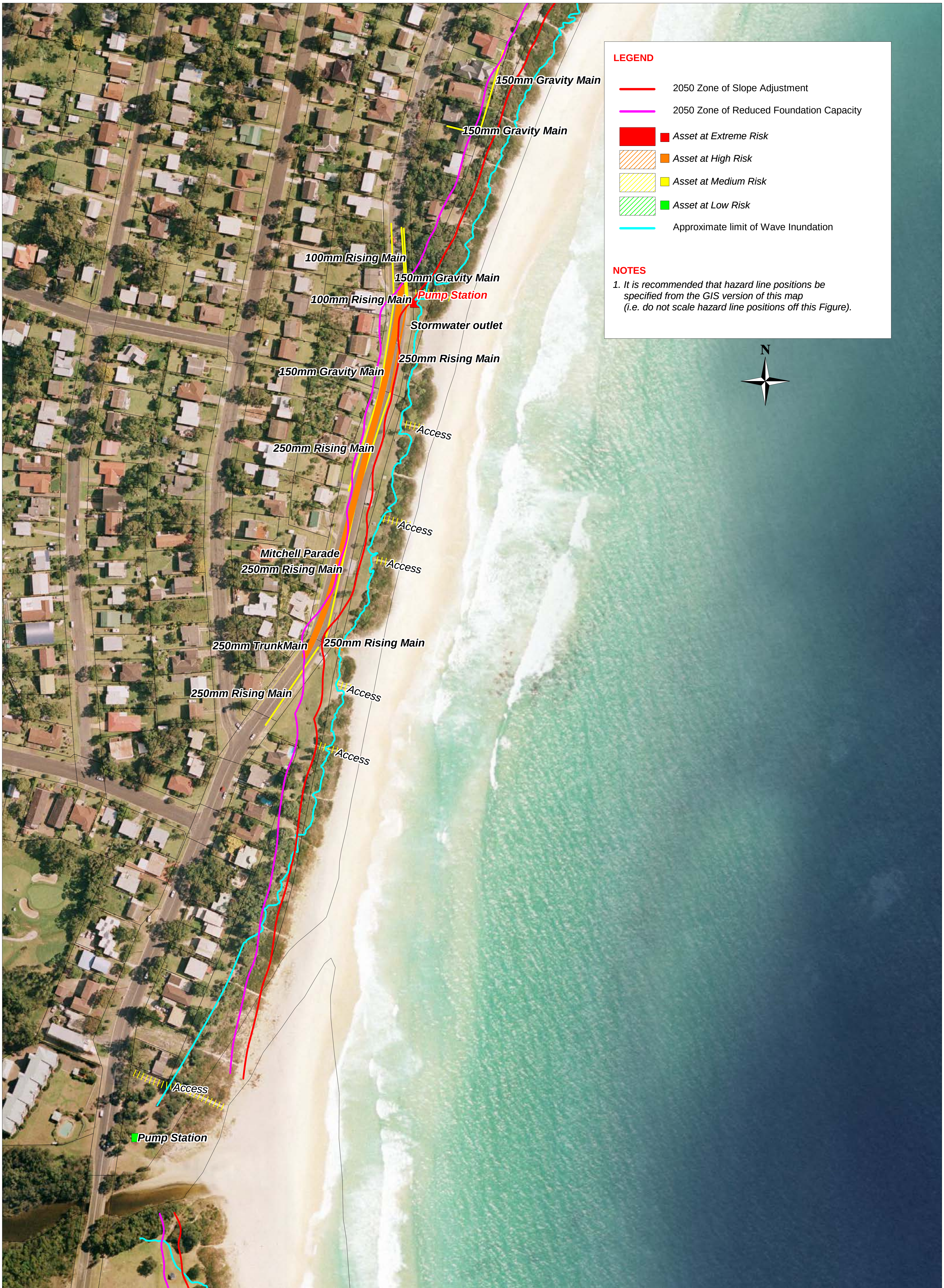
PROJECT NO. 301015-03933

PROJECT TITLE Shoalhaven Coastal Risk Mapping

CREATED BY C. Adamantidis

Shoalhaven City Council

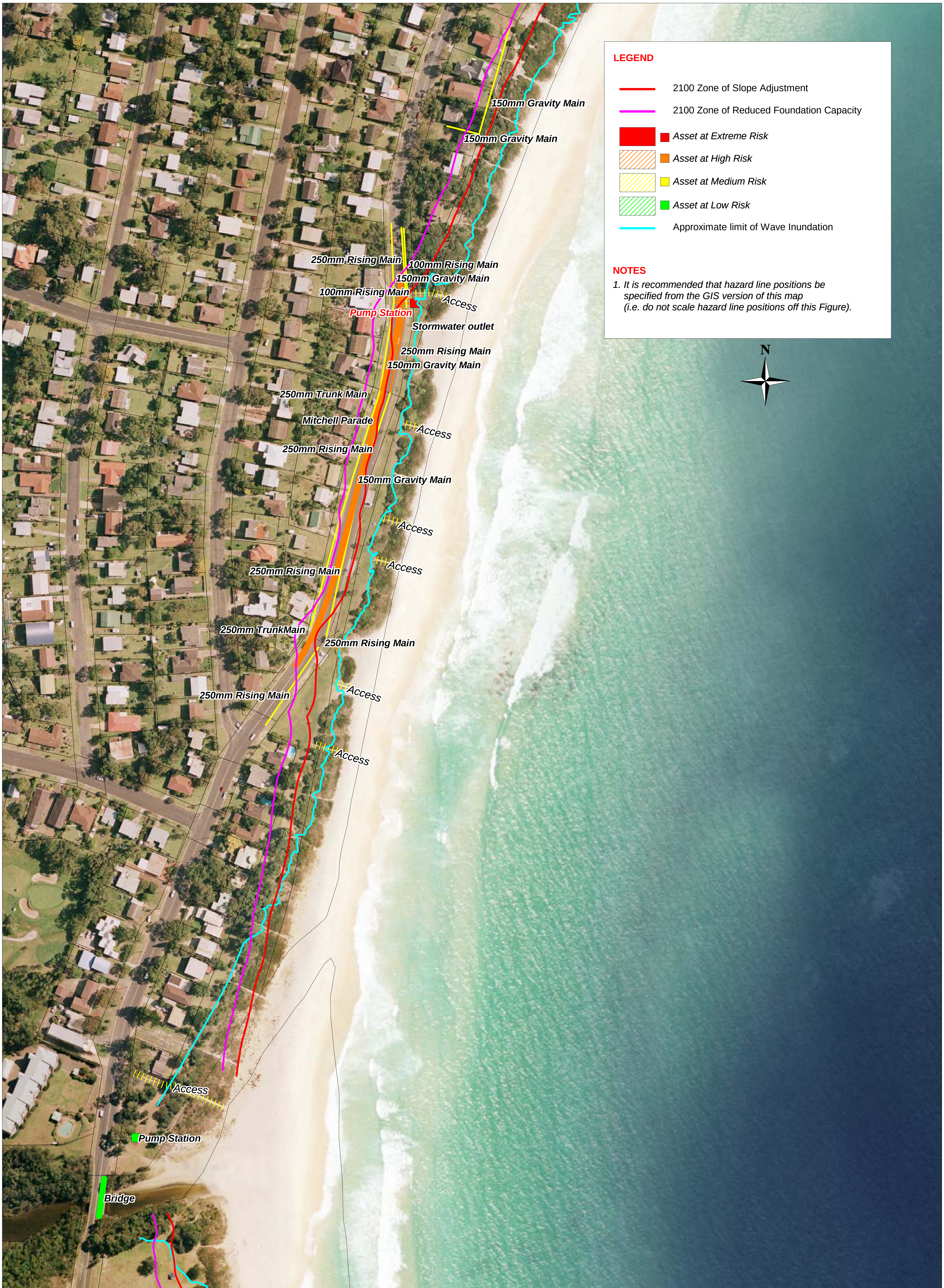
Advisian WorleyParsons Group



DATE 27/04/18	0 25 50 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Mollymook Central 2050 Risk Map
PROJECT NO. 301015-03933	PROJECT TITLE Shoalhaven Coastal Risk Mapping		CREATED BY C. Adamantidis

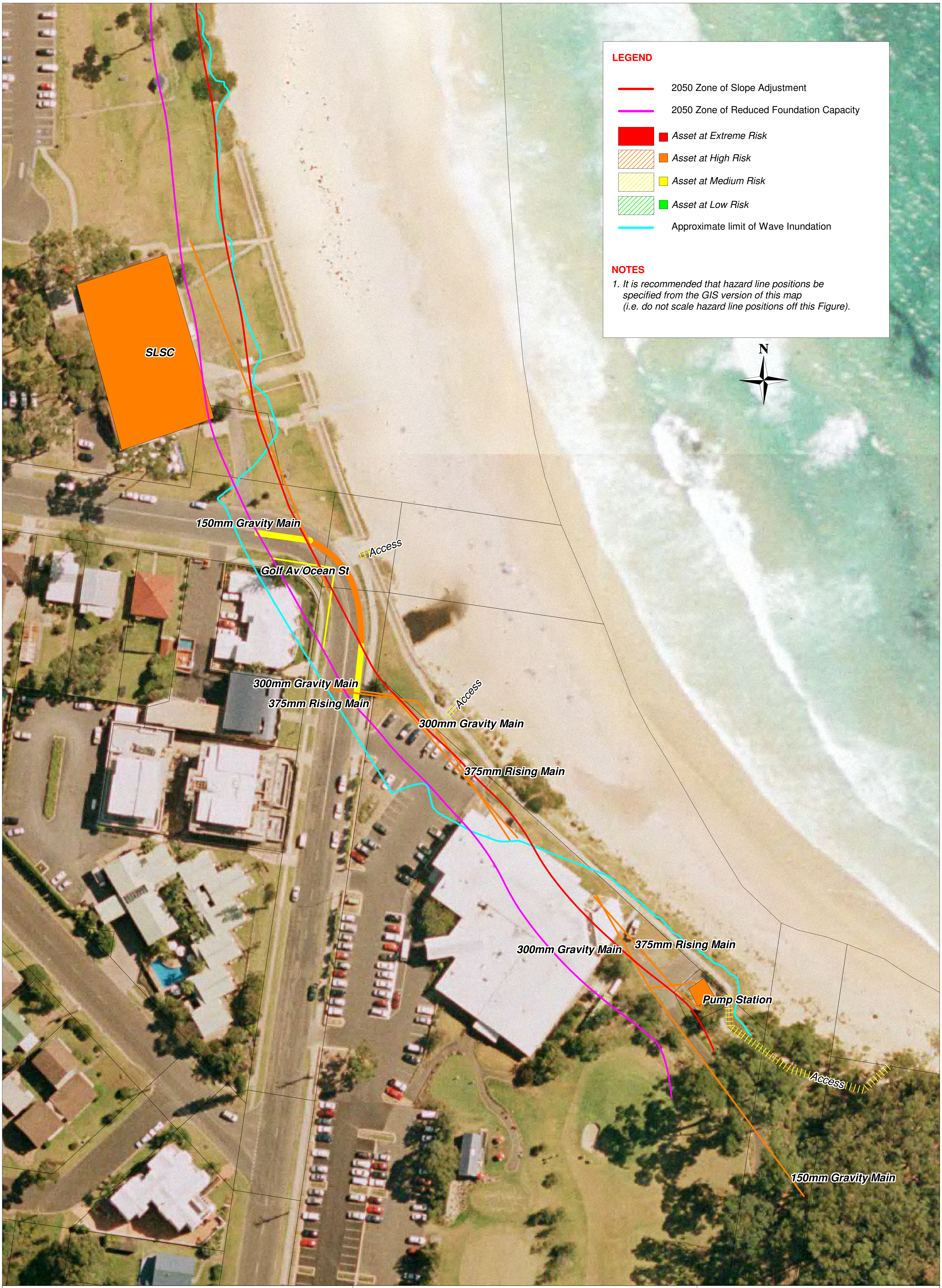
Shoalhaven City Council

Advisian WorleyParsons Group



DATE 27/04/18	0 25 50 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Mollymook Central 2100 Risk Map
PROJECT NO. 301015-03933	PROJECT TITLE Shoalhaven Coastal Risk Mapping		CREATED BY C. Adamantidis

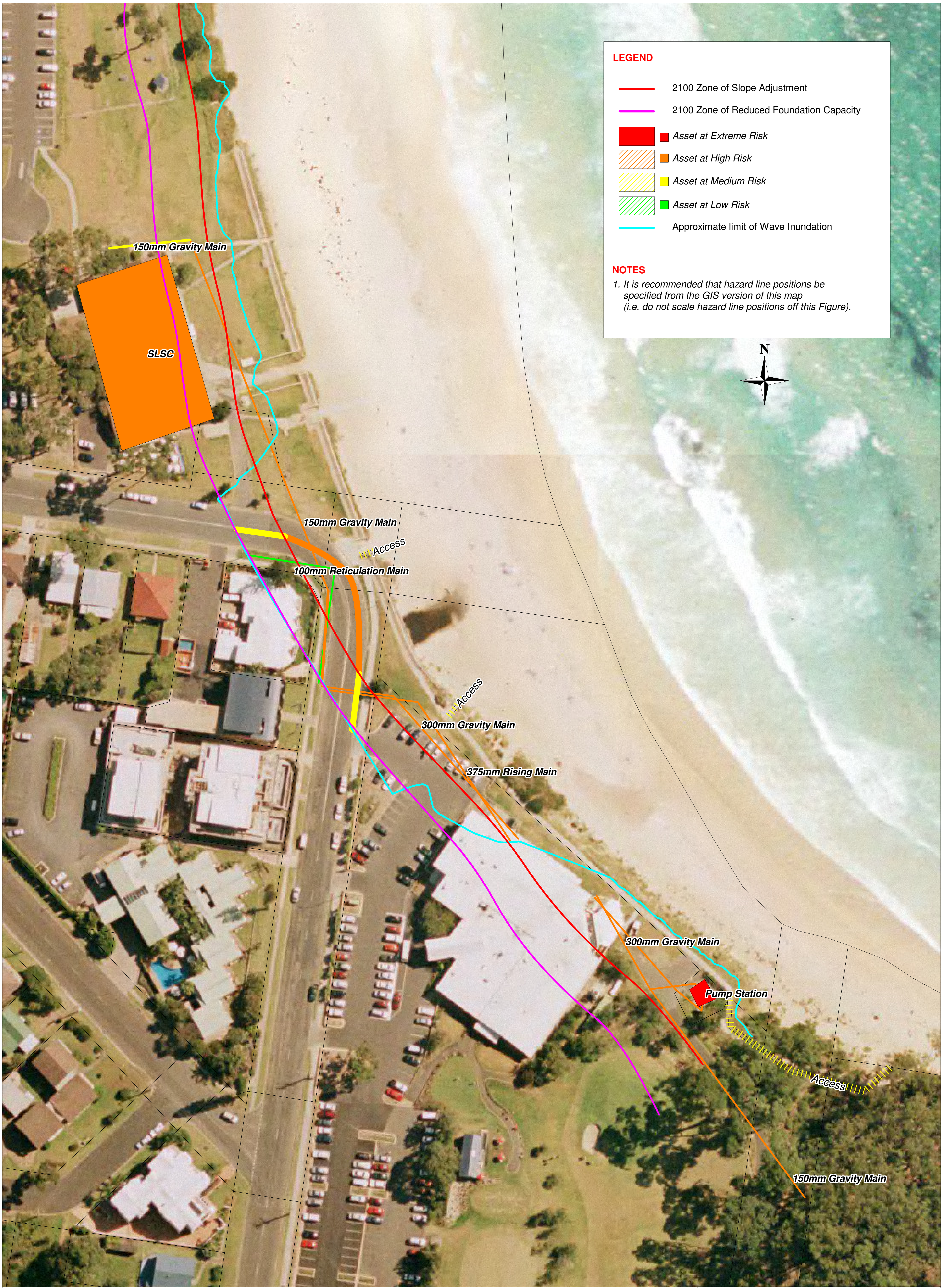
Shoalhaven City Council
Advisian WorleyParsons Group



DATE 27/04/18	0 10 20 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Mollymook South 2050 Risk Map
PROJECT NO. 301015-03933	PROJECT TITLE Shoalhaven Coastal Risk Mapping		CREATED BY C. Adamantidis

Shoalhaven City Council

Advisian WorleyParsons Group



DATE 27/04/18	0 10 20 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Mollymook South 2100 Risk Map	Shoalhaven City Council
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Risk Mapping		**CREATED BY** C. Adamantidis	Advisian WorleyParsons Group

DATE 27/04/18	0 5 10 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Collers 2050 Risk Map
PROJECT NO. 301015-03933	PROJECT TITLE Shoalhaven Coastal Risk Mapping		CREATED BY C. Adamantidis

Shoalhaven City Council Advisian WorleyParsons Group

DATE 27/04/18

0 5 10
metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Collers 2100 Risk Map

PROJECT NO. 301015-03933

PROJECT TITLE Shoalhaven Coastal Risk Mapping

CREATED BY C. Adamantidis

Shoalhaven City Council

Advisian WorleyParsons Group

2016 SUBMISSIONS

Submission type	Summary detail	Times Raised	How has the issue been addressed?
General: affecting substantial or various parts of the plan			
	Oppose adoption of flawed plan - Derived from outdated engineering plans - Incorrect assumptions - Bruun Rule not applicable to JB, excessively conservative - BR weakness does not consider longshore currents, two dimensional - Should undertake Equilibrium Beach Profile - CBPG set up land-based survey monitoring regime, vegetation has moved seaward since 1952 - Does not reflect well on Council - Council has not acted in good faith, will not be afforded protection under s733 LG Act - Cannot be submitted to NSW Government	8	We have extensively revised the draft Coastal Zone Management Plan that was previously exhibited. Expert consultants (Advisian) reviewed the coastal hazards section in 2016 and 2018. We have determined new hazard lines and applied new SLR measures. We have considered land survey monitoring information.
	Access to key documents restricted - CBPG required to apply for WP report	2	Council is required to follow appropriate legal processes when releasing specialist reports.
	Independent Coastal Engineer should review document - Should report to Council working committee, stakeholder representation	2	We engaged independent coastal engineers to review the technical sections of the plan. The revised Coastal Zone Management Plan will be reported to the elected Council for final adoption, before referral to the Minister.
	Staff have inadequate understanding of engineering principles - Locked into flawed process	3	Staff have used highly qualified and credible consultants to provide

	- Did not read CBFG submission - Symptomatic of culture where community views not worth considering - Briefing consultants to use outdated methodology - Plan is more ideology than policy		expert advice on the complex technical sections of the plan. The methodology used has been contemporary and consistent with best practice. All submissions have been read, considered and summarised in this appendix.
	Development controls (DCP118) based on risk management - Should consider ZSA as alternative approach - Residents should accept more responsibility - No details in plan on cost of planned retreat - Beach monitoring should be used as performance measure	1	Appropriate development controls now form part of the single Shoalhaven Development Control Plan 2014. The approach taken is consistent with best practice and NSW Government guidelines.
	Inadequate consultation period - Only 10 days to respond - Little effort made to explain complex issues - Lack of timely process should not override resident rights - Community must be fully informed of costs and consequences	4	The draft plan will now be subject to a third formal public exhibition of 21 days. Residents have also been consulted widely through the Our Coast Our Lifestyle.
	More considered and extensive consultation - Needs to involve wide range of coastal community members - Not just affected beach front residents - Recent Council workshops were effective - Length and complexity of document not conducive to comprehension - Structure related to key coastal sites, promotes narrow interest specific to individuals, narrow community attitude - Terminology incorrect, should be engagement not involvement	3	As detailed above. The revised document has been completely revised in part, to make it simpler and more accessible to the public. We have rationalised much of the technical terminology and made more extensive use of appendices and links which has shortened the main document.

	Hazard lines must be updated to reflect accurate SLR - Do not appreciate impact on property values, leading to financial loss - SLR in Shoalhaven over last 150 years in balance or moving seaward (CB example) - Need to take pragmatic approach to SLR (as endorsed by Minister Stokes)	3	The hazard lines have been revised. They are now based on different SLR thresholds which Council adopted after consideration of a comprehensive expert report and detailed public submissions.
	Support SLR parameters - Existing state government measures should be retained - Most widely accepted by expert advice - Support IPCC projections - Decision to ignore SCRSLR Planning Framework recommendations not based on expert advice - Climate change should be recognised as coastal hazard - Council has existing policy should be maintained	3	As above.
	Maintaining and protecting natural environment not prioritised - Objectives inconsistent with relevant legislation - Amenity is prioritised over maintaining natural vegetation - Mitigating coastal erosion given priority over vegetation protection - Plan aligned with uniformed opinion and private interests - Erosion mitigation adopts engineering approaches, ignores maintaining vegetation - Methods including dredging and reef removal cause degradation problems - Both scoping and evaluation must include science	2	The revised plan includes additional objectives that are consistent with the legislation and include protecting the natural environment. We have attempted to strike a reasonable balance between appropriate levels of vegetation protection, the expectations of individual landowners and the recreational needs of users of our natural assets.
	Protection of ecological values - Protection of high ecological values should not be balanced against conflicting uses	2	The plan provides for appropriate levels of protection for vegetation of high ecological value,

	- No commitment to maintain values into the future		consistent with Council's legal obligations and responsibilities.
	Protection of Coastal Biodiversity - Plan lacks reference to concept of habitat - Shoalhaven Birdlife requires more recognition - Recreational uses should include birdwatching - Birdlife Shoalhaven should be recognised in engagement program	2	The revised plan provides for protection of coastal biodiversity and greater recognition of native fauna.
	Inconsistent with ESD principles - Application of ESD principles, especially precautionary principle fundamental to determining priorities and management action - No reference to principles	1	The revised plan is consistent with ESD principles.
	Coastal erosion prioritised over inundation and flooding - Coastal inundation and flooding should be given greater prominence - Flood studies should be referenced - No evidence to support comments in Royal H report 2014	1	Coastal erosion may appear to be given priority; however, this is a reflection of the severity and potential impact related to this form of coastal hazard. We have clearly referenced the flood studies and management plans in the plan. We have provided for significant levels of mitigation consistent with community expectations and resource limitations.
	Dogs should be recognised as management issue - Plan does not manage source of problem	1	The plan provides for management of dogs in coastal areas. Council commits significant ranger resources to enforcement action in accordance with adopted policies.

Location Specific: relating to one geographic location			
Culburra Beach and Lake Wollumboola	Support proposals in plan applying to CB/LW - many actions already in progress	1	Noted.
Collingwood Beach	Why did vegetation on CB overtake Coastal Zone Management Plan? - Staff dismissive, greater priority should have been given to plan - CB residents unfairly burdened with inaccurate hazard lines	2	Priorities regarding particular locations are influenced by community representations and potential environmental damage. Council attempts to provide a balanced policy position that considers the interests of all residents in a professional, fair and equitable manner.
	Inadequate contact with affected landowners. - Sand dunes are larger and more extensive than when property purchased	1	See comment on community consultation above.
	Proposed CB Management Plan contrary to sound planning - Governance to appease a minority of law breakers - Contradicts Tree Management Policy and Foreshores Reserve Policy - Contrary to relevant legislation - should be 'authorised location' under Act - Should give priority to dune stability and biodiversity protection	1	The proposed CB Management Plan is currently being reconsidered by Council.
Hyams Beach	Plan does not include HB in local strategies - Problems with sewerage line in recognised hazard area - Uncontrolled stormwater outlets onto iconic beaches, erosion	1	The revised Coastal Zone Management Plan includes Local Action Plans that provide for specific works in high priority locations. Budgetary limitations ultimately determine the extent to which these works can meet community expectations.

Sussex Inlet and St Georges Basin	Lack of inclusion of hazard issues in plan - Erosion not exclusively confined to beach alignment, also affect estuaries, lakes, riparian areas - Flooding of basin has significant impacts, not quantified - Data on flooding outdated - Cost of intervention to open basin not included - Storm surge damage of Stingray Bay not mentioned - More resources required	1	The revised Coastal Zone Management Plan provides hazard lines in locations of most critical risk for costal erosion and inundation. Flood studies and management plans provide a separate management approach for flood affected areas. Ultimately, budget limitations determine the extent to which community expectations can be met.

2018 Submissions

Location	Summary of Submission	Comment
Shoalhaven Heads (2 submissions from the same person)	• *Guidelines refer to continuing and undiminished access to beaches, yet CZMP only refers to removal of sand for safety, should include management of sand in front of Surf Club to maintain access to beach* • *Should provide for higher viewing platforms to ensure people with disabilities can view & access beach* • *Maintain public access to beach*	Managing sand in front of Surf Club is included in the Plan as action LA1.5. Text added to LA1.5 to include beach access. LA1.8 identifies maintaining public beach access and viewing platforms in this location. Council has an adopted Disability Inclusion Action Plan; the objectives of this plan can be considered as part of any future upgrades to viewing platforms as opportunities arise at appropriate locations. Maintaining adequate public access to beaches is a key component of the CZMP.
Crookhaven Heads (1)	• *CZMP consistently refers to Crookhaven Heads as Greenwell Point*	Plan amended where required.
Lake Wollumboola (1)	• *Recommend reconsideration of "vision" to give greater recognition to Aboriginal material and spiritual values* • *Priority should be given to coastal flooding and inundation, as well as coastal erosion* • *CZMP underestimates impact of climate change, relies on Council decision to accept non-expert SLR projections – lower projections than Eurobodalla and Kiama* • *Environmental monitoring should include mapping to assess conditions over time – should involve Aboriginal community* • *CZMP does not outline measures to protect shorebird habitat, threatened species under extreme threat form SLR, increased storm intensity, human visitation – access to beaches should at times, be denied and better signs to protect habitat* • *Science Citizens welcome, should be co-ordinated by Council Environmental staff* • *Bushcare program should be better funded*	Coastal inundation is included in the coastal hazard mapping and considered in the Plan as a risk. Council has a comprehensive flood program to undertake flood studies and plans. These are incorporated into Council's Shoalhaven Local Environmental Plan (SLEP) and Shoalhaven Development Control Plan (SDCP) as (s10.7 EP&A Act). Council's SLR policy includes a review provision at least every 7 years and policies are reviewed or reaffirmed after election of each new Council. Section 2 of CZMP includes provision to review SLR projections as per policy review requirements and includes other triggers. Amend CZMP to include greater recognition of Aboriginal cultural heritage.

Currarong (1)	• *Concerns regarding proposal to build very costly and possibly futile groyne* • *Potentially unintended damaging consequences* • *Sand to nourish depleted easterly sections already moving* • *Plastic fibre used for groyne will enter sea and be ingested by fish and birds* • *Groyne opposed at public meeting in October 2016* • *No guarantee the groyne will have desired effect* • *Expert recommending groyne, employed by company that will build groyne – lack of independence – conflict of interest* • *Long term users of caravan park not properly consulted* • *Proposed access road in front of park will create alternative boat ramp* • *Need for groyne motivated by 10 property owners in Warrain Crescent; many of whom destroyed trees and shrubs on dunes opposite* • *Rates will rise; should have been harsher of destruction of trees* • *Groyne will not solve problems of rising sea levels due to climate change*	Construction of trial geotextile groyne at Warrain beach subject to: • review of environmental factors (REF) which must consider potential environmental impacts and suitable avoidance and mitigation measures as well as maintenance and monitoring of the structure and Aboriginal cultural heritage; • Council obtaining necessary licences and approvals; • community consultation; and • further consideration by Council. The groyne is a trial and can be removed.
Jervis Bay & Vincentia (12) 3 supporting 1 submission, 2 copies of 1 submission	• *CZMP is inadequate because it uses unrealistic SLR estimates & ignores the threat of coastal inundation* • *Vincentia Information Session missed opportunity because too many topics discussed* • *CZMP appears to be based on "old" information; should not confuse public with different ages of information, should encourage public participation* • *Executive Summary says estuaries not included but diagram on page 8 indicates strategies feed into EMPs* • *Large variation in age of supporting documentation* • *Huskisson Beach Management Plan still in draft form, needs to be endorsed to give public confidence* • *Coastal flooding & imminent inundation not included in plan; extraordinary omission, ESC estimates Narooma has approx. 1000 coastal properties at risk* • *Not credible to suggest St. Georges Basin, Coonemia Creek, Burrill Lake will not be affected*	CZMP uses Council's adopted sea level rise projections/policy. Council's SLR policy includes a review provision at least every 7 years and policies are reviewed or reaffirmed after election of each new Council. Section 2 of CZMP includes provision to review SLR projections as per policy review requirements and includes other triggers. Coastal inundation is included in the coastal hazard mapping and considered in the Plan as a risk. Council has a comprehensive flood program to undertake flood studies and plans and update these. These studies are incorporated into Council's SLEP and DCP. The diagram on page 8 tries to illustrate that CZMP is one part of Council's integrated

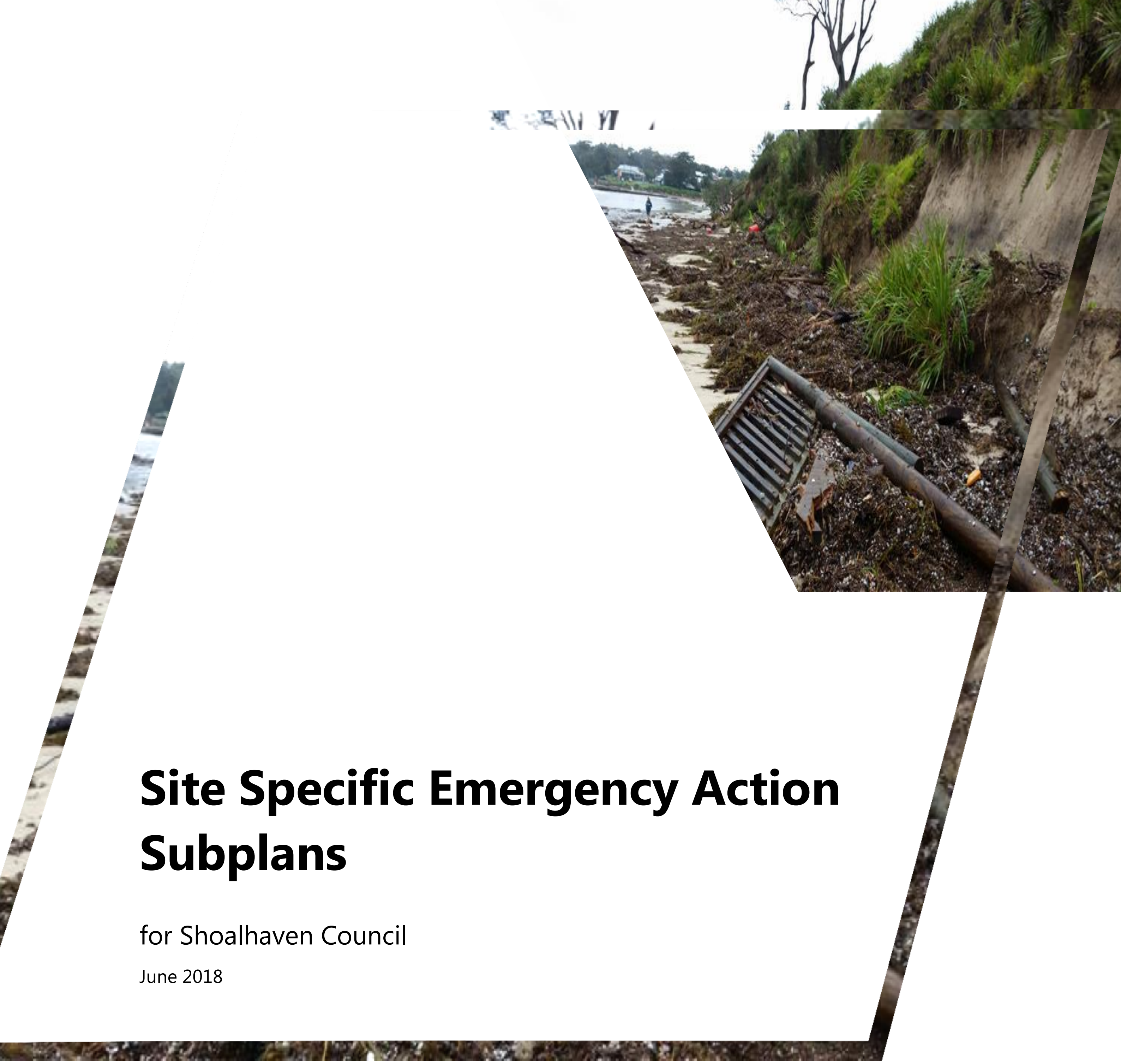
	• *Not fair to residents to pretend there is no risk – not adequately responding to climate change* • *CZMP fails to take opportunity to install demonstration site; demonstrate Bush Plan, resilient dune and iconic views – trial should be for 2 years, not 5* • *Council should engage better with local community who have expertise and knowledge* • *Challenge the CZMP to achieve/address 16 matters including:* ○ *Upgrade storm water design & install infrastructure within 2 years* ○ *Create a draft DCP to immediately implement changes proposed in CZMP* ○ *Maintain & upgrade beach accessways* ○ *Vegetation Plans in accordance with Coastal Zone Management Manual (P68)* ○ *Special staff position should be contracted out (ex-employees of SCC eligible)* ○ *Natural Resource Committee members cannot hold positions for longer than 2 terms* ○ *Local "Defend the Coast Groups" should be set up to execute Vegetation Plans, membership subject to veto from adjoining residents* ○ *EMP for Moona Moona Creek; return sand to restore Collingwood Beach* ○ *Description of Jervis Bay should be replaced with individual beaches* ○ *CBPG should be regarded as "Special Group" providing expert opinion & monitoring advice* ○ *Lifesaving facilities provided for Collingwood Beach* ○ *Views between Bayswater & Berry Streets should be retained* ○ *Remove all pittosporum* ○ *Bush Regeneration Plans should exclude Collingwood Beach* • *Hazard lines at the end of Ilfracombe Ave. are inconsistent with dune heights* • *Collingwood Beach should be recognised as an accreting beach* • *CZMP fundamentally flawed for the following reasons:*	approach to managing the coastal landscape, not the only part. The coastal hazard assessment, risk assessment and emergency action sub plans were all updated as part of the update and revision of the CZMP. The Plan clearly identifies risk factors and private and public assets at risk along the open coast. Flood studies and plans identify properties at risk of inundation in estuaries. These risk based studies and plans inform Council's SLEP and SDCP as well as planning certificates (s10.7 EP&A Act). Council sought to include estuaries as part of the CZMP, however State Government advised it would not certify estuary management plans as part of the CZMP as these were not prepared as CZMP's. Council has successfully obtained funding to transition to a Coastal Management Program, over the next 3 years, that will include 2 estuaries. Council could adopt a rolling program to progressively update its estuary management plans, similar to its flood study/plan program. Work is undertaken as part of the coastal maintenance program to maintain and upgrade beach accessways. Council continually engages and seeks input from the community as part of its coast and estuary programs. Council is committed to

	○ *CZMP has been prepared under the Coastal Management Act 1979 which was repealed on 3 April 2016 as such has no legal standing.* ○ *Community consultation period has been limited to 12 days, time that a complete set of documents has been available, for review on the SCC website, totally inadequate period of time for a comprehensive review.* ○ *The Bruun Rule that has been used to predict shoreline erosion and recession - does not address several key criteria required for a robust analysis and is not best practice.* ○ *The software (SWAN modelling) used to determine inundation maps has been confirmed by the software developer as not being suitable for embayments (like Collingwood Beach)* ○ *Calculating coastal hazard lines and inundation lines utilising methods and parameters that are no longer accepted as best practice has resulted in an assessment that is fundamentally flawed and therefore invalid* ○ *By not utilising best practice techniques arguably SCC has not acted in good faith and will not be afforded protection under section 733 of the Local Government Act 1993 which provides an exemption from liability* ○ *The risk assessment included in CZMP (Advisian) does not consider private housing, includes subjective assessments that are illogical in some instances and is convoluted* ○ *The appropriate level of participation (that is collaboration) documented in the NSW Government A Guide for Engaging Communities in Environmental Planning and the Decision Making, and the International Association for Public Participation Australasia, has not been fulfilled* ○ *The placement of coastal hazard and inundation lines across water front properties has caused the owners of those properties anguish and financial loss* ○ *The fact that SCC has not been able to manage the process of producing a Draft CZMP in a timely manner cannot be used as an excuse to trump the rights of residents* ○ *SCC cannot submit the CZMP to the Minister, which it knows to be flawed, as the reputation of the Shoalhaven will be tarnished further with yet another rejection.*	engaging with the community on these matters and The CZMP recognises the need to maintain adequate public access to beach as a priority throughout the document. Coastal Management Act recognises CZMP's. Council is adhering to the legislative process to seek certification of the CZMP. Once certified the CZMP will be considered a CMP for the purposes of the Act. The coastal hazard mapping takes into account current conditions such as existing dune heights as well as coastal inundation from historical and recent storm events. Public exhibition period was 21 days in accordance with Guidelines. Council was not legally required to re-exhibit Plan again as it has previously been exhibited. The updates and revisions have been made in response to previous submissions and Council resolutions. Coastal hazard mapping and use of Bruun Rule in line with current coastal engineering practices and other Council's within the region have used the same methodology to map coastal hazards and prepare their CZMPs. Council has also complied with the Guidelines for preparing a CZMP and therefore, has acted in good faith in accordance with s733 of the Local Government Act. The risk assessment complies with engineering and risk assessment best practice, as well as CZMP Guidelines.

		Issues with methodology previously raised and addressed when Council adopted the updated coastal hazard mapping in 2016. During the past several years, community engagement has contributed to the development of this CZMP. The coastal hazard mapping, strategies planning provisions and development controls have been in place for many years.
Bendalong / Manyana (1)	• *Unhappy that estuaries & ICOLLs are excluded – significant number of properties at risk* • *Lake Conjola needs sand removed, should be used to replenish surrounding beaches – impacts need to be assessed* • *Properties along Berringer Lake as well as Lake Conjola need to be assessed* • *Boat Harbour Master Plan as well as regeneration of reserve (adjoining caravan park) should be implemented within 2 years.*	Council sought to include estuaries as part of the CZMP, however State Government advised it would not certify estuary management plans as part of the CZMP as these were not prepared as CZMP's. Council has successfully obtained funding to transition to a Coastal Management Program, over the next 3 years, that will include 2 estuaries. A working group from Council's Natural Resources & Floodplain Committee has recommended this include St Georges Basin and Lake Conjola. Management of ICOLL entrances as part of Council's flood mitigation program is included in the CZMP. Council would need to allocate budget to implement the Boat Harbour Master Plan.
Lake Conjola (2) 2 copies of same submission Supports CZMP however disappointed	• *Extremely disappointed that estuaries are excluded from CZMP, no adequate explanation, especially given decades long underfunding of management works to mitigate increased frequency of low level flood events* • *LAP 4 puts forward Boat Harbour Master Plan & Stormwater Upgrade Plan – should be implemented immediately 0-2 years -1.7mill. budget required* • *LAP 5 proposes to manage dune heights at Narrawallee Beach by beach scrapping & nourishment, if sand can be sourced – Lake Conjola entrance should be the source*	Comments as above

estuaries not included	• *Council should provide funding to update plan to include estuaries, ICOLLs & entrance management policies, thereby making works on these waterbodies eligible for funding*	
Mollymook Beach (4):	• *Vegetation should be pruned adjacent to parking at Mitchell Pde Reserve* • *Tree Planting required south of Black Water Creek* • *North end of beach requires some attention – "caravan" used to store surf club equipment, should extend toilet block with room for equipment – drain should be unplugged* • *If affected residents (Mollymook Beach) are required to pay special levy to fund coastal works - should have a say in how it is spent – all ratepayers should pay any levy – unjust to impose additional levies - should be allocated to a special reserve (Coastal Infrastructure Management Reserve) to address coastal storms/events* • *Historical accessways to beach should be preserved; visitors to beach, not residents are stepping outside defined walkways* • *No further planting of shrubs/trees at back of properties fronting beach - bushfire threat, insurance impact* • *Beachfront owners not directly informed – not all full-time residents – cannot attend public meetings – do not read local newspapers*	The road, sewer and water infrastructure are at risk, at Mitchell Pde. Therefore, vegetation is important in maintaining dune resilience. Views of the ocean are adequate in this location. The findings from Our Coast Our Lifestyle community engagement program identified that in general ratepayers did not want to pay for the protection of private property.

Bawley Point / Kioloa (1)	• *Shoalhaven Coastal Zone Map doesn't show Bawley Point/Kioloa*
	• *Coastal risk issues with a number of locations including:*
	  ○ *Gannet Beach – southern end, access tracks heavily undermined*
	  ○ *Malibu Drive, south & west of dunes could be long term risk*
	  ○ *Historic gantry destroyed by large waves*
	  ○ *Kioloa Beach – southern end near boat ramp & Marine Rescue building eroded*
	  ○ *Vegetation subject to vandalism to improve views*
		City wide strategies generally address these issues.
		City wide strategy to update beach risk assessment to determine if any additional beaches require coastal hazard mapping.



Site Specific Emergency Action Subplans

for Shoalhaven Council

June 2018

Level 17, 141 Walker St
North Sydney NSW 2060
Australia

301015-03933-002

www.**advisian**.com

Advisian
WorleyParsons Group

Synopsis

This report documents the Emergency Action Subplan under the Coastal Zone Management Plan for the Shoalhaven Council Area. It has been prepared in accordance with the guidance set out in the NSW Coastal Management Manual (OEH 2018).

Disclaimer

This report has been prepared on behalf of and for the exclusive use of Shoalhaven City Council, and is subject to and issued in accordance with the agreement between Shoalhaven City Council and Advisian.

Advisian accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party.

Copying this report without the permission of Shoalhaven City Council and Advisian is not permitted.

Project No: 301015-03933-002 – Site Specific Emergency Action Subplans: for Shoalhaven Council

Rev	Description	Author	Review	Advisian Approval	Date
A	Draft for Internal Review	C. Adamantidis	A. Nielsen	C. Adamantidis	
B	Draft for Customer Review	C. Adamantidis	A. Nielsen	C. Adamantidis	15/5/18
C	Draft Final	C. Adamantidis	A. Nielsen	C. Adamantidis	18/5/18
0	Final	C. Adamantidis	A. Nielsen	C. Adamantidis	27/6/18

Table of Contents

1 Introduction 6
1.1 Background 6
1.2 Study Area 7
2 Establishing the Context 9
2.1 What is an Emergency? 9
2.2 Triggers for Action 9
3 Coastal Hazards 10
3.1 Short Term Coastal Erosion 10
3.2 Creek entrance instability 11
3.3 Coastal Inundation 11
3.4 Immediate Coastal Hazard Areas 12
4 City-wide Emergency Management Measures 15
4.1 Preamble 15
4.1.1 Prevention 15
4.1.2 Preparedness 16
4.1.3 Response 16
4.1.4 Recovery 17
4.2 Criteria/Thresholds for Action 17
4.3 Before a Storm (Prevention and Preparedness) 20
4.4 During a Storm (Response) 21
4.5 After a Storm (Recovery) 22
5 Local Area Measures 23
5.1 Preamble 23

5.2 Area Specific Management Actions ... 23
5.2.1 Beach Scraping (NABE) ... 24
5.2.2 Dune Reshaping/Stabilisation ... 27
5.2.3 Stormwater Outlet Works ... 29
5.2.4 Public Education ... 29
5.2.5 Stormwater re-routing/detention ... 30
5.2.6 Temporary road/pathway closures ... 30
5.2.7 Development Controls ... 30
5.2.8 Temporary Beach Access Closure/Rehabilitation ... 30
5.3 Shoalhaven Heads Subplan ... 34
5.4 Culburra Subplan ... 34
5.5 Warrain Beach Subplan ... 34
5.6 Currarong Subplan ... 35
5.7 Callala Beach Subplan ... 35
5.8 Huskisson Beach Subplan ... 36
5.9 Collingwood Beach Subplan ... 36
5.10 Bendalong Boat Harbour Subplan ... 37
5.11 Narrawallee Subplan ... 37
5.11.1 Pre-storm Preventative Dune Raising ... 37
5.12 Mollymook Subplan ... 37
5.12.1 Southern End – Pre-storm preventative actions ... 37
5.12.2 Rehabilitation Concept Design for Stormwater Discharge Points ... 39
5.12.3 Monitoring of Existing Measures ... 40
5.13 Collers Beach Subplan ... 41
6 Evaluation of Emergency Protection Measures ... 42

6.1 Approvals Required by Council....43

7 Roles and Responsibilities in Coastal Emergency Management....46

7.1 Preamble....46

7.2 State Emergency Service....46

7.3 Shoalhaven Council....46

7.4 Office of Environment and Heritage....47

7.5 Bureau of Meteorology....47

7.6 NSW Police....48

7.7 Fire and Rescue NSW....48

7.8 Other agencies....48

8 Conclusion....50

9 References....51

Appendix List

Appendix A Immediate Coastal Hazard Areas

Appendix B Local Area Subplans

1 Introduction

1.1 Background

Coastal communities and local councils are facing difficult issues associated with coastal erosion along the NSW coastline. This issue is not new: records show coastal properties being affected by coastal erosion dating back to the 1940s.

NSW has a new framework for managing coastal erosion risks through the *Coastal Management Act* 2016 and the Coastal Management Manual 2018.

This report develops site specific action plans for the Shoalhaven Local Government area based on the requirements of the *Coastal Management Act 2016* as outlined in the Coastal Management Manual (OEH 2018). This report provides local area Coastal Emergency Action Subplans for those areas subject to immediate hazards from coastal erosion or inundation.

According to the statutory provisions in the *Coastal Management Act*, a coastal zone emergency action Subplan is a plan that outlines the roles and responsibilities of all public authorities (including 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.

This Local Area Coastal Emergency Subplan deals with the immediate hazards from coastal erosion and inundation. A separate local area Emergency Action Subplan has been prepared to cover the hazards of cliff and slope instability.

The objectives of this Local Area Coastal Emergency Action Subplan are to:

- Reduce the risk to public safety, the coastal environment and public assets arising from the coastal hazards of erosion and inundation brought about by storm activity
- Identify key actions to be carried out by Council before, during and following a coastal emergency to reduce the risk to public safety, the beach environment and public assets
- Identify the responsibilities of other public authorities during a coastal emergency
- Identify key areas and assets subject to immediate hazards of erosion and coastal inundation and prioritise actions to reduce the risks to those areas and assets

The Plan includes actions covering the four phases of emergency management as described in the Coastal Management Manual, namely:

- Prevention
- Preparedness
- Response
- Recovery

Note that an emergency action Subplan must not include matters dealt with in any plan made under the *State Emergency and Rescue Management Act 1989* (such as a State Emergency Service Local Flood Sub Plan), and no such duplication of material (or change in defined roles and responsibilities) has been included herein.

1.2 Study Area

The study area includes those beaches that were analysed in the updated coastal hazard studies undertaken by Advisian (2016). The study area for this investigation is shown in Figure 1.

The beaches for which updated hazard mapping has been carried out and which are the subject of this Subplan include (from north to south):

- Shoalhaven Heads
- Culburra Beach
- Warrain Beach
- Currarong
- Callala Beach
- Collingwood Beach
- Bendalong Boat Harbour
- Narrawallee
- Mollymook
- Collers Beach.

A brief description of the coastal compartments of the Shoalhaven coast, a description of each of the beaches in the study area, as well as a summary of additional data available for hazard analysis since the previous assessment in 2009 is provided in the updated Coastal Hazard Mapping report (Advisian 2016).

The risks to public assets, based on Council's GIS database of wastewater, water supply, roads, buildings and other Council owned infrastructure, superimposed onto the updated hazard mapping GIS layers and aerial photography, are articulated in the separate Risk Assessment study (Advisian 2018).

Mapping of the assets at immediate risk from coastal hazards is provided in Appendix A.

This report provides an update to the SMEC (2011) Site Specific Coastal Emergency Action Plan, as a result of updated coastal hazard mapping and to address the requirements of the Coastal Management Act 2016.

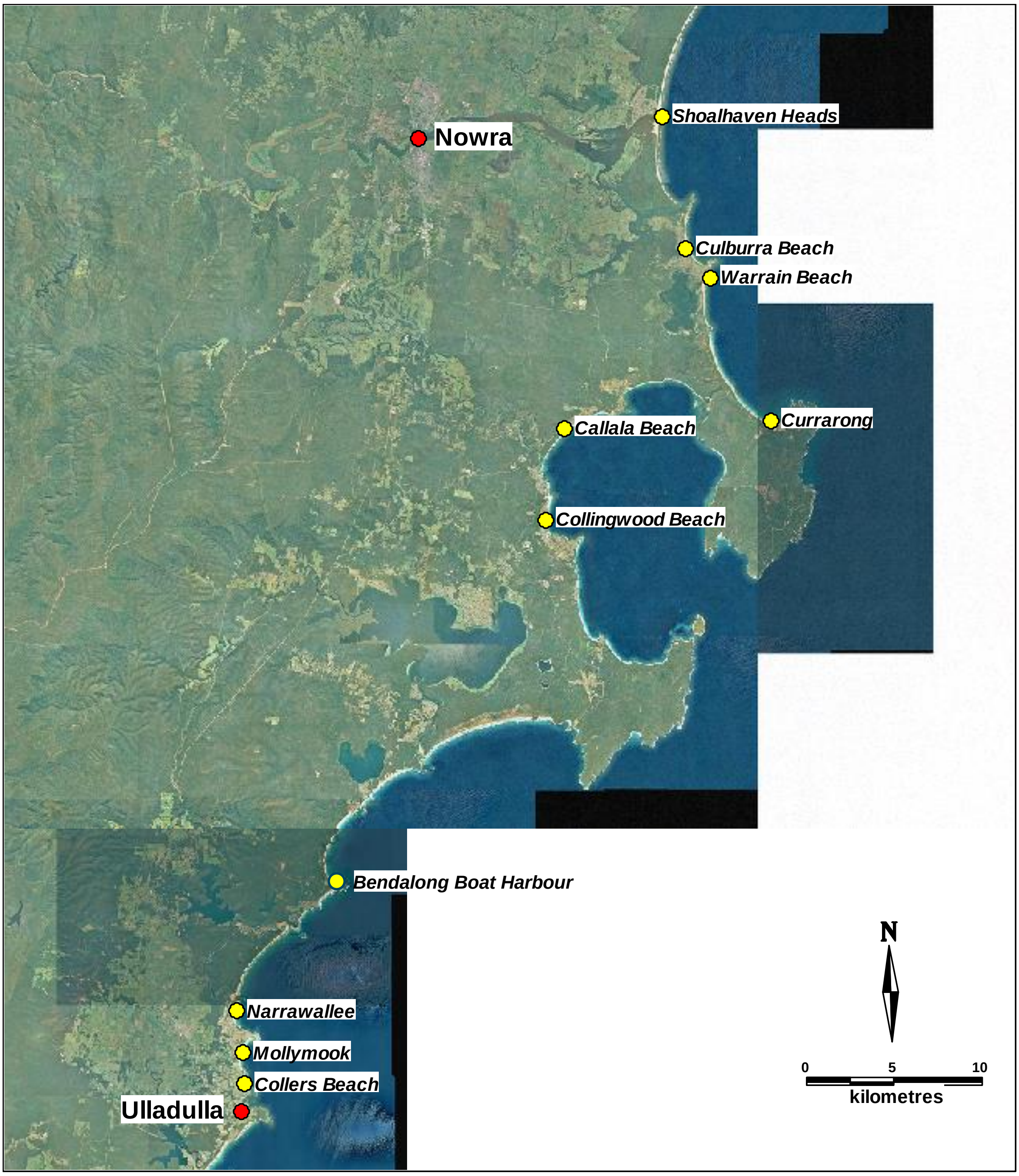


Figure 1 - Study area

2 Establishing the Context

2.1 What is an Emergency?

An "emergency" is defined in the *State Emergency and Rescue Management Act 1989* and the NSW State Disaster Plan as:

"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, any property in the State, being an emergency which requires a significant and co-ordinated response.*

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 the 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."*

A "beach erosion emergency" in the context of this emergency action Subplan can therefore be defined as an actual or imminent occurrence of a beach erosion event which "endangers, or threatens to endanger, the safety or health of persons or animals" or "destroys or damages, or threatens to destroy or damage, any property, being an emergency which requires a significant and co-ordinated response."

2.2 Triggers for Action

The actions contained in this emergency action Subplan are triggered by the release of a "Severe Weather Warning for Damaging Surf" or "Severe Weather Warning for Storm Tides" from the Bureau of Meteorology. This is the same trigger as that used by the State Emergency Service as a primary test of whether or not they should be involved in a potential coastal erosion (and/or inundation) event. In practice, expert engineering judgement would need to be applied at times of storms to assess when to initiate particular actions as required. This approach relies on regular monitoring of environmental conditions and beach behaviour, and seeking appropriate advice when required.

3 Coastal Hazards

The principal hazards induced by the coastal processes that are relevant for an emergency action Subplan in the study area include:

- short-term coastal erosion from severe storms and consequent slope instability
- oceanic inundation of low lying areas.

3.1 Short Term Coastal Erosion

Typically a beach comprises unconsolidated sands that can be mobilised under certain meteorological conditions. The dynamic nature of beaches is witnessed often during storms when waves remove the sand from the beach face and the beach berm and transport it, by a combination of longshore and rip currents, beyond the breaker zone where it is deposited in the deeper waters as sand bars. During severe storms, comprising long durations of severe wave conditions, the erosion continues into the frontal dune, which is attacked, and a steep erosion escarpment is formed. This erosion process usually takes place over several days to a few weeks.

Assuming that the subsurface material in the beach dunes is composed entirely of sand, based on Nielsen et al (1992), a number of coastline hazard zones can be delineated at the beaches in the study area as shown in Figure 2.

The *Zone of Wave Impact* delineates an area where any structure or its foundations would suffer direct wave attack during a severe coastal storm. It is that part of the beach that is seaward of the beach erosion escarpment.

A *Zone of Slope Adjustment* is delineated to encompass that portion of the seaward face of the beach that would slump to the natural angle of repose of the beach sand following removal of sand by wave erosion.

A *Zone of Reduced Foundation Capacity* for building foundations is delineated to take account of the reduced bearing capacity of the sand adjacent to the storm erosion escarpment. Nielsen *et al.* (1992) recommended that structural loads should only be transmitted to soil foundations outside of this zone (i.e., landward or below), as the factor of safety within the zone is less than 1.5 during extreme scour conditions at the face of the escarpment.

In general (without the protection of a terminal structure such as a seawall), dwellings/structures not piled[1] (or otherwise founded to an adequate depth) and located with the *Zone of Reduced Foundation Capacity* would be considered to have an inadequate factor of safety.

The schema for delineating the various zones is shown in Figure 2.

[1] A pile is a structural member that is driven, screwed, jacked, vibrated, drilled or otherwise installed in the ground so as to transmit loads to the surrounding soil or rock (refer to Australian Standard AS 2159–1995, "Piling – Design and installation").

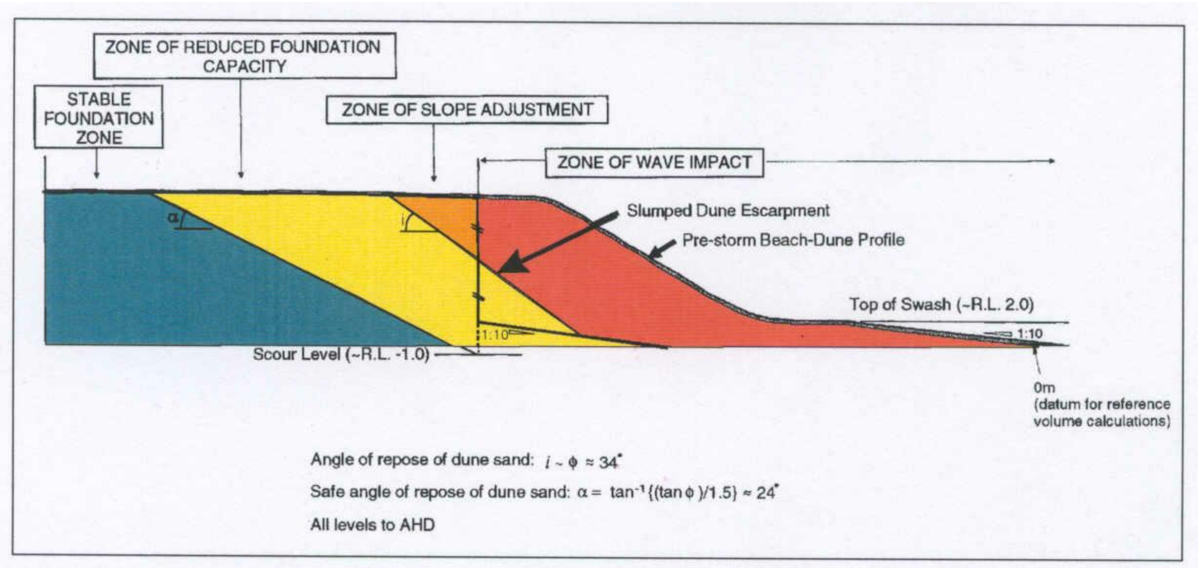


Figure 2 – Schematic Representation of Coastline Hazard Zones

3.2 Creek entrance instability

Short term beach fluctuations can be enhanced at natural estuary entrances. Natural entrances tend to migrate along the beach in response to freshwater flooding and coastal storm effects (NSW Government, 1990). This phenomenon has been seen at some of the beaches in the Shoalhaven, including Mollymook, with the creek entrance location migrating in response to the severe coastal storms of May 1974.

Where applicable, this extent of this hazard has been quantified empirically, with the fluctuation in sand volumes due to the 1974 storm event estimated from the photogrammetric data. The creek entrance instability hazard is applicable only in the zones around creek entrances and has been included within the short term erosion hazard.

3.3 Coastal Inundation

Coastal inundation is the flooding of coastal lands by ocean waters, which is caused by large waves and elevated water levels associated with severe storms. Severe inundation is an infrequent event and, normally, is of short duration, but it can result in significant damage to both public and private property (NSW Government 1990).

The components that give rise to elevated still water levels at times of storms include storm surge (including wind setup and barometric setup) and wave setup. This increased water level may persist for several hours to days and can inundate low lying beach areas and coastal creeks.

Coastal inundation and flooding may also occur as the result of a tsunami. Tsunamis result from earthquakes or underwater landslides and can pose a risk to coastal assets, public safety and human life. This emergency action Subplan does not cover the likelihood and risk associated with tsunamis. However, the NSW State Tsunami Plan can provide important information for councils and assist in their broader emergency management preparedness (NSW OEH, 2018).

Wave runup relates to the rush of water up the beach on the breaking of a wave. The amount of run-up is the vertical height above still water level to which the rush of water reaches. Wave runup is site specific but, typically, reaches levels of around 6 - 7 m AHD on the open NSW coast at present. The level of wave runup on beaches depends on many factors, including:

- wave height and period
- the slope, shape and permeability of the beach
- the roughness of the foreshore area (i.e. whether the foreshore area comprises a smooth sandy beach or a rocky foreshore with boulders)
- wave regularity.

The calculation of wave runup for the beaches in the Shoalhaven is outlined in Advisian (2016).

3.4 Immediate Coastal Hazard Areas

The immediate coastal hazard areas are those areas which may be exposed to the coastal hazards of erosion and inundation in the event of a coastal emergency.

Immediate hazard areas were extracted from the updated coastal hazard studies undertaken for the various beaches located along Shoalhaven City Council coastline (Advisian 2016). Immediate hazard area maps are illustrated in Appendix A. From these maps, the areas that are at immediate risk of storm erosion or inundation are indicated in Table 1.

Table 1 – Areas that are currently subject to immediate coastal hazards

Location	Asset at risk	Erosion Risk	Inundation Risk	Reduced Foundation Capacity
All beaches in the LGA	Council managed public beach accessways	✓	✓	✓
	Dune vegetation and fencing	✓	✓	✓
Shoalhaven Heads	Shoalhaven Heads SLSC (protected by an engineered rock revetment)	✓		✓
	Viewing platform, picnic tables and minor assets	✓	✓	✓
Culburra	Stormwater outlet at Allerton Avenue	✓		✓
	Public carpark at northern end of beach	✓		✓
	Seaward ends of some lots subject to inundation, exacerbated by presence of private beach accessways providing a pathway for wave runup flows		✓	
Currarong	Sewerage infrastructure on seaward side of lots at Beecroft Parade	✓	✓	✓
	Playground in vicinity of boat ramp	✓	✓	✓
	Parts of Warrain Crescent			✓
	Some lots along Beecroft Parade subject to reduced foundation capacity and inundation on their seaward side		✓	✓
Callala Beach	Parts of 80 private Lots	✓		✓
	16 private dwellings on Quay Road	✓		✓
	Up to 53 buildings subject to reduced foundation capacity including Tennis Club			✓
Huskisson Beach	Parts of public cycleway and picnic facilities	✓	✓	✓
Collingwood Beach	Parts of public cycleway and stormwater outlets	✓	✓	✓
	northern end of Ilfracombe Avenue		✓	
	Sewerage infrastructure		✓	
	Seaward end of lots at Montague Street, Susan Street and Elizabeth Drive south of Susan Street.		✓	
Bendalong Boat Harbour	Playground and public carpark at western end	✓	✓	✓
	Picnic area and public carpark at eastern end (east of boat ramp)	✓	✓	✓
	Red Point Road along beach frontage	✓	✓	✓
Narrawallee	Public reserve and amenities		✓	
Mollymook	Golf Club (currently protected by a gabions revetment)	✓	✓	✓
	Sewerage infrastructure including mains and pump station at southern end of beach	✓	✓	✓
	Golf Avenue/Ocean Street		✓	✓
	Parts of Mitchell Parade north of Donlan Road		✓	✓
	Stormwater outlets along Mitchell Parade	✓	✓	✓
	Sewerage infrastructure along Mitchell Parade	✓	✓	✓
	Pump station and amenities at Beach Road	✓	✓	✓
Collers Beach	Sewerage Infrastructure	✓	✓	✓
	Private dwelling	✓	✓	✓

Some further areas that may become vulnerable due to erosion after a significant storm include:

- from Callala Beach Road southward at Callala Beach
- from Susan Street northward at Collingwood Beach
- the corner of Allerton Avenue and Haven Street at Culburra Beach
- Matron Porter Drive at Narrawallee
- The SLSC at Warrain Beach.

The storm approach direction is a significant factor in determining the level of risk that applies to various locales within the storm area. For example, north-facing beaches (Currarong, Bendalong Boat Harbour and the south corner of Culburra and Mollymook) are particularly exposed to storm waves from the east and north-east, such as occurred during the June 2016 East Coast Low. Other beaches, including Collingwood and Callala Beach and the northern ends of the open coast beaches, are more exposed to storm waves from the south.

The present day (or immediate) coastal inundation area has been defined taking account of storm direction, with the worst storm direction adopted for each area. This means that, during a coastal emergency, not all the areas indicated on the immediate coastal hazard maps would be expected to be impacted equally and the degree of impact will depend on the approach direction of the storm as well as the astronomical tide when the storm occurs. For example, the June 2016 and May-June 1974 storm events coincided with spring tides, which exacerbated the impact of those storms on coastal erosion and wave inundation.

To assess the risk of damage to structures in the study area, it would be necessary to:

- evaluate the effectiveness of protective works located seaward, which would require knowledge of toe levels, crest levels, and size of the structural elements in the works (such as rock size where applicable)
- have knowledge of the foundation conditions of the structure (in particular whether the development was founded on deep piles)
- have undertaken geotechnical investigations in areas known to have a non-sandy subsurface.

4 City-wide Emergency Management Measures

4.1 Preamble

The Emergency Management Measures described in this Subplan have been formulated to cover the four phases of emergency management as described in the Coastal Management Manual (OEH 2018), namely:

- Prevention
- Preparedness
- Response
- Recovery

The following sections provide a brief discussion on the triggers for implementation of the Emergency Action Subplan (Section 4.2) along with the identification of potential actions that Council should undertake before, during and after a coastal erosion emergency (Sections 4.3, 4.4 and 4.5 respectively).

4.1.1 Prevention

Prevention describes actions and management measures relating to reducing the risk to public safety, assets and the environment. The actions and management measures are implemented *before* a storm and on an ongoing basis, prioritised based on the exposure of the particular areas to a coastal emergency.

Actions that fall into the prevention phase of emergency management may include:

- works to reduce the risk from immediate coastal hazards
- undertaking necessary environmental assessments and any development approval processes, where necessary, to facilitate emergency works outlined in the Subplan.

SMEC (2011) recommended a number of site specific management actions that have since been implemented and have reduced the immediate hazards. For example, SMEC (2011) recommended dune reshaping and stabilisation for the section of the beach north of the entrance of Mollymook southern creek. The dune height in front of the dwellings located directly north of the creek entrance was low, due to the presence of the creek entrance and lateral movement of the creek entrance along the beach. The creation of a geotextile tripper wall along the entrance and re-shaping of the dune to a minimum level of 6 m AHD was suggested to reduce the impact of the creek flow on the dune and reduce the risk of wave inundation to the at-risk infrastructure in this area. This solution has been implemented and has afforded increased protection to this area, which has been recognised in the updated coastal hazard assessment.

Opportunities for other preventative works elsewhere in the Shoalhaven LGA to reduce further the immediate risks have been described and are outlined in Section 5 of this report, together with engineering advice regarding their implementation.

4.1.2 Preparedness

Preparedness describes actions and management measures to be undertaken *before* a storm event to ensure that Council and the community are prepared in the event of a coastal emergency.

Actions that fall into the preparedness phase of emergency management may include:

- informing the community of the council's intended erosion emergency responses under its emergency action Subplan
- preparing a communication strategy to advise the community of the likelihood of an impending beach erosion emergency that would initiate actions under the Subplan
- preparing for planned emergency actions
- preparing up-to-date personal contact details for key council staff involved in coordinating actions under the Subplan (include responsibilities of staff who prepare for, manage and coordinate recovery from an erosion emergency event) and individuals from whom the council may need advice, such as OEH staff, or with whom to integrate from other emergency sectors)
- regular monitoring of environmental conditions and beach behaviour, and seeking appropriate advice when required
- monitoring beach erosion and weather/wave conditions and forecasts
- ensuring sufficient warning signage and barricades are available for use if required (e.g. to close off damaged and potentially dangerous beach access points)
- provision of information and advice to affected beachfront landowners and the wider community
- consulting with SES and other relevant agencies such as OEH as required.

4.1.3 Response

Response describes management actions and measures to be undertaken *during* a coastal emergency event. This phase of emergency management describes the immediate response to a storm event to reduce the immediate threat to public safety posed by the emergency.

Actions that fall into this category may include:

- regular monitoring of environmental conditions and beach behaviour
- assessing the need for barriers and safety signage to be erected at damaged and potentially dangerous beach access points, to minimise risk to public safety
- erecting barricades and safety signage if required

- assessing the need to remove existing beach signage, bins and dune fencing where threatened by coastal erosion (and removing these assets where safe to do so to prevent damage or being washed away)
- seeking coastal and geotechnical engineering advice where required
- seeking advice from OEH staff as required
- supporting SES as required and where resources allow
- releasing information to the media
- providing information and advice to beachfront landowners and wider community.

4.1.4 Recovery

Recovery refers to actions and management measures to be implemented following a coastal emergency to facilitate recovery from the emergency. Lessons learnt from the emergency event may be documented and applied back to the prevention and preparedness phases for future coastal emergency events.

Actions and management measures following a coastal emergency may include:

- removal of beach storm debris that poses a high public risk
- remedial works to restore safe beach access
- repairing or replacing damaged infrastructure, such as dune fencing and beach accessways once the dune has recovered sufficiently
- rehabilitating damaged dune vegetation
- beach scraping and/or sand nourishment to restore beach amenity
- maintaining photographic and written records of events and decision making processes
- monitoring unauthorised coastal protection works.

4.2 Criteria/Thresholds for Action

The actions contained in this emergency action Subplan are triggered by the release of a "Severe Weather Warning for Damaging Surf" or "Severe Weather Warning for Storm Tides" from the Bureau of Meteorology. This is the same trigger as that used by the State Emergency Service as a primary test of whether or not they should be involved in a potential coastal erosion (and/or inundation) event. This trigger activates the during-storm actions of the sub-plan, particularly the monitoring of environmental conditions and beach behaviour.

Pre-storm actions are to be undertaken as soon as practicable and are independent of the occurrence of a coastal emergency.

During a storm, a prescriptive set of trigger conditions that would be used to initiate individual Council actions in relation to coastal erosion emergencies are impractical to stipulate. This is because to devise such conditions would be exceedingly complex and still would be unlikely to cover every situation[2]. Examples of complexities include variability in storm conditions (wave height and period, wave direction, water level, location of rips), state of the tide, antecedent conditions, forecasts, existing protective works, and existing structure types (in particular foundations). Also, In the case of protective works and foundations, there may be unknowns regarding the nature of the works. In practice, expert engineering judgement would need to be applied at times of storms to assess when to initiate particular (during-storm) actions as required. This approach relies on regular monitoring of environmental conditions, beach behaviour and seeking appropriate advice when required.

Note that flooding in the Shoalhaven River may initiate coastal erosion at Shoalhaven Heads, due to the transport of beach sand into the removal of the beach berm across the river entrance by the flood. The beach at Shoalhaven Heads should be monitored following large flow events in the Shoalhaven River (and not only in relation to the threat of damaging surf conditions). Therefore, a coastal emergency may be triggered by a heavy rainfall and a flood event at Shoalhaven Heads, as well as in the vicinity of other estuary entrances throughout the LGA.

The key public assets at risk in the study area are outlined in Table 1 and include the Shoalhaven Heads SLSC and sewerage infrastructure at Mollymook. The Shoalhaven Heads SLSC is protected by an engineered rock revetment as shown in Figure 3. The performance of these works should be monitored during a storm event.

Council may consider minor assets at risk, such as accessways, viewing platforms or picnic facilities, to be not worthy of protection due to the relatively low cost of the works, which can be reconstructed if damaged following a storm event.

It is not appropriate or practical to attempt to protect minor assets such as dune fencing, bins and signage in any emergency. These could be removed to prevent damage, repaired or replaced as required (where appropriate).

Council intends to undertake actions to warn the public of and/or reduce the risks associated with storm damage and severe beach erosion hazards. All Council units have a responsibility to document records of decisions made and the reasoning in making those decisions (before, during and after coastal erosion emergencies).

Council has no intention to protect private property from coastal erosion and inundation hazards before or during an emergency event, and intends only to undertake the actions identified in Sections 4 and 5 of this Subplan.

---

[2] There is also no single quantitative parameter, such as an offshore significant wave height of a certain magnitude, minimum beach width of a certain value, or distance from an erosion escarpment that can be adopted as <u>the</u> trigger for imminent damage to an asset since there is a combination of many factors involved.

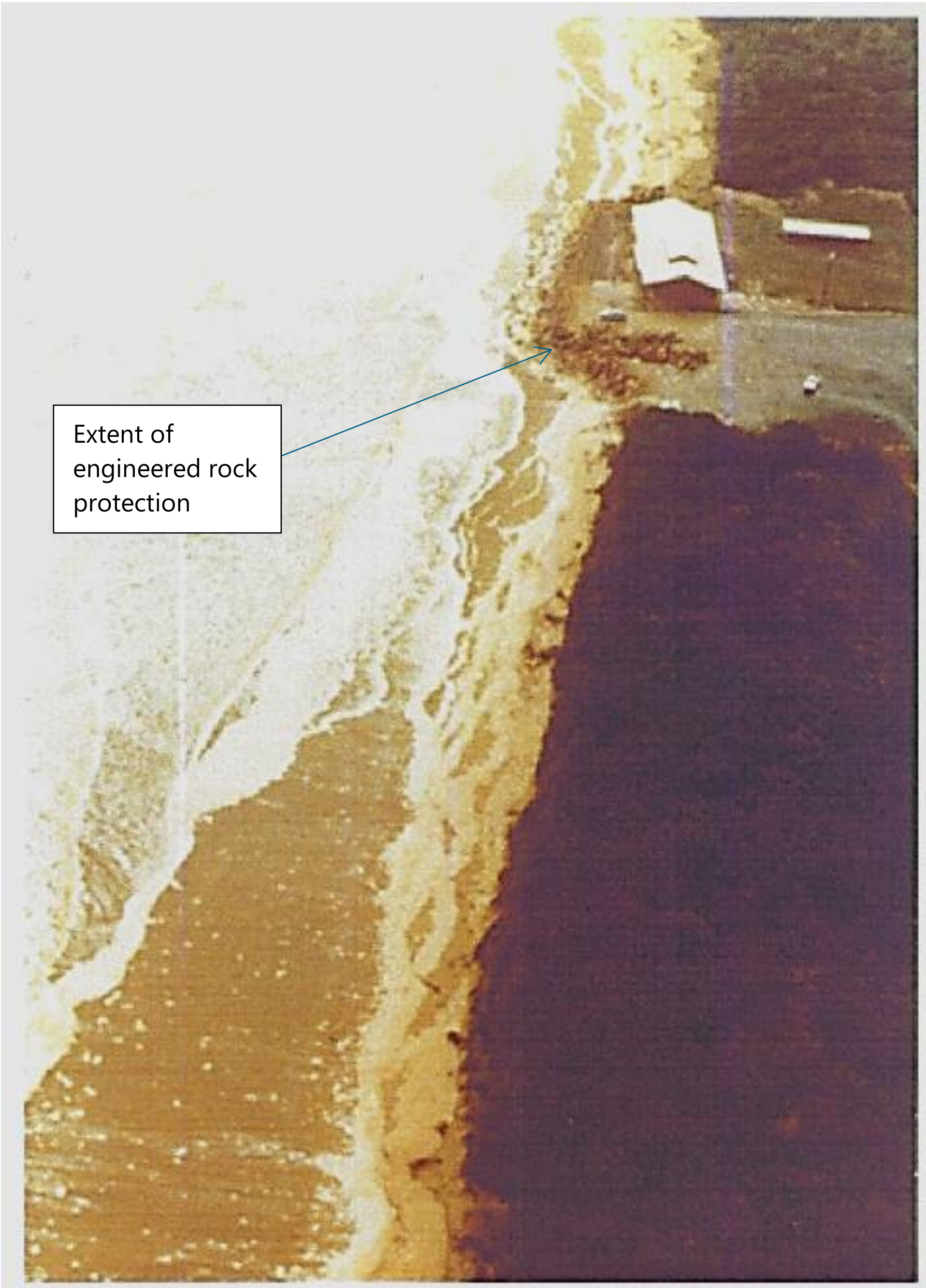


Figure 3 – Shoalhaven Heads SLSC following 1978 storm event (photo credit: Angus Gordon).

4.3 Before a Storm (Prevention and Preparedness)

The following actions should be undertaken before a storm as listed in OEH (2011):

- informing the community of the council's intended erosion emergency responses under its Emergency Action Subplan
- preparing a communication strategy to advise the community of the likelihood of an impending beach erosion emergency that would initiate actions under the Subplan
- preparing for planned emergency actions
- undertaking necessary environmental assessments and any development approval processes, where necessary, to facilitate emergency works outlined in the Subplan
- preparing up-to-date personal contact details for key council staff involved in coordinating actions under the Subplan (include responsibilities of staff who prepare for, manage and coordinate recovery from an erosion emergency event) and individuals from whom the council may need advice, such as OEH staff, or with whom to integrate from other emergency sectors).

Other relevant actions for Council before a storm are listed below:

- monitoring beach erosion and weather/wave conditions and forecasts
- ensuring sufficient warning signage and barricades are available for use if required (*e.g.* to close off damaged and potentially dangerous beach access points)
- providing information and advice to affected beachfront landowners and the wider community
- consulting with SES and other relevant agencies such as OEH as required.

Monitoring is the key to maximising warning time, preparedness and predictive capability in regard to emergency coastal erosion events.

Monitoring of physical environmental conditions would include:

- weather conditions (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)
- beach behaviour (extent of erosion, beach width, understanding of historical beach behaviour at times of storms, location of rips).

In a potential emergency event, the beach areas listed in Table 1 should be inspected daily, particularly at high tide, where resources permit.

As of May 2018, Council is undertaking a cost-benefit analysis of implementing protective works to reduce the risk of damage at the southern end of Mollymook Beach. These works, if implemented, would reduce the immediate risk from coastal inundation and erosion in this area. Works under the Coastal Zone Management Plan are being planned also for protection of infrastructure at Beecroft Parade in Currarong. However, the measures described in this report are independent of the overall protection strategies for Mollymook and Currarong and have been devised based on the current level of risk. The measures described in this Subplan should be reviewed on a regular basis in line with the review schedule for the Coastal Zone Management Plan.

Council should consider the need to develop a communications strategy to keep affected communities informed during an erosion emergency and developing the strategy if required.

4.4 During a Storm (Response)

In the NSW Coastal Zone Management Guide Note on Emergency Action Subplans (OEH 2011) it is stated that actions undertaken during an erosion emergency should be managed by Council officers who understand clearly the Subplan and know the roles and responsibilities of key personnel. It is also stated in the Guide Note that:

- no actions undertaken should impede, conflict or overlap with those of response agencies under the *State Emergency and Rescue Management Act 1989* unless there is prior agreement between the relevant parties
- actions should focus on the safety of personnel who might be working under the extreme adverse weather conditions that gave rise to the emergency
- a communication strategy needs to be in place during an erosion emergency, keeping affected communities informed of the Council's intended responses (this should include giving regular warnings where erosion is likely to sever public access and result in relatively high, unstable, near-vertical erosion escarpments along beaches; in this case, it is vital to advise the public of the dangers these conditions may present)
- the communications strategy may need to be complemented by erecting temporary safety fencing and associated warning signage.

Council actions during a storm shall include:

- regular monitoring of environmental conditions and beach behaviour
- assessing the need for barriers and safety signage to be erected at damaged and potentially dangerous beach access points, to minimise risk to public safety
- erecting barricades and safety signage if required
- assessing the need to remove existing beach signage, bins and dune fencing where threatened by coastal erosion (and removing these assets where safe to do so to prevent damage or being washed away)
- seeking coastal and geotechnical engineering advice where required
- seeking advice from OEH staff as required
- supporting SES as required and where resources allow

- releasing information to the media
- providing information and advice to beachfront landowners and wider community.

4.5 After a Storm (Recovery)

Actions after an erosion emergency listed in OEH (2011) comprise the following:

- restore services and public access and remove any threats to public safety (such as debris deposited or exposed on beaches)
- continue temporary safety fencing and associated warning signage (as necessary)
- monitor the performance and impact of any coastal protection works installed and take remedial action where necessary
- assess the structural integrity of unprotected infrastructure, buildings and other assets exposed during the erosion event and take appropriate action where necessary
- continue to maintain a communication strategy warning of the dangers of any persisting high, unstable or near-vertical erosion escarpments drying out and collapsing without notice (in high-use public areas, the Council may consider collapsing these escarpments with machinery)
- replenish any emergency materials and supplies for use in any future erosion events
- critically review the Subplan to ensure it achieved its performance objectives and revise it to address any identified shortcomings.

Council actions after a storm are likely to include:

- removal of beach/storm debris that poses high risk to public safety
- remedial works to restore safe beach access
- repairing or replacing damaged infrastructure, such as dune fencing and beach accessways once the dune has sufficiently recovered
- rehabilitating damaged dune vegetation
- beach scraping and/or sand nourishment to restore beach amenity
- maintaining photographic and written records of events and decision making processes
- monitoring unauthorised coastal protection works
- repairing dune fencing along access ways running perpendicular to the beach
- repairing and/or replacing bins and signage (s632 notices, dog area signs, dune restoration signs) as soon as practicable after an event
- closing beach accessways if necessary until the beach has recovered sufficiently to allow them to be re-graded
- seeking coastal and geotechnical engineering advice where required.

5 Local Area Measures

5.1 Preamble

Dune overtopping presents a coastal inundation risk to infrastructure landward of the dunes in the following areas:

- Collingwood Beach
- Narrawallee
- Bendalong Boat Harbour
- Parts of Culburra

Wave overtopping in a coastal emergency may also occur at Golf Avenue at the southern end of Mollymook and erosion of the embankment south of Blackwater Creek has occurred due to breakout of Blackwater Creek toward the south.

Specific areas subject to immediate coastal hazards and which pose a public safety risk are described below, together with measures to address the risk in these areas.

Standard rehabilitation advice for dune reshaping and stabilisation are provided below for these locations to reduce the risk of wave overtopping. Standard advice relating to beach scraping is provided also. This technique can be used as both a preventative measure (*e.g.,* enhancing the dune crest elevation to reduce wave overtopping risk, providing additional buffer of dune sand to protect against erosion) and a post-emergency recovery measure to restore beach amenity and restore public access onto and along the beach.

5.2 Area Specific Management Actions

Area specific emergency management actions have been developed for all the areas subject to immediate coastal hazards. These actions are summarised in Table 2 for each area at risk and are mapped on the areas specific emergency action Subplans in Appendix B. The management actions apply in addition to the city-wide actions described in Section 4. Actions that would apply variously to the at-risk areas include:

- Beach scraping (Nature-Assisted Beach Enhancement, or NABE)
- Dune reshaping/stabilisation
- Stormwater outlet works
- Monitoring of existing works
- Public education on dune management and/or what to do in an emergency
- Stormwater re-routing/detention
- Temporary road/pathway closures
- Development Controls for new development in coastal hazard areas
- Temporary beach access closure and rehabilitation, replacement of damaged structures.

Generic details and advice for these management measures are described below.

5.2.1 Beach Scraping (NABE)

Beach scraping is a technique used for accelerating beach recovery following erosion by changing the slope of a beach, periodically, to allow the energy of the sea to bring additional sand onshore. This is achieved by removing a small amount of sand from the beach berm at low tide and adding the sand to the dune system. This process serves to assist nature in beach enhancement by systematically speeding up the natural dune recovery process (Nature Assisted Beach Enhancement or NABE).

Beach scraping comprises a soft engineering technique of responsible beach sand management. The technique has been used successfully at many places. For example, Byron Shire Council has been using the beach scraping technique at New Brighton for many years. Figure 4 shows such beach scraping activity.

It is recognised that the restoration works proposed would not, *per se*, form a permanent solution to an erosion problem and scraping may need to be done again at some future time. However, such soft engineering techniques are encouraged as they do not interfere with the natural processes and they have minimal adverse impacts on the environment. It should be noted also that beach scraping would not work well at high energy open-coast beaches and is best suited to beaches subject to a long, low swell wave climate such as those beaches within Jervis Bay, or the relatively protected southern corner of beaches such as Mollymook.

Beach scraping has higher uncertainty as a protection measure than other coastal management options, so should only be undertaken in conjunction with a comprehensive monitoring program (Carley et al., 2010).

The impact of removing sand from around the low tide mark is to lower the upper part of the sub-aqueous beach profile and, thereby, to flatten that portion of the beach slope. A flatter slope would tend to induce onshore transport of sand under wave action from the nearshore zone, thereby replacing the sand that was won to reinforce the dune by scraping. As the low tide zone is replenished by the natural onshore movement of sand, more sand can be won from this zone and transferred to the dune. In this way, therefore, the dune can be reinforced at an accelerated rate to provide a sand buffer to future storm erosion.

Figure 4 – Example of Beach Scraping at Callala Bay.

The process is schematised in Figure 6. With the scraping of sand from the lower beach face at low tide to be deposited on the dune, when the tide rises the waves find a hole that was not there before, and the effective nearshore beach slope is reduced. This will accelerate the onshore rate of sand movement to a level higher than that it would have been had the hole not been created. The hole fills in faster than the otherwise natural rate and it does this over the higher stages of the tide. When it is low tide again the operation is repeated, winning more sand and accelerating the onshore sand movement rate at the next high tide and so on.

It is important to note here that in building up the upper beach face or dune, while it is causing it to be steeper, this has no effect on the beach recovery rate because it is beyond the reach of the waves and, therefore, outside the active beach system under the lower wave climate.

Beach scraping was used at Pearl Beach on the central coast of NSW following the severe storms that caused dune erosion in 1974. As shown in Figure 5, a bulldozer was used to transfer sand from the lower beach to the dune. This work restored the dune protection to the development without any longer term adverse impacts having been experienced on the beach.

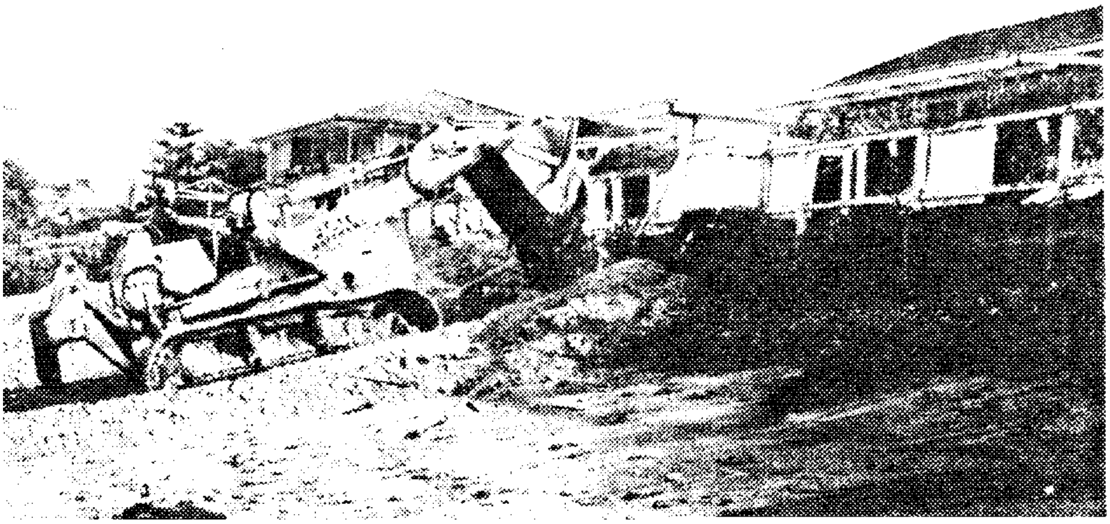


Figure 5 – Example of using beach scraping as an emergency measure at Pearl Beach following the 1974 storms

Beach scraping can be used as a measure to aid recovery where beach access has been damaged following a storm and can be combined with the restoration works for the key beach accessways throughout the LGA.

Sand for beach scraping is borrowed from the intertidal area of the beach and used to enhance the dune. However, it should be recognised that the volume of sand won from beach scraping is small compared with the volume of sand that would be eroded in a large storm. Carley *et al.* (2010) suggest that beach scraping can provide up to 20 m^3/m volume enhancement to the dune for 0.5 m scraping depth, which compares with storm erosion demand volumes of up to 200 m^3/m for the open coast beaches in the study area. Hence beach scraping only provides limited protection against beach erosion but can be feasible as a technique to increase dune crest elevation and reduce the risks from wave overtopping.

Natural dune building occurs when the wind is onshore and exceeds a critical threshold to mobilise a given sand grain size (Carley *et al.* 2010). Carley *et al.* 2010 found also that there is a seasonal pattern to dune building, with onshore winds less frequent from May to August in northern NSW. therefore The timing of beach scraping to provide the maximum benefit for dune building is an important consideration, as are ecological assessments to minimise ecological impact (*i.e.*, avoiding nesting seasons for birds and turtles, and limiting depth of scraping so that benthic organisms can rapidly recolonise the swash zone). However, the ecological impact of minor beach scraping on beaches subject to high pedestrian traffic is likely to be low. This applies to the beaches where this measure is recommended to enhance dune elevation, including Collingwood, Callala, Narrawallee, Bendalong Boat Harbour, Currarong, Culburra and Mollymook beaches.

The timing of NABE works is best carried out when low wave energy is expected to occur, during the spring tidal phase, outside the breeding/nesting seasons, at times of low beach/surfzone access requirements and during the planting season to provide the best opportunity for post NABE foredune stabilisation.

Council should ensure that appropriate equipment is available to undertake the work in a timely manner. Appropriate equipment for working in the harsh environment of the swash zone includes track tread vehicles such as bulldozers and track tread front-end loaders. For movement of sand longshore, rubber-tired vehicles may be more appropriate.

Council should ensure also that necessary approvals are in place for beach scraping prior to a coastal emergency. For coastal management works identified in a certified Coastal Zone Management Plan or Program (presumably including beach scraping), Council is the consent authority and would need to complete a Review of Environmental Factors (REF) for beach scraping under Part 5 of the *Environmental Planning and Assessment Act* 1979. Council would need to also obtain approvals under other legislation from other public authorities such as Department of Primary Industry (Marine Parks).

5.2.2 Dune Reshaping/Stabilisation

The principle of dune raising is to increase the dune crest level to prevent overtopping from wave runup. The dune should be elevated to at least the wave runup level and should be undertaken in order for the dune face to have a stable slope flatter than 1V:4H.

In general for the beaches in the study area, in the areas where the beach dune is subject to wave overtopping, raising the dune crest to 6 m AHD would reduce the inundation risk due to wave run-up and reduce the landward movement due to storm erosion. For the southern end of Collingwood Beach (south of Susan Street), the target dune crest level would be 5.5 m AHD.

For most areas, the most appropriate source of sand for the dune raising would be beach scraping from the beach berm to encourage natural dune building. For some areas, sand may be sourced from nearby estuaries, ideally within the same littoral compartment. Once the dune is raised, it should be stabilised with native vegetation in accordance with the NSW Dune Management Manual (DLWC 2001) or in accordance with Council's existing site-specific dune management plans.

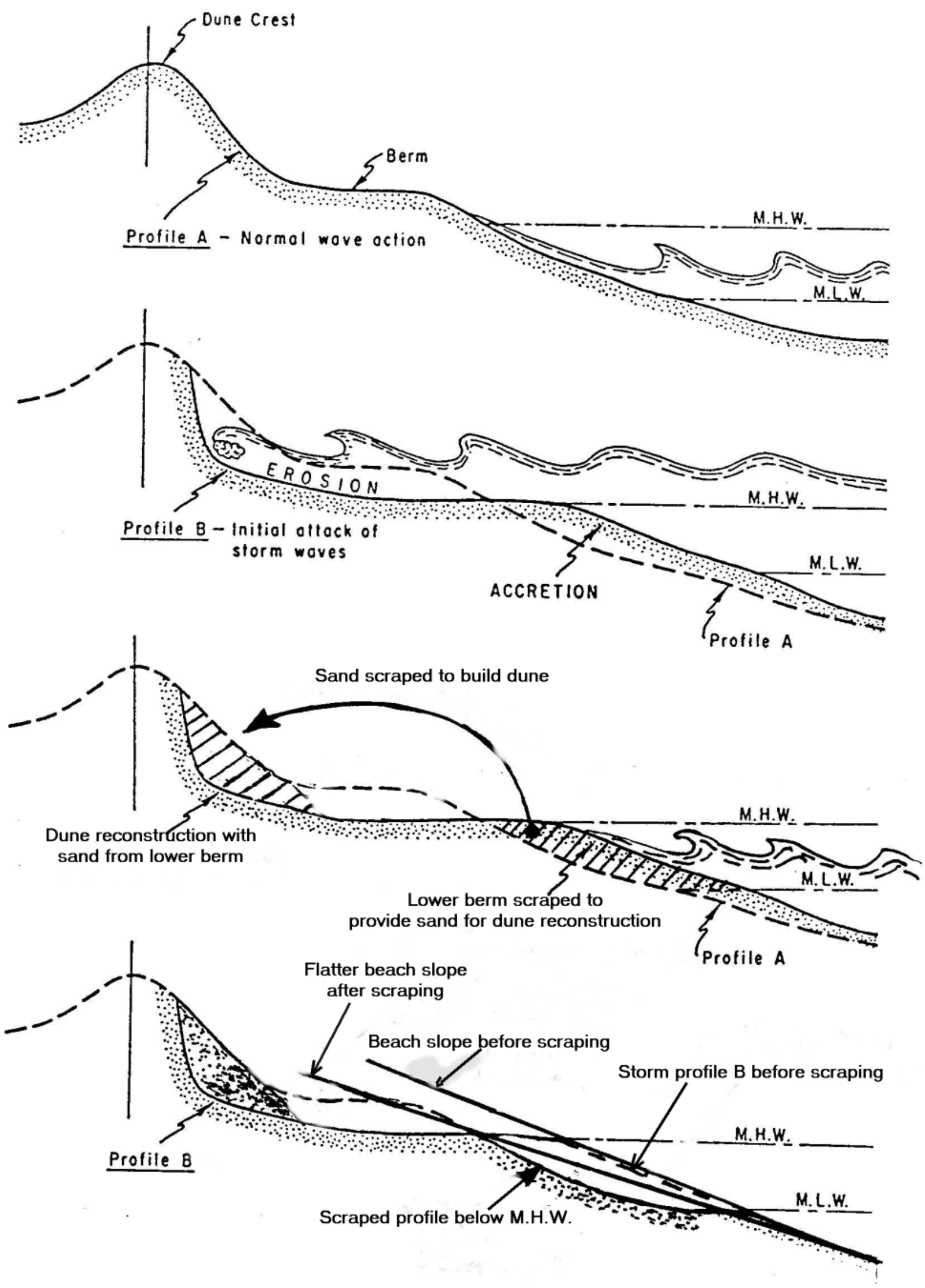


Figure 6 – Schematic diagram illustrating the application of beach scraping (source: Lex Nielsen)

5.2.3 Stormwater Outlet Works

In some areas, erosion is exacerbated by overland flow, scour from stormwater outlets or poor drainage. Existing unprotected stormwater outlets can be protected using various means of stormwater energy dissipation in front of the stormwater outlets. Examples include installing energy dissipation blocks, rock apron, or other methods to reduce velocity of outflows from the stormwater outlet.

Scour from stormwater outlets provides an opportunity for wave overtopping onto landward infrastructure as a result of the low points created by the outlets as well as an increased localised risk of erosion due to a reduction in the volume of sand in these locations. Scour from stormwater outlets has been identified as being a major problem at Mollymook and Bendalong Boat Harbour beaches and has led to more minor issues for some of the other beaches in the study area.

Improving the outlets to reduce discharge velocity and provide embankment protection for the surrounding area would provide the following benefits during a coastal emergency:

- Reduction of scour on the beach berm from stormwater discharge
- Improved public safety during rainfall events
- Allows buildup of dune in the location of the outlets which would enhance the sand buffer against erosion.

In general, beach scraping following heavy rainfall is recommended locally around the major stormwater outlets in the study area to repair scour caused by stormwater flows.

SMEC (2011) indicated that for a rock apron placed in front of the stormwater outlets, a median rock diameter of 700 mm would withstand a flow velocity of up to 4.5m/s (Austroads, 1994) which is assumed to be sufficient for most locations along the Shoalhaven coastline. For the area surrounding the outlets, some form of localised protection is recommended for example, rock or Kyowa bags, with these covered with sand.

5.2.4 Public Education

In some areas, private property is within the immediate coastal hazard area and section of the beach foredune are in private ownership (*e.g.,* Callala Beach, Culburra). For those areas, it is important that local landowners:

- Know what to do, where to go and who to contact for assistance in a coastal emergency. Warning Systems should rely on the State Emergency Service (SES) and Bureau of Meteorology (BoM) notifications and online monitoring.
- Are educated and empowered to maintain the dune under their control as required to reduce the risk to their property and are provided with resources to help them rehabilitate the dune after a storm. Council can provide support and education to these residents and encourage the development of local Dunecare groups, which provides the added social benefit of community participation in bush regeneration.

Council can encourage beachfront residents to maintain the crest level and to vegetate a dune on private property in accordance with the techniques outlined in the NSW Dune Management Manual (*e.g.,* dissemination of community education material, provision of free plants).

5.2.5 Stormwater re-routing/detention

At Bendalong Boat Harbour stormwater discharge is a major factor in exacerbating coastal erosion. A separate stormwater discharge strategy has been developed for Bendalong Boat Harbour and this has identified remedial measures such as rerouting of flows and stormwater detention to reduce the impact to the area in the event of a coastal emergency.

5.2.6 Temporary road/pathway closures

At Mollymook, Collingwood and Bendalong Boat Harbour there are sections of roadway subject to coastal inundation. As the coastal inundation may pose a public safety risk, sections of roadway that may be subject to inundation that pose a high public safety risk should be temporarily closed to public access. This can be done through erection of temporary barricades, cyclone fencing and/or signage. While not preventing access completely, such barricades would indicate clearly that the roadway is closed and access is not advised.

This will rely on close monitoring during a storm event but the areas where wave overtopping is likely in a coastal emergency include:

- Corner of Golf Avenue and Ocean Street, Mollymook – this is a high-use public area and should be a priority for monitoring/temporary closure.
- Ilfracombe Avenue, Collingwood Beach
- The cycleway at Collingwood Beach and Huskisson Beach
- Sections of the shared path at Mollymook adjacent to Mitchell Parade and potentially parts of Mitchell Parade itself
- Red Point Road at Bendalong Boat Harbour.

For most of these areas alternative access is available in the event of a road closure.

5.2.7 Development Controls

Through the DCP and LEP, Council can reduce the risk to new developments by applying development controls on floor levels and stipulating special conditions for building foundations. This is relevant for those areas where lots are subject to slope instability, inundation and/or reduced foundation capacity.

5.2.8 Temporary Beach Access Closure/Rehabilitation

Under Section 7 of the Coastal Management Act 2018, one of the management objectives for the coastal vulnerability area is "*to prioritise actions that support the continued functionality of essential infrastructure during and immediately after a coastal hazard emergency*". The Coastal Zone Management Plan has recommended the investigation of protection for areas of essential infrastructure at immediate coastal hazard risk, including sewerage infrastructure and roads at Mollymook and Currarong beaches. However, these measures are still in their planning stages. To this end, in areas of essential infrastructure where protection has not yet been provided, timely repair and replacement of any essential Council-owned/managed structures that are damaged as a result of a coastal emergency is required.

Shoalhaven Council manages 220 beach access points over 40 beach areas across the LGA. The majority of these access locations are subject to coastal erosion/inundation risk due to their location within the *Zone of Wave Impact and Slope Adjustment*. For standard board-and-chain type beach accessways through beach dunes, during a storm event a steep unstable dune escarpment may form in front of these accessways and they may become unsafe to use. The majority of beach accessways are to be closed/barricaded with fencing to prevent their use during a storm, keeping only key accesses open for use by emergency services. Following the storm event, where the access terminates at a beach scarp greater than 1 m in height, the access should be closed off and the following sequence adopted for repair:

- Collapse the dune escarpment to a slope of 1V:4H using earthmoving equipment (and taking care to not damage dune vegetation) to restore safe access and repair/replace damaged sections of board-and-chain walkways in accordance with the requirements of the NSW Dune Management Manual

- Where the beach scarp is exceedingly high and it is impractical to collapse the scarp to 1V:4H, the beach access is to remain closed until such time that the dune collapses naturally and the foredune has recovered sufficiently to allow the accessway to be re-opened. This process may take many months or years but can be sped up through the use of the NABE techniques described in Section 5.2.1.

- If the accessway cannot be restored safely it should be permanently removed.

- Where accessways consist of, for example, stairs constructed on piles (e.g. Currarong), these should be monitored and inspected for damage following a coastal emergency. If these are damaged they should be repaired in accordance with the techniques discussed in the Dune Management Manual. If there is a drop-off greater than 0.5 m at the toe of the stairs, the accessway should be closed temporarily until the earth-moving equipment can be used to scrape sand from the beach berm up to at least the level of the lowest step.

Table 2 – Area specific emergency management measures

		Immediate Coastal Hazard			Area-specific management measure								
Location	**Asset at risk**	Erosion Risk	Inundation Risk	Reduced Foundation Capacity	Beach Scraping (NABE)	Dune Reshaping/ Stabilisation	Stormwater outlet works	Monitoring of existing works	Public education on dune management and/or what to do in an emergency	Stormwater rerouting/ detention	Temporary road/pathway closures	Development controls for new development in coastal hazard areas	Temporary beach access closure and rehabilitation, replacement of damaged structures
All beaches in the LGA	Council managed public beach accessways	✓	✓	✓									✓
	Dune vegetation and fencing	✓	✓	✓		✓							
Shoalhaven Heads	Shoalhaven Heads SLSC (protected by an engineered rock revetment)	✓		✓				✓					✓
	Viewing platform, picnic tables and minor assets	✓	✓	✓									✓
Culburra	Stormwater outlet at Allerton Avenue	✓		✓				✓					✓
	Public carpark at northern end of beach	✓		✓									✓
	Seaward ends of some lots subject to inundation, exacerbated by presence of private beach accessways providing a pathway for wave runup flows		✓						✓			✓	
Currarong	Sewerage infrastructure on seaward side of lots at Beecroft Parade	✓	✓	✓									✓
	Playground in vicinity of boat ramp	✓	✓	✓									✓
	Parts of Warrain Crescent			✓							✓		
	Some lots along Beecroft Parade subject to reduced foundation capacity and inundation on their seaward side		✓	✓								✓	
Callala Beach	Parts of 80 private Lots	✓		✓	✓				✓			✓	
	16 private dwellings on Quay Road	✓		✓					✓			✓	
	Up to 53 buildings subject to reduced foundation capacity including Tennis Club			✓					✓			✓	
Huskisson Beach	Parts of public cycleway and picnic facilities	✓	✓	✓	✓	✓					✓		✓
Collingwood Beach	Parts of public cycleway and stormwater outlets	✓	✓	✓	✓	✓	✓		✓			✓	✓

Location	Asset at risk	Immediate Coastal Hazard			Area-specific management measure								
	northern end of Ilfracombe Avenue		✓		✓	✓							✓
	Sewerage infrastructure		✓		✓	✓							✓
	Seaward end of lots at Montague Street, Susan Street and Elizabeth Drive south of Susan Street.		✓		✓	✓			✓			✓	
Bendalong Boat Harbour	Playground and public carpark at western end	✓	✓	✓	✓		✓			✓			✓
	Picnic area and public carpark at eastern end (east of boat ramp)	✓	✓	✓	✓		✓			✓			✓
	Red Point Road along beach frontage	✓	✓	✓	✓						✓		✓
Narrawallee	Public reserve and amenities		✓		✓	✓							
Mollymook	Golf Club (currently protected by a gabions revetment)	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓
	Sewerage infrastructure including mains and pump station at southern end of beach	✓	✓	✓	✓		✓	✓					✓
	Golf Avenue/Ocean Street		✓	✓				✓			✓		✓
	Parts of Mitchell Parade north of Donlan Road		✓	✓		✓	✓	✓			✓	✓	✓
	Stormwater outlets along Mitchell Parade	✓	✓	✓			✓	✓					✓
	Sewerage infrastructure along Mitchell Parade	✓	✓	✓	✓	✓							✓
	Pump station and amenities at Beach Road	✓	✓	✓	✓								✓
Collers Beach	Sewerage Infrastructure	✓	✓	✓				✓					✓
	Private dwelling	✓	✓	✓					✓			✓	

5.3 Shoalhaven Heads Subplan

For Shoalhaven Heads, the Subplan comprises the following actions:

- Monitor of the rock protection works at the Surf Club during and following a coastal emergency
- Close the beach accessways that become unsafe during a coastal emergency and repair these in accordance with the method outlined in Section 5.2.8.
- Remove, replace or repair minor infrastructure (*e.g.*, picnic facilities, viewing platforms, garbage bins *etc*.) that are damaged in a storm. Monitor warnings for dangerous surf conditions as per the trigger for the Subplan for all the beaches
- Monitor flood events which trigger the Shoalhaven River entrance flood management protocol as this will provide an additional potential trigger for the Shoalhaven Heads Subplan to come into effect.

5.4 Culburra Subplan

For Culburra, the Subplan comprises the following actions:

- Monitor the stormwater outlet at Allerton Avenue for excessive scour generation and provide energy dissipation works if necessary
- Close the beach accessways that become unsafe during a coastal emergency and repair these in accordance with the method outlined in Section 5.2.8.
- Repair and replace minor infrastructure damaged during a storm
- Provide education material to local beachfront owners that have control over the dune area to reduce the impact of private accessways onto the beach and information on what to do in an emergency.
- Apply development controls to developments in the coastal hazard areas in accordance with the Shoalhaven LEP and DCP.

5.5 Warrain Beach Subplan

No assets were identified as being at immediate coastal hazard risk at Warrain Beach, hence this is not included in Table 2. The city-wide actions apply here. Temporary closure of the beach accessways that become unsafe during a coastal emergency should be undertaken and these should be repaired in accordance with the method outlined in Section 5.2.8. Repair and replacement of minor infrastructure damaged during a storm should be carried out as appropriate.

5.6 Currarong Subplan

For Currarong, the Coastal Zone Management Plan has initiated the planning process for coastal protection works at Beecroft Parade, where sewerage infrastructure is at risk, and for an overall beach nourishment/trial groyne scheme.

As these works are not yet in place, infrastructure is still at risk at Currarong.

One area where entrance instability hazard is a potential issue is at the Peel Street beach access, at the western end of Currarong. Migration of the creek entrance here has threatened to undermine the beach access and it may be prudent to reroute the access toward the east to minimise the risk of damage to the access, rather than construction of a tripper wall.

The Subplan comprises the following actions:

- Monitor, repair and replace infrastructure that may be damaged in a storm event including sewerage infrastructure and the playground near Beecroft Parade. Temporarily isolate/take out of service the sewer pipe if necessary to prevent environmental damage caused by rupture of the sewer mains.
- Monitor the exposure of Warrain Crescent to erosion and/or inundation and implement temporary road closure if needed
- Apply development controls to developments in the coastal hazard areas in accordance with the Shoalhaven LEP and DCP.
- Close the beach accessways that become unsafe during a coastal emergency and repair these in accordance with the method outlined in Section 5.2.8.
- Undertake NABE to assist post-storm recovery for the beach accessways at Peel Street and the eastern end of Warrain Crescent.
- Repair and replace minor infrastructure damaged during a storm.

5.7 Callala Beach Subplan

For Callala, Council's actions relate to public education/provision of essential emergency related information to beachfront property owners that are in the coastal hazard areas.

The Subplan comprises the following actions:

- Obtain the necessary approvals to allow NABE to be carried out in those areas where public infrastructure is at risk. Implement NABE and dune management to enhance post-storm recovery of dune.

- Apply development controls to developments in the coastal hazard areas in accordance with the Shoalhaven LEP and DCP.
- Close the beach accessways that become unsafe during a coastal emergency and repair these in accordance with the method outlined in Section 5.2.8.
- Repair and replace minor infrastructure damaged during a storm.

5.8 Huskisson Beach Subplan

For Huskisson Beach, the Subplan comprises the following actions:

- Close the beach accessways that become unsafe during a coastal emergency and repair these in accordance with the method outlined in Section 5.2.8
- Repair and replace minor infrastructure damaged during a storm
- Temporary barricade/closure of the cycleway
- Obtain the necessary approvals to allow NABE to be carried out in those areas where public infrastructure is at risk. Beach scraping and dune management to enhance post-storm recovery of dune.

5.9 Collingwood Beach Subplan

For Collingwood Beach, the Subplan comprises the following actions:

- As a pre-storm action, raise dune to 5.5 m AHD south of Susan Street and 6 m AHD in vicinity of Ilfracombe Avenue to prevent future overwash of dune area, and vegetate in accordance with local dune management plan. Repair damaged dune vegetation along entire beachfront reserve and manage in accordance with local dune management plan.
- Close the beach accessways that become unsafe during a coastal emergency and repair these in accordance with the method outlined in Section 5.2.8
- Repair and replace minor infrastructure damaged during a storm.
- Temporary barricade/closure of the cycleway and/or Ilfracombe Avenue if affected by coastal inundation/dune overtopping
- Obtain necessary approvals and undertake NABE and dune management to enhance post-storm recovery of dune.
- Monitor and repair/replace sewerage infrastructure that is damaged as a result of a coastal emergency
- Apply development controls to developments in the coastal hazard areas in accordance with the Shoalhaven LEP and DCP.

- Provide information to owners in areas impacted by coastal inundation on what to do in an emergency.

5.10 Bendalong Boat Harbour Subplan

For Bendalong Boat Harbour, a separate Coastal Hazard Analysis report has recommended actions that would reduce the risk in a coastal emergency. In addition, the area is subject to a foreshore master plan that will change the risk profile of this beach. However, in the interim, the Subplan comprises the following actions:

- Temporary barricade/closure of Red Point Road if affected by coastal inundation
- Beach scraping to reduce risk of erosion of dune, loss of middens and damage to picnic areas/carpark/playground
- Implement stormwater management measures
- Repair/replace or relocate minor infrastructure as necessary after a storm.

5.11 Narrawallee Subplan

5.11.1 Pre-storm Preventative Dune Raising

The Subplan for Narrawallee comprises the following actions:

- Obtain approvals to undertake NABE
- Raise the dune crest to 6 m AHD along the south-central half of the beach to reduce the inundation risk due to wave run-up and reduce the landward movement due to storm erosion. Once the dune is raised, stabilise with native vegetation in accordance with the NSW Dune Management Manual guidance.

5.12 Mollymook Subplan

An area specific emergency action Subplan for Mollymook, covering preventative, response and recovery actions, is provided in the area-specific maps in Appendix B. The key preventative actions for Mollymook are described below.

5.12.1 Southern End – Pre-storm preventative actions

Following construction of the tripper wall and dune raising carried out at Blackwater Creek in Mollymook in 2016, there are no areas where new tripper walls are recommended to reduce estuary entrance instability hazard.

However, breakout of the creek tends to occur toward the south, which has created a wide, low-lying depression on the southern side of the creek and results in operational impacts to the SLSC (Figure 7).

Impacts that result from this include:

- Public safety impact for beach access from the shared path area north of the surf club
- Operational impacts to the surf club
- Increased vulnerability of the surf club due to reduction in volume of available sand to satisfy storm erosion demand.

The Subplan comprises the following actions:

- Obtain approvals for and employ beach scraping to enhance the dune to the north of the surf club.

- Develop an entrance management plan for Blackwater Creek. Manage the creek entrance by digging a small channel to provide defined opening line/s and angles which will minimise bank erosion, dune instability and minimise damage to the beach front in the area immediately north of the Surf Club, and include the opening guidelines within Council's entrance management plan.

- Undertake NABE at the area in front of the Golf Club to cover the existing Gabions revetment and encourage development of an incipient foredune in this area, thus enhancing the level of protection available for the sewerage infrastructure along this beach frontage.

Figure 7 – Southerly breakout of Blackwater Creek causing erosion of embankment and increasing vulnerability of surf club

5.12.2 Rehabilitation Concept Design for Stormwater Discharge Points

The Subplan comprises the following actions:

- Protect existing unprotected stormwater outlets along Mitchell Parade north of Blackwater Creek using an appropriate means of stormwater energy dissipation in front of the stormwater outlets. Examples include installing energy dissipation blocks, rock apron, or other methods to reduce velocity of outflows from the stormwater outlet and reduce scour on the beach berm from stormwater discharge.

- Undertake beach scraping following heavy rainfall locally around the stormwater outlets to repair scour caused by stormwater flows. This would be triggered by monitoring of the outlets and the need to repair scour that in the opinion of Council officers would pose an unacceptable safety risk to beach users (*e.g.* scour deep enough to prevent pedestrian access along the beach, or that results in direct wave impact to the road embankment and stormwater outlet). Scour from these stormwater outlets provides an opportunity for wave overtopping onto the road as a result of the low points created by the outlets as well as an increased localised risk of erosion due to a reduction in the volume of sand in these locations. An example of scour at the stormwater outlets at Mollymook with illustration of the associated increased erosion risk to the roadway and surrounding dune is shown in Figure 8.

Figure 8 – Stormwater outlet at Mitchell Parade illustrating beach scour and exposure of adjacent roadway to wave inundation and erosion.

5.12.3 Monitoring of Existing Measures

The Subplan comprises the following actions:

- Monitor existing protection works such as the gabions seawall at the southern end of Mollymook Beach for performance and maintenance purposes as per the general city-wide Subplan actions provided in Section 4.
- Inspect and monitor ongoing performance of the northern creek entrance tripper wall.

5.13 Collers Beach Subplan

The Subplan comprises the following actions:

- Provide education material for the one dwelling subject to coastal hazards on what to do in an emergency.
- Apply development controls for new developments in the coastal hazard areas in accordance with the Shoalhaven LEP and DCP.

6 Evaluation of Emergency Protection Measures

Various potential temporary or long-term measures (protective works) can be considered for implementation at those areas subject to immediate risk from coastal erosion, assuming that environmental impacts have been assessed to be acceptable and appropriate approvals are in place. Areas where such works may be considered include:

- Seaward of Beecroft Parade in Currarong
- Seaward of the Golf Club, Surf Club and Golf Avenue/Ocean Street at Mollymook
- Seaward of Beach Road at Mollymook

These works could include:

- Beach scraping (or NABE)
- Beach nourishment
- sand-filled geotextile containers (0.75m^3 and 2.5m^3 bags have been evaluated)
- rock (basalt or sandstone).

Beach scraping is described in Section 5.2.1.

Beach nourishment involves importing additional sand to the beach to act as a buffer for storm erosion. If the works are included within a certified Coastal Zone Management Plan or Program then they are classified as *Exempt Development* under the Coastal Management SEPP, subject to approvals required under other legislation. If sand nourishment is not identified in a certified Coastal Zone Management Plan or Program, a Part 5 assessment (REF) is required under the *Environmental Planning and Assessment Act* 1979.

Rock can be dropped in place (random placement), achieved by specification of a minimum rock strength and other requirements such as maximum rock aspect ratio for rock.

Rock has well established and accepted design guidelines, and can be sized to provide adequate protection. Rock also has much faster placement rates than sand-filled geotextile containers, and can generally be placed at times of storms. For more severe events than the design event, rock would be more likely to interlock (since these materials are randomly placed) after any movement and suffer damage more progressively than bags.

However, exposed rock remaining in the long term after a storm may be unacceptable, and may require removal except when they would be covered with sand during natural beach recovery.

In summary, to achieve effective protection during an emergency only rock can be considered to be appropriate, with rock also being the cheapest option. That stated, such works could only be implemented if environmental impacts were acceptable. Installation of such temporary or long term coastal protective works may only be permissible if approval were granted under Part 4 of the *Environmental Planning and Assessment Act 1979* and Section 27 of the *Coastal Management Act* 2016, as described below.

6.1 Approvals Required by Council

Section 27 of the *Coastal Management Act* 2016 and clause 19 of the *State Environmental Planning Policy (Coastal Management)* 2017 (CM SEPP) relate to development consent and approvals for coastal protection works carried out by public authorities and other persons.

Section 27 of the *Coastal Management Act* 2016 describes the arrangements relating to granting of development consent relating to coastal protection works as follows:

(1) Development consent must not be granted under the Environmental Planning and Assessment Act 1979 to development for the purpose of coastal protection works, unless the consent authority is satisfied that:

(a) the works will not, over the life of the works:

(i) unreasonably limit or be likely to unreasonably limit public access to or the use of a beach or headland, or

(ii) pose or be likely to pose a threat to public safety, and

(b) satisfactory arrangements have been made (by conditions imposed on the consent) for the following for the life of the works:

(i) the restoration of a beach, or land adjacent to the beach, if any increased erosion of the beach or adjacent land is caused by the presence of the works,

(ii) the maintenance of the works.

(2) The arrangements referred to in subsection (1) (b) are to secure adequate funding for the carrying out of any such restoration and maintenance, including by either or both of the following:

(a) by legally binding obligations (including by way of financial assurance or bond) of all or any of the following:

(i) the owner or owners from time to time of the land protected by the works,

(ii) if the coastal protection works are constructed by or on behalf of landowners or by landowners jointly with a council or public authority—the council or public authority,

Note. *Section 80A (6) of the Environmental Planning and Assessment Act 1979 provides that a development consent may be granted subject to a condition, or a consent authority may enter into an agreement with an applicant, that the applicant must provide security for the payment of the cost of making good any damage caused to any property of the consent authority as a consequence of the doing of anything to which the consent relates.*

(b) by payment to the relevant council of an annual charge for coastal protection services (within the meaning of the Local Government Act 1993).

(3) The funding obligations referred to in subsection (2) (a) are to include the percentage share of the total funding of each landowner, council or public authority concerned.

Section 19 of the Coastal Management SEPP describes the consent process for coastal protection works as follows:

Note. *Section 4 (1) of the Coastal Management Act 2016 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 27 of the Coastal Management Act 2016 also contains provisions dealing with the granting of development consent to development for the purpose of coastal protection works.

(1) ***Coastal protection works by person other than public authority***

Development for the purpose of coastal protection works may be carried out on land to which this Policy applies by a person other than a public authority only with development consent.

Note. *See clause 8A of Schedule 7 to State Environmental Planning Policy (State and Regional Development) 2011, which declares certain development for the purpose of coastal protection works to be regionally significant development for which a Sydney district or regional planning panel is the consent authority.*

(2) ***Coastal protection works by public authority***

Development for the purpose of coastal protection works may be carried out on land to which this Policy applies 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

(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.

Note.

See clause 8A of Schedule 7 to State Environmental Planning Policy (State and Regional Development) 2011, which declares certain development for the purpose of coastal protection works to be regionally significant development for which a Sydney district or regional planning panel is the consent authority.

(3) ***Emergency coastal protection works by public authority***

Development for the purpose of emergency coastal protection works carried out on land to which this Policy applies 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 (or a coastal zone management plan under the Coastal Protection Act 1979 containing an emergency action Subplan that continues to have effect under clause 4 of Schedule 3 to the Coastal Management Act 2016).

(4) In this clause, ***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.*

Part 5 of the *Environmental Planning and Assessment Act 1979* applies to coastal protection works (emergency or long term) undertaken by Council, unless the works can be considered to be exempt development.

If the works are not exempt development, before installing protective works it would be necessary for Council to undertake an environmental assessment, that is either a Review of Environmental Factors or an Environmental Impact Statement (the latter if significant impacts were expected).

Council would generally be the determining authority for these works.

A number of emergency works may be considered to be exempt development under *the Coastal Management SEPP*, including emergency works undertaken by Council to protect roads and stormwater management systems, as long as the works are of minimal environmental impact and structurally adequate.

7 Roles and Responsibilities in Coastal Emergency Management

7.1 Preamble

The roles and responsibilities of the State Emergency Service, Shoalhaven Council, Office of Environment and Heritage, Bureau of Meteorology and NSW Police in coastal emergency management are described below in turn. Further discussion on these matters is provided in the *NSW State Storm Sub Plan* (dated September 2015).

7.2 State Emergency Service

NSW State Emergency Service (SES) is responsible for the protection of persons from danger, to their safety and health, and to protect property from destruction or damage arising from storms (SES Act, 1989).

The SES is the designated Combat Agency for storm damage control including property protection for coastal erosion and for coordinating the evacuation of affected communities. The role of the State Emergency Service (SES) in coastal erosion and inundation emergencies is essentially warning and evacuation of residents at risk, and lifting and/or relocating readily moveable household goods and commercial stock and equipment. These activities would be carried out in accordance with a Coastal Erosion Annex to the SES Local Flood Sub Plan.

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

The NSW State Storm Emergency Subplan (2015) outlines specific roles for the SES for storm activity likely to result in or actually causing coastal erosion and/or inundation or dangerous beach conditions.

SES use the release of a "Severe Weather Warning for Damaging Surf" or "Severe Weather Warning for Storm Tides" from the Bureau of Meteorology as a primary test of whether or not they should be involved in a potential coastal erosion (and/or inundation) event. If required (that is if an emergency developed) when neither of these warnings had been issued, it is expected that Council would call on SES for assistance in matters that SES deal with.

7.3 Shoalhaven Council

Council 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 coastal emergency protective works to protect public assets from coastal erosion and inundation is Council's role, if it chooses to undertake such measures.

Council could choose to undertake physical erosion protection measures to protect public assets from coastal erosion and inundation if considered to be appropriate (assuming adequate environmental assessment had been carried out).

However, private landholders are responsible for private land. Council does not have a positive obligation to take particular action to protect private property from erosion events. There is, however, a statutory obligation upon Council to consider any valid development application for erosion protection works which may be lodged by property owners.

If a "Severe Weather Warning for Damaging Surf" or "Severe Weather Warning for Storm Tides" had been released or SES was mobilised in some other manner, Council would assist SES as required and where resources permit.

If SES was not mobilised (e.g. if neither of the above warnings had been released by the Bureau of Meteorology), Council may undertake some of the activities that would otherwise be conducted by SES (where resources allow, although not obligated to), but note that Council cannot order evacuation. If required, Council could request SES taking on a Combat Agency role if an actual emergency was occurring.

In practice, typical tasks that Council 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) would be as discussed in Section 4.

Council should consult with the NSW SES prior to finalising this Subplan to ensure compatibility with NSW SES Subplans.

7.4 Office of Environment and Heritage

The Office of Environment and Heritage (OEH) is the NSW government authority responsible for advising on coastal zone management. Their role is to provide advice to Councils and SES on areas subject to coastal erosion and/or inundation and coastal management including procedures for addressing coastal hazards, coastal processes and risks, management options and coastal policies.

7.5 Bureau of Meteorology

The release of a "Severe Weather Warning for Damaging Surf" or "Severe Weather Warning for Storm Tides" by the Bureau of Meteorology is the trigger adopted by SES for involvement in a coastal erosion/inundation episode.

A "Severe Weather Warning for Damaging Surf" is issued if waves in the nearshore zone are forecast to exceed a significant wave height of 5 m (irrespective of wave period) in the next 24 hours. A "Severe Weather Warning for Storm Tides" is included if storm surge, wave setup or and/or outflow from river flooding are expected to raise ocean water levels significantly above Highest Astronomical Tide.

7.6 NSW Police

The NSW Police Force is the agency responsible for:

- law enforcement and search and rescue
- controlling and coordinating the evacuation of victims from the area affected by the emergency in conjunction with the combat agencybeing the combat agency for terrorist acts.

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 SES where required (for example controlling and coordinating evacuation) when SES was acting in its Combat Agency role or
- if SES was not mobilised, police may undertake or coordinate activities such as evacuation, barricading, removal of the contents of buildings and the like.

The NSW Storm Emergency Subplan specifies that the NSW Police Force is not responsible for controlling, coordinating or mitigating any physical mitigation works to protect properties or structures at risk from coastal erosion, either during or outside the period of storm activity.

7.7 Fire and Rescue NSW

Fire and Rescue NSW has a Mutual Aid Agreement with the SES and would have a support role assisting the SES during a coastal emergency. In particular, Fire and Rescue NSW would become involved during a coastal emergency in the following ways:

- Assist the SES in monitoring / reconnaissance of areas potentially damaged by storms
- Provide storm damage response teams to assist the SES, including strike teams when requested, to assist the SES
- Assist with the evacuation of at-risk communitiesProvide staff to support a spatial information group established by the SES.

7.8 Other agencies

Other agencies with a role in Emergency Management include:

- NSW Ambulance
- Department of Justice, Office of Emergency Management
- Housing NSW
- Marine Rescue NSW

- National Parks and Wildlife Service
- NSW Rural Fire Service
- NSW Volunteer Rescue Association
- Roads and Maritime Services
- Surf Lifesaving NSW

Full details of the role of these Agencies are described in the NSW Storm Emergency Subplan.

8 Conclusion

A coastal erosion emergency action Subplan under the Shoalhaven Coastal Zone Management Plan for the beaches in the Shoalhaven has been documented in this report. The Subplan includes general city-wide management actions for Council as well as area-specific Subplans for each beach where significant infrastructure is at risk.

This Subplan has been prepared in accordance with the guidance provided in the Coastal Management Manual (OEH 2018) and contains actions covering the four phases of emergency management – Prevention, Preparation, Response and Recovery.

Despite the low immediate risk to assets and public safety within the Shoalhaven LGA, much of the coastline would be directly exposed after a significant storm with many dwellings and infrastructure located very close to the dune escarpment. Therefore, monitoring of the erosion and post-storm rehabilitation actions would be a significant element of the emergency action Subplan. Actions such as beach scraping (NABE) have been described in detail and recommended for many of the beaches in the study area. NABE is often sufficient for the beach to recover faster than in natural conditions. However, in areas where public infrastructure (*e.g.*, roads or sewerage infrastructure) are on the edge of the escarpment, further action can be undertaken such as localised protective works.

A number of emergency works may be considered to be exempt development under the Coastal Management *SEPP*, including emergency works undertaken by Council to protect roads and stormwater management systems.

To achieve effective protection during an emergency only rock or concrete blocks would be appropriate. That stated, such works could be implemented only if environmental impacts were acceptable.

Under the *Coastal Protection Act 1979*, Council 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 coastal emergency protective works to protect public assets from coastal erosion and inundation is Council's role, if it chooses to undertake such measures.

Council could choose to undertake physical erosion protection measures to protect public assets from coastal erosion and inundation if considered to be appropriate (assuming adequate environmental assessment had been carried out).

However, private landholders are responsible for private land. Council has no intention to take particular action to protect private property from erosion events. There is, however, a statutory obligation upon Council to consider any valid development application for erosion protection works which may be lodged by property owners.

Council's intended actions before, during and after coastal erosion emergencies have been described in Section 4.3, 4.4 and 4.5 respectively. Local area actions have been described in Section 5 and mapped in Appendix B.

9 References

Austroads (1994) *Waterway Design – A guide to the Hydraulic Design of Bridges, Culverts and Floodways*

Advisian (2016) *Shoalhaven Coastal Hazard Mapping Review*, 301311-13501-001

Advisian (2018) *Shoalhaven Coastal Zone Management Plan, Risk Assessment, DRAFT report no. 301015-03933-001*

Carley, JT, IR Coghlan, MJ Blacka and R J Cox (2010) *Development of a Proposal and Environmental Assessment of Beach Scraping – New Brighton and Southern Golden Beach*, WRL Report no. 2008/19, February 2010

Kulmar, Mark; Lord, Doug and Brian Sanderson (2005), "Future Directions for Wave Data Collection in New South Wales", *Proceedings of the 17th Australasian Conference on Coastal and Ocean Engineering and the 10th Australasian Port and Harbour Conference, 2005 Coasts and Ports Australasian Conference*, edited by M Townsend and D Walker, conference held from 20-23 September at Adelaide, South Australia, Institution of Engineers, Australia, ISBN 0 646 45130 8, pp. 167-172

Nielsen, A.F., D.B. Lord & H.G. Poulos (1992) *Dune Stability Considerations for Building Foundations*, IEAust., Aust. Civ. Eng. Trans., Vol. CE 34, No. 2, 167-173.

NSW Department of Land and Water Conservation: DLWC (2001). *Coastal Dune Management: A Manual of Coastal Dune Management and Rehabilitation Techniques*, Coastal unit, DLWC, Newcastle.

NSW Office of Environment and Heritage (2018) *NSW Coastal Management Manual*

NSW Office of Environment and Heritage [OEH] (2011), *Coastal Zone Management Guide Note, Emergency Action Subplans*, 978 1 74293 300 9, OEH 2011/0631, July

NSW Government (1990) *Coastline Management Manual* (now superseded)

NSW Government (2015) *NSW State Storm Plan – A Subplan of the State Emergency Management Plan (EMPLAN)*

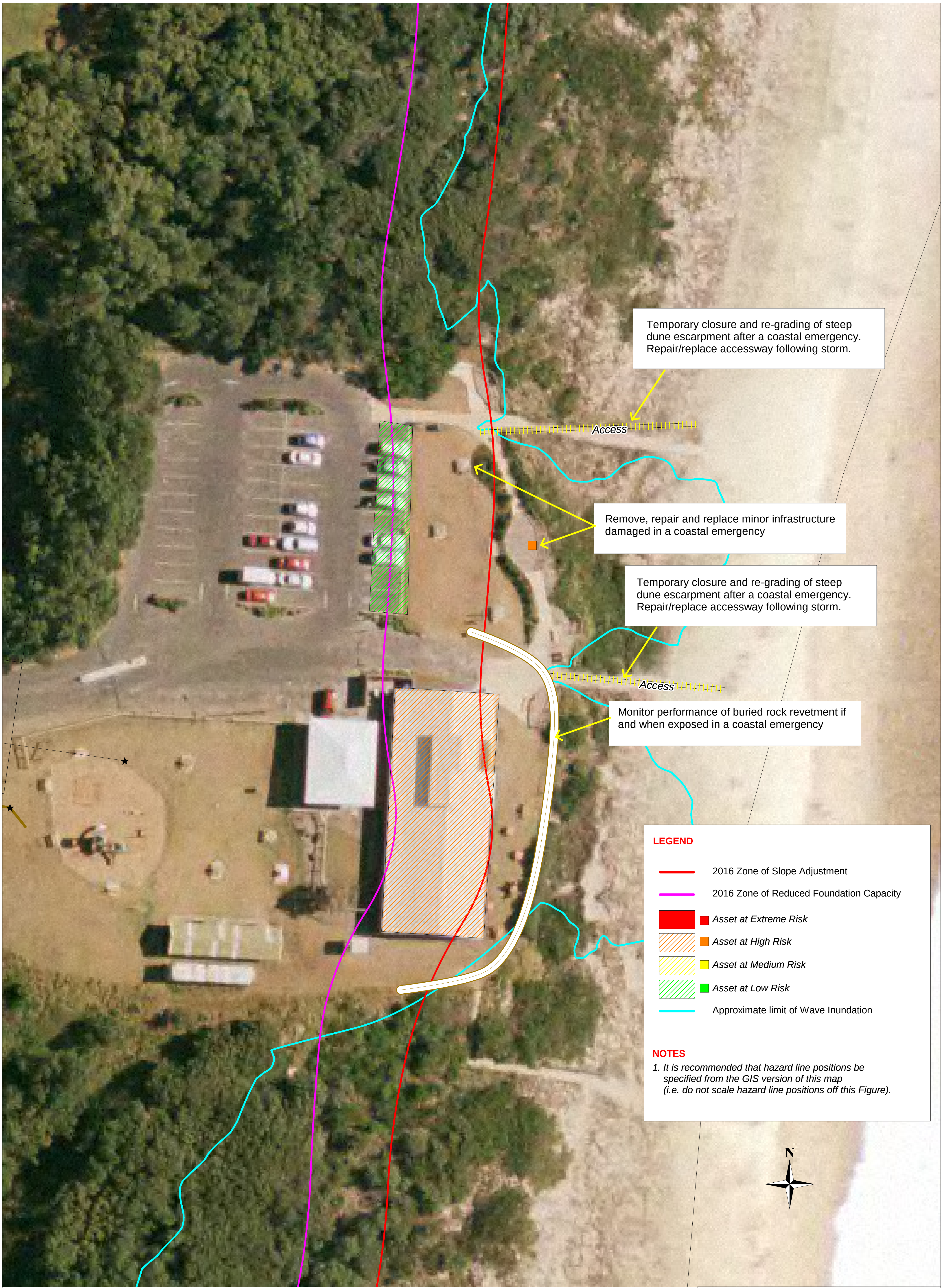
SMEC (2007) *Shoalhaven Coastal Hazard Study – Shoalhaven Heads*, Report no. 3001209-017, August.

SMEC (2009) *Shoalhaven Coastal Hazard Study – Summary Report*, Report no. 3001209, July.

SMEC (2011) *Site Specific Emergency Action Plans for Shoalhaven Council,* Report no. 3001721, May.

Appendix A Immediate Coastal Hazard Areas

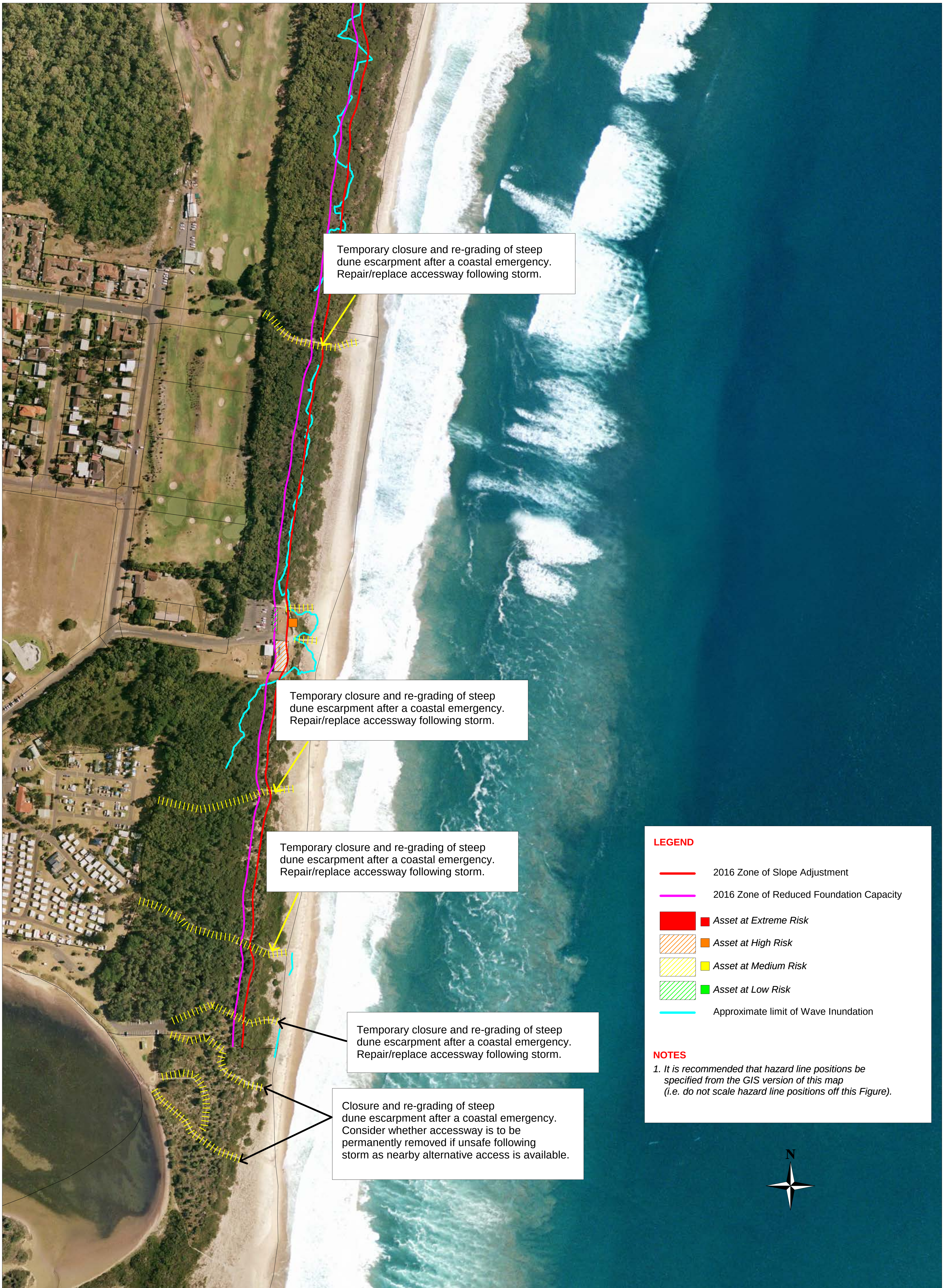
Appendix B Local Area Subplans



DATE 13/05/18	0 5 10 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Shoalhaven Heads 2016 Risk Map SLSC Local Area Emergency Action Subplan
PROJECT NO. 301015-03933		PROJECT TITLE Shoalhaven Coastal Risk Mapping	CREATED BY C. Adamantidis

Shoalhaven City Council

Advisian WorleyParsons Group



DATE 27/04/18

0 50 100 metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Shoalhaven Heads 2016 Risk Map showing Beach Access locations and local area Emergency Actions

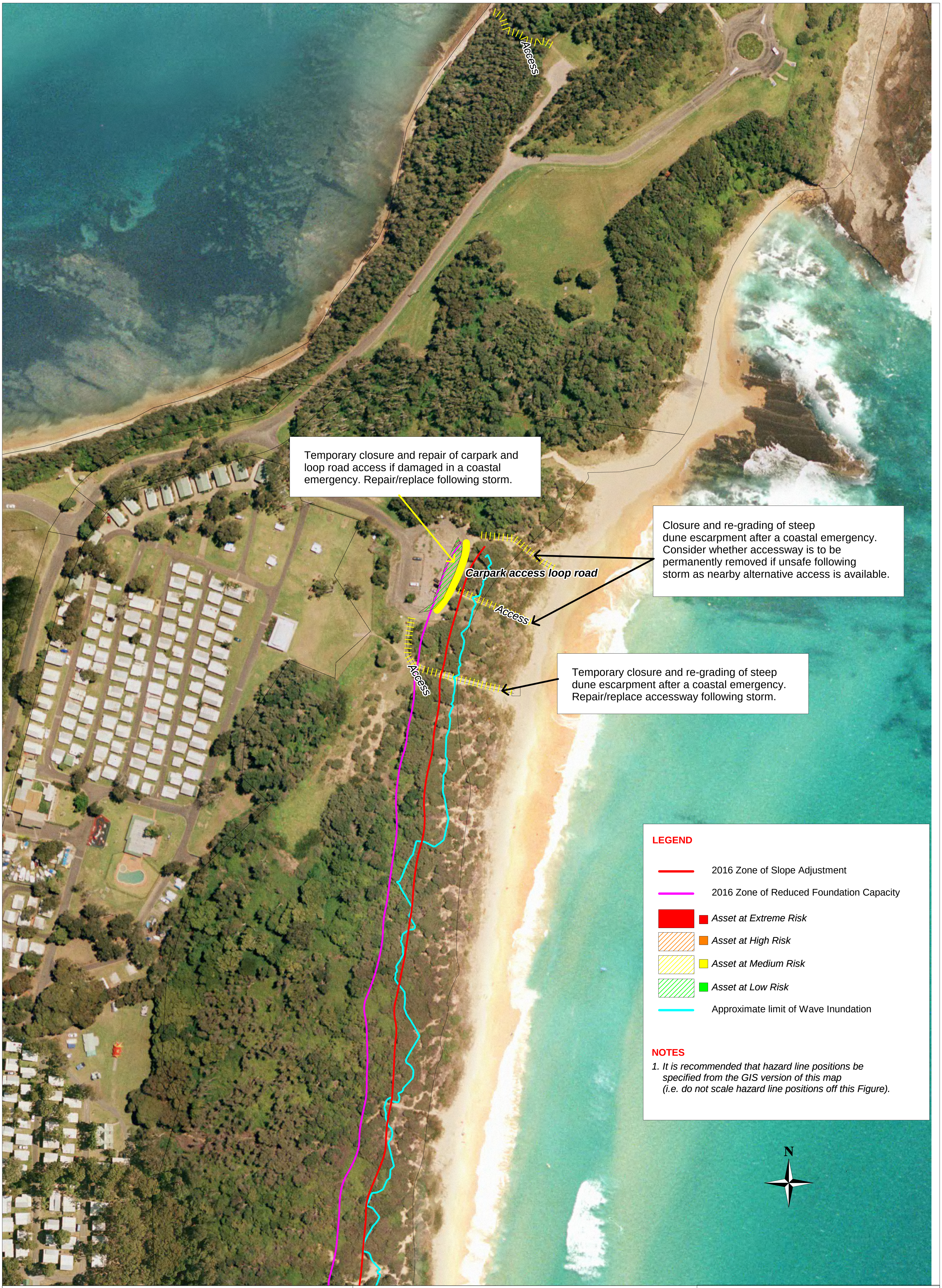
PROJECT NO. 301015-03933

PROJECT TITLE Shoalhaven Coastal Risk Mapping

CREATED BY C. Adamantidis

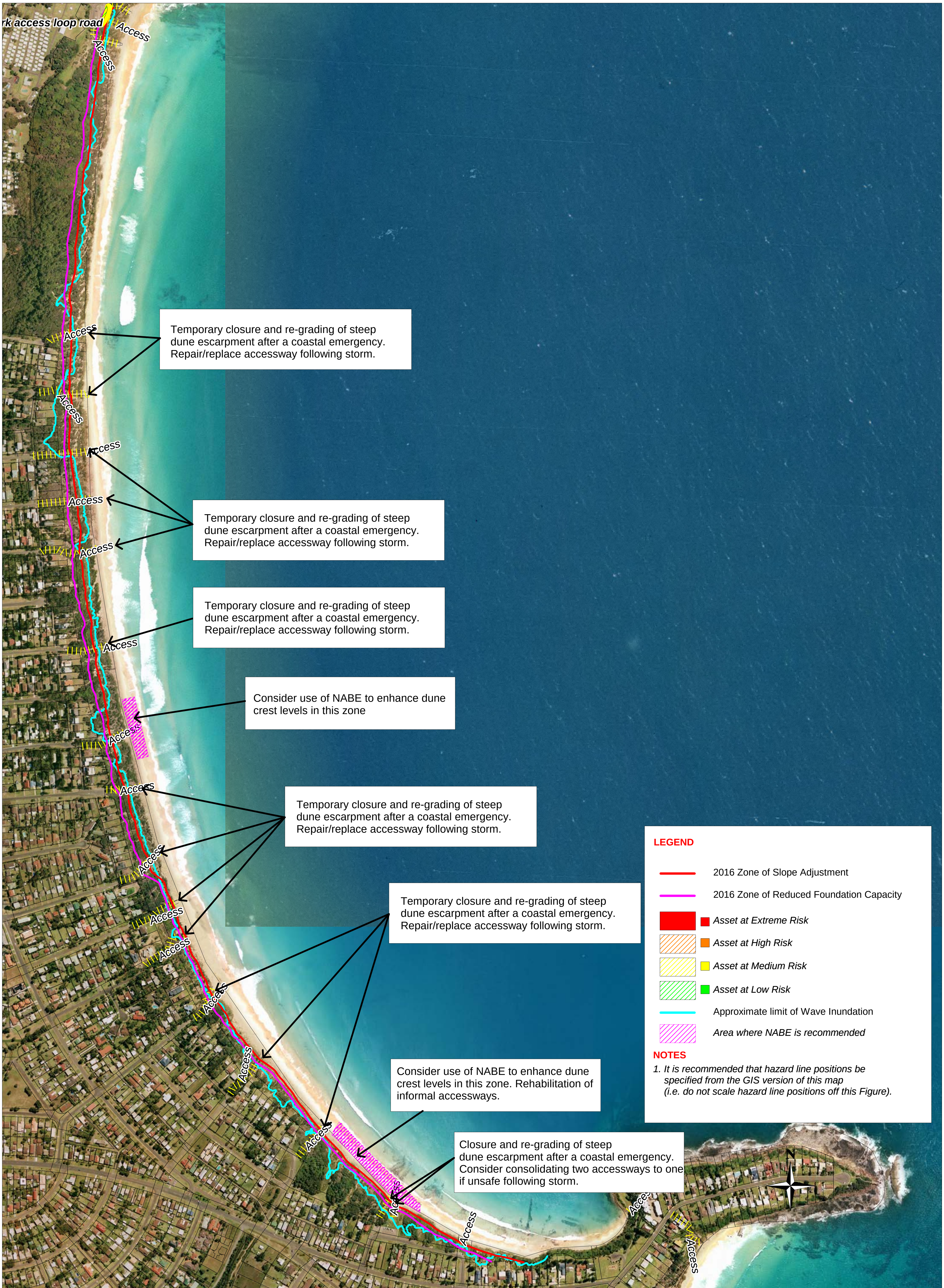
Shoalhaven City Council

Advisian WorleyParsons Group



DATE 27/04/18	0 25 50 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Culburra 2016 Risk Map (North) Local Emergency Action Subplan
PROJECT NO. 301015-03933	PROJECT TITLE Shoalhaven Coastal Risk Mapping		CREATED BY C. Adamantidis

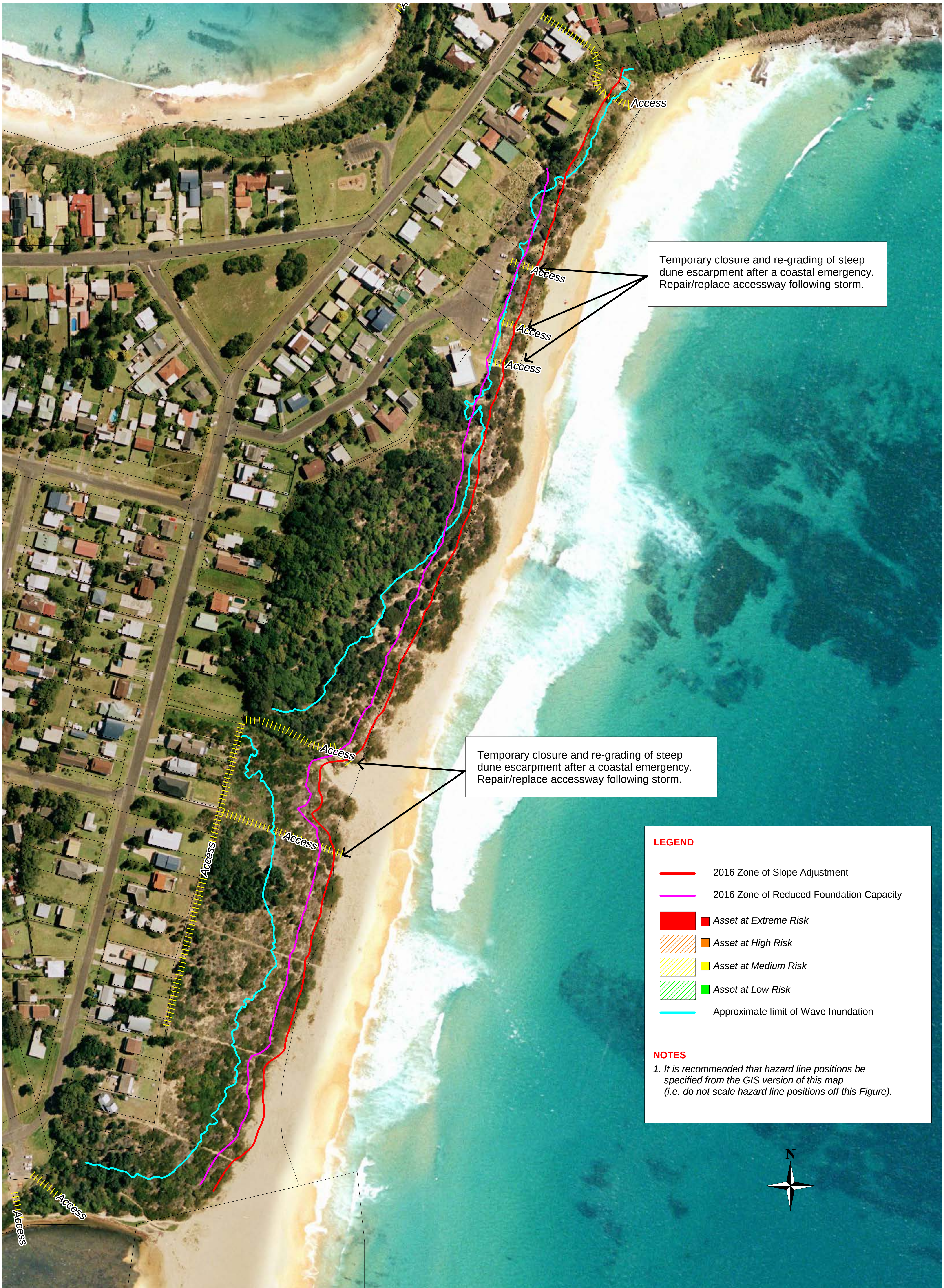
Shoalhaven City Council | Advisian WorleyParsons Group



DATE 27/04/18	0 100 200 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Culburra 2016 Risk Map showing Beach Access locations and local area Emergency Actions
PROJECT NO. 301015-03933	PROJECT TITLE Shoalhaven Coastal Risk Mapping		CREATED BY C. Adamantidis

Shoalhaven City Council

Advisian WorleyParsons Group



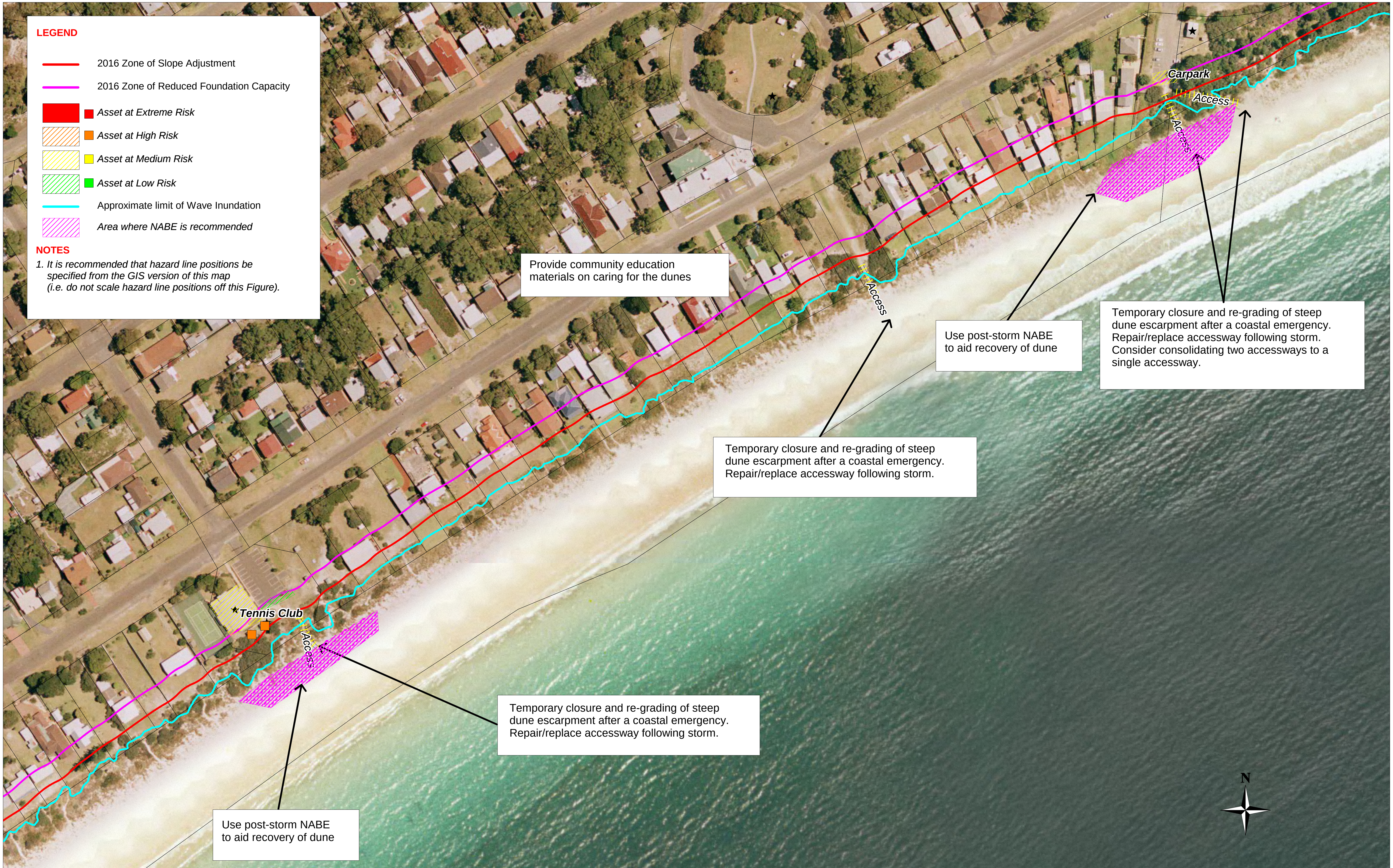
DATE 27/04/18	0 25 50 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Warrain 2016 Risk Map Local Area Emergency Action Plan
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Risk Mapping		**CREATED BY** C. Adamantidis

Shoalhaven City Council
Advisian WorleyParsons Group

DATE	27/4/18	0 50 100 metres	COORDINATE SYSTEM	MGA Zone 56	FIGURE TITLE: Currarong 2016 Risk Map and Local Area Emergency Action Plan
PROJECT NO.	301015-03933	PROJECT TITLE	Shoalhaven Coastal Mapping		CREATED BY: C. Adamantidis

Shoalhaven City Council

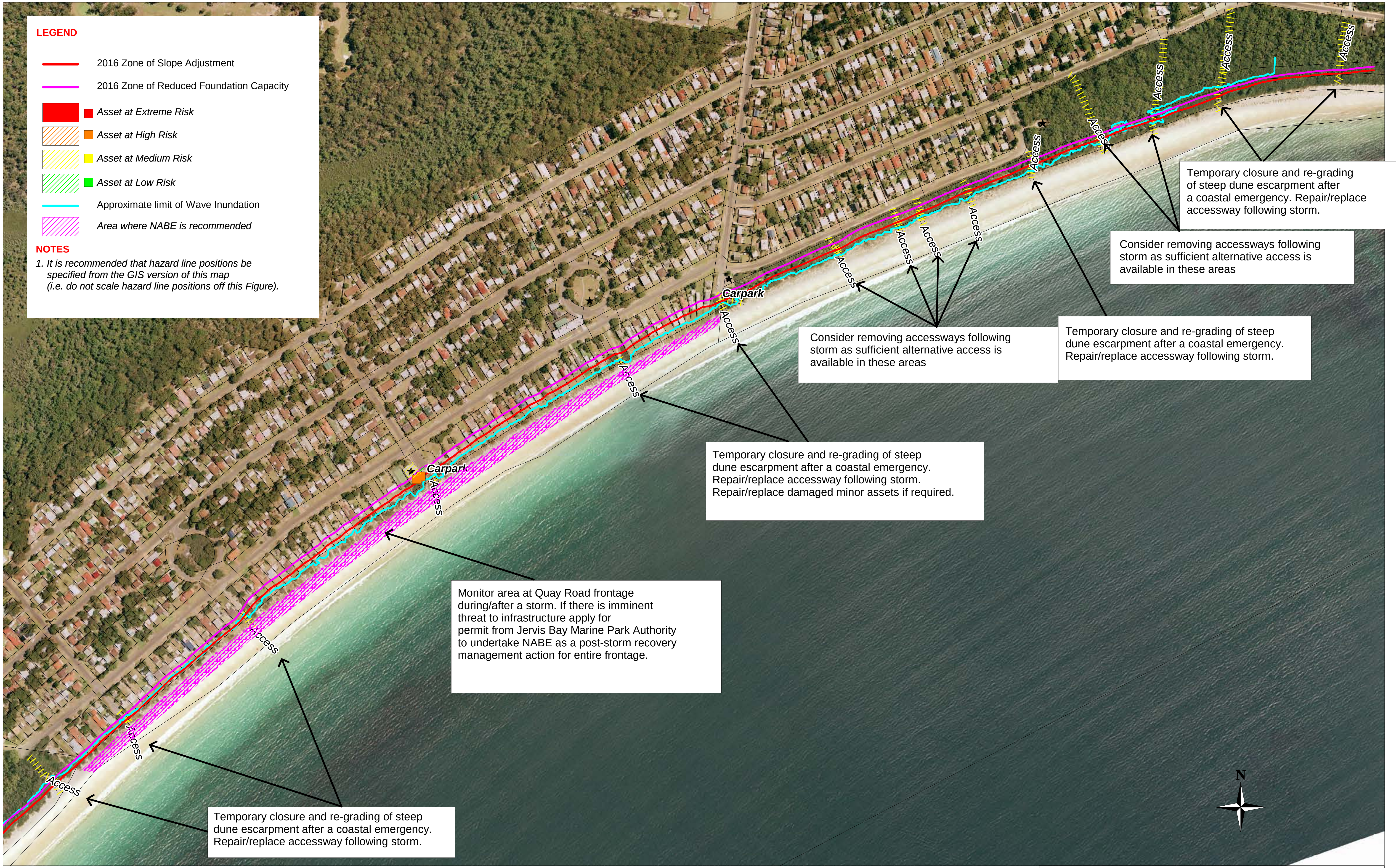
Advisian
WorleyParsons Group



DATE	27/4/18	0 25 50 metres	COORDINATE SYSTEM	MGA Zone 56	FIGURE TITLE: Callala 2016 Risk Map Emergency Action Subplan
PROJECT NO.	301015-03933	PROJECT TITLE	Shoalhaven Coastal Mapping		CREATED BY: C. Adamantidis

Shoalhaven City Council

Advisian WorleyParsons Group

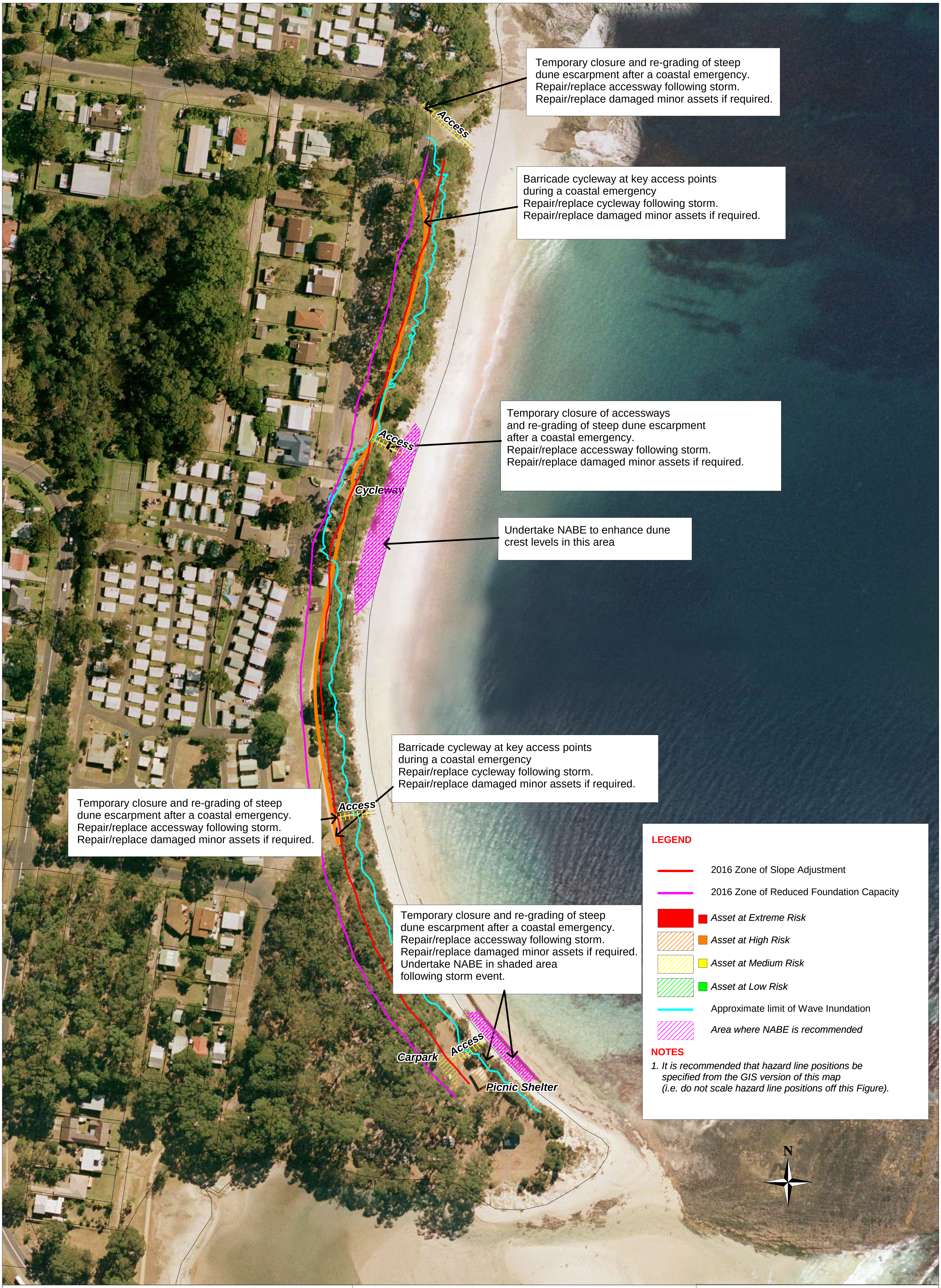


DATE	27/4/18	COORDINATE SYSTEM	MGA Zone 56
PROJECT NO.	301015-03933	PROJECT TITLE	Shoalhaven Coastal Mapping
FIGURE TITLE	Callala 2016 Risk Map - Beach Accessways Emergency Action Subplan	CREATED BY	C. Adamantidis

0 50 100 metres

Shoalhaven City Council

Advisian
WorleyParsons Group



DATE 27/04/18 | 0 25 50 metres | COORDINATE SYSTEM MGA Zone 56

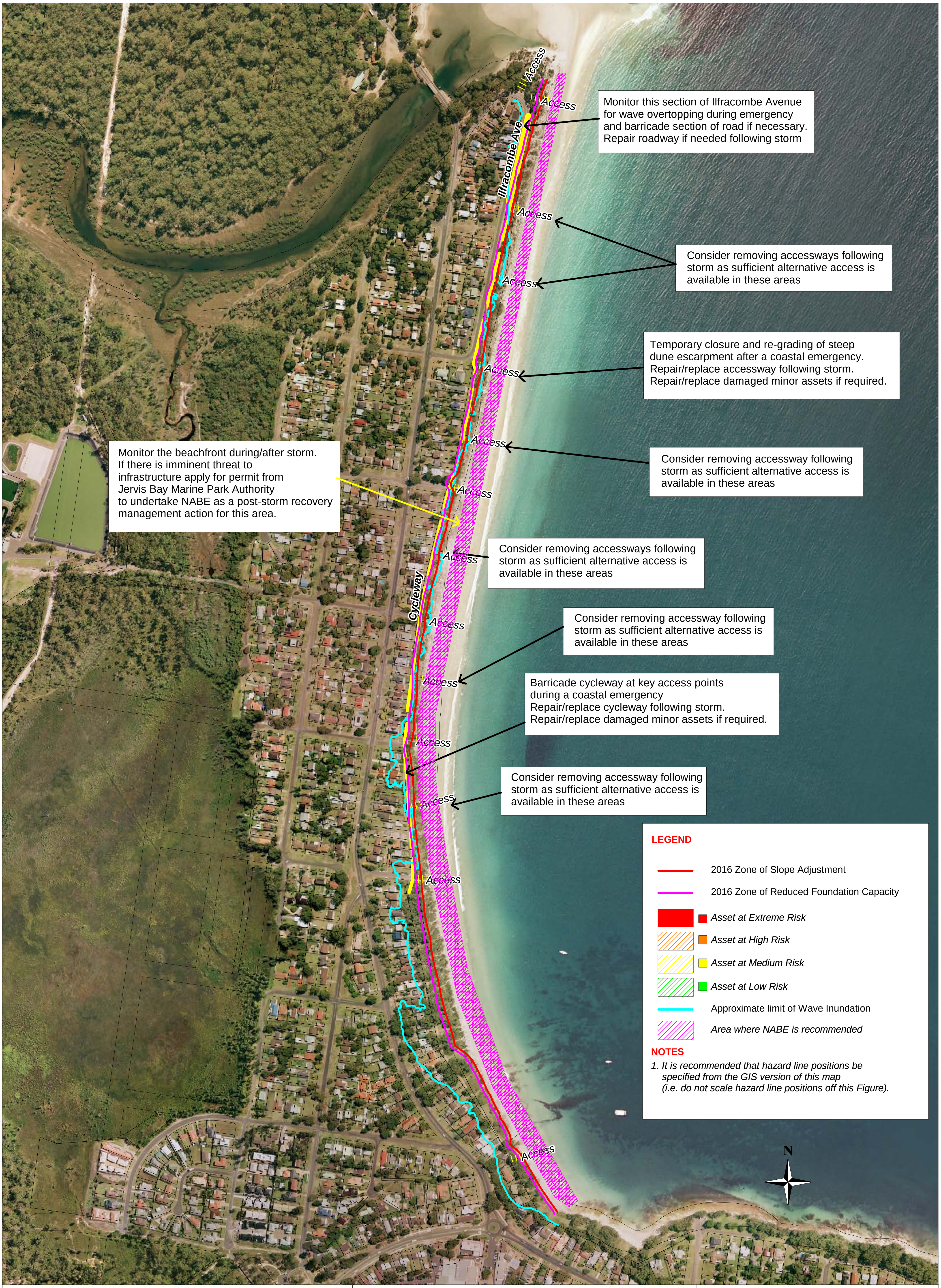
PROJECT NO. 301015-03933

PROJECT TITLE Shoalhaven Coastal Risk Mapping

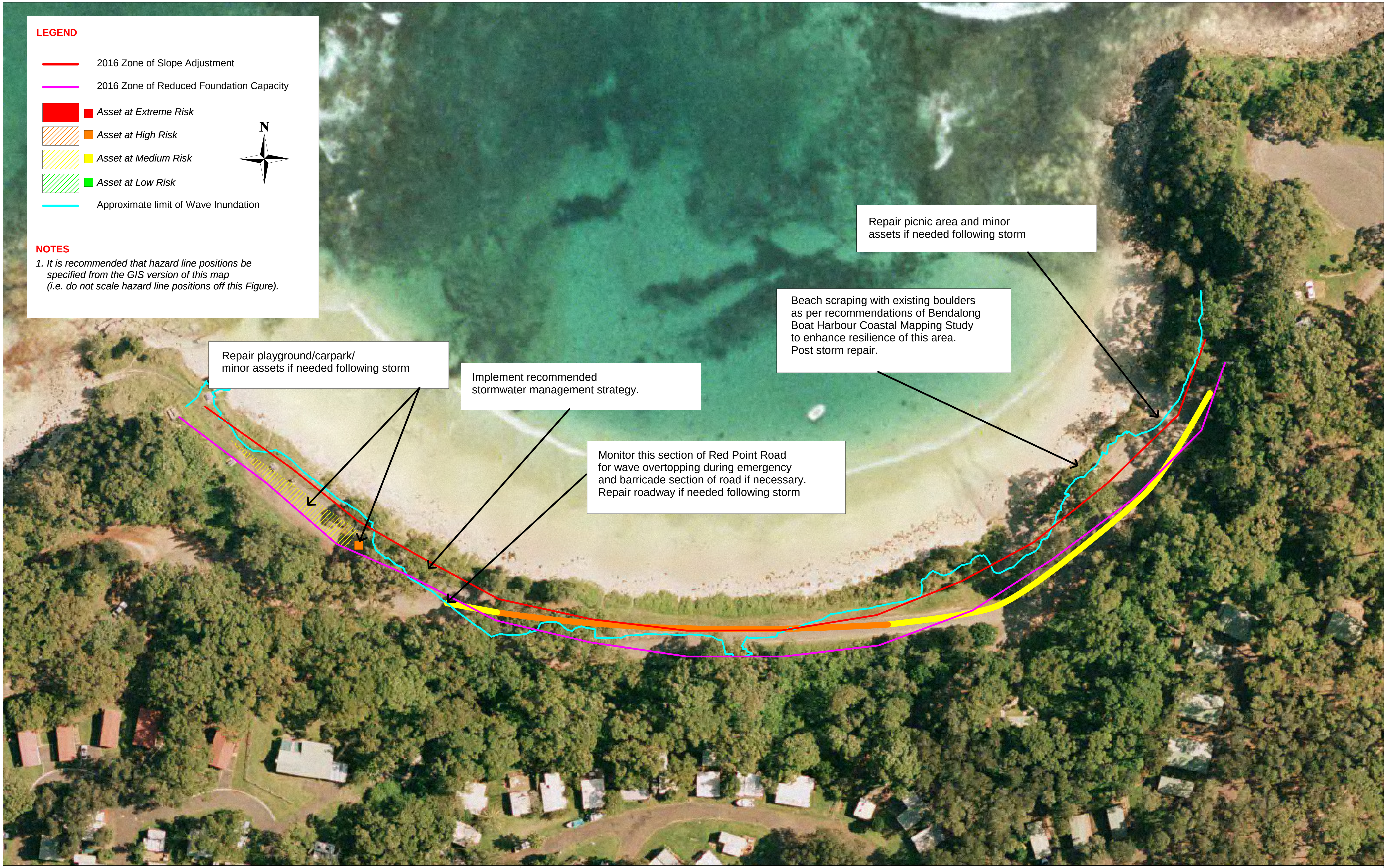
FIGURE TITLE Huskisson 2016 Risk Map Local Emergency Action Plan

CREATED BY C. Adamantidis

Shoalhaven City Council | Advisian WorleyParsons Group



DATE 27/04/18	0 50 100 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Collingwood 2016 Risk Map - Beach Access Emergency Action Subplan
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Risk Mapping		**CREATED BY** C. Adamantidis

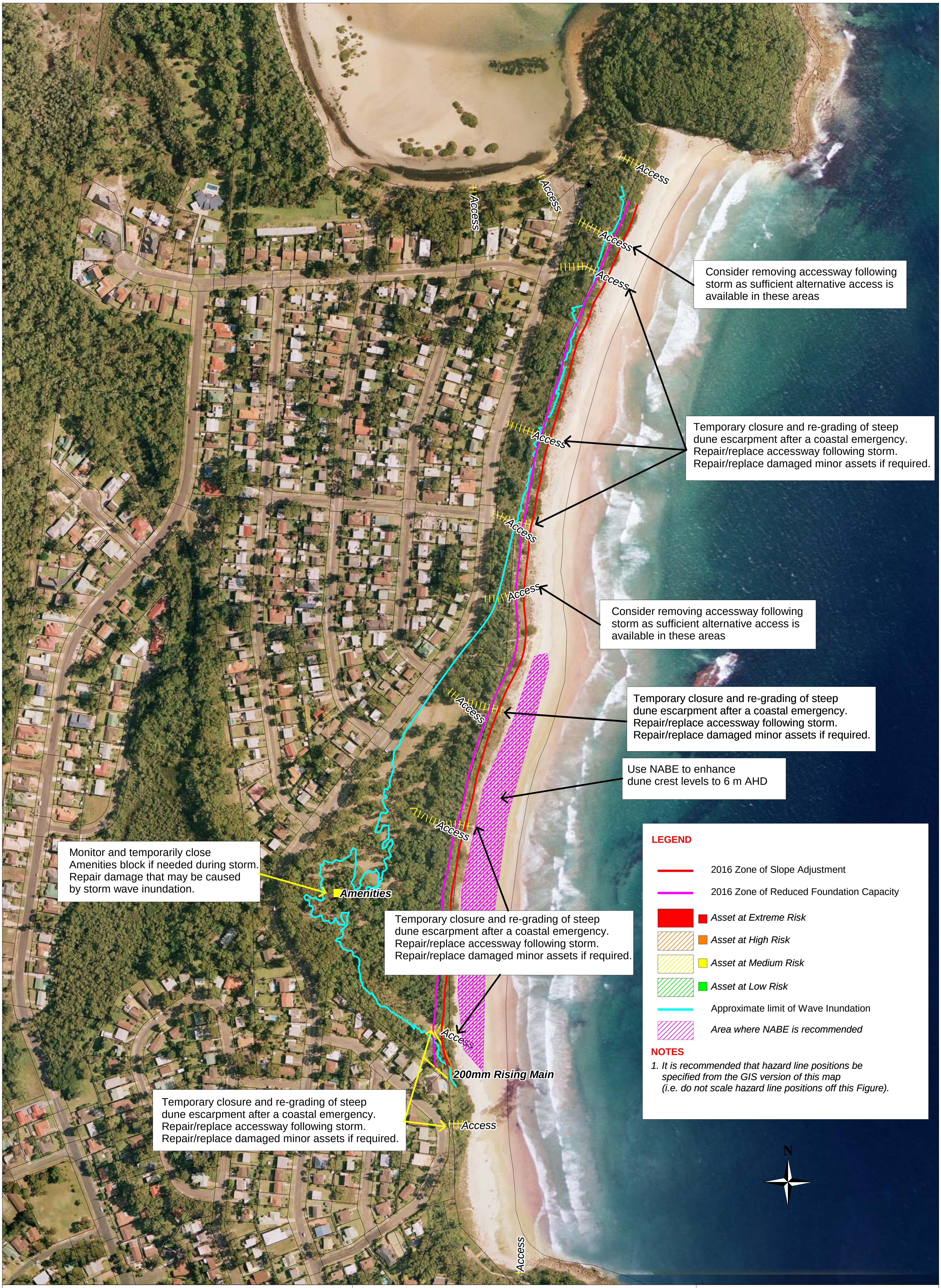


DATE	27/4/18	COORDINATE SYSTEM	MGA Zone 56
PROJECT NO.	301015-03933	PROJECT TITLE	Shoalhaven Coastal Mapping
FIGURE TITLE	Bendalong Boat Harbour - 2016 Risk Map Emergency Action Subplan	CREATED BY	C. Adamantidis

0 10 20
metres

Shoalhaven City Council

Advisian
WorleyParsons Group



DATE 27/04/18 — 0 50 100 metres — **COORDINATE SYSTEM** MGA Zone 56

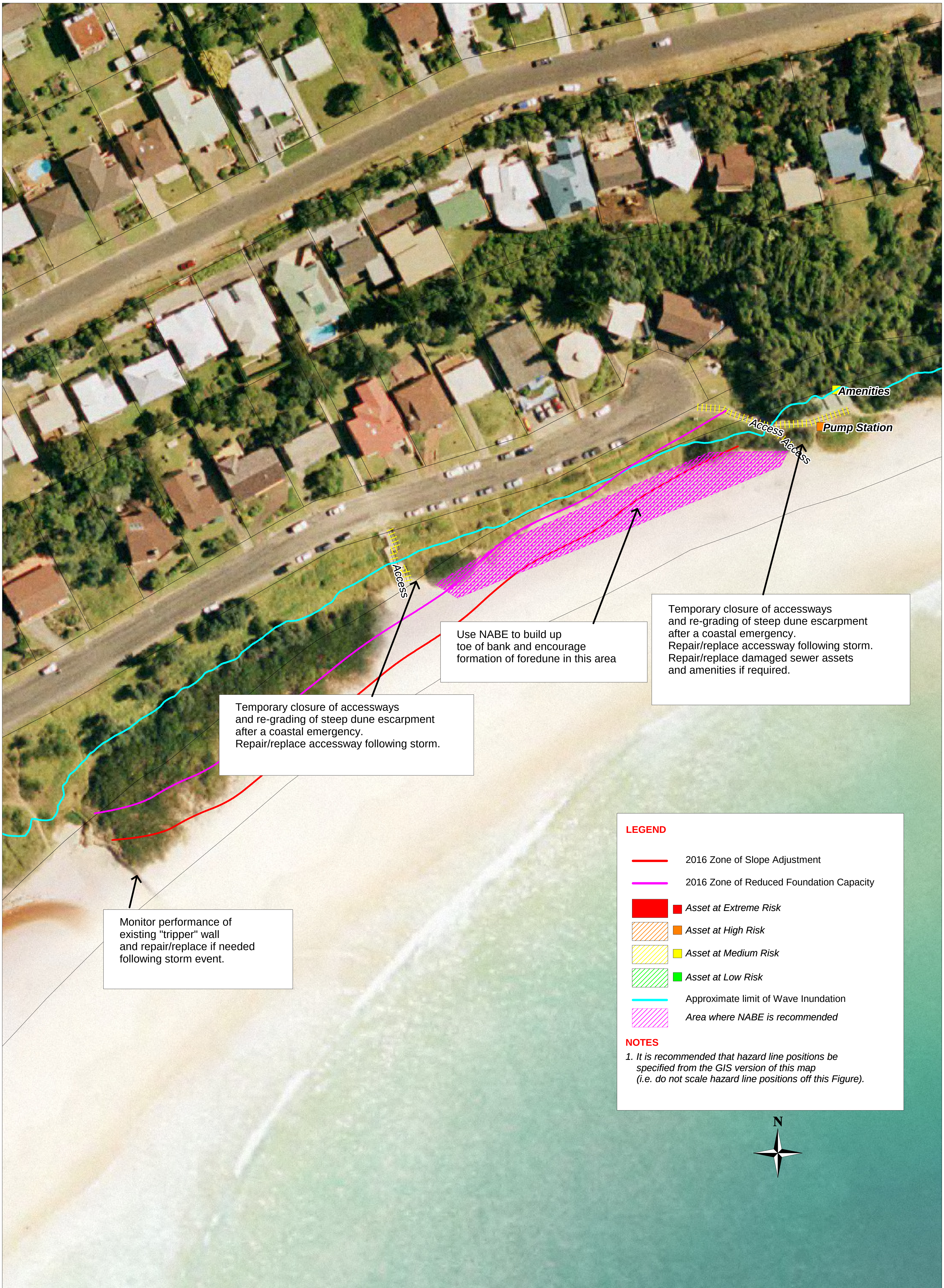
PROJECT NO. 301015-03933

PROJECT TITLE Shoalhaven Coastal Risk Mapping

FIGURE TITLE Narrawallee 2016 Risk Map - Beach Access Emergency Action Subplan

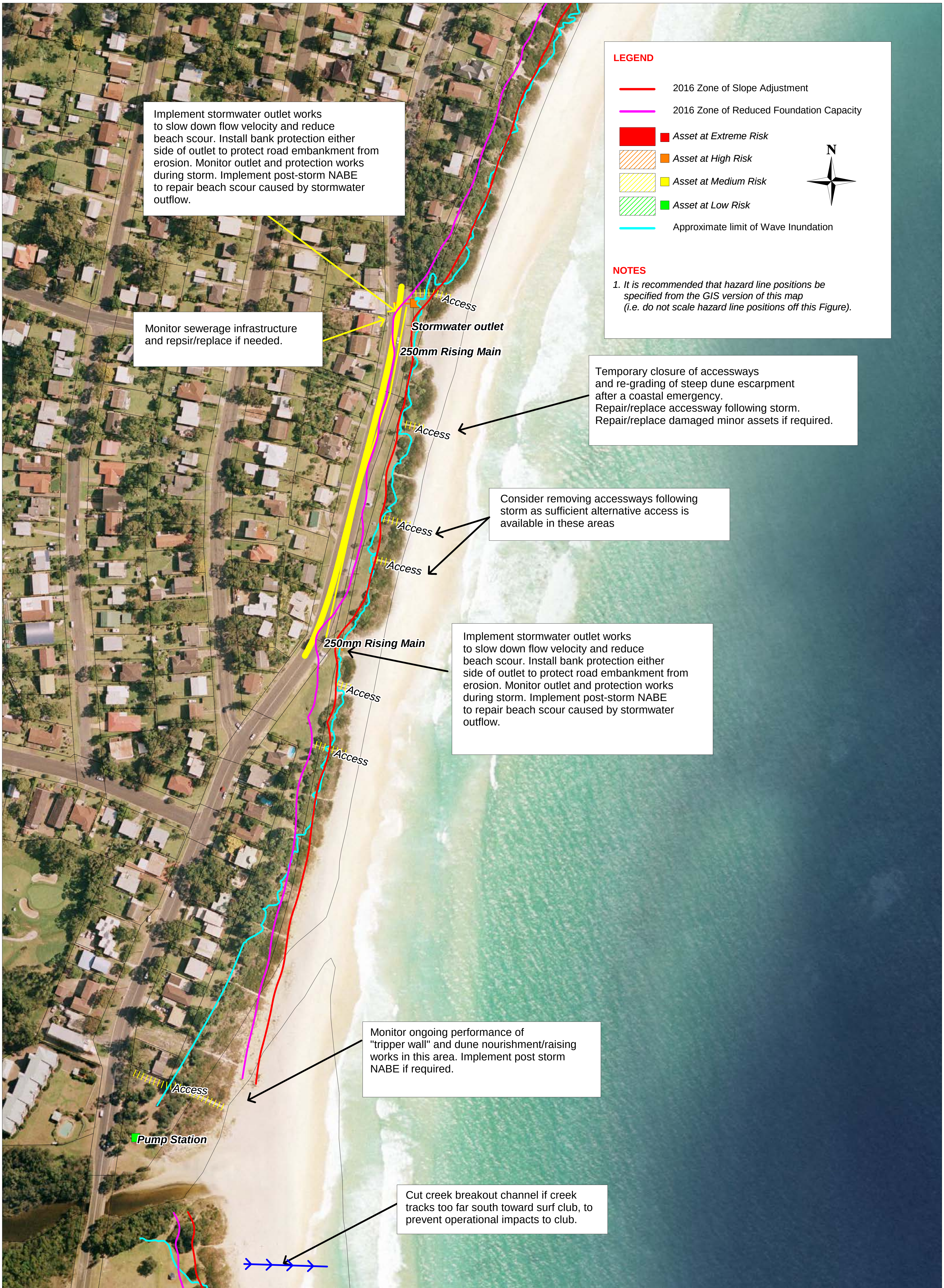
CREATED BY C. Adamantidis

Shoalhaven City Council — Advisian WorleyParsons Group



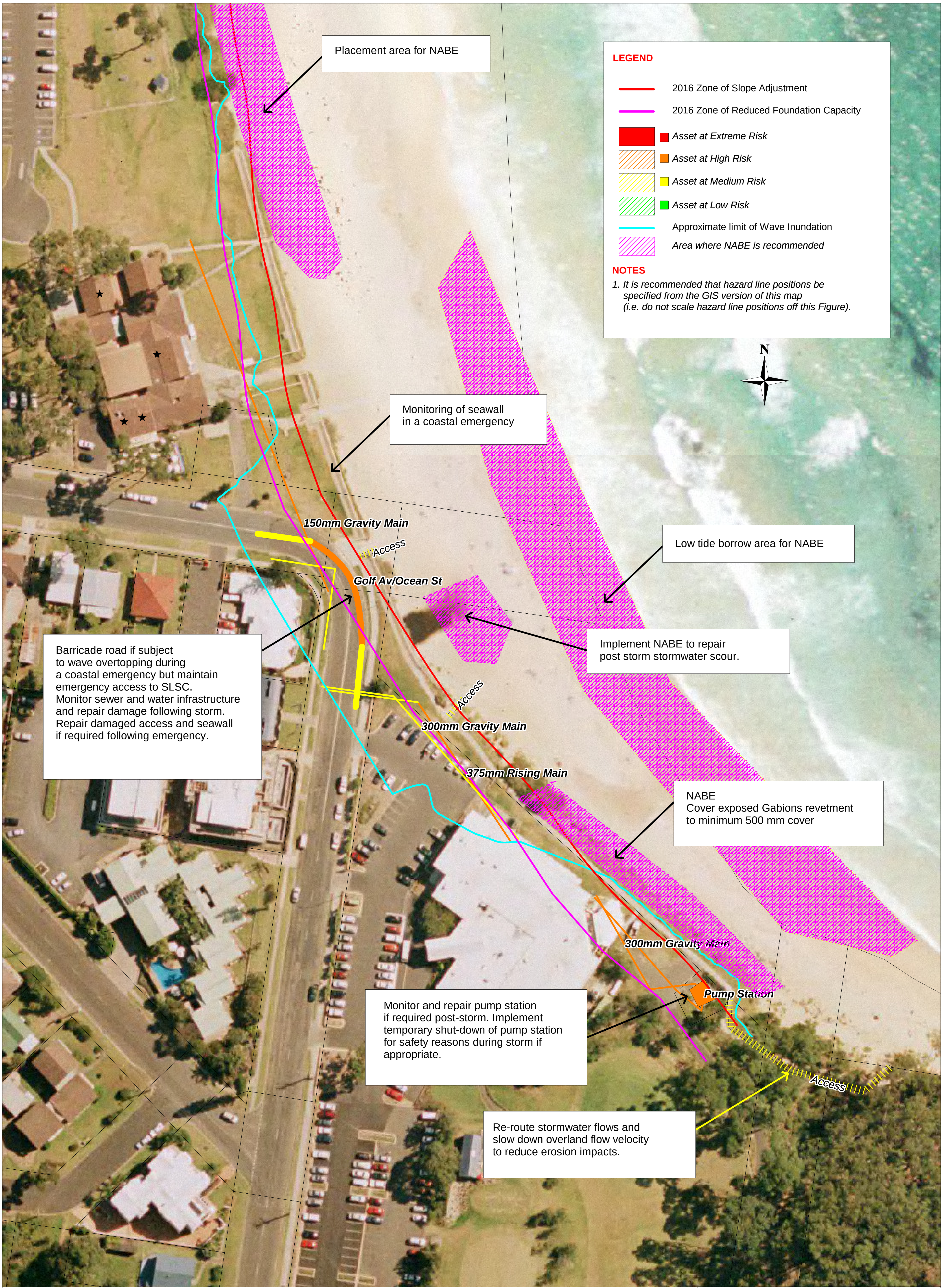
DATE 27/04/18	0 10 20 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Mollymook North 2016 Risk Map Emergency Action Subplan
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Risk Mapping		**CREATED BY** C. Adamantidis

Shoalhaven City Council · Advisian WorleyParsons Group



DATE 27/04/18	0 25 50 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Mollymook Central 2016 Risk Map Emergency Action Plan
PROJECT NO. 301015-03933	PROJECT TITLE Shoalhaven Coastal Risk Mapping		CREATED BY C. Adamantidis

Shoalhaven City Council
Advisian WorleyParsons Group



DATE 27/04/18	0 10 20 metres	COORDINATE SYSTEM MGA Zone 56	FIGURE TITLE Mollymook South 2016 Risk Map Emergency Action Subplan
PROJECT NO. 301015-03933	PROJECT TITLE Shoalhaven Coastal Risk Mapping		CREATED BY C. Adamantidis

Shoalhaven City Council
Advisian WorleyParsons Group

DATE 27/04/18	0 5 10 metres	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Collers 2016 Risk Map Emergency Action Plan
PROJECT NO. 301015-03933	**PROJECT TITLE** Shoalhaven Coastal Risk Mapping		**CREATED BY** C. Adamantidis

Shoalhaven City Council

Advisian
WorleyParsons Group

REPORT

Shoalhaven City Council Coastal Cliffs and Slopes Recommendations Report

Emergency Action Sub Plan

Client: Shoalhaven City Council

Reference: M&APA1474R002F0.2

Revision: 0.2/Final

Date: 18 May 2018

Royal HaskoningDHV
Enhancing Society Together

Royal HaskoningDHV

HASKONINGDHV NEDERLAND B.V.

Unit 2
55-57 Township Drive
QLD 4220 Burleigh Heads
Australia
Maritime & Aviation
Trade register number: 56515154

+61 07 5602 8544 **T**
project.admin.australia@rhdhv.com **E**
royalhaskoningdhv.com **W**

Document title:	Shoalhaven City Council Coastal Cliffs and Slopes Recommendations Report
Document short title:	Emergency Action Sub Plan
Reference:	M&APA1474R002F0.2
Revision:	0.2/Final
Date:	18 May 2018
Project name:	Shoalhaven Risk Management and Adaptation Planning
Project number:	PA1474
Author(s):	Amanda McGuane, Gary Blumberg
Drafted by:	Amanda McGuane
Checked by:	Gary Blumberg
Date / initials:	18/5/18 GB
Approved by:	Gary Blumberg
Date / initials:	18/5/18 GB

Classification
Internal use only

MANAGEMENT SYSTEM CERTIFICATION DNV·GL ISO 9001 = ISO 14001 OHSAS 18001

Royal HaskoningDHV

Table of Contents

1	**Introduction**	**4**
1.1	Context and Associated Plans and Guidelines	4
1.2	Definition of Emergencies and Triggers	4
1.3	Purpose of the EASP	5
1.4	Communication and Warnings	5
1.5	Geographical Setting	6
2	**Emergency Action Sub Plan for Identified Risk Areas**	**8**
2.1	Background	8
2.2	Overview of Risk	9
2.3	Council actions	10
2.3.1	Penguin Head and Culburra Beach	10
2.3.2	Narrawallee	10
2.3.3	Mollymook	10
2.3.4	Rennies Beach	10
2.3.5	Racecourse Beach	10
2.4	Private Property Owner Actions	11
2.4.1	Penguin Head and Culburra Beach	11
2.4.2	Berrara Point	11
2.4.3	Inyadda Point	11
2.4.4	Collers Beach	11
3	**Remediation and Coastal Protection Works on Private Property**	**12**
3.1	Private Property Remediation Works	12
3.1.1	Approvals Required for Implementation of Remediation Works	12
4	**Roles and Responsibilities**	**15**
4.1	State Emergency Service	15
4.2	Shoalhaven City Council	15
4.3	Office of Environment and Heritage	16
4.4	Bureau of Meteorology	16
4.5	NSW Police	16
4.6	Private Landowners	16
4.7	Key Contacts	16

5 References 18

Table of Tables

Table 1: Key Contacts for EASP 16

Table of Figures

Figure 1: Shoalhaven LGA cliffs and slopes risk areas 7

Appendices

Attachment 1 – Site inspection/maintenance record sheet template

1 Introduction

Significant weather conditions resulting in increased rainfall, generation of strong winds, large waves and elevated sea water levels can trigger a series of coastal hazards along NSW coastlines. In addition to excessive beach erosion, coastal cliffs and slopes can experience increased levels of instability affecting both bedrock cliff faces and soil foreshore slopes.

For the Shoalhaven area, a number of risk areas have been identified, and potential geotechnical hazards addressed. The hazards include mechanisms of instability which may result in landslides.

Shoalhaven City Council's long term strategy for managing coastal threats and hazards is documented within the Shoalhaven Coastal Zone Management Plan (CZMP). This Emergency Action Sub Plan (EASP) forms an integral part of the CZMP, outlining Council's intended response to coastal emergencies relevant to cliffs and slopes within Shoalhaven coastal areas, in accordance with the Coastal Protection Act 1979 (CPA). The EASP also outlines ways in which property owners can place emergency protection works relevant to instability hazards.

This EASP has been structured in a similar format as the Coastal Emergency Action Subplans for Beaches in Shoalhaven City Council (2011)[1].

1.1 Context and Associated Plans and Guidelines

This Emergency Action Subplan has been prepared in accordance with the Coastal Protection Act 1979, Coastal Management Act 2016, and the Shoalhaven Coastal Zone Management Plan. This EASP should be read in conjunction with the following plans and guidelines:

- NSW State Storm Plan (SES 2018 (draft)) - covers arrangement for emergency management of storms in accordance with the State Emergency Service Act 1989 and the State Emergency and Rescue Management Act 1989;
- NSW State Emergency Management Plan (EMPLAN) (2012);
- Shoalhaven Coastal Zone Management Plan (2012);
- Guide to the Statutory Requirements for Temporary Coastal Protection Works (OEH 2013);
- Code of Practice under the Coastal Protection Act 1979 (OEH 2013);
- Shoalhaven Emergency Management Plan (Shoalhaven EMPLAN) (2016);
- Coastal Emergency Action Subplans for Beaches in Shoalhaven City Council (Draft 2011).
- Coastal Zone Management Guide Note – Emergency Action Subplans (OEH, July 2011).

This EASP should be reviewed periodically in conjunction with review of Council's CZMP and EMPLAN, and specifically following a coastal cliffs and slopes related emergency event as defined within in Section 1.2 of this document. Other triggers for review of this EASP include where deficiencies have been identified, where roles and responsibilities of agencies change, and in the event of legislative changes.

1.2 Definition of Emergencies and Triggers

In accordance with the Shoalhaven EMPLAN, there are number of hazards which have risk of causing loss of life, property, utilities, services and / or the community's ability to function within its normal

[1] *This document is currently being updated as a part of the updates to the CZMP*

capacity. Hazards (such as a flood, storm, earthquake, landslip) have been identified which have the potential to create an emergency situation.

The EASP is triggered in an emergency, which in this case is defined as:

"*a situation in which instability of cliffs and slopes is imminent, occurring or has occurred, and the threat of landslide endangers, or threatens to endanger the safety or health of people or destroys or damages, or threatens to destroy or damage any property and which requires a significant and coordinated response*." (Source: definition adapted based on the Shoalhaven DISPLAN).[2] However, for coastal cliffs and slopes, proactive measures for management of risk areas should be implemented in preparation as this is the best measure for ensuring emergency situations are minimised. Therefore this EASP includes pre, during and post emergency action measures.

With regards to coastal cliffs and slopes, an emergency situation is most likely to arise due to periods of heavy and/or prolonged rainfall. Monitoring heavy and prolonged rainfall is suggested against the following:

- Heavy Rainfall: at least 150mm of rainfall in one day; and
- Prolonged Rainfall: at least 250mm of rainfall over a 5 day period.

Application of expert engineering judgement at times of storms is required to assess when emergency action may be required. This requires regular monitoring of environmental conditions and cliff and slope behaviour, seeking appropriate advice when necessary. Coastal property residents or other community members should also provide early warning to Council in the event of coastal instability or hazards.

In monitoring the potential for instability and/or landslide, signs of impending slope instability such as distortions to fences and structures, ground depressions and tension cracks, falling rock or debris should also be assessed, as well as forecast environmental conditions.

1.3 Purpose of the EASP

The key objective of the EASP is to document the actions that Shoalhaven City Council and/or coastal landowners can and/or will take in response to coastal instability emergency situations relevant to the cliffs and slopes within Shoalhaven. In order to achieve this above objective, specified actions are required with regards to emergency preparedness, response and recovery phases of any emergency situation. This EASP outlines the requirements for identified key areas of risk of coastal related hazards and instability of cliffs and slopes within Shoalhaven.

Primarily the focus is for Council to ensure prevention of harm to property and/or harm to or loss of life. Consistent with standard emergency procedure Council will also seek to ensure that their public assets and infrastructure (such as stormwater drainage systems, kerbs and gutters) are maintained and managed. Whilst there is also a role for private property management and maintenance, Council's aim is to provide facilitation for approved, adequate actions by landowners through the implementation of the EASP.

1.4 Communication and Warnings

In a coastal emergency event, Council provides the following information and warnings to the community.

---

[2] *The DISPLAN 2011 has been superseded by the Shoalhaven EMPLAN 2016. However the EMPLAN does not include a robust definition of emergency relevant to landslide, therefore the definition for the DISPLAN 2011 has been retained here.*

- During an emergency event, Council will coordinate with SES to provide additional support through emergency response centres / local community centres;
- Placement of barriers and signs at lookouts, car parks and access ways that are closed due to instability hazards;
- After an emergency event, Council will provide updates to the community with regards to any closures of lookouts and carparks within risk areas;
- Information on Council web site about public area closures due to instability hazards. Update information when public areas re-opened.

1.5 Geographical Setting

A number of sites were considered as risk areas for instability and landslides along the coastline of Shoalhaven Local Government Area (LGA) and this EASP is relevant to those areas, outlined as follows:

1. Penguin Head and Culburra Beach;
2. Plantation Point;
3. Hyams Point;
4. Berrara Point;
5. Inyadda Point, Manyana;
6. Narrawallee;
7. Bannisters Point;
8. Collers Beach;
9. Rennies Beach; and
10. Racecourse Beach.

Figure 1 indicates the 10 risk areas considered as a part of this EASP.

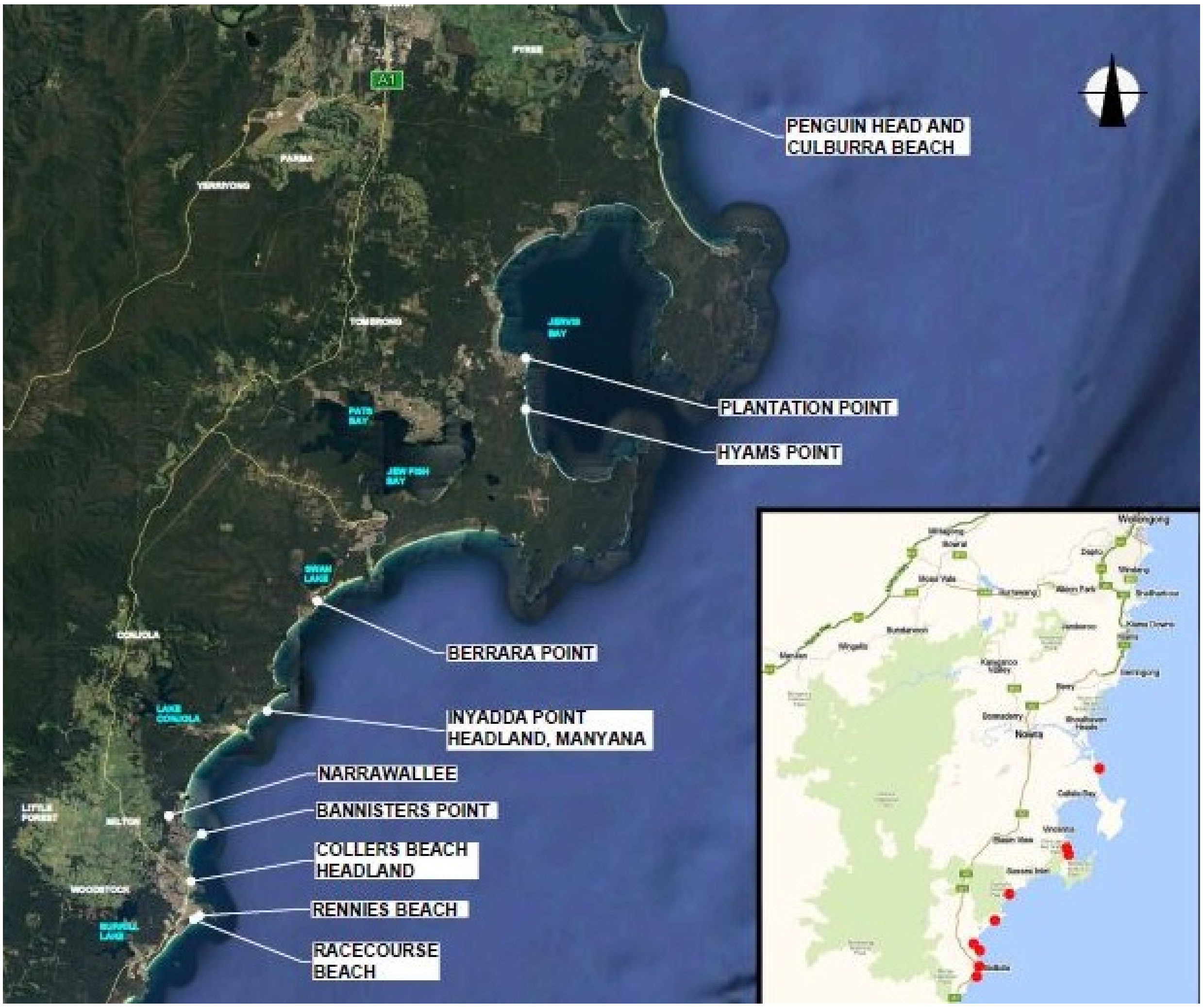


Figure 1: Shoalhaven LGA cliffs and slopes risk areas

The above risk areas include both public and private property. This EASP considers those areas of cliffs and slopes only, not the active beach systems (those have been considered within a separate EASP for beach erosion hazards - Coastal Emergency Action Subplans for Beaches in Shoalhaven City Council (Draft 2018)).

The following section outlines the emergency actions for each of the identified risk locations.

Royal HaskoningDHV

2 Emergency Action Sub Plan for Identified Risk Areas

2.1 Background

Hazardous landslides have occurred in parts of Shoalhaven Local Government Area (LGA) in January and February 2008, and again in August 2015. The landslides occurred in areas previously identified to be at risk of coastal cliff and slope instability. SCC has in the past commissioned a number of expert reports to assess slope instability and the risk of landslide hazards. A Coastal Cliffs and Slope Instability Risk Management Program was developed to assist the effective development of the EASP. A number of previous studies and reports were reviewed and considered as a part of the risk management program and considered in the context of forward planning for emergency actions in the event of future hazards.

Following detailed site assessments at specific properties, a geotechnical assessment was undertaken by JK which addressed the geological setting of each of the sites and the key factors affecting cliff face stability with regards to the bedrock cliff faces and the soil foreshore slopes.

The assessment of bedrock cliff faces within the risk areas revealed a number of relatively weak features:

- Extremely weathered claystone (Tertiary sediments) underlying sub-vertically jointed Tertiary basalt (an old volcanic lava flow) at Bannisters Point and Sunset Strip, Manyana;
- Tertiary claystones overlying Conjola Formation sandstone at Rennies Beach;
- Tertiary sediments forming cliff faces at Collers Beach Headland;
- Siltstone bands within the sandstone at Penguin Head and Berrara; and
- Weaker silty sandstone bands within sandstones and conglomerates at Plantation Point, Hyams Point, Inyadda Point (Manyana), Narrawallee, Bannisters Point (Mollymook), and Collers Beach Headland, Rennies Beach and Racecourse Beach (Ulladulla).

Additional triggers to collapse of potentially unstable features (undercuts, overhangs, blocks and wedges) over the cliff faces where also highlighted:

- Water pressure in sub-vertical joints (rainfall, leaking pipelines, vegetation);
- Localised tree root 'jacking';
- Water collecting in open defects;
- Expansion and contraction of bedrock due to temperature variations;

Colluvial and/or residual soils slopes comprising moderately steep to steep slopes were identified at the sites. Instability of such slopes is usually caused by elevated water pressures within the soils, or over-steep slopes caused by erosion or excavation during development.

Based on this assessment and in combination with site observations and the review of previous reports and documentation, it has been concluded that the majority of instability affecting the foreshore areas at the ten sites has impacted soil slopes. Where the lower portion of the soil profile impacted by landslips represents a residual profile, bedrock has occasionally been impacted.

Whilst the principal trigger for the known landslips was rainfall, there is an increased likelihood of instability associated with a number of other factors. These are highlighted at the following locations:

- The areas of erosion over the upper portions of soil slopes described at various sites;
- The older instabilities that have impacted the slopes lining the north-eastern side of Mollymook Beach below Mitchell Parade and Cliff Avenue;
- Landslips at a number of private properties in Berrara , Manyana and Mollymook;

- The area of recent and older instability at Surfers Avenue, Tallwood Avenue and Bannister Head Road, Narrawallee. Elevated groundwater levels (possibly artesian) are believed to be the most significant factor impacting stability.

There are some recent areas of instability along Sunset Strip, Manyana, the southern side of Penguin Head and the upper portion of the cliff face at the eastern end of Rennies Beach Close, Ulladulla, which are also likely to have been triggered during rainfall events. Whilst it is evident that erosion of the cliff face is occurring in some locations, the instability appears to be localized and typically of relatively small scale. However, larger scale instabilities of the cliff faces were noted at the Eastern end of Racecourse Beach, Ulladulla (an old landslip), Bannister Head Road Narrawallee and Bannisters Point, Mollymook.

2.2 Overview of Risk

As a part of geotechnical assessment undertaken for the Coastal Cliffs and Slope Instability Risk Management Program, a qualitative assessment of risk to property was undertaken in accordance with the guidance provided in Australian Geomechanics Society (2007c) Practice Note Guidelines for Landslide Risk Management (The Guidelines). These overall risks are summarised here.

The assessment indicates that for hazard related to instability of overhang/undercut features, blocks and/or wedges of rock over the cliff face the assessed risk to property is Low in all risk areas. This would be considered to be ‘acceptable’[3], in accordance with the criteria given in the Guidelines.

For hazards related to instability of foreshore colluvial/residual soil slopes, small scale (less than $5m^3$) and a larger scale instability impacting the full width of a residential lot (at least $200m^3$), the assessed risk to property is Very Low for small scale instability and Low for larger scale instability. This would be considered to be ‘acceptable’, in accordance with the criteria given in the Guidelines.

For hazards related to large scale cliff face instability, the assessed risk to property is Very Low or Low. The Guidelines consider that this is and ‘acceptable’ level of risk.

Levels of risk to property at both the Penguin Head Lookout, Culburra Beach and the timber lookout at, Bannisters Point, Mollymook Beach were considered to be ‘acceptable’ in accordance with the criteria given in the Guidelines.

Levels of risk to property were considered to be ‘tolerable’[4] in accordance with the criteria given in the Guidelines at a number of private properties in Culburra Beach, Berrara, Manyana, Mollymook and Ulladulla. There were 2 properties in Manyana identified as having levels of risk to property considered to be ‘unacceptable’[5] in accordance with the criteria given in the Guidelines.

The following sub-sections outline the proposed Emergency Action Sub Plan for the 10 identified risk areas within the Shoalhaven LGA. The EASP is based on specific requirements noted to be necessary for immediate implementation at risk areas, and in the event of an emergency event or situation.

---

[3] *Very Low qualitative risk, manage by normal slope maintenance procedures.*
[4] *Moderate qualitative risk, requires investigation, planning and implementation of treatment options to reduce risk to Low.*
[5] *High or Very High qualitative risk requiring essential treatment based on detailed investigation, planning and implementation to reduce risk to Low or acceptable level.*

Royal HaskoningDHV

2.3 Council actions

Council will respond to potential instability hazards by implementing the following actions:

- As a part of emergency response preparedness (where there is sufficient warning) check public stormwater drainage within identified risk area, repair/upgrade as required as part of maintenance programs.
- Monitor identified risk areas on public land (where it is safe to do so) during periods of heavy and/or prolonged rainfall and identify where instability hazards may occur.
- Close access to public areas where identified instability hazards may cause risk to property or people.
- Immediate closure of public lookouts in the event of instability occurring due to heavy rainfall or extreme weather events.
- Place signage and barriers at other public areas to ensure no access until a detailed inspection of condition and safety is conducted and remediation measures implemented.
- Post significant storm events and/or rainfall, check public stormwater drainage for leaks and repair/upgrade as required.

Council actions specific to individual risk areas have been outlined in the following sections.

2.3.1 Penguin Head and Culburra Beach

- Immediately close the Penguin Head lookout in the event of instability occurring due to heavy rainfall or extreme weather events.
- Immediate prevention of access to public car parking bays at the crest of cliffs.
- Place signage and barriers at the lookout to ensure no access until a detailed inspection of condition and safety is conducted and remediation measures implemented.

2.3.2 Narrawallee

- Install groundwater instrumentation near instability at Surfers Avenue and Tallwood Avenue to ascertain information on groundwater levels and movements. Based on this identify suitable landslip remediation measures at this location.

2.3.3 Mollymook

- Council should immediately close the car park at Bannisters Point near the lookout, in the event of instability occurring due to heavy rainfall or extreme weather events.

2.3.4 Rennies Beach

- Kerb and guttering to be inspected and upgraded/repaired where necessary to appropriately direct drainage away from cliffs and slopes.

2.3.5 Racecourse Beach

- In the event of instability impacting the car park at Racecourse Beach, Council is to immediately prevent access to the car parking bays at the crest of the hill.
- Place signage and barriers at car park to ensure no access until a detailed inspection of condition and safety is conducted and remediation measures implemented.

2.4 Private Property Owner Actions

Property owners will respond to potential instability hazards on their properties by implementing the following actions:

- Seek their own geotechnical advice regarding the stability of the coastal portions of their sites where required.
- Assess drainage, water mains, sewer systems, pool backwash systems, any other water carrying services for leaks/damage. Repair as necessary.
- Ensure no uncontrolled discharge of stormwater through property or over slopes.
- Private properties undergoing remediation works must ensure approved design documentation is included to support applications for permitting of works by Council. Council will require geotechnical assessments to support development applications for landslip remediation works on private property, including confirmation that risk will be reduced to ‘acceptable’ levels (geotechnical engineer to approve the design of the remediation measures/works).
- Seek their own geotechnical advice regarding the stability of their sites where required.
- Monitor and record information on instability concerns and seek advice from geotechnical/coastal engineer (refer template for site inspection/maintenance sheet **Attachment 1**).

Property owner actions specific to individual risk areas have been outlined below.

2.4.1 Penguin Head and Culburra Beach

- Penguin Head Road property owners with coastal frontage to seek their own geotechnical advice regarding the stability of the coastal portions of their sites where required.

2.4.2 Berrara Point

- Myrniong Grove property owners with coastal frontage to seek their own geotechnical advice regarding the stability of the coastal portions of their sites where required.

2.4.3 Inyadda Point

- Property owners along Sunset Strip Inyadda Point with coastal frontage to seek geotechnical advice regarding the stability of the coastal portions of their sites where required.

2.4.4 Collers Beach

- Property owners along Shipton Crescent with coastal frontage to seek their own geotechnical advice regarding the stability of the coastal portions of their sites where required.

Royal HaskoningDHV

3 Remediation and Coastal Protection Works on Private Property

3.1 Private Property Remediation Works

A number of varying remediation measures may be prescribed for individual private properties, dependent on the types and degree of risk associated with each. Suitable remediation measures must be, designed by a suitably experienced and qualified geotechnical and/or coastal engineer as part of a development application for the proposed works.

Potential remediation works for blocks within or adjacent to coastal cliffs and slopes may include:

Landslides in rock:

- Trimming the slope to remove hazardous blocks of rock.
- Bolting, or anchoring, to fix hazardous blocks in position and prevent movement.
- Installation of catch fences and other rock fall protection measures to limit the impact of rock falls.
- Deep drainage designed to limit changes in the ground water table.

Water, drainage and surface protection:

- Limit the effect of water with sensible drainage design and clearing of surface water drains.
- Surface protection to prevent scour and minimise water inflow to slope.
- Sub-soil drains constructed behind retaining walls and on hillsides to intercept groundwater.
- Deep drainage designed to limit changes in the ground water table.

Soil slopes:

- Retaining walls to support cuts and fills. Design of retaining walls more than 900 mm high should be undertaken by a geotechnical/structural engineer.
- Walls should be inspected at least annually for tilting and other signs of deterioration.
- Keeping vegetation clearance to a minimum as vegetation helps keep the ground water table lower, in turn helping to maintain stability of the slope. While roots of saplings and small trees generally assists by reinforcing the soil, roots from larger mature trees can pose a landslide hazard due to ability to dislodge boulders. Removal of such vegetation should be considered.

Further information and guidance on potential remediation measures for coastal properties can be found here:

- Australian Geomechanics Society (2007c) 'Practice Note Guidelines for Landslide Risk Management', Australian Geomechanics, Vol 42, No 1, March 2007.
- The latest versions of the GeoGuides are downloadable from the AGS website: www.australiangemechanics.org.

3.1.1 Approvals Required for Implementation of Remediation Works

Council approval is required for any development on private property within Shoalhaven. Remediation or land stabilisation works on coastal properties require development approval via a Development Application (DA). For advice on DA's, property owners should go to Council's website:

https://shoalhaven.nsw.gov.au/Planning-amp-Building/Planning-amp-Building-Copy

https://www.shoalhaven.nsw.gov.au/Planning-amp-Building/Development/Development-in-areas-of-coastal-instability

Royal HaskoningDHV

The Shoalhaven Development Control Plan (DCP 2014), Section 5.1.2, outlines specific requirements for development within areas of cliff/slope instability:

A2.1 A geotechnical report prepared by a professional geotechnical engineer is to be submitted with a development application. This report is to:

- *Analyse the existing site stability and the suitability of the proposed development and its likely impact on that site stability. The report is to make reference to:*
  - *Shoalhaven City Council Coastal Zone Management Study and Plan – Coastal Slope Instability Hazard Study Final Report (SMEC August 2008); and*
  - *Douglas Partners Report – Supplementary Geotechnical Observations Project 72051 (DP July 2011); and*
  - *Douglas Partners Report – Scoping Study and Stability Assessment Project 78319 (DP December 2011).*
- *Provide recommendations for engineering design of the proposal. This is to include building foundation design and stormwater drainage design; and*
- *Be prepared in accordance with the Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning Accompanying Commentaries and Practice Note (Australian Geomechanics Society, 2007).*

The *Coastal Management Act 2016* (CM Act*)* replaces the *Coastal Protection Act 1979* and establishes management objectives specific to vulnerable coastal areas. Under the CM Act, local councils are to implement coastal management programs, inclusive of linkages to and/or updates to their development control plans. The CM Act also outlines requirements with regards to granting of development consent relating to coastal protection works:

Part 5, Section 27, Clause 1:

1) Development consent must not be granted under the *Environmental Planning and Assessment Act 1979* to development for the purpose of coastal protection works, unless the consent authority is satisfied that:
   (a) the works will not, over the life of the works:
      (i) unreasonably limit or be likely to unreasonably limit public access to or the use of a beach or headland, or
      (ii) pose or be likely to pose a threat to public safety, and
   (b) satisfactory arrangements have been made (by conditions imposed on the consent) for the following for the life of the works:
      (iii) the restoration of a beach, or land adjacent to the beach, if any increased erosion of the beach or adjacent land is caused by the presence of the works,
      (iv) the maintenance of the works.

The *State Environmental Planning Policy (Coastal Management) 2018* identifies development controls for consent authorities to apply to each coastal management area in order to achieve the objectives of the CM Act.

Part 3, Section 19, Clause 1, 2 and 3:

1) Coastal protection works by person other than public authority Development for the purpose of coastal protection works may be carried out on land to which this Policy applies by a person other than a public authority only with development consent.
2) Coastal protection works by public authority Development for the purpose of coastal protection works may be carried out on land to which this Policy applies 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
   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.

3) Emergency coastal protection works by public authority Development for the purpose of emergency coastal protection works carried out on land to which this Policy applies 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 (or a coastal zone management plan under the *Coastal Protection Act 1979* containing an emergency action subplan that continues to have effect under clause 4 of Schedule 3 to the *Coastal Management Act 2016*).

4) In this clause, 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.

Royal HaskoningDHV

4 Roles and Responsibilities

There are a number of stakeholders with roles and responsibilities in coastal emergency management within Shoalhaven LGA. The NSW State Storm Plan (Draft 2018) is a sub plan of the State Emergency Management Plan (EMPLAN). The State Storm Plan sets out the state wide multi-agency arrangements for emergency management of storms in NSW, and outlines roles and responsibilities of stakeholders with regards to coastal erosion. Roles and responsibilities include those relevant to planning, preparation, response and recovery. Outlined within the EASP are those roles and responsibilities relevant to emergency response.

4.1 State Emergency Service

With regards to emergency situations and management of risks due to instability of coastal cliffs and slopes, the State Emergency Services (SES) has the following roles and responsibilities:

- Maintain effective control of storm operations, emergency response action centres and incident control centres as required.
- Provide effective liaison between SES and other agencies/stakeholders
- Coordinate resources, equipment and logistics
- Provision of information and warnings to the community:
  - Timely and effective warnings are distributed to the community.
- Protection of life and property:
  - Coordinate the project of life and property from damage arising from storms to minimise further damage/potential injury
  - Coordinate the protection (relocation/removal) of property (limited to readily movable contents) from destruction or damage arising from coastal erosion.
- Protection of essential services:
  - Minimise disruption to the community by ensuring protection of infrastructure and supply of essential energy, telecommunication and utility services.
- Evacuation management and welfare:
  - Evacuate people from dangerous or potentially dangerous places created by storm damage or coastal erosion to safe locations away from the hazard.
  - Maintain the welfare of communities and individuals affected by the impact of a storm.
  - Coordinate available and accessible health services for storm affected communities.
- Control and coordinate search and rescue of people from collapsed structures.
- Coordinate resupply to isolated areas.
- Establish access to properties, dwellings and impact areas.

4.2 Shoalhaven City Council

With regards to emergency situations and management of risks due to instability of coastal cliffs and slopes[6], Shoalhaven City Council has the following roles and responsibilities:

- During and following major rainfall and/or storm events:
  - Close access ways, carparks and lookouts during or immediately after a storm event;
  - Inspect access ways, carparks and lookouts post storm;
  - Photograph any damage;

[6] *Note: Many of the roles and responsibilities are as per those for emergency action on beaches.*

    - Repair access ways, carparks and lookouts (in prioritised order); and
    - Inspect remediated landslide areas.
- Coordinate emergency protection works on public property;
- Maintain records of impacted assets;
- Consult with the SES and other relevant agencies when developing emergency management arrangements;
- Provide SES with copies of relevant coastal hazard and management studies if available to assist with emergency planning and operational intelligence systems;
- Assist the SES with community awareness programs to ensure people in locations potentially threatened by coastal instability understand the threat and its management;
- Assist the SES with reconnaissance of areas susceptible to coastal instability;
- After the storm, remove and/or mitigate the impact of temporary physical protective measures on the beach; and
- Assist the SES with the protection of readily moveable household and business contents in areas where coastal storms (likely to result in coastal erosion / inundation) are forecast or occurring.

4.3 Office of Environment and Heritage

The Office of Environment and Heritage (OEH) is the New South Wales government authority responsible for advising on coastal zone management. OEH provides a Coastal Zone Management Guide Note for preparation of Emergency Action Subplans.

4.4 Bureau of Meteorology

The Bureau of Meteorology (BoM) is responsible for releasing Severe Weather Warnings. Severe Weather Warnings provide official triggers to the SES for mobilisation and involvement in coastal hazards.

4.5 NSW Police

The NSW Police Force has responsibility for law enforcement and search and rescue, and controlling and coordinating the evacuation of victims from areas affected by emergencies. Typically, in a coastal instability related emergency NSW Police may assist SES where required, undertake or coordinate activities such as evacuation, barricading, removal of contents of buildings etc., where SES is not available or mobilised. Some members of the NSW Police may also be appointed as Local Emergency Operations Controllers (LEOCON).

4.6 Private Landowners

Private property owners have responsibilities to monitor, manage, prepare and repair their properties for risks associated with instability. Council should be notified immediately of any concerns outside of their property, however property owners should seek advice directly from suitably qualified geotechnical and/or coastal engineers with regards to instability concerns within their property boundaries.

4.7 Key Contacts

The following list of contacts indicates the range of persons that should be included on a contact list for the purposes of implementing this Plan. The key contacts list should be maintained and regularly updated to ensure current and in effect at all times.

Table 1: Key Contacts for EASP

Title/ Contact Name	Phone Number/s
State Emergency Service	132 500

Royal HaskoningDHV

	02 4251 6111
Police – Emergency **Police - South Coast District (Nowra)**	000 02 4421 9699
Shoalhaven City Council general phone line and website	Business hours: 02 4429 3111 After hours: 02 4421 3100 Website: www.shoalhaven.nsw.gov.au
Office of Environment and Heritage (Coastal Management Unit) local representative	0244244199

Royal HaskoningDHV

5 References

1. NSW State Storm Plan (SES 2013)
2. NSW State Storm Plan (Draft 2018)
3. NSW State Emergency Management Plan (EMPLAN) (2012)
4. Draft Shoalhaven Coastal Zone Management Plan (2012)
5. Guide to the Statutory Requirements for Temporary Coastal Protection Works (OEH 2013)
6. Code of Practice under the Coastal Protection Act 1979 (OEH 2013)
7. Shoalhaven Emergency Management Plan (Shoalhaven EMPLAN) (2016)
8. Shoalhaven Local Disaster Plan (DISPLAN) (2011)
9. Coastal Emergency Action Subplans for Beaches in Shoalhaven City Council (Draft 2011)
10. Coastal Zone Management Guide Note – Emergency Action Subplans (OEH, July 2011)

Attachment 1 – Site inspection/maintenance record sheet template

INSPECTION/MAINTENANCE RECORD

(Tick boxes as appropriate and add information as required/relevant) Date: ______________________

Site location (street address / lot & DP numbers / map reference / latitude and longitude):

____

FEATURE	NOTES	Inspected	Photos attached	Tested	Maintained	By owner	By professional	Notes added
Slopes & surface protection:								
☐ Natural slope/cliff		☐	☐	☐	☐	☐	☐	☐
☐ Surface water drains		☐	☐	☐	☐	☐	☐	☐
☐ Shotcrete		☐	☐	☐	☐	☐	☐	☐
☐ Cut/fill slope		☐	☐	☐	☐	☐	☐	☐
☐ Stone pitching		☐	☐	☐	☐	☐	☐	☐
☐ Other		☐	☐	☐	☐	☐	☐	☐
Retaining walls:								
☐ Cast in situ concrete		☐	☐	☐	☐	☐	☐	☐
☐ Masonry (natural stone)		☐	☐	☐	☐	☐	☐	☐
☐ Cribwall (concrete)		☐	☐	☐	☐	☐	☐	☐
☐ Anchored wall		☐	☐	☐	☐	☐	☐	☐
☐ Sub-soil drains		☐	☐	☐	☐	☐	☐	☐
☐ Concrete block		☐	☐	☐	☐	☐	☐	☐
☐ Masonry (brick, block)		☐	☐	☐	☐	☐	☐	☐
☐ Cribwall (timber)		☐	☐	☐	☐	☐	☐	☐
☐ Reinforced soil wall		☐	☐	☐	☐	☐	☐	☐
☐ Weep holes		☐	☐	☐	☐	☐	☐	☐
Ground improvement:								
☐ Rock bolts		☐	☐	☐	☐	☐	☐	☐
☐ Ground anchors		☐	☐	☐	☐	☐	☐	☐
☐ Deep subsoil drains		☐	☐	☐	☐	☐	☐	☐
☐ Soil nails		☐	☐	☐	☐	☐	☐	☐
Effluent and storm water disposal systems:								
☐ Effluent treatment system		☐	☐	☐	☐	☐	☐	☐
☐ Effluent disposal field		☐	☐	☐	☐	☐	☐	☐
☐ Storm water disposal field		☐	☐	☐	☐	☐	☐	☐
Other:								
☐ Netting		☐	☐	☐	☐	☐	☐	☐
☐ Catch fence		☐	☐	☐	☐	☐	☐	☐
☐ Catch pit		☐	☐	☐	☐	☐	☐	☐

Observations/Notes (add pages/details as appropriate) ______________________________

____

____

Attachments: ☐ Sketch(es) ☐ Photograph(s) ☐ Other (eg measurements, test results)

Record prepared by: ______________________ (name) ______________________ (signature)

Contact details: Phone: ______________________ E-mail: ______________________

Professional Status (in relation to landslide risk assessment): ______________________