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Great Lakes Coastal Zone Management Plan: Options Study

Final Report

December 2015

Great Lakes COUNCIL

Great Lakes Coastal Zone Management Plan: Options Study

Prepared for:	Great Lakes Council
Prepared by:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Synopsis: **This Great Lakes Coastal Zone Management Plan presents management options for treating risks from erosion and recession and from coastal inundation to assets and land within the beaches. The report presents the risk assessment for coastal hazards, then risk treatment options to manage coastal hazards for each asset at intolerable risk by 2100.**

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1.1 Purpose of the Great Lakes Coastal Zone Management Plan

Great Lakes Council (Council) with the assistance of the NSW Office of Environment & Heritage (OEH) has resolved to prepare a Coastal Zone Management Plan (CZMP) for the beaches of the Great Lakes Local Government Area (LGA). The beaches south from Black Head to Hawks Nest are included in the Plan, including the beaches of Tuncurry, Forster, Pacific Palms, Smiths Lake, Seal Rocks, and Hawks Nest. Jimmys Beach is not included in this Plan as it is the subject of a separate CZMP because it is an identified coastal risk "hot spot" of state significance. The estuaries (Wallis Lake, Smiths Lake, Myall Lakes) are also not included in this Plan, as they are the subject of separate estuary coastal zone management plans.

This Plan is intended to cover all aspects of the Great Lakes open coastal zone. In accordance with the *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013), this plan includes:

- practical actions to address the risks to assets and land from ***coastal hazards*** (erosion, recession and inundation) at the present, 2060 and 2100;
- broad objectives and actions to manage ***community use and amenity*** of the coastal zone; and
- broad objectives and actions to manage ***ecological health*** in the coastal zone, including rehabilitation and protective actions for ecological assets.

The main coastal hazards addressed by this CZMP are:

- ***Erosion*** of the beach and dunes during storms;
- ***Recession*** (or retreat) of the shoreline due to projected sea level rise, which will occur as periodic erosion that progressively reduces the beach and foredune width;
- ***Inundation*** and overtopping of coastal barriers by the ocean waves during storms, which will increase in frequency and depth with rising sea levels; and
- ***Slope Instability***, typically occurring as debris slides or rock falls, at specific locations on the coast.

The above coastal hazards may threaten houses, roads and associated assets, and affect the amenity and enjoyment of the beaches by the community. Stormy periods in the past have been known to significantly erode the frontal dunes and inundate local creeks, for example in the 1970s at Blueys and Boomerang beaches. The severity of these hazards is expected to increase in the future with rising sea levels. In contrast, there is strong pressure to redevelop residences on the coast. This is most evident for the beachfront properties, such as at Boomerang and Blueys beaches where property values are amongst the highest in the LGA.

The CZMP has been prepared in accordance with the *Coastal Protection Act, 1979* and its associated *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013), and other relevant NSW legislation.

The risk-based approach used for this study as it accords with the plan preparation process typically followed under the *Coastal Protection Act, 1979* is shown in Figure 1-1.

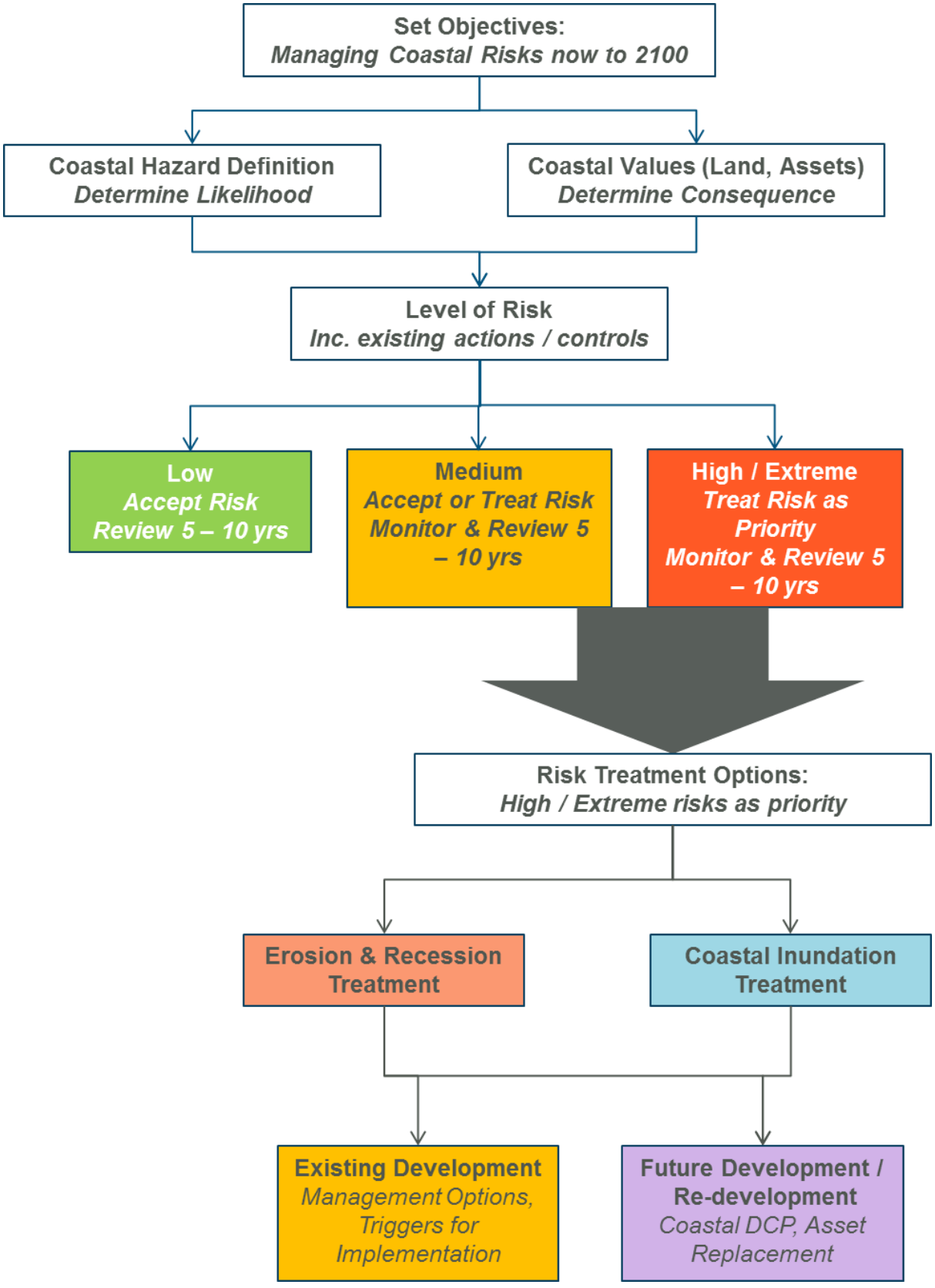


Figure 1-1 Approach to Developing Coastal Risk Management Actions in the CZMP

The likely extent of coastal hazards was defined in the *Boomerang Beach and Blueys Beach Coastal Processes and Hazards Definition Study* (WorleyParsons, 2011) and the *Great Lakes Coastal Hazards Study* (SMEC, 2013) for the remaining Great Lakes beaches. The hazards studies identified the coastal hazards and their potential severity at the immediate, 2060 and 2100 timeframes.

This Plan has considered the potential consequence of coastal hazards, considering the natural, economic, social, and cultural heritage values of assets and land at the beaches that may be affected (see Figure 1-1). The priority risks (high and extreme) were targeted for treatment over relevant timeframes. Management options were also differentiated between existing assets and future assets (or redevelopments) that require different funding mechanisms and community priorities for implementation (see Figure 1-1). The development of risk priorities and future options has involved direct engagement with the Great Lakes community.

Other plans relating to community use and ecological health exist for Great Lakes LGA, but there is no single, coordinated document for the whole of LGA coastline. This Great Lakes CZMP therefore aims to link with existing programs, and extend or modify management actions for community use and ecological health issues on the coast.

In terms of community use and ecological health, a broad assessment of the community and ecological values associated with the Great Lakes coastal zone, and the level of threat to these values posed by issues typically experienced along the coast has been conducted. This has guided a broad listing of existing actions and new strategies to preserve ecological health and community enjoyment of the Great Lakes coastal zone.

1.2 Objectives of the Great Lakes CZMP

The objectives for the Great Lakes CZMP identified by Council are as follows.

- Link Council's coastal zone management planning with other planning processes in the coastal zone to facilitate integrated coastal zone management.
- Engage the community in the preparation of the CZMP, including providing information relating to the plan as soon as practicable.
- Recognise and accommodate natural coastal processes and hazards. The CZMP will include strategies to deal with threats to existing development and to ensure that new development adequately manages such threats.
- Maintain the condition of high value coastal ecosystems; rehabilitate priority coastal ecosystems where practicable.
- Recognising the limits of economic practicability, protect and preserve beach amenity, maintain and improve public access arrangements to beaches, estuary foreshores and headlands, support recreational uses and protect the cultural and heritage environment.
- Incorporate effects of projected climate change, including sea level rise, on coastal hazards, ecosystem health and community uses of the coastal zone into an adaptation pathway to guide future investment.

- Prioritise management actions within the CZMP on the basis of public benefit; including cost-effectively achieving the best practical, transitional and long-term outcomes.
- Develop a rational sequence of responses based on cost-effectiveness (typically cost effectiveness analysis) that are relevant to the challenges faced in particular locations and which have projected timeframes, trigger points and action thresholds.
- Base decisions for managing risks to public safety and built assets, coastal ecosystems and community values on the best available information and reasonable practice, including an adaptive management approach.
- Adopt a risk management approach to threats to public safety and assets and pressures on coastal ecosystems, including avoiding risks where feasible and mitigation where risks cannot be reasonably avoided, and adopting interim actions to manage high risks while long term options are implemented.

1.3 Study Area

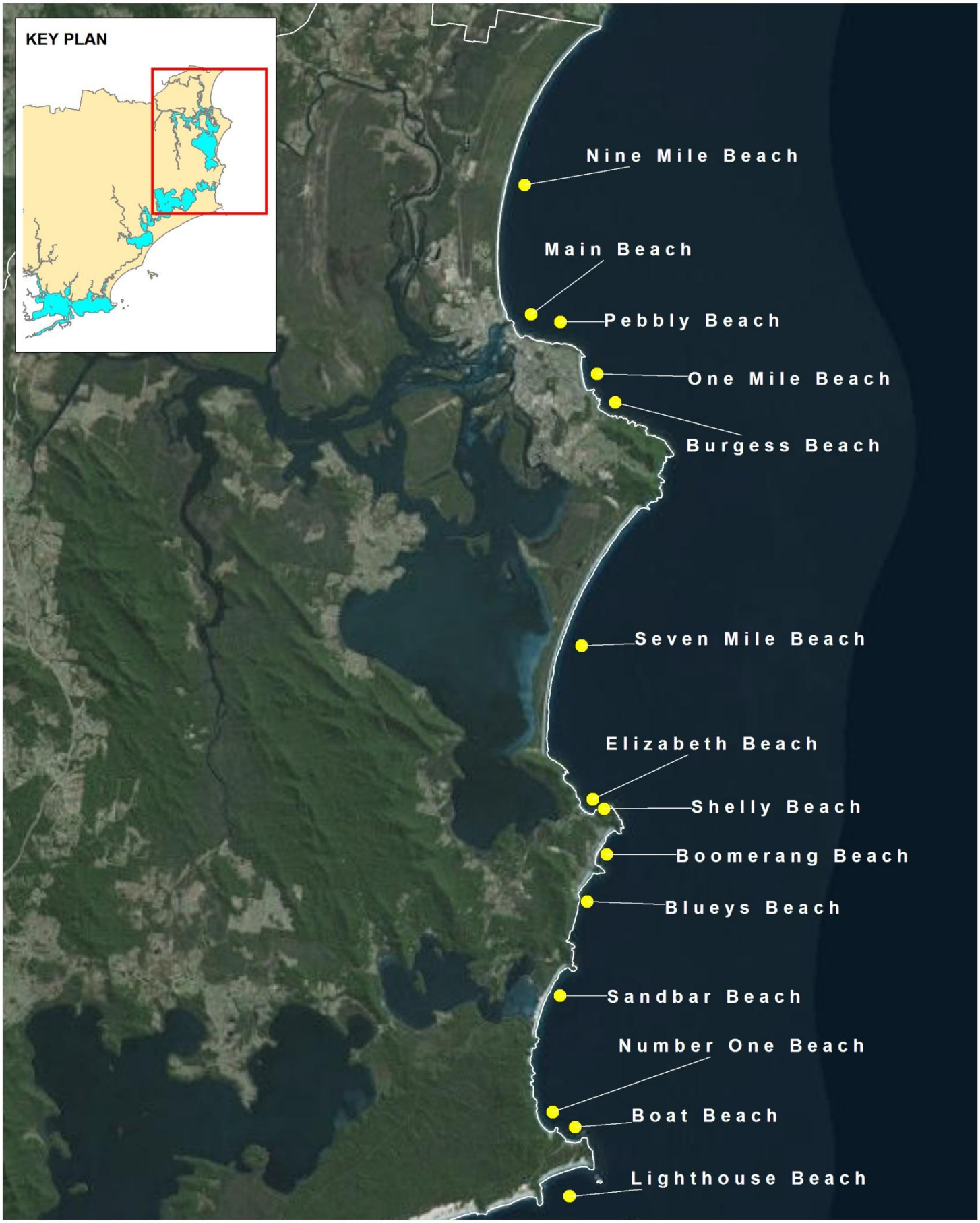
The Great Lakes LGA coastline lies on the mid north coast around 300 km north of Sydney. The coastline extends from Black Head at the northern end of Nine Mile Beach to Yacaaba Head at the southern end of Bennetts Beach (see Figure 1-2 and Figure 1-3). The beaches, headlands, nearshore and dunes of these embayments are included in the Plan. The beaches included in this Plan are listed in Table 1-1.

This CZMP excludes Jimmys Beach, as a separate CZMP has been prepared for this beach. Coastal waterways entering the ocean via the beaches (i.e. Wallis Lake, Smiths Lake, Myall Lakes) are also not included in this Plan, as they are the subject of separate estuary coastal zone management plans.

The Great Lakes coastline is diverse, comprising a series of long barrier beaches (e.g. Nine Mile and Seven Mile Beaches) interspersed between prominent cliffed headlands. Occasional bluffs backed by smaller pocket beaches (e.g. Pebbly and Elizabeth Beaches) are also present. The beaches are mostly exposed to a high energy wave climate, with the exception of some north facing pocket beaches which are sheltered from the dominant south easterly swells (e.g. Burgess, Boat Beaches).

As well as recreational and environmental lands, the study area includes prime beachfront residential lots noted to have the highest land values in the LGA. Many of the beachfront dwellings are holiday houses and/or investment properties. However an increasing number of landowners are becoming permanent residents, as they retire from fulltime occupations elsewhere.

The majority of the beaches are located within the Department of Primary Industries Port Stephens – Great Lakes Marine Park (PSGLMP) (see Table 1-1). Some beaches are also within National Parks (e.g. Treachery, Lighthouse Beaches), and so coastal hazards have not been assessed (see SMEC, 2013). Those beaches are under the jurisdiction of the Office of Environment and Heritage National Parks and Wildlife Service (NPWS), but contain some minor Council lands and assets (e.g. road asset at Lighthouse Beach, Caravan Park at Treachery Beach). Generally, it is expected that the beaches in National Parks will be allowed to respond naturally to future recession and erosion processes.



Title:

Great Lakes Council CZMP
Northern Beaches

Figure: 1-2

Rev: A

N

0 3.75 7.5km

Approx. Scale

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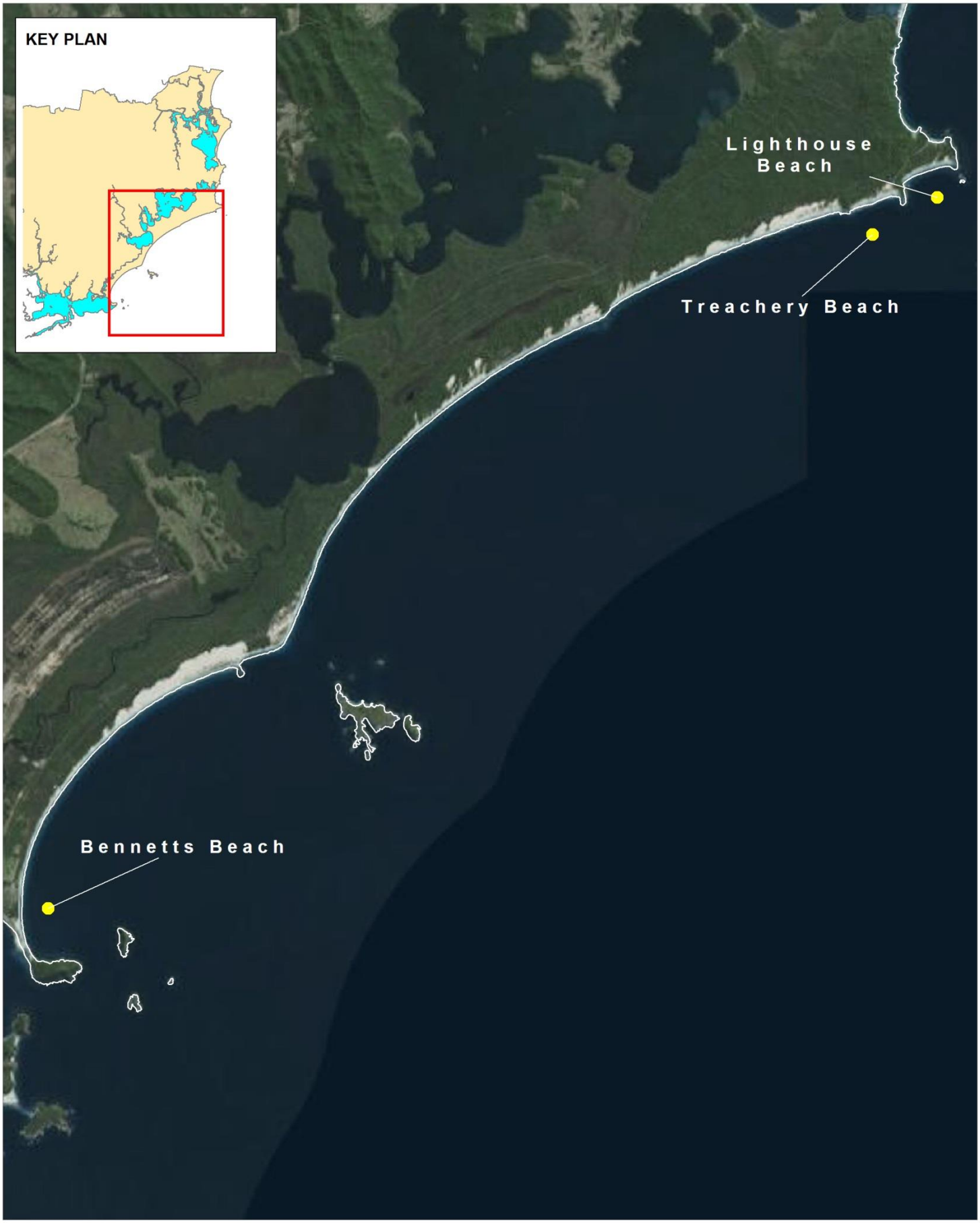

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Great Lakes Council CZMP
Southern Beaches

Figure: 1-3

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Table 1-1 Great Lakes Beaches to be covered by this CZMP

Beach	Description[1]	Within PS-GL[2] Marine Park	Hazards Mapped / Defined
Tuncurry - Nine Mile	Long open coast beach with dunes in a mostly natural state.	No	Erosion, recession, wave runup, southern end only
Forster Main	Small beach backed by a vertical seawall, with high density development behind.	No	Erosion, recession, wave runup.
Pebbly	Small pocket beach with rock outcrops at either end.	No	Wave runup only.
One Mile	Open coast beach backed by urban development.	Cape Hawke only, sanctuary zone	Erosion, recession, wave runup.
Burgess	Pocket beach protected by rock outcrops all along the beach.	Yes, habitat protection zone	Wave runup only.
Seven Mile	Long open coast beach.	Yes, habitat protection zone	Erosion, recession, wave runup.
Elizabeth	Pocket beach, backed by road.	Yes, habitat protection zone	Erosion, recession, wave runup.
Shelly	Pocket beach	Yes, habitat protection zone	None.
Boomerang	Open coast beach backed by urban development.	Yes, habitat protection zone	Erosion, recession, wave runup.
Blueys	Open coast beach backed by urban development.	Yes, habitat protection zone	Erosion, recession, wave runup.
Sandbar	Open coast beach fronting Smiths Lake.	Yes, habitat protection zone	Erosion, recession, wave runup.
Seal Rocks - Number One	Open coast beach, backed by caravan park and road.	Yes, habitat protection zone, with Skelton Rocks a sanctuary zone.	Erosion, recession, wave runup, and slope stability.
Seal Rocks - Boat	Pocket beach backed by development.	Yes, habitat protection zone	Erosion, recession, wave runup, and slope stability.
Seal Rocks - Lighthouse	Open coast beach.	Yes, habitat protection zone	Wave runup only.
Treachery (inc. Yagon and Mungo)	Long open coast beach.	Yes, habitat protection zone; beach between Yagon Gibber and Big Gibber in sanctuary zone	Wave runup only.
Bennetts	Long open coast beach.	Yes, habitat protection zone	Erosion, recession, wave runup, southern half only

[1] Description is taken from SMEC, 2013 or Worley Parsons, 2011.
[2] PS-GL Marine Park = Department of Primary Industries Port Stephens – Great Lakes Marine Park.

1.4 Coastal Management Process in NSW

This CZMP has been prepared in accordance with *the Coastal Protection Act 1979, the NSW Coastal Policy 1997*, and the *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013), as well as other legislation and guidelines applicable to managing the coastal zone of NSW.

A range of legislation is relevant to managing the coastal zone in NSW, as summarised in Appendix A. In addition, how this Great Lakes CZMP meets the minimum requirements for Coastal

Zone Management Plans in accordance with the *Coastal Protection Act 1979, the NSW Coastal Policy 1997*, and the *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013) has been tabulated in Appendix A.

The process being followed to prepare this CZMP is outlined below. This report comprises Steps 3 to 6 of this process. Step 1 of this process was completed by Council. Step 2 of this process was completed in 2013 with the *Great Lakes Coastal Hazards Study* (SMEC, 2013), and *Boomerang Beach and Blueys Beach Coastal Processes and Hazards Definition Study* (WorleyParsons, 2011).

(1) Establish a Committee or Working Party to oversee the preparation of the study;

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

(3) Adopt a Risk Management Approach to assessing the level of risk from coastal hazards (now and at 2060 and 2100);

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

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

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

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

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

It is noted that the NSW Government is embarking on Stage 2 of its coastal reforms package (further details are given in Appendix A). Where possible, the CZMP has been prepared to align with likely changes arising from the coastal reforms.

1.4.1 Guidelines for Preparing Coastal Zone Management Plans

The *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013) ('CZMP Guidelines') specify the requirements for preparing a coastal zone management plan in accordance with the *Coastal Protection Act 1979*, including requirements additional to those specified in the Act.

Under Section 733 of the *Local Government Act 1993*, councils are taken to have acted in 'good faith' and thus receive an exemption from liability for land affected by coastal hazards where their actions substantially accord with the principles contained in the specified manual, in this case being the CZMP Guidelines. The Principles for Coastal Management outlined in the CZMP Guidelines, and how this CZMP addresses these principles is detailed in Appendix A.

1.5 Previous Studies Supporting This CZMP

1.5.1 Coastal Hazards Studies

The extent of the coastal hazards at the immediate, 2060 and 2100 timeframes was defined for Boomerang and Blueys Beaches in the *Boomerang Beach and Blueys Beach Coastal Processes and Hazards Definition Study* (WorleyParsons, 2011), and for the remaining Great Lakes beaches in the *Great Lakes Coastal Hazards Study* (SMEC, 2013). Both of these studies applied a standard approach to the estimation of coastal hazards, as follows:

- The immediate erosion hazard was derived by considering the historical beach volume data (available from photogrammetry), and then applying the standard storm erosion volume typically used in NSW;
- Recession by 2060 and 2100 due to sea level rise was calculated using the Bruun Rule. The calculation was based upon bathymetric data from Charlotte Head, and used the sea level rise projections prescribed in Council's Sea Level Rise Policy, which was based upon the latest science available at the time;
- Wave run up was calculated using numerical wave modelling, with inputs including wave data from Crowdy Head, sea level rise projections given by Council's Sea Level Rise Policy (and based upon the latest projection available at the time), and ocean water levels prescribed for the NSW coast by OEH (see DECCW, 2010); and
- Slope instability risk was assessed at two specific sites only, being Boat Beach (between Kinka Road (crest of the slope) and the beach (toe of the slope)) and Number One Beach (between Seal Rocks Road (crest of the slope) and the beach (toe of the slope). Risk assessments for slope instability hazards were conducted in accordance with the method set out in the *Landslide Risk Assessment Procedures* in Australian Geomechanics, Volume 42, Number 1, March 2007.

The community has raised concern regarding the limitations in the data and the assumptions used to prepare the hazard studies. Because of these assumptions and limitations, some have claimed that the hazard studies should be ignored. However, coastal erosion is a known risk in Great Lakes, having threatened coastal land and property (private and public) during the severe storms in the 1970s. Thus, there is an imperative to take action to manage coastal erosion impacts, prior to damages occurring again in the future.

Likewise, sea level rise is occurring at present and there is 'very high confidence' (see CSIRO, 2015; IPCC 2014) that sea levels will continue to rise, and at a faster rate in the future. As such, the effects of sea level rise on the coastline, such as beach retreat, are also known risks for which action will be required.

In order to manage these known risks, in accordance with the International Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000:2009) it is appropriate to use the best science and information available to date. While the previous hazard studies adopted various assumptions and limitations (see SMEC, 2013; WorleyParsons, 2011), they remain the best available information on coastal risk.

The International Standard Risk Management Principles and Guidelines also state that risk management is a process that must be continually updated to ensure that new data is incorporated into the assessment of risk, and its management. This CZMP represents the first assessment of coastal risk for Great Lakes, and shall be revised every 5-10 years so that new data is incorporated into the definition of coastal hazards, and their appropriate management.

1.5.1.1 A Note on Sea Level Rise

Council has a legal imperative to consider sea level rise, as it is a known and measured coastal process that will affect the likely occurrence and severity of coastal hazard impacts. Under Section 733 of the *Local Government Act 1993* (the LG Act), Council has a duty of care to inform its local constituents of known risks and receives an exemption from liability for acting in good faith with respect to known hazards (including coastal hazards). Under Section 733(4) of the LG Act, Council is considered to have acted in good faith where decisions are made substantially in accordance with the relevant manual for the hazard, in this case, the CZMP Guidelines.

The incorporation of sea level rise into the assessment of coastal hazards is a requirement of the CZMP Guidelines upon which the LG Act exemption from liability is based. Similarly, object (h) of the *Coastal Protection Act 1979* is "to encourage and promote plans and strategies for adaptation to coastal climate change impacts, including projected sea level rise".

The *NSW Sea Level Rise Policy Statement 2009* was repealed in September 2012. This means that prescribed state-wide sea level rise benchmarks no longer apply to coastal hazard assessments, such as this CZMP. The NSW Government indicated that local councils "have the flexibility to determine their own sea level rise projections to suit their local conditions" (NSW Environment and Heritage, 2012), although it is unclear if or how local councils may be equipped to do this. In lieu of prescriptive sea level rise benchmarks, the Office of Environment and Heritage (OEH) suggest that councils should adopt sea level rise values that are "widely accepted by competent scientific opinion" (OEH, 2013).

At the time of preparation of the hazards studies for this CZMP, the sea level rise projections that were 'widely accepted by competent scientific opinion' were that given by the former Sea Level Rise Policy Statement, being 0.4 m and 0.9 m rise above 1990 mean sea level by 2050 and 2100, respectively. These projections were based upon the latest reports by the IPCC (2007) and CSIRO (2007) available at that time. The NSW Chief Scientist and Engineer (2012) assessed the former NSW Sea Level Rise Policy Statement levels and advised that the science informing the policy levels was adequate. In 2010, Council adopted the Sea Level Rise Policy Statement benchmarks of 0.4 m and 0.9 m rise above 1990 mean sea level by 2050 and 2100, respectively.

The global projections for sea level rise are largely unchanged between the IPCC (2007) and the most recent IPCC report in 2014. The CSIRO also released new regional projections for Australia in 2015, including the east coast. These projections suggest a 'likely' range for sea level rise of 0.45 to 0.88m by 2090 for the highest emission scenario (and along which sea level rise is currently tracking). The minor discrepancy between the sea level rise projections adopted in the hazard studies supporting this CZMP and the latest projections is unlikely to substantially affect the actions prescribed in this CZMP for the next 5-10 years. At the next update for this CZMP, any revisions to sea level rise projections will be incorporated into the hazard estimates at that time.

1.6 Council's Integrated Planning and Reporting Framework

The NSW Office of Environment and Heritage (OEH) has indicated that through the Stage 2 coastal reforms there will be a transition to incorporating coastal zone management planning within the local government IPR. This aims to mainstream coastal management into councils' overall service delivery and asset management responsibilities. It is also likely that streamlining actions in the CZMP with the service delivery and asset management process of Council will improve implementation of CZMPs. The IPR process is explained below.

In 2009 the NSW Government introduced an Integrated Planning and Reporting framework (IPR) so that councils can determine and reflect the community's aspirations within their short, medium and long term plans, guiding their yearly and longer term budgets and activities. This framework requires councils to plan funding priorities and service levels in partnership with their community for a sustainable future.

Councils must prepare a number of integrated plans which provide the detail on how the council intends to deliver works and services in the short and long term. The integrated plans for Great Lakes as shown in Figure 1-4 include:

- a long term community strategic plan, *Great Lakes 2030*, which is developed in consultation with the community and outlines the community's long term aspirations over the next 20 years;
- a four year delivery program (Delivery program 2013-2017) that describes Council's principal activities to deliver on *Great Lakes 2030*, and all plans, projects, activities and funding allocation by Council must be linked to this program;
- a one year operational plan (Operational Plan 2014-2015, Operational Plan 2015-2016) that outlines Council's intended actions, performance measures and estimated budgets to achieve its principal activities over the financial year; and
- a resourcing strategy, which includes a Long Term financial plan (10 years), Asset Management Strategy and Plans (10 years) and a Workforce Management Plan (4 years) to set out Council's ability to provide the resources to implement its Delivery Program and Operational Plan.

An Annual Report is then prepared to document Council's progress in implementing the Delivery Program and Operational Plan activities over each financial year period.

The Implementation Schedules of the CZMP (refer BMT WBM, 2015) were therefore designed to demonstrate alignment between the actions and activities in the current Delivery Program and Operational Plan 2013-2017, and provide appropriate details for inclusion of actions in subsequent, relevant documents.

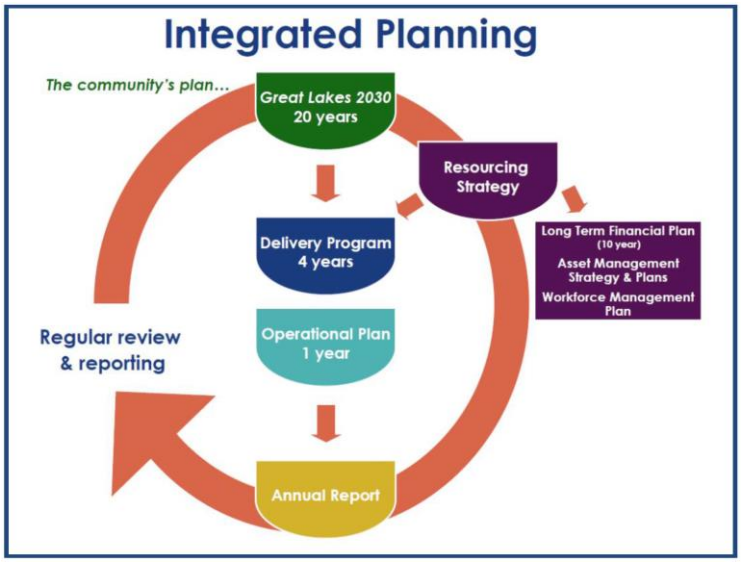


Figure 1-4 Great Lakes Council's Integrated Planning and Reporting Framework

1.7 Community Consultation

Community consultation is vital when developing a CZMP, and in gaining support for its implementation. A range of activities were conducted throughout the course of this project to engage with the general community, Council, the state agencies and other stakeholders. A summary of the consultation activities is given below (in chronological order).

- To promote the commencement of the Plan and advertise the online survey to local community, a media release was issued and a range of interviews were conducted with the local media (ABC Radio, Great Lakes FM Radio, Prime7 and NBN television networks, the Advocate local newspaper).
- An online survey was compiled, and advertised to the general community as above. A link to the online survey was placed on Council's website homepage. The survey and media release were also issued to known community contacts, local schools (Great Lakes College Tuncurry Senior Campus, Tuncurry Junior Campus, Forster Campus; Bulahdelah High; Gloucester High; St Clare's High Taree), Tuncurry and Taree TAFEs, University of Newcastle, University of New England, Southern Cross University, University of NSW, Tea Gardens Online Business Group, and coastal real estate agents (who manage holiday rentals along the coast).
- There were 197 responses to the online community survey. The results were used to understand the issues, determine the consequence of coastal hazards to assets and land; and derive coastal management options in this CZMP. A summary of the findings of the community survey is given in Appendix B.
- A webpage on Council's website was prepared, providing information about the CZMP, contact details and a link to the online survey.
- A Risk Assessment and Management Options Workshop was held internally at Council involving key representatives from the various departments of Council, as well as relevant NSW Government agencies and other stakeholders. This technical workshop involved an assessment

of the risk from coastal hazards, collation of details on existing management actions being undertaken or deemed successful in the past, and discussion of new management options and the likely practicality for Council and others to implement such options. The workshop provided guidance as to the types of management options that were likely to be effective and practical for Council and others to implement.

- The draft Options Study was placed on exhibition from 15th December 2014 to 13th February 2015. The document was made available on Council's website and in hard copy at Council offices for review, in addition to other community involvement initiatives, as listed below.
- Residents directly affected by the CZMP were notified by letter of the Options Study draft exhibition period, as well as the dates for community information sessions and the online survey.
- An online survey was made available via Council's website, explaining key concepts in the Options Study draft and requesting community preference for different short and long term options. There were 12 responses to the survey online.
- A brochure explaining the Options Study was prepared (both hard copy and online format) for distribution to the local community.
- Two Community Information Sessions were held, at the Pacific Palms Community Centre on January 22nd and Councils Administration Office at Forster on January 21st 2015 (noting a third session was planned for Seal Rocks, but had to be cancelled due to bad weather). The sessions enabled one-on-one discussions between the study team and the community, to both provide information about the CZMP process and management options; and to gather feedback about the community's concerns and preferences for management options.
- A meeting with the Blueys and Boomerang Beach Group (BBBG) was held at the Pacific Palms Community Centre on January 22nd 2015 to discuss specific concerns relating to Blueys and Boomerang Beaches arising from the preparation of a CZMP. The meeting aimed to give the BBBG an opportunity to voice concerns regarding the CZMP process to date, with a view to some agreement towards future steps of the process.
- There were 56 submissions on the draft CZMP – Options Study from the community. The majority of the submissions related to Blueys and Boomerang Beaches, in particular the validity of the WorleyParsons (2011) coastal hazards study for use in developing a CZMP. Submissions were as far as possible considered in finalising this report and the CZMP. Council responses to the 56 submissions received on the Options Study are tabulated in Appendix C to this report.
- A meeting with Council staff overseeing preparation of the CZMP was held to select the options to be recommended for implementation in the CZMP.
- As part of public exhibition of the CZMP, a further two Community Information Sessions to provide open discussion of the management actions selected to form the Plan and provide the community with information from which they may provide submissions on the draft CZMP.

- A Special Council Meeting after the public exhibition of the draft CZMP was held, to enable individual residents and community groups to make a short presentation to the elected Council outlining any further concerns they may have on the draft CZMP.

1.7.1 Consultation at Blueys and Boomerang Beaches

Originally, a CZMP was commenced for Blueys and Boomerang Beaches separately to the remaining beaches. Upon release of the Options Study, consultation activities for Blueys and Boomerang Beaches have been held in conjunction with activities for the remaining Great Lakes beaches, as documented in Section 1.7 above. A summary of consultation activities conducted prior to the commencement of the Great Lakes CZMP includes the following (in chronological order).

- A webpage was added to Council's website providing information about the CZMP, contact details and a link to an online survey.
- Signage was erected at both beaches, to advise of the CZMP's preparation and provide contact details from which the community could gather further information or provide input.
- A brochure and survey was distributed to the local community, via mailout and letter drop and made available at public venues. There were 104 responses to the community survey (102 in hard copy and 2 online), and the results were used in understanding the issues and deriving options to manage coastal hazards in this CZMP. The community survey findings are summarised in Appendix B.
- Community Drop-in Sessions were held at the commencement of the project, to discuss and document the views of the general community about preparation of the CZMP.
- A Risk Assessment and Management Options Workshop was held internally at Council. The workshop involved key representatives from the various departments of Council, as well as relevant NSW Government agencies and other stakeholders. During the workshop, attendees were involved an assessment of the risk from coastal hazards, collation of details on existing management actions being undertaken or deemed successful in the past, and discussion of new management options and the likely practicality for Council and others to implement such options. The workshop provided guidance as to the types of management options that were likely to be effective and practical for Council and others to implement.
- A Community Drop-in Session was held to outline the findings of further geophysical and geotechnical investigations that were used to refine the hazard lines mapped for Blueys and Boomerang Beaches (as documented in the *Ground Penetrating Radar Investigation of Blueys and Boomerang Beaches* (BMT WBM, June 2014) and the *Bedrock Based Coastal Hazard Revision for Blueys and Boomerang Beach* (BMT WBM, June 2014)).

2 Risk Assessment for Coastal Hazards

2.1 Application of the ISO 31000:2009 Risk Assessment Principles and Guidelines to Coastal Management

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

The Risk Assessment process utilised for this Great Lakes CZMP is adapted from the Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000:2009), as described below and presented schematically in Figure 2-1. According to AS/NZS ISO 31000:2009, risk is defined as the combination of likelihood and consequence.

Risk = Likelihood x Consequence

The use of a risk-based approach for managing coastal hazards is a requirement of the CZMP guidelines and principles (see Section 1.4.1), and accords with current international best practice for natural resource management. The risk management approach for coastal management is explained herein.

- **Establish the Context –** the requirements of a coastal zone management plan as set by NSW Legislation and Guideline documents provides the context of the risk assessment and intended outcomes. The NSW Coastal Policy provides guidance on management objectives. The purpose and context and objectives for this CZMP were outlined in Section 1.1.
- **Identify the Risks –** the risks arise from the coastal hazards, as defined in the *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013) and the former Coastline Management Manual (1990). Coastal hazards were defined by SMEC (2013) for Great Lakes Beaches, as summarised in 0. The key hazards of interest for this risk assessment are beach erosion and recession (including dune slope instability) and coastal inundation.
- **Analyse the Risks –** coastal hazards are considered to be the event that is analysed through risk management. In this case, both **likelihood** and **consequence** of the hazards needs to be analysed. The combination of likelihood and consequence defines the overall level of risk (extreme, high, medium, low).

  The *likelihood* of risks is related to the extent of coastal hazards, now and in the future. The likelihood of erosion and recession (incorporating slope instability) and coastal inundation at the immediate, 2060, 2100 timeframes is defined in Section 2.2.

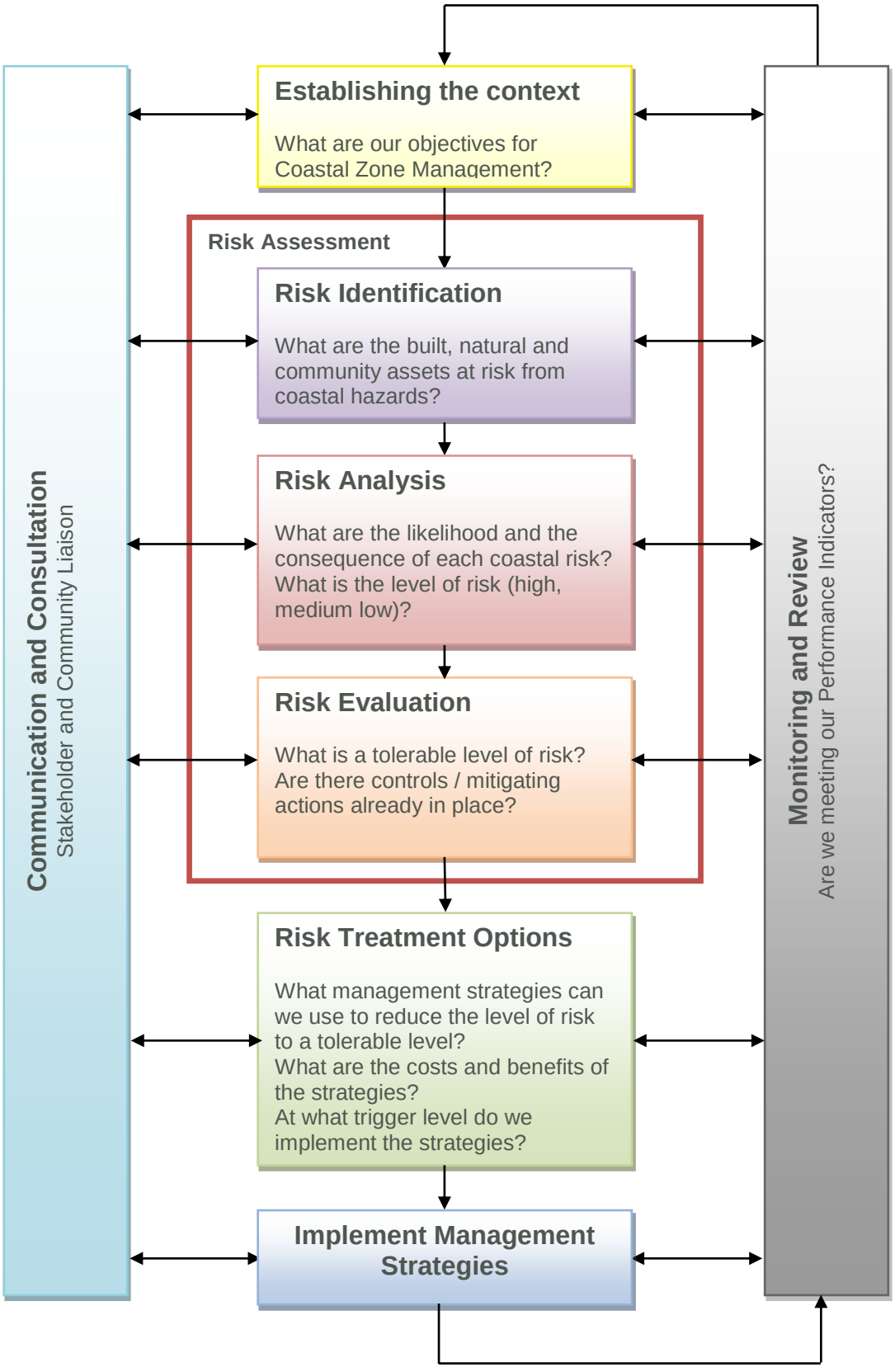


Figure 2-1 Risk Management Framework (ISO 31000:2009) adapted to Coastal Zone Management

The *consequence* of the risks relates to the impact of the hazards upon the land and existing and future assets, including the aesthetic, recreational, ecological and economic values associated with the coastal zone. The values of the community associated with these beaches were assessed through a community survey (summarised in 0). In addition to this, a formal Risk Assessment Workshop with key stakeholders to assess the consequence of coastal hazards was conducted. The consequence assessment is detailed in Section 2.3.

The consequence and likelihood are combined (using GIS processing) to determine and map the *level of risk* for assets and land in the coastal zone. The level of risk is then revised to include existing controls that may reduce the level of risk, for example, existing Council policies, structural works etc. The outcomes of the risk assessment (i.e. combination of likelihood and consequence) is documented in Section 2.5, including a register of assets and their level of risk over the immediate to 2100 timeframe and mapping of coastal risk.

- **Evaluate the Risks –** in consultation with Council and other state agencies, the level of risk that is deemed acceptable, tolerable and intolerable was determined. The evaluation criteria determine the intolerable risks that must be treated as a priority and to which management effort shall be directed, refer Section 4.2.
- **Treat the Risks –** the process of developing coastal management options is directly related to reducing or eliminating intolerable risks wherever possible. Tolerable (low) risks can be flagged for monitoring, with no further resources necessary. Management options can be designed to reduce the likelihood of the risks (e.g. planning setbacks to reduce the likelihood of erosion and recession impacts), or reduce the consequence of the risk (e.g. emergency management to reduce the consequence of shoreline recession) or both. Management options first need to be technically viable for the study area. A cost benefit analysis is then used to determine which of the risk treatments will provide the greatest benefit (relative to cost) in treating the highest priority risks. Management options are outlined and analysed in Section 4.3.1 and Appendix E.

  For existing development given the uncertainty and timeframes over which hazards may manifest, a trigger for implementing the options has been flagged. Setting triggers ensures the management option and associated resources are not utilised until it is absolutely necessary to do so, which is particularly important for difficult and costly, but necessary, options. This is described further in Section 5.1.
- **Implement Management Strategies (Risk Treatments) –** The coastal zone management plan provides the forum detailing how the recommended management options (risk treatments) shall be implemented (costs, timeframes etc.) and funded, and over what timeframe/trigger. Ongoing monitoring and review of both the risks and management options is also detailed.

2.2 Likelihood of the Coastal Hazards

Coastal hazards along the Great Lakes coastline were defined in two separate studies, being:

- *Boomerang Beach and Blueys Beach Coastal Processes and Hazards Definition Study* (WorleyParsons, 2011) and

- the *Great Lakes Coastal Hazards Study* (SMEC, 2013) which covered the remaining Great Lakes beaches excluding Blueys and Boomerang Beaches.

The assessment of likelihood has been conducted separately for the two studies. The term 'whole of coast' has been used to infer the beaches of the Great Lakes LGA excluding Blueys and Boomerang beaches.

2.2.1 Likelihood Scale

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

A scale of 'likelihood' of occurrence for a coastal hazard impact based upon the Australian Standard for Risk Management (AS/NZS ISO 31000:2009) and its companion document (HB 436:2004), is given in Table 2-1. This likelihood scale has been developed over the course of the many other coastal zone studies that BMT WBM have conducted in NSW.

The scale is tailored to both the long timeframes for coastal planning (up to 100 years) and the potential for relatively infrequent, but damaging events that can occur within that timeframe (e.g. 1 in 100 year storm erosion events). A likelihood has been ascribed to the coastal hazards from this scale, based upon a technical review of the analysis used to define the hazards (see below).

Table 2-1 Risk Likelihood for Coastal Hazards (100 year timeframe)

Likelihood	Description
Almost Certain	There is a high possibility the event will occur as there is a history of frequent occurrence
Likely	It is likely the event will occur as there is a history of casual occurrence
Unlikely	There is a low possibility that the event will occur, however, there is a history of infrequent and isolated occurrence
Rare	It is highly unlikely that the event will occur, except in extreme circumstances, which have not been recorded historically.

2.2.2 Beach Erosion

2.2.2.1 Whole of Coast

SMEC (2013) determined beach erosion as an estimated equivalent storm erosion volume, representing the amount of sand that may be eroded during a storm event(s). The equivalent storm erosion volume consisted of "the sum of the measured volume difference between pre and post-storm photogrammetric profiles (Volume 1) and the assumed post-storm recovered volume (Volume 2). The equivalent storm erosion volume is said to correspond with the zone of wave impact and erosion plus zone of slope adjustment (i.e. the area of dune slumping following a storm event), defining the immediate erosion hazard.

SMEC (2013) noted that numerical modelling techniques are not able to represent storm erosion volumes, due to the complexity of the beach environment (rip cells and other currents) and varying conditions, such as a series of closely spaced storms that may erode more than a single "design" storm event. Conversely, there are no specific measurements of storm erosion volumes at any of the Great Lakes beaches.

The most clearly visible storm impact evident in the photogrammetric data was used to calculate the equivalent storm erosion volume. For each beach, the maximum storm erosion at any one location was applied across the entire beach, to account for rip heads and other complexities, and to provide a conservative storm erosion estimate. Storm bite volumes (as m^3 per m of beach length) for each beach and their derivation are described in 0.

The assessment utilised available historical data (i.e. photogrammetry), and applied the maximum volumes calculated for each beach across its entire length. Therefore, the immediate beach erosion hazard estimates are said to be "unlikely" as defined by Table 2-1 (i.e. "there is a low possibility that the event will occur, however, there is a history of infrequent and isolated occurrence").

2.2.2.2 Blueys and Boomerang Beaches

The Beach Erosion hazard extent for Blueys and Boomerang Beaches was defined by WorleyParsons (2011) as follows:

- a storm demand value of 250 m^3/m was applied along the entire length of Blueys and Boomerang Beaches, as an "upper bound allowance for planning purposes in accordance with the precautionary principle" (WorleyParsons, 2011); plus
- an allowance for the Zone of Slope Adjustment, that is, slumping of the erosion escarpment after the storm. This was calculated using the method described in Nielsen *et al*. (1992) and assuming the back beach area is composed entirely of sand. The method of Nielsen *et al*. (1992) for dune slope instability hazards is described in Section D.9.

Utilising the likelihood scale in Table 2-1, the 2010 (Immediate) beach erosion hazard, being the combination of storm demand and Zone of Slope Adjustment values, is considered to have an "unlikely" likelihood at the present timeframe. The change in likelihood over time due to sea level rise is defined in Section 2.2.5. This is based upon a review of the derivation of these values that indicates they are conservative and reasonable, as described below. Further details on the derivation of the beach erosion hazard are provided in 0.

A storm demand of 250 m^3/m is often applied to high energy beaches in NSW, as it was measured before and after storms in the late 1970s to 1980s on a few beaches Sydney and the Central Coast. A "crude" estimate of storm demand calculated as the difference between the volume of the 1972 and 1975 photogrammetric profiles on Blueys and Boomerang Beaches produced volumes of 230 to 280 m^3/m (WorleyParsons, 2011). The similarity between the coarsely measured erosion values at Blueys and Boomerang Beaches and the standard 250 m^3/m value indicates this is a sufficiently conservative and reasonable storm demand to apply to these beaches.

There has been criticism in the general community that the 250 m^3/m beach erosion value was adopted along the entire length of both beaches by WorleyParsons (2011). This criticism is

because the events of 1974 eroded the northern end of both beaches to a greater extent than the southern end of the beach, and so, concern was raised that the beach erosion value is too conservative at the southern ends of the beaches.

Adopting the erosion value along the entire length of the beach provides a suitable buffer for future events that should not be expected to be identical to the 1974 events. There are a number of variables that contribute to beach erosion, most notably, wave height, water level, wave direction relative to beach orientation that will affect cross-shore and longshore transport at different sections of the beach, headland bypassing, and pre-existing beach state (e.g. if the beach is eroded or accreted) and so on. Furthermore, rip currents may occur at any location along the beaches, which would enhance the erosion observed. The application of the 250 m^3/m value along the entire length of the beach is considered appropriate due to the variability in the conditions producing beach erosion at any one time.

Preliminary review of the borehole data of PWD (1985) indicates bedrock to be at depths at or below sea level along both beaches. This was confirmed during the Ground Penetrating Radar investigation conducted by BMT WBM (2014). The assumption of sand when calculating Zone of Slope Adjustment is reasonable and provides a conservative buffer in the context of providing hazard lines for planning purposes. WorleyParsons (2011) noted clearly that geotechnical investigations should be conducted for individual developments, to more precisely define the stable foundation zone based upon site specific conditions.

2.2.3 Shoreline Recession

Shoreline recession is the progressive landward movement of the beach profile over time. Recession will occur where the losses of sediment from a beach are greater than the gains over the long term. In the future, shoreline recession is also expected to occur in response to sea level rise. As the sea level rises, wave, tide and wind related sand transport processes are shifted to a higher position on the beach. This results in a reworking of the beach and dune position landwards, so that the beach and dune are in balance with the new sea level.

Particularly in relation to sea level rise, shoreline recession should not be expected to occur as a gradual landward shift of the beach. Instead it is more likely that following storm erosion events, the beach does not quite recover to its original position. Thus the beach gradually shifts landward, but it may not be obviously distinguishable from episodic erosion events.

2.2.3.1 Whole of Coast

To determine the historical rate of recession on Great Lakes' beaches, SMEC (2013) assessed both the change in sand volumes and the position of the dune face over time at each beach, from the photogrammetric data. A detailed analysis of sediment budgets was not within the scope of the SMEC (2013) study. The adopted recession rates for each beach are provided in 0.

For the purpose of assessing the future recession hazard extent, sea level rise of 0.4 m by 2050 and 0.9 m by 2100 above the 1990 mean sea level was adopted, based upon the guidance of the NSW Sea Level Rise Policy Statement 2009. Since the repeal of the Policy Statement in 2012, Council has adopted the same sea level rises for use in coastal, flooding and climate change assessments (see also Section 1.5.1.1).

Future recession due to sea level rise was estimated using the Bruun Rule (1962), where recession is equal to the amount of sea level rise multiplied by the inverse slope of the active beach profile. Based upon measured bathymetric data at Boomerang Beach, an active beach profile slope of 1:50 has been adopted for the remaining beaches. Sea level rise of 0.5m by 2060 and 0.9 m by 2100 equates to shoreline recession of 22 m by 2060 and 42 m by 2100 (from present, i.e. the assessment discounted the amount of sea level rise that has occurred to date).

The recession hazard adopted for Great Lakes Beaches comprised:

- A small rate (<0.1m/year) of historical, or underlying, recession at most beaches with the exception of larger recession rates at Nine Mile Beach (1 m/year), Tuncurry Beach (0.5m/year) and Main Beach (0.4m/year);
- 22 m of recession by 2060, and 42 m of recession by 2100, based upon sea level rise of 0.5m by 2060 and 0.9 m by 2100 (as per Council policy); and
- To derive the 2060 and 2100 Hazard Lines, the shoreline recession allowances were added to the immediate beach erosion hazard extent.

The Bruun Rule (1962) has a number of limitations (see Ranasinghe et al., 2007), in particular, it does not account for underlying bedrock, reefs, headlands, which in turn may limit the transport of sediment as sea level rises, and therefore, the extent of recession along the beach.

Sea level rise modelling conducted by various regions in NSW by BMT WBM has illustrated that for coastlines with a net northerly longshore sediment transport, sea level rise tends to exacerbate the extent of recession at the southern end of the beach. This is because the sediment transport is constricted at intervening headlands due to the higher sea level, and so the southern end of the beach supplies the northern end. For the central portion of the beach, the sea level rise modelling indicated that the Bruun Rule is a reasonable approximation.

For this reason, the future recession values adopted for Great Lakes' beaches were considered to be a reasonable first pass assessment for planning purposes. When combined with the conservative historical recession rates and "unlikely" beach erosion, the 2060 and 2100 hazard estimates were also considered "unlikely" at their respective timeframes.

The likelihood assessment provided above does not consider, or make comment upon, the likelihood of sea level rise itself. The assessment is focussed upon the likelihood of the coastal response to sea level rise.

The hazard lines were mapped based upon the 2006 aerial laser survey (ALS) data, as this data was considered to avoid the anthropogenic influences present in the photogrammetric data (sand mining, dune works etc.). Anthropogenic influences distort the calculation of "average" beach profiles upon which to measure the erosion hazard.

SMEC (2013) did not map the erosion hazard for the following beaches, because there is no property or infrastructure at risk at these locations:

- Pebbly Beach;
- Burgess Beach;

- Shelly Beach;
- Lighthouse Beach;
- Treachery Beach.

2.2.3.2 Blueys and Boomerang Beaches

The long term recession hazard adopted by WorleyParsons (2011) for Blueys and Boomerang Beaches comprised:

- A zero rate of historical, or underlying, recession on the beaches; and
- 22 m of recession by 2060, and 42 m of recession by 2100, based upon sea level rise of 0.4m by 2050 and 0.9 m by 2100 (as per Council policy, see also Section 1.5.1.1).
- To derive the 2060 and 2100 Hazard Lines, the shoreline recession allowances were added to the immediate beach erosion hazard extent.

Utilising the likelihood scale in Table 2-1, the 2060 and 2100 Beach Erosion and Shoreline Recession Hazard is considered to have an “unlikely” likelihood at the 2060 and 2100 timeframes respectively. The “unlikely” likelihood is driven by the occurrence of beach erosion, not the occurrence of sea level rise and shoreline recession. Future recession due to sea level rise alone is considered to be likely or almost certain, due to the limitations noted below. With the addition of shoreline recession, the beach erosion extent remains ‘unlikely’, and so the overall 2060 hazard remains ‘unlikely’.

For Blueys and Boomerang beaches, future recession due to sea level rise was also estimated using the Bruun Rule (1962), where recession is equal to the amount of sea level rise multiplied by the inverse slope of the active beach profile. WorleyParsons (2011) utilised an active profile slope of 1:50, determined from the nearshore profile measured out to 40 m water depth off Charlotte Head, provided in PWD (1985). This equates to recession of 22 m by 2060 and 42 m by 2100 (from present).

The limitations to the Bruun Rule described in the previous section are also applicable here. Most notably for littoral drift coasts, modelling by BMT WBM has illustrated that the Bruun Rule tends to underestimate recession at the southern end of beaches, and over-estimate recession at the northern end of the beaches. This is because the interruption of sand bypassing by headlands as sea level rises is not captured by the Bruun Rule. Blueys and Boomerang Beaches were assumed to experience net northerly transport of up to 30,000 m^3/year (PWD, 1985, cited in WorleyParsons, 2011). Therefore, the recession allowances provided by WorleyParsons (2011) may be underestimated at the southern end of the beaches, and over-estimated at the northern end of the beaches.

WorleyParsons (2011) did not adopt any rate of historical recession to date, as both beaches have been stable over the long term. That is, they oscillate between eroded and accreted states with overall balance over the long term. The PWD (1985) study adopted a rate of 0.3 m/year for historical recession, which was based upon data captured during a highly erosive period on the coast (i.e. the decade of the 1970s) and during the period of sand mining and rehabilitation on both beaches. Data analysed between 1975 and 2006 indicated the beaches to have experienced

considerable accretion (WorleyParsons, 2011). It is misleading to assume from the 1975 to 2006 data that the beaches are experiencing long term accretion, as the data commences from a highly eroded beach state (in the 1970s) and includes two periods of substantial accretion in the coastal record (the 1980s and early 2000s). Since 2006, many beaches in NSW have experienced erosion due to frequent storms after 2007. It is therefore reasonable and prudent to adopt a zero rate of historical recession, reflecting the overall stability of the beaches.

The change in likelihood over time due to sea level rise is defined in Section 2.2.5. Further details on the derivation of the shoreline recession hazard are provided in 0.

2.2.3.3 Reduced Foundation Capacity of Dunes Following Erosion and Recession

The Zone of Reduced Foundation Capacity (ZRFC) is defined as the area landward of the immediate hazard area that has reduced bearing capacity for structures because it is in proximity to the area of storm erosion and dune slumping (Nielsen *et al.,* 1992, see diagram in Figure D-1, 0). Structures should be located outside of the ZRFC, by either piling downwards or shifting landward into the stable foundation zone (Nielsen *et al.,* 1992).

2.2.3.3.1 Whole of Coast

Hazards mapping by SMEC (2013) included an additional allowance for the ZRFC landward of each of the Immediate, 2060 and 2100 erosion hazard lines. The ZRFC was calculated using the method of Nielsen *et al.* (1992) and assuming the dune to be composed of erodible material (presumably sand). It was noted that erosion may be limited in the presence of bedrock, but this was not included when mapping the erosion hazard. The assumption of sand is a reasonable approach for deriving the ZRFC hazard in a planning context.

The ZRFC lines have not been included in the assessment of beach erosion and recession likelihood. This is because the likelihood of occurrence of a zone of reduced foundation capacity is dependent upon the occurrence of a beach erosion event (that is, a zone of reduced foundation capacity exists in relation to the dune face at all times). Managing the risk of erosion and recession necessarily requires consideration and management of the zone of reduced foundation capacity for structures. In this case, the risk ascribed to assets and land from erosion and recession should also reflect the potential risk to foundation capacity from erosion events (that is, managing the erosion risk should incorporate management of reduced foundation capacity).

2.2.3.3.2 Blueys and Boomerang Beaches

WorleyParsons (2011) calculated the ZRFC using the method of Nielsen *et al.* (1992) and assuming the active beach and dune areas to be composed of sand (i.e. the same methodology as used by SMEC (2013) for the remaining Great Lakes beaches).

A review of the borehole data provided by PWD (1985) indicates that bedrock is not present above mean sea level within the foredunes of either Blueys or Boomerang beaches. The borehole data does suggest material other than sand is present in some locations, particularly banded indurated sands and stiff clays. The indurated sands and clays offer different stability than sand, but this is best determined by a geotechnical analysis on a site-by-site basis at the planning stage for a foreshore development, as recommended by WorleyParsons (2011). It is also worth considering

that the ZRFC is a wedge, with its widest point at the land's surface. Buildings located on the land's surface with foundation piles taken below the ZRFC are still considered to be within the stable foundation zone. The assumption of sand is a reasonable approach for deriving the ZRFC hazard in a planning context.

For the same reason as described above for the other Great Lakes beaches, the ZRFC lines have not been included in the assessment of beach erosion and recession likelihood.

2.2.4 Coastal Inundation Hazard

Coastal inundation refers to the inundation of low-lying land hydraulically connected to the ocean, such as via creek entrances. The high ocean water levels during storms may contribute to the extent of inundation of these back beach areas. The coastal inundation hazard also encompasses wave runup and overtopping of coastal barriers (e.g. dunes, seawalls). The coastal inundation hazard comprises:

- Elevated water levels in the ocean during a storm; and
- Wave runup above the ocean water level, caused by wave breaking on the shoreline.

Both of these factors will increase with sea level rise.

2.2.4.1 Whole of Coast

SMEC (2013) provided a maximum runup and 2% runup[1] level above AHD for various locations along the Great Lakes coastline. Different locations may experience different wave runup levels, based upon their different orientations and therefore exposure to waves.

The runup levels provided for by SMEC comprised the addition of:

- wave runup (above the still water level) at various locations, calculated for the 0.1% AEP (Annual Exceedance Probability) offshore significant wave height of 10.2 m at Crowdy Head;
- the nearshore water level at various locations (comprising wave setup and wind setup);
- elevated ocean water level of 1.48 m (which represents a 1 in 100 year ocean water level measured at Sydney); and
- for 2050 and 2100, projected sea level rise was added to the present day wave runup levels.

Derivation of the coastal inundation levels is detailed further in 0.

The likelihood of coastal inundation at the levels described is considered 'unlikely'. The levels are calculated based upon 1 in 100 year and 1 in 1000 year ARI events, reasonably considered to have a history of infrequent occurrence (see Table 2-1). The 2050 and 2100 levels are also considered 'unlikely', as they incorporate an expected amount of sea level rise plus the 'unlikely' storm event. The change in likelihood of the coastal inundation levels over time due to sea level rise is defined in Section 2.2.5.

[1] The 2% wave runup level is the runup level exceeded for 2% of waves, which is commonly adopted for engineering design and overtopping assessments (refer Pullen *et al*., 2007)

As the shoreline alignment will be expected to change in the future along sandy shorelines, it is not possible to accurately predict the future limits of inundation due to wave runup. Hazard mapping is based upon the height of the existing foredune, but the foredune height, shape and position are expected to change as recession occurs due to sea level rise. Without being able to accurately predict the future height and shape of dunes, it is not possible to accurately map the future coastal inundation hazard.

SMEC (2013) made note of this, however, an indicative future runup level for 2050 and 2100 was estimated and mapped, assuming that the nearshore beach slopes and wave climate are unchanged. SMEC (2013) noted this is only a rough estimate of the extent of future wave runup but provides an indication of infrastructure which may be at risk from future inundation due to wave runup.

2.2.4.2 Blueys and Boomerang Beaches

The elevated ocean level adopted for Blueys and Boomerang Beaches was 2.7 m AHD at the immediate timeframe, increasing to 3.1 m by 2050 and 3.6 m by 2100 with 0.4 m and 0.9 m of sea level rise respectively (WorleyParsons, 2011). The 2% wave runup level (that is, the runup level exceeded for 2% of waves) was calculated as 5.3 m for the immediate timeframe, increasing to 6.2 m by 2100 with 0.9 m sea level rise (WorleyParsons, 2011). Derivation of the coastal inundation levels is summarised in D.10.

The coastal inundation hazard mapping for Blueys and Boomerang beaches displays the 2.7 and 3.6 m AHD elevated water levels, and the 5.3 m and 6.2 m AHD wave runup levels (representing Immediate and 2100 timeframes respectively), based upon the present day height of the foredune.

The main area of hazard is the southern end of Blueys Beach in the vicinity of the unnamed creek entrance. Elevated water levels plus wave runup may penetrate through the depression in the dunes, causing inundation via the creek line of low-lying land behind the beach around Ampat Place and Newman Avenue. An indicative hazard area of inundation plus a ‘potential minor inundation due to wave action’ has been illustrated in the coastal inundation hazard mapping (WorleyParsons, 2011). The elevated ocean water levels would also preclude the outflow of water from the creek, enhancing any catchment flooding coincident at that time. The coastal inundation hazard mapping provides an indicator of future hazard extent only, as it does not include catchment processes in defining the depth of inundation.

Due to the substantial height of dunes along Boomerang Beach and the northern and central portions of Blueys Beach, the coastal inundation hazard is retained seaward of the main barrier dune for the remainder of the two beaches.

The likelihood of inundation at the immediate levels described is considered ‘unlikely’. The levels are calculated based upon 1 in 100 year ARI events, reasonably considered to have a history of infrequent occurrence (see Table 3-3). The 2060 and 2100 levels are also considered ‘unlikely’, as they incorporate an expected amount of sea level rise plus the ‘unlikely’ storm event. The change in likelihood over time due to sea level rise is defined in Section 2.2.5.

It is noted that the same issues of mapping a future coastal inundation hazard noted for the whole of coast above is also relevant to Blueys and Boomerang beaches. That is, the future height and

position of the foredunes is somewhat uncertain as this will be affected by recession due to sea level rise, and so mapping the future runup level based upon present day dune levels is not necessarily representative of the future hazard extent.

2.2.5 Change in Likelihood with Time

The likelihood ascribed to the coastal hazard lines aims to incorporate the key concept associated with sea level rise, whereby the likelihood of a present day erosion impact increases over time and with proximity to the ocean, due to the occurrence of sea level rise itself.

The concept of increasing likelihood overtime, illustrating the likelihood ascribed to all of the erosion and recession hazard lines at each timeframe is demonstrated in Table 2-2. The likelihood values were assigned spatially (within GIS) to each relevant hazard line mapped for the beaches.

Table 2-2 Increasing Likelihood of Hazards Over Time due to Sea Level Rise

Probability			2100
Almost Certain		2060	Immediate Hazard Line
Likely	Immediate	Immediate Hazard Line	2060 Hazard Line
Unlikely	Immediate Hazard Line	2060 Hazard Line	2100 Hazard Line
Rare	2060 Hazard Line	2100 Hazard Line	
	2100 Hazard Line		

The likelihoods given at each timeframe to each hazard line in Table 2-2 are explained as follows.

- **At the present day**: the Immediate hazard extent is considered to have an 'unlikely' likelihood (see Section 2.2.2 and 2.2.4); the 2060 hazard extent is considered to have a 'rare' likelihood. While it would not be expected that such an extent of erosion or inundation would occur at the present, there is a rare chance that this could occur. It is conceivable that such dramatic events have occurred historically, but that photogrammetric or water level data was not able to be recorded. The 'rare' likelihood line may be thought of as similar to the Probable Maximum Flood event that is utilised in flooding assessments.
- **At 2060**: the Immediate hazard extent, which does not incorporate any allowance for sea level rise, becomes far more frequent as to be considered 'likely'; the 2060 hazard extent is considered to have an 'unlikely' likelihood (see Section 2.2.3 and 2.2.4); and impacts beyond the 2060 hazard extent would still be relatively infrequent and isolated, such that the occurrence of the 2100 hazard extent would be considered 'rare'.
- **At 2100**: the Immediate hazard extent, becomes 'almost certain', as there is no recession or inundation allowance for sea level rise; the 2060 hazard extent becomes 'likely', as it

incorporates a smaller allowance for sea level rise; and the occurrence of erosion to the 2100 hazard extent is 'unlikely' (see Section 2.2.3 and 2.2.4).

The possibility that sea level rise will not rise at the rate projected is also catered for within this approach: at each timeframe, it is not assumed that the relevant hazard line for that timeframe is absolutely certain or even 'almost certain'. The possibility that sea level rise will not occur needs also to be considered when developing future management options. This is done through prescribing likelihood to hazard extents, as well as setting triggers for implementation of management actions (refer Section 5.1) that are event based rather than time based.

2.2.6 Slope Instability

Slope instability was identified as a significant issue at specific sites at Seal Rocks, namely:

- Boat Beach, specifically between Kinka Road (crest of the slope) and the beach (toe of the slope); and
- Number One Beach, specifically between Seal Rocks Road (crest of the slope) and the beach (toe of the slope).

Risk assessments for slope instability hazards are conducted in accordance with the method set out in the *Landslide Risk Assessment Procedures* in Australian Geomechanics, Volume 42, Number 1, March 2007. The outcome of the landslide risk assessment is to identify a risk to property and a risk to loss of life. The Landslide Risk Assessment process differs from that described for the other coastal hazards in this report (in Section 2.1), but in essence, both assessments require the consequence and likelihood of the hazard to define the level of risk.

The outcomes of the slope instability hazard risk assessment are provided with the outcomes for the other hazards in Section 2.5 below.

2.3 Consequences of the Coastal Hazards

2.3.1 Consequence Scale

The other component of risk is *consequence*. The consequence of impact from coastal hazards largely relates to the land and assets and their values (i.e. aesthetic, recreational, ecological, cultural and economic) affected by hazards. The type and duration of impact needs also to be considered when assessing the consequence of the different coastal risks, such as the long term permanent loss of land with recession compared with short term periodic inundation.

A consequence scale was developed specifically for this CZMP that is relevant to both the type of impact to coastal land and assets and its effect across the entire community and the timeframe (up to 100 years) for coastal risk planning. The consequence scale follows a triple bottom line approach, to determine the consequence to the society and community, environment, and economy. Terminology of 'major', 'moderate', 'minor', and 'insignificant' was adopted for the consequence scale, which is consistent with terminology in Standards Australia (2004) *Handbook Risk Management Guidelines Companion*, which accompanies the Risk Management Principles and Guidelines. The consequence scale is given in Table 2-3.

The scope of the consequence categorisations was derived for the risk to the whole of the Great Lakes Beach communities, in terms of social, economic or environmental impacts. Thus, the values ascribed within the 'economy' scale relate to damages to property, infrastructure or the local economy.

The consequence scale differs from scales used for health and safety or Councils operations, because:

- The scale related to consequence to Council's operations, not coastal land that is used and owned by visitors and residents and private and public landholders, all of which are stakeholders in the CZMP; and
- The scale was not relevant over the timescale of interest to a CZMP (i.e. 100yrs).

It is noted that, while the consequence to economy is considered as part of the risk assessment, the financial cost of options has also been considered as part of the cost benefit analysis of management options see Section 4.3.

Table 2-3 Consequence Scale for Coastal Hazards/Issues

Consequence	Society / Community	Environment	Economy
Major	Major permanent or widespread medium term disruption to community's services, wellbeing, or culture (e.g. 50 % of community affected), or regional loss, or Few, if any, suitable alternative sites exist	Widespread permanent or semi-permanent impact, or widespread pest / weed species proliferation, or semi-permanent loss of entire regionally important habitat. Recovery may take many years, if at all.	Damage to property, infrastructure, or local economy >$2 million
Moderate	Minor long term or major short term (mostly reversible) disruption to services, wellbeing, or culture of the community (e.g., up to 25 % of community affected), or sub-regional loss, or Some suitable alternative sites exist	Significant environmental changes isolated to a localised area, or loss of regionally important habitat in one localised area. Recovery may take several years.	Damage to property, infrastructure, or local economy >$250,000 - $2 million
Minor	Small to medium short term (reversible) disruption to services, wellbeing, finances, or culture of the community (e.g., up to 10 % of community affected), or local loss, or many alternative sites exist	Environmental damage of a magnitude consistent with seasonal variability. Recovery may take one year.	Damage to property, infrastructure, or local economy >$50,000 -$250,000
Insignificant	Very small short term disruption to services, wellbeing, finances, or culture of the community (e.g., up to 5 % of community affected), or neighbourhood loss, or numerous alternative sites exist	Minimal short term impact, recovery may take less than 6 months, or habitat affected with many alternative sites available.	Damage to property, infrastructure, or local economy <$50,000

2.3.2 Consequence of the Coastal Hazards

Based on the asset identification in GIS, a list of assets that may be affected by coastal hazards by 2100 was compiled, including both a broad asset type and names of specific assets within that type where possible or relevant. The assets identified included roads, residential and rural property, sewer, stormwater, water supply, public buildings (e.g. amenities), parks and reserves, and the beach system themselves.

Consequence values were assessed separately for the erosion and recession hazard, and for the coastal inundation and wave overtopping (runup) hazard, because the types of impact are different (i.e. long term permanent loss of land compared with short term periodic inundation of land) even though the value of the land may be the same. For example, once erosion has undermined a building on a sandy dune, the loss of the building is permanent and the land, even if there is some beach recovery, cannot be used in the same way. In contrast, the consequence of coastal inundation from a periodic storm event is somewhat lower, as the water recedes after the storm ebbs and, even though potential damages will need to be repaired, the land is not permanently affected.

Consequence values were initially assessed as part of two risk assessment workshops conducted with representatives from the various sections within Council and various government agencies. Within the workshop, attendees worked in groups to agree upon a separate social, economic and environmental consequence for each asset type. Then, the groups determined an overall consequence level, which could be the social, economic, or environmental consequence alone, on average or in combination for that asset. That is, the weighting between social, economic or environmental consequence was decided by the attendees, and on an asset by asset basis.

The consequence values obtained through the risk assessment workshop were combined with the outcomes from the community survey regarding the values associated with land and assets at the beaches (see 0). Refinement by the study team aimed to resolve any discrepancies between the two sources. Generally, the average of the various groups' responses was applied, except in circumstances where there were an insufficient number of answers. In this case, the study team applied findings from previous studies and understanding of comments from attendees that were documented during the workshop. The coastal assets and consequence values are listed in Table 2-4 and Table 2-5.

It is interesting to note the major consequence of impacts to the beach itself in developed areas, which outweighed many other assets. It is the beach itself that lends value to all the other assets adjacent to it, including residential property, tourism, beach access, recreation and so on. Preserving the sandy beach is of key importance to retaining the value of the other assets associated with it. Management options that preserve the sandy beach must necessarily be favoured over options that protect assets behind the (houses, roads etc.), particular where those options will negatively impact the sandy beach (e.g. seawalls, groynes etc).

Table 2-4 Consequence of Erosion and Recession

Asset	Location	*Consequence of Erosion & Recession*	*Reasoning for Consequence level*
Beaches and Dunes			
Beaches	*Tuncurry (Nine Mile southern end), Forster Main, Pebbly, One Mile, Elizabeth, Blueys, Boomerang, Sandbar, Seal Rocks (Number One, Boat, Lighthouse), Treachery (northern end, Bennetts (south of GC).*	*Major*	These beaches are highly valuable to the community, environment and local economy. Beaches backed by development (e.g. houses, roads) will experience greater impacts as natural migration of the beach inland is impeded by the development.
Beaches	*Nine Mile (northern end), Burgess, Seven Mile, Shelly, Treachery (southern end), Bennetts (from GC north).*	*Minor*	These beaches are also valued by the community, and have high ecological values. The beaches are much less accessible and generally undeveloped, allowing the beach to migrate inland without obstruction. The consequence is thus lower.
Dunes and Dune Vegetation	*Tuncurry (Nine Mile southern end), Forster Main, Pebbly, One Mile, Elizabeth, Blueys, Boomerang, Sandbar, Seal Rocks (Number One, Boat, Lighthouse), Treachery (northern end), Bennetts (south of GC).*	*Major*	The 'naturalness' of Great Lakes beaches is afforded by the quality and extent of vegetated dunes. The naturalness of the beach is highly valued by the community. At beaches backed by development (e.g. houses, roads), there is limited opportunity for the dunes to naturally migrate inland with sea level rise. The consequence of erosion is therefore major.
Dunes and Dune Vegetation	*Nine Mile (northern end), Burgess, Seven Mile, Shelly, Treachery (southern end), Bennetts (from GC north).*	*Minor*	While the dunes and vegetation at these beaches are equally important as at other sites, there is no back beach development hindering the natural migration of dunes and vegetation inland as sea level rises.
Rocky Shore Platforms	*All beaches*	*Insignificant*	Erosion will not significantly impact the rocky foreshore areas. Recession of the hard rocky shorelines due to incremental, permanent sea level rise will see rocky platforms become gradually submerged.
Services and Other Infrastructure			
Water Supply Lines	*All beaches*	*Major*	Water, sewer and stormwater assets provide vital services to social health and functioning. They are also expensive to replace.
Sewer Lines, Pump Stations	*All beaches*	*Major*	
Stormwater Pipes	*All beaches*	*Major*	
Stormwater Outlets	*All beaches*	*Moderate*	Stormwater outlets may remain functional even if shortened in length due to erosion and recession of the surrounding beach.

Asset	Location	*Consequence of Erosion & Recession*	*Reasoning for Consequence level*
Seawalls, Breakwaters	*Forster Main, Wallis Lake (Forster-Tuncurry) Breakwaters.*	*Minor*	Over time, the impact of waves on the structures will require maintenance.
Seawalls	*Seal Rocks Road, Number One Beach*	*Major*	The structure has not been designed to withstand erosion during storms. The structure and adjacent road may be undermined by erosion and recession.
Residential and Rural Development			
Residential Property	*All zonings*	*Major*	Loss of houses and their land would have a major economic consequence for the individual owners, although a lesser impact on the greater community. Loss of houses would affect the wellbeing of the local community in the short term.
Rural Property	*Rural landscape and village zonings*	*Moderate*	Rural properties are generally less developed than the residential land and are therefore more resilient to erosion impacts.
Transport Infrastructure			
Major Road(s)	*No alternate routes available (Seal Rocks Rd, Number One Beach; Lakeside Cr, Elizabeth Beach; The Lakes Way, Seven Mile Beach, Boomerang Drive, Boomerang Beach).*	*Major*	Impacts to a major road route, which may cut access to a public area and/or houses, with no alternative routes available.
Major Road(s)		*Moderate*	Impacts are to road side reserve only, but may require further investigation of stability of adjacent road.
Minor Road(s)	*No alternate routes available (North St, Main Beach; Cliff Rd, One Mile Beach; Red Gum Avenue, Boomerang Beach; Newman Avenue, Blueys Beach; Kinka Rd, Boat Beach; Beach Rd, Bennetts Beach)*	*Major*	The loss of a road(s) will cut vehicular access to the beach, a public area and/or houses, with no alternate routes available. Efforts to protect road at Jimmys Beach demonstrate the consequence of erosion impacts even for relatively minor roads.
Minor Roads(s)	*Boomerang Beach Rd*	*Moderate*	Boomerang Beach Road is highly valued and utilised by community for parking, walking and accessing the beach.

Asset	Location	*Consequence of Erosion & Recession*	*Reasoning for Consequence level*
Minor Road(s)	*Alternate routes are available (Beach St, West St, North Lane, Main Beach; Burrawong Pl, Konda Pl, Palmgrove Pl, Strand St, One Mile Beach; Lethbridge Rd, Elizabeth Beach Booner St, Mirreen St, Bennetts Beach)*	*Minor*	Impacts affect end of roadway only or otherwise do not impinge upon access to the beach, public areas, houses or key transport routes for residents and broader community. Investigation of stability of road after erosion impacts may still be required.
Car Parks	*All*	*Moderate*	Beach car parks are important community assets as they provide for beach access for many. This is enhanced where land to relocate car parks is limited.
Community Infrastructure			
SLSCs	*Forster Main, Elizabeth, One Mile, Bennetts*	*Moderate*	Highly valued community and economic assets.
Beach Accessways.	*All*	*Moderate*	Beach accessways have a high community value and are also relatively cheap and easy to replace. However, the consequence of damage is considered higher due to public safety impacts (e.g. walkways above erosion escarpments). And when blocked off after erosion, informal access around the original walkway can damage adjacent dunes and vegetation, resulting in further erosion, safety issues and dune 'blowouts'.
Amenities, Viewing Platforms	*All*	*Minor*	These assets are highly utilised by the community. They are generally of a minor to insignificant economic consequence, and easy to replace as needed.
Tourist / Holiday / Caravan Parks	*All*	*Moderate*	Greatly utilised community facilities with high economic values.
Camping Grounds / Reserves	*(i.e. without facilities)*	*Minor*	Greatly utilised community facilities with high economic values, but are more easily adapted to erosion and recession. Reserve is still functional even where reduced in size.
Public Recreation and Open Space.	*All*	*Minor*	Undeveloped land has the ability to absorb permanent recession impacts, and the park is still functional for the community even where reduced in size.
Boat Ramps	*Elizabeth Beach, Boat Beach*	*Moderate*	Highly valued community and economic assets. Sites for open ocean boat ramps are limited (specific ocean conditions are required), increasing the impact of loss.
Ocean Baths	*Forster Main*	*Insignificant*	Erosion is not expected to impact upon the pool.

Asset	Location	*Consequence of Erosion & Recession*	*Reasoning for Consequence level*
Natural Assets			
Parks and Reserves	*All*	*Minor*	Areas without development are generally considered more resilient to the impacts of erosion, and recession with sea level rise, as habitats are free to migrate inland; and the park is still functional for the community even where reduced in size. The natural values of these conservation areas are likely to remain intact even if there is erosion at the seaward boundary.
National Parks, PSGL Marine Park	*All*	*Minor*	Areas without development are generally considered more resilient to the impacts of erosion, and recession with sea level rise, as habitats are free to migrate inland. As above, it would generally be considered that the conservation values of National Parks and PSGL Marine Parks will remain intact, even if there is erosion at the seaward boundary.
Littoral Rainforest *(SEPP26)*	*All*	*Major*	Littoral rainforest is a highly valuable ecological asset. Rainforest remnants are limited in extent and have a limited ability to migrate inland with sea level rise.
Natural Watercourse	*All*	*Minor*	There may be some impacts to the outlets of watercourse with sea level rise and recession, but generally the impacts upon the functioning of the watercourse would be considered minor.

Table 2-5 Consequence of Wave Runup and Overtopping

Asset	Location	*Consequence of Wave Runup*	*Reasoning for Consequence level*
Beaches and Dunes			
Beaches	*All*	*Insignificant*	No notable impact arising from short term coastal inundation, with the exception of temporary (hours at most) loss of access.
Dunes and Dune Vegetation	*All*	*Insignificant*	
Rocky Shore Platforms	*All*	*Insignificant*	
Services and Other Infrastructure			
Water Supply Lines	*All*	*Insignificant*	Considered less likely to experience inundation within closed water supply lines. Impact if did occur likely to be minor saltwater infiltration (diluted by the main supply) over a short period (hours).
Sewer Lines, Pump Stations	*All*	*Major*	Even short term inundation of the stormwater and sewer network may have substantial consequences upon the community (e.g. flooding due to reduced drainage by stormwater system, overflowing of the sewerage system). The impacts of permanent inundation with sea level rise on the functionality of the stormwater and sewerage networks was not investigated as part of the Coastal Hazards Study (SMEC, 2013). This risk assessment may be used as a proxy to investigate the impacts of permanent sea level rise on these networks.
Stormwater Outlets and Pipes	*All*	*Major*	
Seawalls, Breakwaters	Forster Main, Wallis Lake (Forster-Tuncurry) Breakwaters.	*Moderate*	Wave overtopping is a safety hazard to people on the structures during storm events. Over time, the impact of waves on the structures themselves will require maintenance.
Seawalls	Seal Rocks Road, Number One Beach	*Major*	The structure has not been designed to withstand or protect road users from wave overtopping and spray, presenting a risk to the public.
Residential and Rural Development			
Residential Property	*All zonings*	*Moderate*	The impact of wave runup (as separate from erosion) may cause minor damage to a residential asset and its interiors, however the damages are repairable.

Asset	Location	*Consequence of Wave Runup*	*Reasoning for Consequence level*
Rural Property	*Rural landscape and village zonings*	*Minor*	The impact of wave runup (as separate from erosion) on undeveloped areas within the property will be minimal, and may cause minor damage to buildings, however the damages are repairable.
Transport Infrastructure			
Major Roads	*Alternate routes are available*	*Minor*	May limit road use, but alternative routes are available. Overtopping may cause damage to the road surface.
Major Roads	*No alternate routes available*	*Moderate*	More significant impact where road access to an area becomes blocked over short term, as both a nuisance and potential safety hazard. Overtopping may cause damage to the road surface.
Minor Roads	*All*	*Minor*	Wave runup and inundation / foam may limit vehicular access for local residents over a short period (hours only). Overtopping may cause damage to the road surface.
Road Reserve	*All*	*Insignificant*	No notable impact arising from short term wave runup.
Car Park	*All*	*Insignificant*	Very short term loss of asset use (hours). Overtopping may cause damage to the road surface.
Community Infrastructure			
SLSC	*Forster Main, Elizabeth, One Mile, Bennetts*	*Moderate*	The impact of wave runup (as separate from erosion) may cause damage to club house and associated assets, however the damages are repairable.
Beach Accessways	*All*	*Insignificant*	Minimal damages may occur and short term loss of asset use.
Amenities, Sheds, Picnic Shelters, Viewing Platforms	*All*	*Insignificant*	As above.
Tourist / Holiday / Caravan Parks	*All*	*Minor*	Short term loss of asset use. May be impacts to residents, particularly if storm occurs during busy periods. Minor damage to built facilities, causing relatively small financial impact.
Camping Grounds / Reserves	*(i.e. without facilities)*	*Insignificant*	Minimal (if any) damages may occur and short term loss of asset use.
Public Recreation, Foreshore and Open Space.	*All*	*Insignificant*	As above.

Asset	Location	*Consequence of Wave Runup*	*Reasoning for Consequence level*
Boat Ramps	*Elizabeth Beach, Boat Beach*	*Insignificant*	Short term loss of use of facilities during and after storms (not expected to be used in stormy conditions anyway). Facilities likely to have been built to withstand wave impacts.
Ocean Baths	*Forster Main*	*Insignificant*	As above.
Cycleway	*All*	*Minor*	Limited damages may occur from wave runup, similar to a minor road. Loss of asset use would be short term.
Footpath	*All*	*Insignificant*	Minimal economic impact to paving may arise from wave runup and overtopping.
Natural Assets			
Parks and Reserves	*All*	*Insignificant*	Areas likely to be affected by wave runup will be those adapted to saltwater impacts.
National Parks and PSGL Marine Park	*All*	*Insignificant*	While the ecological values within National Parks and PSGL Marine Park are higher than other parks, Areas likely to be affected by wave runup will be those adapted to saltwater impacts.
Littoral Rainforest (SEPP 26)	*All*	*Moderate*	Important ecological community not tolerant to saltwater inundation.
Natural Watercourse	*All*	*Insignificant*	Watercourses and waterways are adapted to periodic inundation from the ocean.

2.4 Existing Controls

The risk assessment process takes into consideration any existing controls that may mitigate or reduce the level of risk, prior to determining the residual level of risk. Discussion of the existing plans, policies or works that may already directly or indirectly manage coastal hazards at Great Lakes beaches are summarised below.

In general, while there are some very good initiatives in place (particularly planning for coastal developments), these were not considered to substantially change the assessment of risk to existing developments. Instead, recommendations to improve the strength of the existing controls have been noted with the controls, as below.

2.4.1 Great Lakes Local Environment Plan

Great Lakes Local Environmental Plan 2014 (LEP 2014) provides local environmental planning provisions for land in Great Lakes LGA in accordance with the relevant standard environmental planning instrument under Section 33A of the EPA Act. It was prepared under the direction of the State Government to all local councils, as per the *Standard Instrument (Local Environmental Plans)*

Order 2006. The LEP was adopted by Council in 2012 as a draft and recently gazetted by the Minister of Planning in April 2014.

In terms of managing coastal hazards, the LEP 2014 contains two specific clauses.

- 'Part 5.5. Development within the Coastal Zone' is a compulsory clause for all LEPs that apply to land within the 'coastal zone' (as defined on gazetted maps with the Department of Planning and Infrastructure). Part 5.5 sets out objectives and matters for consideration by the consent authority prior to granting consent to development on land wholly or partly within the coastal zone. The objectives of this Clause include implementing the principles of the NSW Coastal Policy, one of which is to recognise and accommodate coastal processes and climate change. The considerations for developments subject to this clause thus relate to preserving coastal environments, maintaining public access to the shoreline, suitability and impacts on scenic values and amenity, impacts upon coastal biodiversity and ecosystems, cumulative impacts upon the coastal catchment including effluent and stormwater, and the impact of the development on or from coastal hazards.
- 'Part 7.4 Coastal risk planning' is a non-compulsory clause to enable local provision for managing coastal risks. The clause wording from the LEP is as follows.

  (1) The objectives of this clause are as follows:

  (a) to avoid significant adverse impacts from coastal hazards,

  (b) to ensure uses of land identified as coastal risk are compatible with the risks presented by coastal hazards,

  (c) to enable the evacuation of land identified as coastal risk in an emergency.

  (2) This clause applies to the land identified as "Coastal Risk Planning area" on the Coastal Risk Planning Map.

  (3) Development consent must not be granted to development on land to which this clause applies unless the consent authority has considered whether the development:

  (a) is likely to be adversely affected by the impacts of coastal hazards, and

  (b) is likely to cause detrimental increases in coastal risks to other development or properties, and

  (c) is likely to alter coastal processes and the impacts of coastal hazards to the detriment of the environment, and

  (d) incorporates appropriate measures to manage risk to life from coastal risks, and

  (e) avoids or minimises potential adverse effects from the impact of coastal processes and the exposure to coastal hazards, particularly if the development is located seaward of the 2060 hazard line, and

  (f) provides for the relocation, modification or removal of the development to adapt to the impact of coastal processes, coastal hazards and sea level rise planning benchmarks.

(4) A word or expression used in this clause has the same meaning as it has in the NSW Coastal Planning Guideline: Adapting to Sea Level Rise (ISBN 978-1-74263-035-9) published by the NSW Government in August 2010, unless it is otherwise defined in this clause.

(5) In this clause:

2060 hazard line means the landward extent of erosion, recession and stability hazards consistent with the projected 2060 sea level rise of 0.5 metres above the 1990 mean sea level.

coastal hazard has the same meaning as in the Coastal Protection Act 1979.

Compared with Clause 5.5, this clause directly addresses the risks associated with coastal hazards. Clause 7.4 aims to ensure that coastal hazards assessment and amelioration or mitigation to manage such risks is undertaken during development of land potentially at risk from coastal hazards.

At present, the Coastal Risk Planning Area maps gazetted with the LEP only cover Jimmys Beach (including Winda Woppa) and Blueys and Boomerang Beaches. The maps are based upon the latest 2060 Hazard areas for Jimmys, Blueys and Boomerang Beaches including provision for beach erosion, shoreline recession due to sea level rise, and a zone of reduced foundation capacity behind the erosion escarpment

To accompany this CZMP, the LEP 2014 is being amended to include new coastal risk planning area maps. The new maps cover the remaining council managed beaches in the LGA (i.e. excluding beaches within national parks), including: Tuncurry - Nine Mile Beach (southern end only), Forster Main Beach, Pebbly Beach, One Mile Beach, Seven Mile Beach, (southern end only), Elizabeth Beach, Sandbar Beach, Seal Rocks Number One Beach (covering area of development only), Seal Rocks Boat Beach, Bennetts Beach (southern end only). The new maps are based on the 2060 Hazard area as defined in the Great Lakes Coastal Hazard Study (SMEC, 2013).

Application of both the compulsory and non-compulsory clauses within the LEP provides the strongest coastal hazards control currently permissible within an LEP under the current NSW planning framework. The clauses provide a “heads of consideration” for developments, rather than specific controls, and so are not considered to change the level of risk to existing developments.

2.4.2 Great Lakes Development Control Plan 2014

The Great Lakes Development Control Plan (DCP 2014) was prepared in conjunction with Great Lakes Local Environmental Plan 2014 (LEP 2014) and came into force when Great Lakes LEP 2014 was published in April 2014.

The DCP 2014 supports the implementation of the LEP by providing additional controls, guidelines and information on how development should be undertaken within a certain zone or location, with the LEP prevailing in the case of any inconsistency.

As part of the environmental matters for consideration within DCP 2014, sea level rise and coastal erosion are specifically addressed, and some control upon development in coastal hazard prone areas is provided. The controls stated in the DCP 2014 are as follows.

- “For development proposals on land identified as potentially being affected by coastal erosion and/or sea level rise a report from a suitably qualified engineer specialising in coastal marine

processes and a geotechnical engineer, shall be required to determine suitable measures for protection of the building against coastal erosion and recession, changes in storm frequency and intensity, and sea level rise.

- Where native vegetation that currently protects a dune system from erosion processes will be affected by proposed development, a Vegetation and Environmental Impact Assessment by a qualified arborist or ecologist may be required.
    - A linear sea level rise of 0.91m to the year 2100 is to be taken into account.
    - For development proposals on land potentially affected by coastal hazards, such as Winda Woppa, Seal Rocks, Bluey's Beach and Boomerang Beach, a report from a suitably qualified geotechnical engineer and an engineer specialising in coastal marine processes shall be required, to determine the geotechnical and physical stability of the land is not compromised and to determine suitable measures for protection of the building against coastal erosion and recession, changes in storm frequency and intensity and sea level rise.
    - Where native vegetation that currently protects the dune system from erosion processes will be affected, a Vegetation and Environmental Impact Assessment by a qualified ecologist may be required".

The controls specified above are the same as that listed in the former Pacific Palms DCP for Blueys and Boomerang Beaches (excluding the 15 m setback provision), now applying more generally to all coastal risk planning areas identified on gazetted maps with the LEP. These controls are currently being redrafted, to accompany the draft amended Coastal Risk Planning Area maps in the LEP. The DCP draft shall also build upon recommendations for coastal hazard development controls made in this CZMP (see Chapter 4). Therefore, the current DCP provisions were not considered to substantially reduce the risk to existing development.

The DCP clause in its current form requires coastal engineering and geotechnical engineering assessments to address coastal erosion and sea level rise for new developments (including infill development). However, the DCP provisions are limited in terms of providing guidance to developers as to the assessment criteria and acceptable solutions to meet these criteria.

Under the amendments to the DCP, Council intends to provide better clarity to developers regarding:

- Objectives for coastal hazard areas being implemented through the development controls; and
- Assessment criteria for developments in coastal risk areas.

2.4.3 Time Limited Development Consent

In assessing and approving beachfront development at Great Lakes Beaches, Council has begun the use of time-limited conditions of consent for development applications (DAs). This is a permitted power for consent authorities under the EPA Act 1979. In addition to this, Council has in the past also required the time-limited development consent to be attached to the Land and Property / Plan Title for the subject development, under Section 88B of the *Conveyancing Act 1919*.

For time limited consents, if the property is under threat by 2060, Council will order demolition, removal or moving of the structure, in accordance with the original development consent.If the erosion and recession hazard has not eventuated to the extent expected by 2060 (or within ~ 5 years before then), the property owner may re-apply to Council to have timeframe for the consent revised (to some later date), based upon a coastal consultant report detailing the latest projections for coastal hazards impacts.

Time limited consents have been applied some 26 times in the LGA, although to date there has not been a consistent application of date a consent would lapse. Typically 2060 has been applied (i.e. approximately a 50 year development lifespan).

The adoption of time-limited consents is progressive for the Council, and accords with the 'duty of care' principles of the *Local Government Act 1993* (Section 733). However, one such consent has been challenged in court. The application of a time-limited consent to a development on a property at Winda Woppa was overruled by the Land and Environment Court, because the adjacent properties were not subject to such consents. Furthermore, consents may also be subject to challenge where Council has not given clear specification as to the grounds upon which it would judge a development unviable, requiring removal. That is, the development consent does not give a clear definition of the trigger at which the consent would be rescinded, for example, a distance between the erosion escarpment and the building, a requirement for a geotechnical assessment and so on.

This existing action does reduce the risk for those individual properties to which it applies, but has not been included in the risk assessment. To ensure that erosion events that may threaten or undermine the building prior to the time limit set for a development consent, conditions of consent should preferably be based upon an event trigger. In this case Council can rescind the development consent and issue a demolition or removal order when a coastal hazards event threatens the structure.

Given that this control applies to less than two properties at the current time, the existing control has not been included in the risk assessment. Improvements to this action are also recommended in the Appendix E (see Coastal Hazard).

2.4.4 Councils Sea Level Rise Benchmarks

Council has adopted the previously State Govt SLR benchmarks of 0.4 and 0.9, by 2050 and 2100 (relative to 1990 levels). This policy simply includes NSW Coastal Planning Guideline: Adapting to Sea Level Rise (as developed by the Dept of Planning) in its entirety. This guideline (and thus Council's policy) in turn adopts the now repealed NSW Sea Level Rise Policy (2009). I spoke with Alex, who says that she expects this currently policy to be repealed when the new draft coastal hazards DCP is put forward for adoption next year, which will include details of the SLR benchmarks. The new DCP will then essentially form Councils new SLR policy.

In June 2011, Council adopted the *NSW Coastal Planning Guideline: Adapting to Sea Level Rise* as Policy (PL-PLN-002). This policy was developed by the then NSW Department of Planning in August 2010. This policy in turn adopts the (now rescinded) NSW Sea Level Rise Policy Statement 2009, which applied sea level rise benchmarks of 0.4 m by 2050 and 0.9 m by 2100, relative to

1990 mean sea levels. The policy provides guidance on how sea level rise is to be considered in land use planning and development assessments within the coastal zone.

Through the adoption of this policy, Council has adopted seal level rise planning benchmarks of 0.5 m by 2060 and 0.9 m by 2100, above 1990 mean sea levels (by linear interpolation).

It is expected that this policy will become repealed when the draft DCP relating to coastal hazards is put forward to Council for adoption in March 2015. The new DCP is however expected to include the same sea level rise planning benchmarks, which are also contained within Council's Draft Flood Prone Land Policy.

2.4.5 Forster Main Beach Seawall

A vertical concrete seawall extends from the ocean baths to just north of the Forster SLSC at Forster Main Beach. This structure would certainly protect from present day erosion events, however it is more than 40 years old, and likely requires maintenance and improvements to withstand future recession impacts. That is, under a rising sea level the seawall will be more frequently exposed to wave attack.

While the seawall should be considered to reduce the risks arising particularly from the immediate erosion hazard, it has not been included in the risk assessment. This is to prompt including maintenance of the structure as a management action in the CZMP, which is critical to mitigating existing and future risk at Forster Main Beach.

2.4.6 Dune Management

There are currently 15 volunteer organisations that conduct bush or dune rehabilitation and weed management activities in the LGA. These groups have successfully improved dune vegetation at a number of beaches, such as Boomerang Beach.

To provide for ongoing support to these activities through the CZMP, it has been recommended that dune management be continued and expanded to other beaches, to assist with remediating erosion events, capturing sand as a buffer for future erosion events, and for ecological health and community values associated with the beaches (see Chapter 3).

2.4.7 Landslip Management Structures

To manage hazards associated with landslip, some on-ground works have been undertaken.

- On Kinka Road at Boat Beach, Seal Rocks, a gabion retaining wall has been constructed along the roadside to mitigate drainage issues that result in undermining. Further works have been recommended at this location, as noted in the Slope Stability risk registers, in Table 5-3.
- A rock armour structure has been built along a section of Seal Rocks Road, north of the Seal Rocks Holiday Park (see Figure 2-2). The rock wall was designed to manage drainage issues that are undermining the roadway in this location. As can be seen in Figure 2-2, this structure was not designed to withstand coastal processes such as wave attack, erosion and overtopping. Indeed there is no coastal hazard mapping for the site, even though a hazard exists due to its location on the sandy beach. The rock revetment and road is at risk from coastal processes, and may also cause public safety issues where the roadway is undermined and /or the

undersized rock armour is dislodged. The structure is therefore not considered to provide erosion protection, and instead has been included within the coastal asset risk registers for future management (see Table 5-1). For example, it is recommended that the roadway instead by re-aligned, and the structure removed. The roadway could be removed, or remediated to a public facility (car park, picnic area, etc).

Figure 2-2 Rock revetment recently constructed to manage landslide risks to Seal Rocks Road, Number One Beach

2.4.8 Other Policies Relevant to Coastal Zone Management

There are a range of other activities currently underway by Council that assist with coastal management, but do not directly manage coastal hazards. These are described where they are relevant to managing other coastal issues, in Chapter 3.

2.5 Analysis of the Level of Risk

Within a risk assessment approach, risk is defined as *likelihood X consequence*. A risk matrix defining the level of risk from the various combinations of likelihood and consequence was developed specifically for this coastal hazards risk assessment, as given in Table 2-6.

As for the likelihood and consequence scales, the risk matrix differs from that used for other risk assessments (e.g. health and safety, operational risk and so on), as it has been designed for the timeframes and considerations involved in coastal hazards planning.

The level of risk has formed the basis for prioritising which assets require treatment, and the timeframe for that treatment (e.g. within this plan or future timeframes).

Using the risk matrix to determine the level of risk from the combination of likelihood and consequence ascribed to the different assets, risk maps displaying the level of risk from known coastal hazards at Great Lakes Beaches are provided in Appendix F. The likelihood and consequence values were assigned spatially (in GIS) to the hazard zones and assets, respectively. Through GIS processing, the two spatial values (consequence and likelihood) were combined to produce an overall level of risk, using the risk matrix scores in Table 2-6. Limitations as to the extent of risk mapping available along the coastline are outlined below.

Coastal Asset Risk Registers were prepared from the risk maps, and are given in Section 5.1. The registers detail the level of risk at present, 2060 and 2100 to those assets affected by the coastal hazards (beach erosion and recession, coastal inundation as wave runup). The slope instability risk register from SMEC (2013) is reproduced with new management options for Seal Rocks Road in Table 5-3.

Table 2-6 Risk Matrix for Coastal Management

		CONSEQUENCE			
		Insignificant	Minor	Moderate	Major
LIKELIHOOD	Almost Certain	Low	Medium	High	Extreme
	Likely	Low	Medium	High	Extreme
	Unlikely	Low	Low	Medium	High
	Rare	Low	Low	Low	Medium

2.5.1 Limitations to Risk Mapping

Risk mapping was not able to be completed along all sections of beach because coastal hazards were not mapped by SMEC (2013) along all sections of beach.

Both likelihood and consequence are required when defining a level of risk. The hazard mapping spatially defines the likelihood of a coastal hazard occurring. While the consequence of coastal hazards has been defined for all coastal assets, the risk to some assets could not be assessed where the hazard mapping (representing likelihood) was not present. For undeveloped beaches (such as in the National Parks), it is not critical to define the level of risk as the natural shoreline is

somewhat resilient to hazards (erosion is a part of the natural cycle, and the beach and associated habitats are unimpeded in migrating with sea level rise).

However, there are some locations where the hazards mapping should be extended, so that the level of risk to assets can be understood and managed, as follows.

Erosion and Recession Mapping Limitations

- In general, the erosion hazard lines should be "tied" to the local bedrock, to avoid the lines ending in space. This would give better certainty to the likely impact to the areas adjacent to the hazard lines, by capturing or excluding sites that are sited on bedrock (or otherwise). For example, it could be confirmed if Burgess Beach, Pebbly Beach and Shelly Beach are protected by natural bedrock.
- The remaining length of Number One Beach, Seal Rocks (i.e. adjacent to the area of urban development) has not been included in erosion and recession hazard mapping. Most notably there is no definition of this hazard for Seal Rocks Road, including the new rock revetment. Given the stormwater issues identified for the road, it is critical that the likely impacts of erosion (at present) and future recession (due to sea level rise) are also understood, so that appropriate measures to manage the road can be implemented.
- At the southern end of Elizabeth Beach the carpark and boat ramp are outside of the recession hazard mapping. This site has been included in the risk registers, to ensure management action is included in the CZMP.
- Both ends of One Mile Beach are excluded from erosion hazard mapping. Bare sand and dunes are evident with development (houses) behind the northern end. This location may be underlain by bedrock of suitable height to protect the houses from erosion impacts, but this needs to be clarified. At the southern end, the recession hazard covers a small section of Cliff Road, however there may be a greater or lesser section of road at risk, depending on the underlying bedrock geology.
- Along the northern end of Seven Mile Beach, the Lakes Way extends nearly the entire length of the beach. While it is unlikely that the recession hazard will extend to the road, it would be helpful clarify this. There are also a number of beach accessways that can be expected to be impacted by erosion along the northern end of the beach. These accessways have been noted for inclusion in management actions identified for accessways generally.
- At the southern end of Seven Mile Beach, a private residence leased from NPWS lies outside of the erosion hazard mapping. The residence is presumably on bedrock, but again, it would be helpful to clarify the risk in this location.
- The ends of Boat Beach, with Kinka Road, public reserve and some additional houses, were excluded from hazard mapping. The quaternary geology mapping suggests the beach is backed by a high, transgressive dune field. In this case, it cannot be assumed that the ends of the beach are protected by bedrock. Further mapping would include or exclude the additional assets identified. As a precaution, these assets have been included in the risk register (although not in the risk mapping), with management options identified.

Wave Runup Mapping Limitations

The wave runup hazard is generally more extensively mapped, with the following notable exceptions.

- At One Mile Beach, the 2100 wave runup hazard extends beyond the 2100 recession hazard. In general it should be expected that the wave runup footprint would lie within the recession hazard footprint. This exposes the problem with mapping future runup levels on sandy beaches. The height and position of the beach and dune by 2100 is unknown because it is driven by the recession hazard.
- Again, the southern end of Elizabeth Beach around the carpark and boat ramp lies outside the wave runup hazard mapping. This site has been included in the risk registers, to ensure management action is included in the CZMP.

Inclusions and Exclusions in the Asset Risk Registers

As noted above, the following assets have been included in the asset risk registers (but not risk mapping), to enable management options to be developed as part of this study:

- Erosion and Recession Risk to Seal Rocks Road (and rock revetment), Number One Beach Seal Rocks;
- Erosion and Recession, and Inundation Risk to the carpark and boat ramp, southern end of Elizabeth Beach;
- Erosion and Recession Risk to Kinka Road and the public reserve at the northern end of Boat Beach, Seal Rocks; and
- Erosion and Recession Risks to beach accessways on all beaches.

The additional houses identified outside of the hazard mapping (e.g. southern end Boat Beach, northern end One Mile Beach) have not been included in the risk registers. Reliable hazard mapping, which can then be incorporated into Council's planning documents (LEP, DCP), is required when determining management actions for private property.

3 Risk Assessment for Non-Hazard Coastal Issues

3.1 Introduction and Context

In accordance with the *Guidelines for Preparing Coastal Zone Management Plans*, coastal zone management plans may address the following key areas:

- Coastal hazards
- Community use
- Ecological health.

Local councils variously manage each of these elements in different ways. For some councils, Plans of Management for community land (including foreshores, public open space) and/or Crown land will address community use issues; and specific ecological resilience or condition studies will address ecological health issues on the coast. For these LGAs, the CZMP focuses on coastal hazards.

For Great Lakes, other plans relating to community use and ecological health exist, but there is no single, coordinated document for the whole of LGA coastline. This Great Lakes CZMP therefore aims to provide a link to existing programs, and extend or modify management actions for community use and ecological health issues.

In order to identify the key values and set objectives for the study; and identify issues for management through the CZMP, a risk identification and assessment was conducted. The assessment was largely compiled from Council and State Agency staff input, with addition of community elements gathered through the online survey.

The risk assessment followed the same format as described for the coastal hazard risk assessment in Section 2.1. The likelihood (or frequency) and consequence of risks to the community use and ecological values within the current timeframe (extending roughly 10 years, or the life of the CZMP) was assessed. The outcomes of the risk identification and assessment process are detailed herein.

3.2 Identification of Coastal Values

The values associated with the Great Lakes coastline were derived from community feedback (online surveys) and Council input (workshops, discussions). The ecological values and community values associated with the Great Lakes coastline are listed in Table 3-1 and Table 3-2 respectively.

Table 3-1 Ecological Values Identified for the Great Lakes Coastline

Ecological Value	Description, Examples
Habitats for threatened species	Green Turtle, Loggerhead Turtle Nesting Sites (e.g. Nine Mile Beach)
	Shorebirds, Migratory birds
	Little Tern feeding, nesting sites
	Pied Oyster Catchers

Ecological Value	Description, Examples
	Rock pools – Sooty Oyster Catchers
	Rock pools – Black Cod
	Juvenile Great White Shark Nursery – Yacaaba Head / Bennetts Beach
EEC vegetation communities	Littoral Rainforest Themada Grassland on Seacliffs at Sandbar Beach
Ecological corridor areas	Coastal State Corridor
	Subregional Corridors – Huge projects, funding agreements through Federal, OEH, Coastcare, Local Govt environment levy, in-kind contributions
Areas regenerating or sensitive to future impact	Whole coast (except areas with houses)
Marine Estate and associated ecological values	Great Lakes LGA coastline from Cape Hawke southwards to Port Stephens, and including Smiths Lake and the Myall Lakes, lies within the PSGL Marine Park. The majority of the beaches are within a habitat protection zone, with sanctuary zones across Cape Hawke, Skeleton Rocks, and between Yagon Gibber and Big Gibber.

Table 3-2 Community Values Identified for the Great Lakes Coastline

Community Use and Amenity Values	Description or Type	Specific Locations
High visual amenity and natural quality	Natural beauty of the beach and surroundings	Entire coastline, particularly Seal Rocks region, Blueys, Boomerang, Sandbar, Cliffed coastline Pebbly to One Mile
	Clean water and sand	Entire coastline
	Abundance of native wildlife (birds, dolphins, whales, fish)	All beaches
	Undeveloped nature of the coastline	National Parks and reserves (e.g. Treachery, Seven Mile, Nine Mile, Seal Rocks region) and PSGL Marine Park.
	Low key development (lack of commercialisation)	Blueys, Boomerang, One Mile, Pebbly, Elizabeth,
	Natural vegetation along urban beaches	Blueys, Boomerang, One Mile, Pebbly
	Quiet and undisturbed	Beaches in NP / reserves / PSGL Marine Park, Blueys
Availability and enjoyment of	Iconic surfing locations	Treachery, Sandbar / Celito, Blueys, Boomerang

Community Use and Amenity Values	Description or Type	Specific Locations
recreational uses and facilities	Recreational fishing	Tuncurry, Seal Rocks (e.g. Boat Beach), Jimmys Beach, Smiths Lake, Wallis Lake, other beaches to a lesser degree
	4WDing on beaches	Tuncurry, Sandbar, Bennetts
	Dog walking	Blueys Beach
	Swimming, sunbathing, nature appreciation	All beaches
	Picnicking, barbequing, family gatherings	Boomerang, One Mile, Forster Main, Pebbly,
	Walking, running	Cliffed coastline Pebbly to One Mile, all beaches
	Safe for children	Elizabeth, Forster Main and Ocean Baths, Number One, Boat Sandy areas of Blueys, Boomerang
	Accessible with parking, viewing platforms, toilets etc	Boomerang Beach (especially northern end), Forster Main, Blueys, One Mile, Elizabeth
Availability of commercial uses	Dive tours	
	Dolphin / Whale watching tours	
	Commercial fishing	North Tuncurry
	Tourism / Holiday parks, Camping	Treachery, Sandbar, Booti, Cellito
Sites of cultural heritage significance	Non-indigenous heritage sites	Seal Rocks Lighthouse (State heritage register, and award winning tourism facility)
	Aboriginal heritage places/sites	Dark Point, Bennetts Beach, Yacaaba, Many sites on NPWS land (not identified in local plans, as managed by NPWS)
	Aboriginal heritage walking tours	
	Gun emplacements	Yacaaba Head
Special facilities	Breakwaters	Wallis Lakes
	Open coast boat ramps	Elizabeth Beach, Boat Beach

3.3 Identification of Non-Hazard Coastal Risks

In general, there are a range of issues that may be expected to occur along any coastline. Through the course of numerous coastal zone studies for estuaries and the open coast throughout NSW, the generic list of issues that pose a threat to coastal values has been identified in Table 3-4. The

extent to which the issues occur in Great Lakes was determined through both direct consultation with Council staff and responses to the online surveys.

3.4 Risk Assessment

To determine the extent to which the issues may pose a risk to the values associated with the Great Lakes coastline, a risk assessment was completed by Council and State agency officers, augmented with feedback from the community regarding their use and values of the coast. The risk assessment process and outcomes are detailed below.

3.4.1 Likelihood Scale

To determine the frequency with which the issues may threaten the Great Lakes coastline, a likelihood scale was developed, as given in Table 3-3. The scale is consistent with that used for the coastal hazard risk assessment, but focuses on the frequency with which the issues have or will occur over a 10 year timeframe. While coastal hazards will need to be managed and considered over a far longer timeframe (100 years or more), community use and ecological issues should ideally be managed within the lifetime expected of the CZMP, being 5-10 years.

Table 3-3 Threat Likelihood /Frequency Scale for Coastal Issues (10 year timeframe)

Likelihood	Frequency
Almost Certain	Occurs frequently (e.g. weekly, monthly)
Likely	May occur once or twice a year
Unlikely	May occur once every 5 years
Rare	Occurs as a 'one off' issue or otherwise very infrequent (once every 10 years+)

3.4.2 Consequence Scale

For the purpose of the non-hazard risk assessment, the same consequence scale as utilised for the coastal hazard risk assessment was used, as given in Table 2-3. While the timeframe for the occurrence of risks may vary between coastal hazards and other issues, the impacts (or consequence) of those events upon the local community, environment and / or economy would be the same.

3.4.3 Existing Controls

There are a number of initiatives currently underway to manage community use and ecological health elements of the coastal zone. The existing plans, policies, programs and actions being undertaken to manage each of the issues in the coastal zone have been listed in Table 3-4.

Under a standard risk assessment, the extent to which existing activities mitigate or reduce the level of risk would be incorporated, to determine the residual level of risk requiring new management action. Rather than being included in the assessment of the level of risk from the

coastal issues, the existing activities will be incorporated into the implementation tables for this CZMP. This will encourage the continued funding and implementation of these initiatives in future. Incorporating the existing controls into the CZMP also ensures the plan optimises the links to existing plans relating to the management of the coastal zone, in accordance with the *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013).

Indeed, the level of risk assessed by the workshop attendees tended to focus upon those issues that are not currently being adequately addressed by existing management action.

3.4.4 Level of Risk from Non-Hazard Coastal Issues

As per the risk assessment approach described in Chapter 2, risk can be defined as *frequency X consequence*. The risk matrix in Table 2-6, which defines the level of risk from the various combinations of likelihood and consequence, has been used to define the level of risk here also.

The likely threat from the various issues identified along the Great Lakes coastline is detailed in Table 3-4 below.

To accompany the “existing controls”, a range of potential new actions to manage the coastal issues have been suggested, in Table 3-4. The new actions were largely generated by attendees to the Risk Assessment Workshops (see Section 1.7). The new actions will be analysed, refined and prioritised following the exhibition of this Options Study to community and relevant stakeholders.

Table 3-4 Assessment of Issues, Level of Risk /Threat, Existing Controls and Potential New Management Actions for the Great Lakes Coast

Issue	Specific Locations / Examples	Risk/ Threat level	Existing Controls/Actions, Programs	Suggested New Actions
Pedestrian access (provision, rationalisation, erosion due to informal access)	All beaches, especially: • Seal Rocks Number One Beach • Blueys Beach • Pebbly Beach Tanks (opposite Forster School) • Nine Mile Beach – Tuncurry end • Burgess Beach – accessway, viewing platform – erosion and unstable cliffs. • Boat Beach (parking and access conflicts)	High	• Reserves Plan of Management. • Council's Asset Management Plan • Council's annual Delivery Program • Delivery plans of Crown Lands and NPWS. • Development consent required for accessways from private properties, in some cases from other authorities (e.g. Crown Lands, NPWS). • Encroachment of Public Reserves in Dune Areas Policy, which aims to prevent damage to dune vegetation by adjoining landowners. It prohibits the erection or construction of fences, playground equipment, barbecues, clothes hoists, paths, etc in dune areas, and damage to vegetation.	• Collate inventory of accessways (location, construction type) and add this to Asset Management Plan. Prioritise maintenance via Asset Management Plan. • Safety assessment and repairs after erosion - see Beach Access Management in Hazard Management options. • Consolidate number of private accessways through consultation and education of dune values (e.g. at Blueys, Boomerang). • Consolidate public accessways (formalise preferred, rehabilitate others). • Investigate type of materials used, to reduce storm impacts (i.e. people going around cordoned off access, causing damage to dunes), and reduce creation of informal paths e.g. consider showers as a way of attracting use to formal paths (see also Beach Access Management in Hazard Management options). • Investigate internet/smart phone based feedback between works crews and asset management plan: e.g. for maintenance, officers can then feed information on condition back to AMP; can facilitate inspection of accessways and repairs after storm impacts (see also Beach Access Management in Hazard Management options). • Increased resources for compliance, repairs (Council, Crown Lands).

Risk Assessment for Non-Hazard Coastal Issues

Issue	Specific Locations / Examples	Risk/ Threat level	Existing Controls/Actions, Programs	Suggested New Actions
Conflicts between passive recreation users	• Conflicts between local surfers and surfing competitions, at Boomerang, One Mile, Bennetts, Blueys • Perception that too many surf permits have been issued (especially in Pacific Palms area). • Unauthorised surfing competitions	High	• Permits required for Surfing Competitions from Council and MEMA. • Compliance activities. • Note that sporting clubs (such as local boardriders clubs) are exempt from the Use of Council Reserves by Commercial Fitness Groups and Personal Trainers Policy.	• Council coordination of events across LGA, to ensure equity for surfers and beach users. Consider use of: – booking calendar (which could also be available online), – google mapping of activities (available online) and / or – event coordinator, who would provide a single overview of activities, guide applicants through the process, assist applicants with consents needed from other authorities (e.g. MEMA for surf permits), and issue codes of conduct. • Require competition organisers to advertise their event in local newspaper prior to competition. • Consultation with community to agree on acceptable number of events/year, and locations. • Event advertising (to promote events and use of alternative beaches). • Increased resources for compliance. • Use permitting process to educate competitors about surfing etiquette (e.g. “code of conduct” provided with permit, to be issued to all competitors. • Consider applying for National Surfing Reserve status for Blueys and Boomerang Beaches.
	Dogs vs. environment, e.g. One Mile Beach	Low	• Council’s Dogs on Beaches Policy. • Designated areas (and times of day) when dogs permitted (including off-leash areas). • Signage, • Bag dispensers on main access tracks near bins. • Compliance activities (Council rangers).	• Increased resources for compliance. • Community education to reduce impacts of dogs, e.g. – 1 page “code of practise” for dog owners; – Council meet and greet with dog owners.
	Seal Rocks Number One Beach conflicts between users (parking, beach access, facilities), and impacts to dunes	High	• NPWS existing management and works programs • Council’s Parks and Recreation works programs	Prepare a Number One Beach Seal Rocks Local Area Plan (e.g. POM, Public Domain Plan etc.) to define community uses, including to: • Manage parking conflicts, which may include rationalisation, improvements to existing assets; • Formalise beach accessways and remediate informal paths; • Determine future uses for former road corridor, in concert with plans to re-align Seal Rocks Rd (see Hazard Management options), including making future uses sacrificial to allow beach retreat; • Manage provision of services and conflicts of use between the camp ground and the beach; and • Preserve environmental values of the precinct.

Risk Assessment for Non-Hazard Coastal Issues

Issue	Specific Locations / Examples	Risk/ Threat level	Existing Controls/Actions, Programs	Suggested New Actions
Vehicular use/access to beaches	• At Legal 4WD access at North Tuncurry (Nine Mile Beach) there have been issues with education and compliance, resulting in impacts on environment and infauna, e.g. crushing shellfish on beaches, destruction of vegetation. • Legal 4WD access at Sandbar affecting Little Tern nesting • Illegal 4WD access at Jimmys, Hawks Nest / Bennetts Beach / Yacaaba, Number One, Treachery, Lighthouse	**Medium**	• Vehicles on Beaches Policy (in concert with Greater Taree City Council) – permitting system. A map of where vehicles are permitted and general codes of conduct is provided with the permit. • Compliance activities (Council, NPWS). • PSGL Marine Park Zoning Plan and Map - vehicles permitted on beaches for the purpose of launching and retrieving vessel from designated boat launching facilities.	• Rationalise and simplify signage to increase compliance (requires collaboration between authorities). • Add 4WD accesses to GIS / Asset Management Plan, to monitor and maintain accessway and fencing etc. • Targeted community education (e.g. via holiday rentals) about illegal and legal access, and 4WD impacts. • Link Sandbar/Smiths Lake 4WD access to entrance conditions. • Installation of physical barriers to aid with 4WD direction • Increase / target compliance to peak usage times of day/year, events (e.g. surfing comps). Compliance activities should target both areas of illegal and legal access. • Monitor patterns of usage and impacts. • Temporary closures to allow regeneration (with consultation with community regarding why), which may be needed following storm events. • Consider increase in fines for non-compliance.
Provision and maintenance of community infrastructure (rec. facilities, BBQs, seating & shade, toilets, water stations etc)	• Yes, everywhere, every beach. • One Mile, Bennetts have an increasing amount of facilities. • Public always requests more facilities. • Provision of facilities is not done by a plan, but on an as needs, reactive basis (e.g. when complaints or requests are received). This is because the facilities are considered relatively inexpensive.	**Medium**	• Plans of Management (for some reserves). • Council's Asset Management Plan. • Council's annual Delivery Program.	• Conduct community survey to determine needs at beach locations. • Prepare whole of LGA plan to determine priorities for new assets. To help determine priorities, study should collate inventory of what is present, and use outcomes of community survey also. The plan shall also consider coastal hazards mapping, to avoid intensifying risk. • Inventory of existing facilities (and new facilities as they are added) to be added to Asset Management Plan. • Relocation (replacement of assets further landward) after erosion impacts (see Hazard Management options). • Investigation of use of alternative materials – sacrificial, relocatable etc.

Risk Assessment for Non-Hazard Coastal Issues

Issue	Specific Locations / Examples	Risk/ Threat level	Existing Controls/Actions, Programs	Suggested New Actions
Illegal camping	• Opportunistic illegal overnight camping (e.g. wicked campers, winnebago, juicy rentals). • May be at carparks, or 4WD access locations e.g. at Sandbar, Seven Mile Beach, Shelly Beach, Number One Beach,	Medium	• Compliance activities and penalties by Council, Crown Lands, NPWS. • Signage. • Camping on Private Land Policy states camping is not permitted at any time on council controlled public lands, contravention of this may lead to prosecution. • Formal campsite information on internet.	• Monitor to determine the extent of the problem, i.e. how often, where it is occurring, are there significant economic impacts to fee paying camp grounds? • If there is a need (as identified though monitoring), consider creating locations for free camping; and fencing off non-suitable areas. • Provide information to car/van rental companies about location of formal and /or free campsites, and legalities of illegal camping. • Provide GLC free campsite information on social media sites. • Increased resources for compliance.
Fire management / Camping	• Small risk of fire from illegal campers (e.g. Sandbar, Number One, . • Hazard reduction burns have threatened illegal campers, e.g. Seven Mile Beach National Park.	Low	• Signage (not known if this makes note of risk of bushfire to illegal campers) • Compliance activities by Council, Crown Lands, NPWS	• Education (signage, info to rentals) re: risks from bushfire from use of informal sites. • Notices and notification (e.g. on radio, news etc.) prior to hazard reduction burns. • Checking high risk / common sites for campers prior to hazard reduction burns. • Provide information to emergency services about location of common illegal campsites. • During replacement of beach access infrastructure, consider use of non-flammable materials.
Fire management	• Hazard reduction burns. • Asset Protection Zone maintenance on Council and Crown Lands, NPWS lands. • Fire management integrates with vegetation management.	Low	• Hazard Reduction certificates. • Bushfire Act. • Asset Protection Zone maintenance and hazard assessment. • “10-50” rule for clearing around property.	• Implement mosaic burning patterns through coastal scrub on beaches with Rural Fire Service assistance. • Follow burn with chemical treatment of weed species. • Encourage species diversity in dunal vegetation regeneration.
Heritage Management	Aboriginal cultural heritage protection required at: • Nine Mile Beach, • Forster Main to Burgess Beach including headlands and Pebbly and One Mile Beaches, • Sandbar Beach, • Seal Rocks Number One and Boat Beaches, • Bennetts Beach – Hawks Nest and Yaccaba.	Low	• Existing NPWS legislation, POMs for Aboriginal Cultural heritage management • PS GL Marine Park Zoning Plan and Map.	• Engage with NPWS and local Worimi people to develop or augment management of known sites. • See “Heritage Management Action” for managing sites uncovered by erosion or recession in future.

Risk Assessment for Non-Hazard Coastal Issues

Issue	Specific Locations / Examples	Risk/ Threat level	Existing Controls/Actions, Programs	Suggested New Actions
Dune and beach vegetation systems (restoration, maintenance)	• Dune vegetation restoration/maintenance requirements at all beaches. Condition at beaches is varied. • Removal of dune vegetation by foreshore residents for views, e.g. Bennetts Head, Bennetts Beach; One Mile Beach, Burgess Beach, Sandbar Beach • Sand encroachment e.g. from northern dunes onto houses at One Mile Beach, natural blowout at Lighthouse Beach. • Bitou (see "Weed control" below).	High	• Encroachment of Public Reserves in Dune Areas Policy, but does allow clearing of a 2 m strip adjacent to private property. • DCP landscaping buffer provides some scope for habitat migration. • Dunecare voluntary groups helped by Council funding, equipment and advice. Involved in dune rehabilitation. • Council's works programs. • OEH funding and partnerships. • LLS grants, funding for works. • Catchment action plan (now managed by LLS).	• See Dune Management in Hazard Management options, which includes prioritisation of areas for rehabilitation • Collaboration between tenures • Trials/ pilot programs for best practise methods • Education of dune habitat values to community (factual information) • Increased resources for volunteer Dunecare groups. • Investigation of impact of vegetating active sand blowouts, i.e. at northern One Mile Beach. • Investigation of capture and deterrent methods for landowners clearing vegetation to improve their views, e.g. installation of remote cameras.
Vegetation management (rehabilitation etc)	Known endangered species and habitats, e.g. • Themada Grassland on seacliffs at Sandbar Beach (which supports endangered species). • Burgess Beach – threatened species.	Medium	• Management of Illegal Removal of Vegetation from Council Controlled Reserves Policy sets down a sequence of actions to be taken in the event of reported/identified illegal damage to vegetation on Council managed land. • Reserve system – NPs, Crown Lands, GLC. • Dunecare, Landcare and Coastcare, 15 voluntary organisations helped by Council with funding, equipment and advice. Involved in bush regeneration. • Following projects funded by the Environmental Special Rate Levy. – Healthy Lakes Program, – Biodiversity Conservation, – Vegetation Strategy. • *Threatened Species Conservation Act 1974* and *Environment Protection and Biodiversity Conservation Act 1999*, with associated mapping, recovery plans, and management responsibilities of Council, Crown Land and NPWS. • POMs outline planting and watering. • Tree Preservation Orders. • Vegetation Mapping (in progress), currently on Hawks Nest / Tea Gardens and Wallis Lakes Wetlands. Regional vegetation mapping in collaboration with Hunter Councils Environment Division. • EMPs for the lakes (Wallis, Port Stephens/Myall Lakes, Smiths). • DCP landscaping buffer. • Focus on weed reduction.	• See Investigate Habitat Preservation Options in Hazard Management options, to guide plan for succession / migration for key habitats.

Issue	Specific Locations / Examples	Risk/ Threat level	Existing Controls/Actions, Programs	Suggested New Actions
	Aquatic habitats	Medium	• PSGL Marine Park Zoning Plan and Map – specifies different levels of protection within sanctuary, habitat protection, general use and special purpose zones accordingly, to conserve marine habitats and species. • To protect aquatic habitats, permits are required from MEMA for a variety of activities, including: commercial activities; collecting for commercial and private aquariums; competitions including line fishing and spearfishing; hovercrafts, airboats and seaplanes; traditional Indigenous fishing use; organised events including sporting or other activities; and research. • Community Seagrass Monitoring. • Recreational Fishing Trust – provides resources for improving saltmarsh resilience. • Wollamba River Memorandum of Understanding for Water Quality and Rivercare Plans. • Wallis Lake Wetlands Strategy.	• Community education regarding impact of plastics on aquatic life.
	Seaweed washed up on beaches – complaints from people to have removed.	Low	• DPI Fisheries policies on seaweed harvesting. • MEMA allows hand collection only for sea lettuce (*Ulva lactuca*) and bait weed (*Enteromorpha intestinalis*) in habitat protection and general use zones of the PSGL Marine Park.	
	Littoral rainforest. Known remnants at One Mile, Burgess, Seven Mile, Sandbar	High	• SEPP 26 Littoral Rainforest (and mapping). • Landcare, Coastcare groups.	• See Investigate Habitat Preservation Options in Hazard Management options, to guide plan for succession / migration for key habitats. • Trial / research of best practise for re-establishment of littoral rainforest, saltmarsh etc. • Negotiate retreat areas for coastal ecosystems (if/where necessary). • Education programs to help community identify valuable areas. • Resilience programs for Littoral Rainforest (reduction of weed threat).

Issue	Specific Locations / Examples	Risk/ Threat level	Existing Controls/Actions, Programs	Suggested New Actions
	Intertidal – rocky shore habitat damage and over extraction, e.g. at: • Forster Main to Burgess Beach, including rock platforms between. • Seven Mile Beach • Elizabeth Beach (including adjacent rock platforms and rocky shores) • Sandbar Beach • Number One, Boat, Lighthouse at Seal Rocks.	**Medium**	• Community Education programs(e.g. Project Aware) • Monitoring programs (e.g. by LLS). • PS GL Marine Park Zoning Plan and Map details the permissibility of shore and water-based recreational fishing of listed fish species using specified methods, and commercial fishing. The various zones shown on the Zoning Map also outline what type of fishing is allowed. Permits for commercial fishing and some recreational fishing activities (i.e. competitions) are required from MEMA.	• Partner with LLS to enhance education and monitoring campaigns, targeted to key sites affected. May include signage at key sites.
Weed control	Bitou Bush; Weed invasion is a known issue at: • Nine Mile Beach: *Asparagus aethiopicus, Gloriosa superba, Opuntia sp. Chrysanthemoides monilifera ssp. rotundata* • Pilot Hill to Second Head, Forster • Second Head to Bennetts Head, Forster • One Mile Beach, Burgess Beach, East Forster • South from Cape Hawke to Booti Hill, Seven Mile Beach • Booti Hill to Charlotte Head, Elizabeth Beach • Sandbar Beach • Number One Beach, Boat Beach, Lighthouse Beach, Treachery Beach, Seal Rocks • Bennetts Beach	**Medium**	• Bitou Threat Abatement Plan. • Dunecare, Landcare and Coastcare - 15 voluntary organisations helped by Council, involved in weed management. • Aerial spraying programs (NPWS / GLC collaboration). Council spraying program has been underway for past 7 years, annually collaborate with NPWS to make sure spraying programs complement each other. • Noxious weeds policy, which describes how Council will achieve its responsibilities under the *Noxious Weeds Act 1993* (and other related legislation). • Crown Lands, NPWS, Council weed management projects, works. • OEH provides grants for weed removal etc. in coastal reserves.	• Collaboration between tenures (LG, Crown, NPWS), to take advantage of activities e.g. fire control, aerial spraying by one party is good opportunity to undertake action by other authority in adjacent areas of jurisdiction. Following fire is strategic opportunity to control bitou, and if not done, can be significant regeneration of bitou after fire. • Checklist for services, to have dunecare groups follow up. • Trials / pilot programs, e.g. biological control. (tip moth). • Improve biodiversity to dunal system through endemic plantings. • Develop a management plan for high risk areas for weeds, and access available funding programs.
	Littoral rainforest – Some small areas near urban development affected by weeds from local gardens.	**Low**	• Landcare and Coastcare programs.	• Education regarding dumping of garden (and other) waste in reserves. • Other weeds may also be opportunity to target after fire.

Issue	Specific Locations / Examples	Risk/ Threat level	Existing Controls/Actions, Programs	Suggested New Actions
Pest animal control and dangerous wildlife	Wild dogs / Dingos Foxes Rabbits Pests are known issues at: • Nine Mile Beach (foxes, rabbits) • Pebbly Beach (foxes) • One Mile Beach (foxes) • Burgess Beach (foxes) • Seven Mile Beach • Elizabeth Beach • Sandbar Beach • Lighthouse, Treachery beaches at Seal Rocks • Bennetts Beach	Low	• Feral Pest and Threatening Animal Policy aims to provide guidance in the management of feral (including pest) and threatening animals on Council owned and controlled land, including Community Land. • Hawks Nest / Tea Gardens Endangered Koala Recovery Plan. • GLC fox den gassing program. • Fox control Threat Abatement Plan sites (managed by NPWS and / or LLS). • NPWS programs. • Council pest animal control programs. • Use of community title “no domestic animals” conditions for (some) new developments.	• Community education on impacts of domestic animals (e.g. 1 page “code of practise” for dog owners); pest animal species. • Develop a management plan for high risk areas for pests, and access available funding programs. • Partner with NPWS for existing or new programs (e.g. at Seven Mile, Elizabeth, Lighthouse, Treachery etc). • Continue funding to run long term fox den gassing program cross tenure (NPWS / GLC / Crown and Local Aboriginal Land Councils) • Investigate a cross tenure Dingo management policy • Investigate a cross tenure wild dog program.
Permits and leases for commercial and group activities	SLSCs Ocean haul fishing e.g. Jimmys Professional Fishers - Mullet run, Tuncurry Nine Mile, Seal Rocks Beaches, Bennetts and Yacaaba Heads. Surf schools Fitness groups Caravan Parks Other commercial operations – Stand Up Paddleboards etc.	Low	• Development controls apply to SLSCs • Vehicles on Beaches Policy • Use of Council Reserves by Commercial Fitness Groups and Personal Trainers Policy, outlines provision of licences to qualified persons for 1 year on non-exclusive basis, with bookings for certain areas required, and max of 2 sessions in any one area. Policy does not apply to SLSCs. Would likely apply to surf schools. • Crown Land licences, POMs and Trusts (e.g. for some CPs) • Licences to operate caravan parks or camping ground from Council required, under *Local Government Act 1993.* • Permits from MEMA are required for commercial activities (including fishing); competitions including line fishing and spearfishing; hovercrafts, airboats and seaplanes; organised events including sporting or other activities; and research.	• Consider licencing ocean haul fishing. Licencing should involve providing a 1 page code of practise, to educate users. • Investigate the number, type and areas covered by commercial activities versus community needs and impacts on the environment. • Consider changing commercial licence from Council to commercial operators to make clear that council is not liable for lack of income when beach is unusable after storm damage.

Risk Assessment for Non-Hazard Coastal Issues

Issue	Specific Locations / Examples	Risk/ Threat level	Existing Controls/Actions, Programs	Suggested New Actions
Litter, waste and water management (supply, maintenance, amenity, human health)	Marine debris and litter - left on beach by users, especially after tourist influx periods - washed up on beach from ocean. Sites with known marine debris and littering issues: • Nine Mile Beach (marine debris), Forster Main (littering), Pebbly, One Mile, Burgess, Seven Mile, Elizabeth, Sandbar, Number One, Boat, Lighthouse, Treachery (marine debris), Bennetts. Stormwater outlet pollution known to occur: • Forster Main • Pebbly • One Mile • Burgess.	Medium	• The Coasts Catchments Initiative - identified ways to reduce impacts of sediment, nutrients and faecal coliforms on Wallis, Smiths and Myall Lakes. Fed into the Water Quality Improvement Plan. • Garbage collection and other works programs of Council, and strategic bin placement. • Community education programs. • DPI Fisheries initiatives (e.g. “take in, take out”, for fishing by-products). • The following projects funded by the Environmental Special Rate Levy: – Structural Solutions for Urban Water Quality, – Restoring our Urban Creeks, – Water Quality Monitoring (Waterwatch), – Stormwater Pollution Awareness, and – Gravel Roads Best Practice Erosion Control.	• Investigate joining the Regional Marine Debris Monitoring Program (run by LLS). • Identify key sites for regular monitoring and maintenance, and target waste bins at popular spots. • Increase clean ups and maintenance of pollutant traps (e.g. GPTs, WSUD). • Increase litter collections at high usage areas during peak times. • Targeted education for key users (recreational fishers, commercial fishers, tourists, school children, surfers, SLSCs etc). • Consider installation of stormwater pollutant trap devices at key sites (e.g. Burgess Beach). • Coordinated clean up events following storms (e.g. Yagon to Yacaaba Head is known to be heavily polluted after big south seas, with plastics washed onto beach).
	Overflows of the sewer or water system. Includes onsite water treatment outlet at Seven Mile Beach.	Low	• Currently managed by Mid Coast Water.	• In future, level of risk is dependent upon coastal erosion and recession with sea level rise. See Hazard Management Options for recommended vulnerability assessment. • Vulnerability assessment by Mid Coast Water for coastal hazards, and monitoring, to determine consequence from impacts, and appropriate response (e.g. one small break in line can have significant impacts).

*NPWS- National Parks and Wildlife Service; MEMA – Port Stephens-Great Lakes Marine Estate Management Authority; LLS – Local Land Services; DPI – Department of Primary Industries; OEH – Office of Environment and Heritage, GLC – Great Lakes Council.

4 Management Options Assessment: Coastal Hazards

4.1 Overarching Approach

Management options are principally focused on treating erosion and recession hazards and inundation hazards associated with coastal storms combined with long term sea level rise, over both the short and long term. Risks associated with Future Development are different from risks to Existing Development, and therefore different management approaches are required. Figure 4-1 provides a conceptual framework for application of coastal hazard management tools. The options fall generally within the categories of protect, accommodate, retreat for existing development; and avoid, accommodate, accept for future development, as explained below.

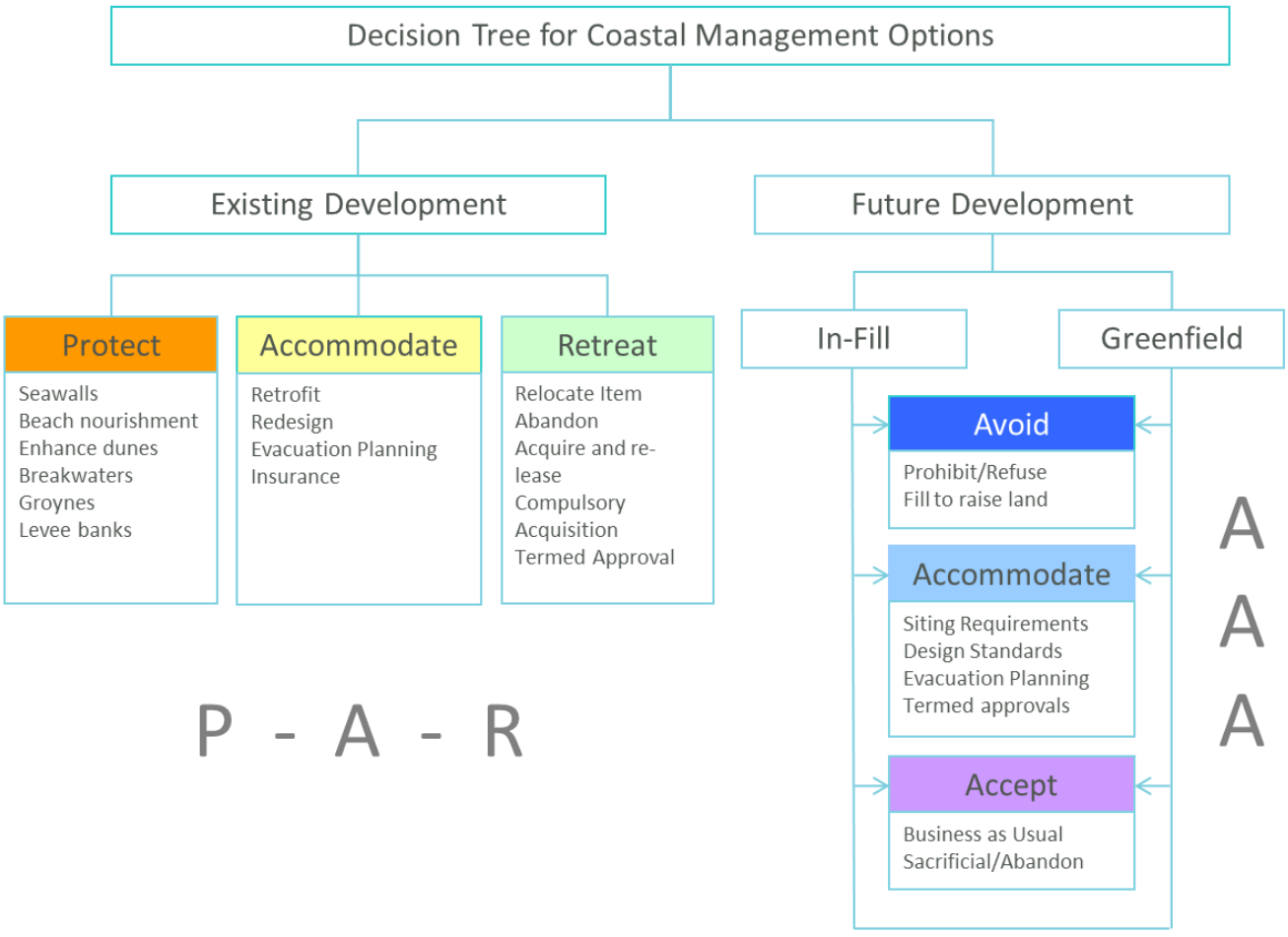


Figure 4-1 Conceptual Framework for Application of Coastal Management Options

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

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

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

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

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

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

Retreat development, which is a 'no defence' approach that aims to preserve beach / shoreline amenity by allowing natural retreat of the foreshore alignment due to coastal processes, particularly in response to future sea level rise. The options for existing development involve relocating or sacrificing infrastructure, public assets or private property, if and when impacts occur. The retreat option may include compensation to private property owners for a depreciation in landuse value, where feasible and appropriate; and

Accommodate the risk, which aims to retrofit (or redevelop) existing infrastructure, public assets and private property in a manner that minimises damage and other losses from potential impacts (e.g. stronger foundations).

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

Setting a trigger point is not an excuse to "do nothing", i.e. undertake no coastal management action at the present time. Planning controls, "no regrets" actions and preliminary investigations

must still be undertaken to effectively reduce the scale and cost of risk treatment required in the future. That is, setting triggers without taking action in the present timeframe to reduce the intensity of assets and values within known risk areas only enhances the difficult and costly actions required from future generations. Setting triggers must be accompanied by actions now to prepare the funding and resources required and to reduce the scale or costs of impacts in the future.

No regrets and Preliminary Actions have been devised to support the implementation of P-R-A and A-A-A options associated with existing and future development, and their triggers in the immediate timeframe. Such options offer a range of assessments and works to provide further information (including approvals) required prior to implementing larger scale options for specific assets, particularly where a more costly or difficult option may be needed. The 'no regrets' options also include activities that will improve resilience and preparedness for coastal risks, without limiting the ability to change a management approach and without negative long term impact should risks change in the future.

4.2 Risk Tolerance and Priority for Treatment

Determining which risks to treat is based upon Council's (and the community's) tolerance to risk. A risk tolerance scale was developed and confirmed during the risk assessment workshop (which involved representatives of Council, the state agencies and other stakeholders). In the risk tolerance scale, given in Table 4-1:

- Extreme and high risks are intolerable and must be treated as a priority;
- Medium risks are tolerable, and can be treated where resources are available (or incidentally treated by an action for another risk); and
- Low risks are acceptable and can be monitored, rather than demanding valuable management resources.

In addition to the tolerability of risk, the need for management action can also be prioritised to some degree based upon the estimated timing for the risks, i.e. immediate, 2050 or 2100. As in Table 4-2:

- Present day risks must be treated as a priority.
- For risks not expected until 2050 or 2100, management option(s) should be identified along with a trigger for implementing the option, but it is unlikely that implementation of these options will be necessary within the life of the CZMP (i.e. 5-10 years).

Identifying a management option(s) with a trigger for implementation at the present time enables Council and others to be prepared should an extreme or high risk present itself earlier than anticipated. It does not commit Council or others until monitoring indicates the risk is approaching an unacceptable level and a decision is necessary. Setting the trigger to allow enough time for Council or others to gather the funding and approvals necessary to implement an option is vital to avoid unacceptable risk outcomes.

In the interim until a trigger for action is reached, Council and others should pursue 'no regrets' actions that:

- Build the resilience of assets to future impacts (e.g. planning controls, dune rehabilitation);
- Collate information to better understand the risk (e.g. beach volume monitoring);
- Monitor triggers and coastal processes, and audit existing infrastructure needs and capacity; and
- Investigate alternative funding sources and designs (e.g. pilot studies for new seawall/groyne materials or designs).

The time period between now and when a risk becomes certain shall be used to increase information / data upon which to base future decisions and improve certainty regarding the likely impacts of coastal hazards (particularly sea level rise). This period may also see an improvement in management approaches and /or funding to treat particular risks.

Table 4-1 Risk Tolerance Scale

Risk Level	Action Required	Tolerance
Extreme / High	Eliminate or Reduce the risk or Accept the risk provided residual risk level is understood	**Intolerable**
Medium	Reduce the risk or Accept the risk provided residual risk level is understood	**Tolerable**
Low	Accept the risk	**Acceptable**

Table 4-2 Prioritisation for Risk Treatment Based upon Expected Timeframe

Timeframe for Extreme / High Risks	Treatment Approach
Present Day	• Implement no regrets actions • Implement site specific management actions as required
2050	• Identify trigger for action. • Implement no regrets actions • Identify potential management option(s) for implementation if the trigger is reached.
2100	

4.3 Options Cost Benefit Analysis

The options compiled for this study are based on various sources including the NSW Coastline Management Manual (1990), the CZMP Guidelines (OEH, 2013), the First Pass National Assessment of Climate Change Risks to Australia's Coast (2009), the NSW Coastal Planning Guideline: Adapting to Sea Level Rise (2010) and other coastal management plans and studies.

The list of options investigated is given in Table 4-4, with detailed descriptions provided in Appendix E. The one to two page descriptions provided in Appendix E are intended as discussion paper(s) for internal Council discussions or community education activities.

A cost-benefit analysis guided the consideration of options, as either “no regrets” options to be implemented now, options that may be suitable for some but not all locations / assets, and options that should not be considered further. For each option, a brief description, outcome of the cost-benefit analysis and recommended locations / assets for suitable options is provided in Table 4-4.

The range of criteria against which the options were analysed is given in Table 4-3 and described below.

- **Capital Cost and Recurrent Cost**, with values based upon an order of magnitude difference in expenditure, which would require investigations and approvals by Council before proceeding;
- **Environmental or Social Impact**, to identify where the option may have trade-offs upon the surrounding environment, including beach amenity and access;
- **Community Acceptability**, which is based upon general feedback from this locality and other coastal areas (Council is advised to undertake specific community consultation before proceeding with any major option);
- the ability for the option to be **Reversible / Adaptable in the Future**, which is particularly relevant where there is considerable uncertainty and or long time frames for a future impact;
- **Effectiveness Over time**, to consider where an option presents a long term solution or a short term solution that would require additional management action or upgrades in the future;
- **Legal / Approval Risk**, to highlight the legislative and approval requirements (or impediments) to implementing an option within the current legal framework; and
- The **Technical Viability**, to highlight where certain options may or may not be technically feasible or would require significant engineering (or other) investigations and construction / implementation capabilities.

A “traffic light” colour system was used to assess the option against each criterion, as either:

- **“GO”**;
- **“SLOW”**, and proceed with caution; or
- **“STOP”**.

The criteria and the limits associated with these three levels are outlined in Table 4-3.

The criteria used were not weighted, meaning that each has an equal influence on the overall score for each option assessed.

Table 4-3 Options Assessment Criteria

	Capital Costs	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable Future	Effectiveness Over Time	Legal / Approval Risk	Technical Viability
STOP	Very expensive ($300K to millions)	Very expensive ($300K to millions)	Will impact negatively on environment, community or beach amenity	Unlikely to be acceptable to community and politically unpalatable; Extensive community education, endorsement by Minister(s) and Council required	Option is irreversible once implemented; Option limits alternatives options in the future	Option does not provide long term solution; Only effective over short term	Will require an EIS and/or Govt program to implement; There is a residual risk that approval will not be obtainable for the proposed works / strategy	Is unlikely to be technically viable without substantial engineering (or other) design investigation and capabilities for implementation
SLOW	Moderately expensive ($100,000 - $300,000)	Moderately expensive ($50,000 - $300,000)	No net impact	Would be palatable to some, not others (~50/50 response); Briefing to Councillors, GM and community education required	Option is reversible or adaptable, but at considerable cost / effort	Option is only a short term solution, but has other benefits; or Option requires further resources / changes to be effective over long term	Will require Govt approvals to be implemented, or assistance through existing Govt program; Generally approvals/assistance would be granted assuming requirements are met	Is likely to be technically viable at the site, but would require further investigations to clarify
GO	Limited cost (<$100,000)	Limited cost (<$50,000)	Will benefit environment, community or beach amenity (e.g. improve beach access, recreation, habitats etc.)	Is very politically palatable, acceptable to community; Minimal education required	Option can be easily adapted for future circumstances or should impacts not occur, option would not negatively impact future generations	Option provides a long term solution	No or minimal government approvals required to implement	Is technically viable at the site / location

Table 4-4 Assessment of Management Options

Option	Brief Description of Option *(refer to Appendix D for detailed information on all options)*	Treats Erosion	Treats Recession	Treats Wave Run-up & Overtopping	Treats Coastal Inundation	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Technical Viability	Score (G = 1, SI = 0, St = -1)	Recommended Asset Type / Location for Application of Option
Monitoring	Monitor beach condition and erosion volumes, and storm inundation level / frequency to determine when risks approach unacceptable levels; and improve data for review of hazard estimates.	✓	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	Beaches Waterways See Coastal Asset Risk Registers
Append Asset Management Plan	Document in Council's Asset Management Plan the hazard type (erosion/recession, inundation, wave runup) and timeframes for impact (immediate, 2060, 2100) for all assets in coastal hazard zones. Use hazard likelihoods as part of calculating asset replacement costs and timeframes.	✓	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	Roads Car Parks Stormwater SLSCs Tourist Parks Walkway / Cycleways Community Facilities Sewer Assets (MCW) Water Assets (MCW)
Investigate Future Replacement Action	To augment above action, determine suitable future action for assets at high risk (which may include relocation, retrofit/redesign or manage to fail). Document preferred action in Asset Management Plan for implementation, either when the asset is due for replacement, or a hazard impact occurs.	✓	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	For above assets at high and extreme risks. *See Asset Risk Registers for specific sites*
Upgrade Existing Seawall	Assess the seawall at Forster Main Beach to determine current condition, ability to provide future protection from recession and wave runup, and maintenance needs (including raising the structure to manage wave runup). May require excavation to view seawall. Undertake upgrades to the seawall based upon investigation outcomes. Add seawall into Asset Management Plan, and schedule ongoing maintenance.	✓	✓	✓		GO	SLOW	GO	GO	GO	GO	GO	GO	7	Forster Main Beach Seawall
LEP Update	Update LEP Coastal Risk Planning Area maps (as per current amendment; and overtime as hazards information is reviewed). Consider rezoning of land to provide retreat buffers for migration of beach and other coastal ecosystems (if/where necessary).	✓	✓	✓	✓	SLOW	GO	GO	SLOW	GO	GO	SLOW	GO	5	Future development Rezoning to provide buffers: Littoral rainforest, saltmarsh Current zonings are suitable at beaches at present (no changes required).

Management Options Assessment: Coastal Hazards

Option	Brief Description of Option *(refer to Appendix D for detailed information on all options)*	Treats Erosion	Treats Recession	Treats Wave Run-up & Overtopping	Treats Coastal Inundation	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Technical Viability	Score (G = 1, Sl = 0, St = -1)	Recommended Asset Type / Location for Application of Option
Coastal Hazard DCP	Apply controls to new- and re-developments, which are appropriate to type of development and likely hazard over lifespan of development. Controls would seek to avoid development of unsuitable land, but not unnecessarily sterilise land prior to impacts occurring.	✓	✓	✓	✓	GO	GO	GO	SLOW	GO	GO	GO	GO	7	All future developments (infill, re-developments, greenfields) in the Coastal Risk Planning Area.
Coastal Hazard Construction Checklist	Prepare a checklist / policy for internal use by Council for replacing, repairing, protecting or building new infrastructure in the coastal zone. The checklist shall augment the self-assessment (REF) process. The checklist shall identify: • Other officers in Council to be consulted; • Other agencies required to give concurrent consent (e.g. Crown Lands, MEMA, NPWS); • Where to access hazard mapping / information; and • Controls / measures to reduce coastal risk to the new construction (could be based upon DCP), for example, setbacks appropriate to design life of asset.	✓	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	Future council assets, Replacement council assets (*see Asset Risk Registers for specific sites)*
Revise Hazard Lines Based on Geological Data	Using geophysical assessment and interpretation of geological data, update the hazard lines to tie into stable bedrock, particularly at the ends of beaches. This will capture key assets that currently lie outside of the hazard zones (e.g. Boat Ramp at Elizabeth Beach, Seal Rocks Rd, Number One Beach). For Number One Beach, this action shall include extending the hazard lines along the remainder of the beach.	✓	✓	✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	High Priority: • Number One • One Mile • Elizabeth • Boat Medium Priority: • Forster Main • Pebbly • Seven Mile Low Priority: • Sandbar • Bennetts • Nine Mile (Tuncurry).

Management Options Assessment: Coastal Hazards

Option	Brief Description of Option *(refer to Appendix D for detailed information on all options)*	Treats Erosion	Treats Recession	Treats Wave Run-up & Overtopping	Treats Coastal Inundation	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Technical Viability	Score (G = 1, Sl = 0, St = -1)	Recommended Asset Type / Location for Application of Option
Commence Process to Re-align Seal Rocks Road	Commence gaining permissions from NPWS and Crown Lands to re-route Seal Rocks Road. Investigate use of former Crown Roads easement (west of the Seal Rocks Holiday Park) to relocate road. The existing road section west of the Seal Rocks Holiday Park shall then be removed (including recent seawall construction) and land rehabilitated, as part of the Number One Beach Local Area Plan (see Non-Hazard coastal issues). Any future facilities replacing the current roadway must be of a sacrificial nature. This is vital to ensure that recession of the sandy beach can progress unimpeded into the large transgressive dunes behind the current roadway. Allowing erosion of the dunes may supply substantial sand reserves to Number One Beach that could slow the progress of recession and provide for a continued sandy beach asset.	✓	✓	✓	✓	STOP	GO	GO	GO	GO	GO	SLOW	GO	5	Seal Rocks Road
Combined Flood Studies	Conduct flood study of the combined impact of elevated ocean water levels and catchment rainfall to determine flood planning levels.			✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	Creek at southern Blueys Beach Elizabeth Creek, on Elizabeth Beach
Materials and Design for Saltwater intrusion	Investigate appropriate designs and materials for services affected by saltwater (inundation, spray)			✓	✓	GO	GO	GO	GO	GO	GO	GO	GO	8	Stormwater Water Sewer
Heritage Management (Aboriginal and non-Indigenous)	Develop a decision support tool (or similar) for managing known and unknown Aboriginal and other heritage items uncovered by coastal hazards. May include mapping of known sites, where possible.	✓	✓	✓	✓	GO	GO	GO	GO	GO	SLOW	SLOW	GO	6	Indigenous Heritage Items Non-indigenous Heritage Items at all beaches

Management Options Assessment: Coastal Hazards

Option	Brief Description of Option *(refer to Appendix D for detailed information on all options)*	Treats Erosion	Treats Recession	Treats Wave Run-up & Overtopping	Treats Coastal Inundation	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Technical Viability	Score (G = 1, Sl = 0, St = -1)	Recommended Asset Type / Location for Application of Option
Community Education	Build acceptance and resilience for coastal risk management in the community by providing ongoing information regarding coastal hazards, risks, monitoring and implementation of actions.	✓	✓	✓	✓	GO	GO	GO	GO	GO	SLOW	GO	GO	7	Suitable across the whole LGA, not just beachside residents. Council should consider establishing beach-based Coastal Stakeholder Groups comprising OEH, Council, property owners, local beach users from wider area, community organisations (Boardriders, Dunecare), tourism, utilities (sewer, water, electricity, telecomms, etc.), Department of Planning and other relevant state agencies.
Investigate Habitat Preservation Options (Translocation, Migration, etc)	For important habitat remnants, determine translocation, facilitated migration or other feasible option to preserve the remnant, where possible. This may include a trial of methods e.g. for littoral rainforest, saltmarsh etc.	✓	✓	✓	✓	GO	GO	GO	GO	GO	GO	SLOW	SLOW	6	Littoral Rainforest remnants at Seven Mile Beach; Sandbar Beach, One Mile Beach
Dune Management	Implement dune care / revegetation programs, with new programs in locations where vegetation is degraded, and support for existing successful programs.	✓		✓		GO	GO	GO	GO	GO	STOP	GO	GO	6	Highest Priority: • Blueys • One Mile Continue Programs: • Boomerang Beach Medium Priority Remaining Council managed beaches
Beach Access Management	Management of beach accesses, including: • Inventory of accesses added to Council's Asset Management Plan • Removal of unnecessary or informal access paths; • Formalise preferred public paths • Negotiate shared paths for beachfront residents Conduct inspection and repairs to public accessways after erosion.	✓		✓		GO	GO	GO	GO	GO	STOP	GO	GO	6	High Priority • Blueys Beach (private accesses) • Number One Beach (linking to POM option) • One Mile Beach • Boomerang Beach • Boat Beach Medium Priority Remaining Council managed beaches
Land Acquisition	High risk private properties are bought at market prices then demolished to become public land.	✓	✓	✓	✓	STOP	GO	GO	SLOW	SLOW	GO	SLOW	GO	3	The very high cost of foreshore land makes this unlikely to be a feasible option at present. The option has been investigated for southern Boomerang Beach, to provide continued beach amenity through allowing it to translocate over time.

Management Options Assessment: Coastal Hazards

Option	Brief Description of Option *(refer to Appendix D for detailed information on all options)*	Treats Erosion	Treats Recession	Treats Wave Run-up & Overtopping	Treats Coastal Inundation	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Technical Viability	Score (G = 1, Sl = 0, St = -1)	Recommended Asset Type / Location for Application of Option
Buy Back / Lease Back	High risk private properties are bought at market prices, and then rented out until hazard impacts are imminent (years). When hazard is imminent, the property is demolished and land returned to the public.	✓	✓	✓	✓	STOP	GO	GO	SLOW	GO	GO	SLOW	GO	4	As above, although this option is more suitable as loan arrangements are a better way of managing initial outlay, rental incomes assist loan repayments, and the houses can be resold if future assessments revise risk levels to low.
Accept Impacts	Accept loss of land or assets affected by a hazard event (i.e. once affected, the assets or land is not replaced). Allows beach to translocate landward, retaining a sandy beach over time.	✓	✓	✓	✓	GO	GO	GO	SLOW	SLOW	GO	SLOW	GO	5	Land within Tourist Parks Camping Grounds Car Parks Parks and Reserves National Parks Public Open Space *See Asset Risk Registers for specific sites*
Relocate Assets	Relocate services and assets: 1) For minor facilities, relocate and/ or replace asset landward of immediate impact area, if and when damages occur. 2) For major assets where land is available, relocate landward of 2060 or 2100 hazard zone, either at a trigger point before impact, or when asset replacement is due.	✓	✓	✓	✓	STOP	GO	GO	GO	GO	GO	SLOW	SLOW	4	Roads Sewer Stormwater Water SLSCs Minor community facilities: picnic tables, viewing platforms, amenities, cycleways, footpaths *See Asset Risk Registers for specific sites*
Redesign or Retrofit	Modify existing built structures / assets, or rebuild using designs to withstand hazard impact.	✓	✓	✓	✓	STOP	GO	SLOW	GO	GO	SLOW	GO	SLOW	3	Roads Sewer Stormwater Water SLSCs (Forster Main) Should be investigated if suitable land for relocation is not available. *See Asset Risk Registers for specific sites*
Sand Borrowing / Scraping	Nature assisted beach accretion, through scraping of sand from low tide into dunes or dredging of local coastal lakes.	✓		✓		SLOW	SLOW	SLOW	GO	GO	STOP	GO	GO	3	May be suitable at the urban beaches where sand reserves are critical to buffer back beach development from erosion. Can be costly for minimal reduction in risk over the long term. Community debate on the impact of sand scraping upon surf conditions, as sand is removed from the daily active beach to build sand dunes that are only accessed in storms.

Management Options Assessment: Coastal Hazards

Option	Brief Description of Option *(refer to Appendix D for detailed information on all options)*	Treats Erosion	Treats Recession	Treats Wave Run-up & Overtopping	Treats Coastal Inundation	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Technical Viability	Score (G = 1, Sl = 0, St = -1)	Recommended Asset Type / Location for Application of Option
Beach Nourishment	Placement of sand on beach and dunes to protect against erosion and wave overtopping.	✓	✓	✓		STOP	SLOW	GO	GO	GO	SLOW	SLOW	SLOW	2	Minimal social impact compared with hard protection structures. Sand sources and funding is a significant constraint. May be appropriate at Southern Boomerang Beach, to manage: • Private properties • Boomerang Beach Drive • Public land • Water and sewer assets
Seawalls	Construction of a permanent revetment at the back of the beach to hold the shoreline in position.	✓	✓	✓		STOP	SLOW	STOP	SLOW	STOP	SLOW	SLOW	GO	-3	Seawalls have a very high impact on beach amenity (loss of sandy beach in front of wall on receding beaches). Any decision to use this option must be weighed against the environmental and social (loss of beach) and economic (loss of tourism, cost of structure and upkeep) impacts. May be appropriate at Southern Boomerang Beach, to manage: • Private properties • Boomerang Beach Drive • Public land • Water and sewer assets
Artificial Breakwaters and/or Reefs	Construct a nearshore artificial reef or breakwater in the surfzone to reduce shoreline wave impacts.	✓				STOP	SLOW	STOP	STOP	STOP	STOP	STOP	STOP	-6	No suitable locations. Breakwaters are very costly, and frequently do not function as they were intended Breakwaters can negatively impact beach amenity and surf conditions, both of which are highly valued by the community Breakwaters are unlikely to mitigate long term recession impacts.
Groynes / Artificial Headlands	Construct a groyne(s) perpendicular to the shoreline to trap longshore sediment movement and build the beach.	✓				STOP	SLOW	STOP	STOP	STOP	STOP	SLOW	GO	-4	No suitable locations. Longshore transport rates are not high enough on the Great Lakes coast for groynes to be feasible Groynes are very costly and significantly impact upon beach amenity and surf conditions.

4.3.1 Recommendations

Based upon the coarse filtering of the options, those options with a score of 6 or greater were considered to be “no regrets” options that can largely be implemented at the current time, at minimal cost. This includes actions such as dune management, monitoring, asset management planning, and LEP and DCP amendments. Specific locations / assets for which the “no regrets” actions are recommended are provided with the Coastal Asset Risk Registers, in Table 5-1 and Table 5-3.

Those options with a score of 3 to 5 may have merit in specific locations. Some of these options also may not need to be implemented at the current time, and / or may require further investigation prior to committing to the option. This included options such as relocation or redesign of assets, land acquisition and beach nourishment. Recommended future options (as Option 1 to 3) for specific sites / assets at high to extreme risk over the long term (2060, 2100) are also provided within the Coastal Asset Risk Registers, in Table 5-1 and Table 5-3. For these future risks, options are recommended in the case where the risk eventuates prior to the next CZMP review, but there is no obligation to decide on the preferred action at this time.

The coarse filter identified seawalls, artificial reefs and groynes / artificial headlands as generally inappropriate for application in the Great Lakes LGA. There may, however, be certain locations where seawalls may be considered. Upkeep of existing seawalls (e.g. Forster Main Beach) is recommended.

A more detailed analysis of options, including estimated costs and outline of pros and cons, required for southern Boomerang Beach because the immediate risk is likely to require treatment over the short to medium term, or life of this CZMP, outlined herein.

4.4 Detailed analysis of Options for Southern Boomerang Beach

The immediate threat of erosion to Boomerang Beach is to the sandy beach and dunes, but also to a number of foreshore properties at southern end of the beach. As such, the southern section of beach is addressed separately from the central to northern sections of beach. For the purpose of describing the options, “southern Boomerang” refers to the beach and land from immediately north of the entry onto Boomerang Beach Road to the southern headland (Boomerang Point).

4.4.1 Coastal Risk Overview

As listed in the Asset Risk Registers, and reproduced in Table 4-5:

- In the immediate term, the beach / dune system and 11 foreshore residential properties are at risk from erosion at southern Boomerang Beach.
- By 2060, another 2 foreshore properties, a ~100 m length of Boomerang Drive plus associated stormwater, sewer and water and beach accessway are estimated to have intolerable risk from recession.
- By 2100, an additional five land parcels on the landward side of Boomerang Drive (4 of which are vacant), plus an extended length of Boomerang Drive and associated stormwater, sewer and water serves (an additional 300 m), the entrance into Red Gum Road, and Boomerang Drive cycleway are estimated to be at intolerable risk from recession.

- Immediately north of Boomerang Beach Road, a further 4 land parcels (including another 8 apartments and 3 homes) plus the southern beach car park and beach access are also at intolerable risk by 2100.

Table 4-5 Excerpt from Asset Risk Registers for Southern Boomerang

Asset Name	Risk Level		
	Imme-diate	2060	2100
Boomerang Beach (north of Boomerang Beach Road entrance)	High	Extreme	Extreme
Dunes and Dune Vegetation (north of Boomerang Beach Road entrance)	High	Extreme	Extreme
Beach Accessway	Medium	High	High
Environmental Management	Low	Low	Medium
Open Space - Boomerang Beach (north)	N/A	Low	Low
Boomerang Beach Road	Low	Medium	High
Stormwater Drainage Line (3 in total, centre and northern end of beach)	Medium	High	Extreme
Residential Property (4 lots on Boomerang Dr, immediately north of entrance onto Boomerang Beach Rd. Includes 8 of the Oceanside Beachfront Apartments)	N/A	Medium	High
Car Park - Boomerang Beach (south)	Low	Medium	High
Beach Accessway (from southern Car Park)	Medium	High	High
Residential Property (southern foreshore = 2 lots on Boomerang Dr, south of Boomerang Beach Road)	Medium	High	Extreme
Residential Property (southern foreshore = 11 lots on Boomerang Dr, south of Boomerang Beach Road)	High	Extreme	Extreme
BOOMERANG DR	Medium	Extreme	Extreme
Water Line - reticulation (southern foreshore, along Boomerang Dr)	Medium	High	Extreme
Boomerang Beach (south of Boomerang Beach Rd entrance)	High	Extreme	Extreme
Dunes and Dune Vegetation (south of Boomerang Beach Rd entrance)	High	Extreme	Extreme
Beach Accessway (southern foreshore)	Medium	High	High
Viewing Platform - Boomerang Beach (far south)	Low	Medium	Medium
Sewer Line - Rising Main (southern foreshore, along Boomerang Dr)	Medium	High	Extreme
Stormwater Drainage Line (southern foreshore, along Boomerang Dr)	Medium	High	Extreme
RED GUM RD	N/A	Medium	High
Residential Property (5 lots, landward side of Boomerang Dr. 4 of these are vacant lots)	N/A	Medium	High
Sewer Line - Gravity Main (southern foreshore)	Medium	High	Extreme
Cycleway (Boomerang Dr-Headland Rd)	Low	Medium	High
Footpath (Cnr Red Gum Rd/Boomerang Dr)	N/A	Low	Low

4.4.2 Southern Boomerang Beach Options Overview

Typically for future (e.g. 2060 risks), the selection of options for existing development can be delayed until the risk is certain and imminent. The imminence of the risk to southern Boomerang requires discussion of the options with the local and greater community now, prior to an adverse event being realised.

Management of the erosion risk to southern Boomerang is challenging, as no single solution will please all stakeholders (i.e. beach users, landowners, Council etc.). Further, all of the options are extremely costly, and likely will only be realised through joint funding arrangements.

Three options have been identified, as follow.

- Option 1: protect the 'at risk' foreshore assets, through the application of an ongoing beach nourishment program.
- Option 2: protect the 'at risk' foreshore assets, through the construction of a seawall (revetment).
- Option 3: planned translocation of 'at risk' properties and assets, requiring removal of affected foreshore properties, and landward relocation of Boomerang Drive (and associated stormwater, sewer and water assets).

Indeed, each of these options may be suitable over time, in a staged process of application as erosion impacts are realised. The details of these options are discussed below.

4.4.2.1 Option 1: Beach Nourishment

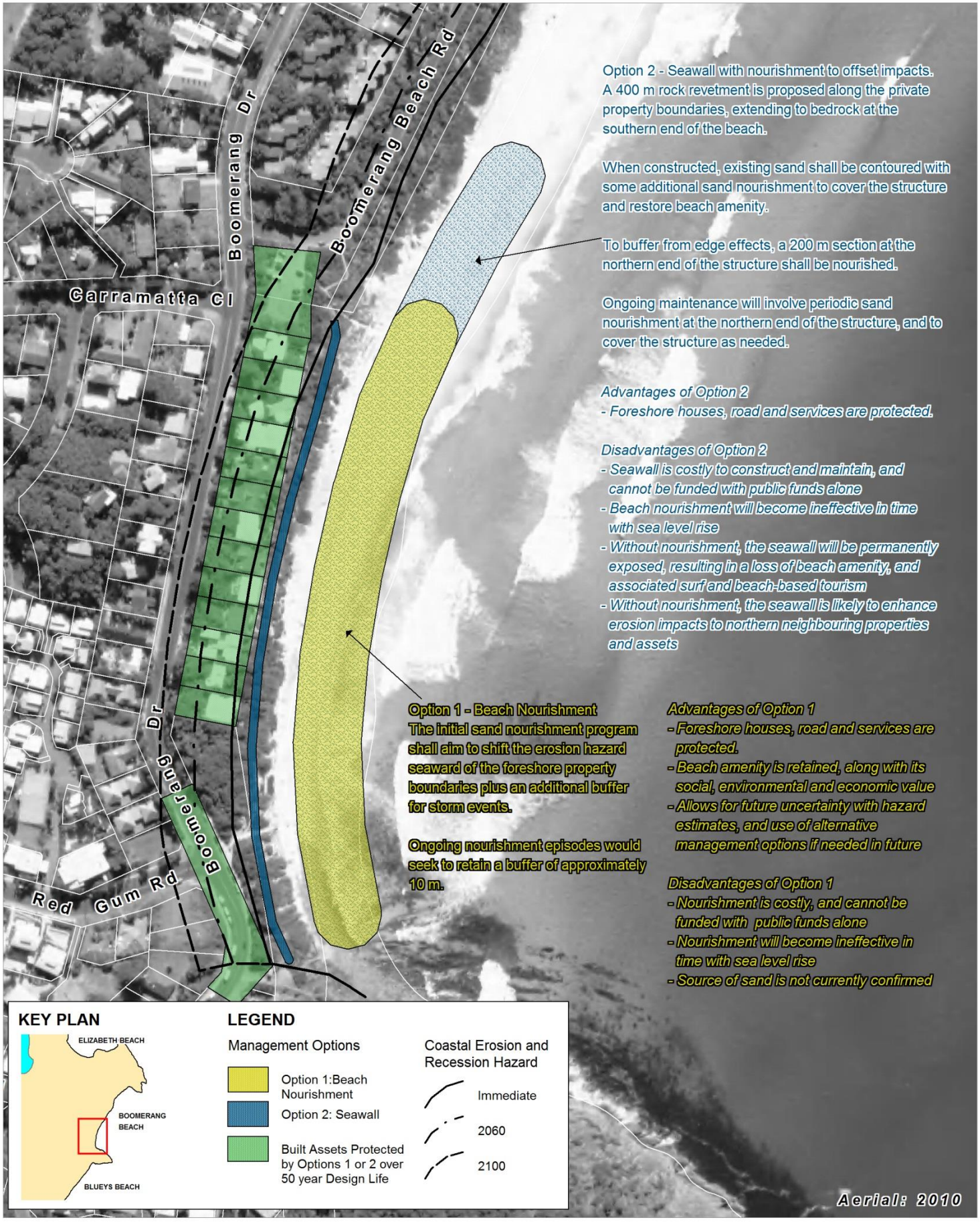
Beach nourishment is the practice whereby external sand reserves are brought in to widen the beach/dune system to remediate storm erosion impacts and restore beach amenity.

This option proposes nourishment of a 400 m equivalent section of shoreline, centred on the 200 m stretch of beach backed by the 13 foreshore properties at risk from erosion, plus tapering nourishment equivalent to 100 m (full nourishment) either side of the target site (see Figure 4-2).

This program would be implemented as:

- initial nourishment of 65,000 m^3 to (a) translocate the hazard line seaward of the foreshore property boundaries (by 8 m), and (b) provide an additional buffer (a further 5 m) for the immediate erosion risk; and
- ongoing maintenance nourishment programs of 50,000 m^3, applied to the 400 m equivalent section of beach on an as needs basis.

The calculations above assume that the existing beach slope would be retained (i.e. the initial nourishment would occur when the beach is in an average beach position), and that nourishment would occur across the beach and dune profile from +5 m AHD to -10 m AHD.



Title:

Southern Boomerang Beach Options (1) Beach Nourishment and (2) Seawall

Figure: 4-2

Rev: A

N

0 50 100m

Approx. Scale

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The cost of the beach nourishment option is approximated at $3.4 M for the initial nourishment program followed by $2.5 M for subsequent maintenance campaigns (see Table 4-6). Costs have been estimated assuming a suitable source of sand is available nearby at a rate of $25/m^3, plus an assumed $25/m^3 to cover transport and placement costs. Assuming that a minimum of four maintenance nourishment campaigns (in addition to the initial campaign) are required by 2060, an indicative cost estimate for this option in total up to 2060 is $13.4 M (see Table 4-6).

Table 4-6 Cost Estimates for Beach Nourishment Option

Seawall Construction	Amount	Rate	Fee
Design & Approvals (REF etc.)			$150,000
Purchase external sand	65,000 m^3	$25/m^3	$1,625,000
Transport and placement of sand	65,000 m^3	$25/m^3	$1,625,000
		TOTAL UPFRONT COST	**$3,400,000**
Maintenance			
Purchase external sand	50,000 m^3	$25/m^3	$1,250,000
Transport and placement of sand	50,000 m^3	$25/m^3	$1,250,000
		MAINTENANCE COST	**$2,500,000**
		TOTAL COST to 2060[1]	**$13,400,000**

[1] *Assumes 4 maintenance campaigns to 2060*

Advantages

- Beach nourishment does not impact on beach amenity, therefore resulting in good social, environmental and economic outcomes.
- The option accommodates any uncertainty in the hazard estimations (i.e. shoreline response to storms and sea level rise), such that maintenance nourishment episode are implemented on an 'as needs' basis.
- If projected sea level rise and recession is not realised, future maintenance nourishment campaigns will be less frequently required and other options (a seawall, or retreat) can be avoided.
- Conversely, this strategy allows alternate management options (a seawall, or retreat) to be implemented in the future, such as when nourishment is no longer feasible.

Disadvantages

- The initial and ongoing cost of this option is high, and would likely need contribution from all benefiting parties to be feasible (see funding arrangements below).
- The availability of sand for nourishment has not been clarified.

- Shorter intervals between nourishment episodes should be expected over time due to the increasing frequency of erosion episodes with sea level rise. The amount of sand required to repair an eroded beach may be higher than the estimates provided here. And nourishment will become increasingly ineffective over the long term with projected sea level rise.

Funding Arrangements

The option directly benefits a small number of foreshore landowners. The wider community benefits through provision of beach amenity compared with Option 2 (seawall), however there are other alternatives to achieve beach amenity, such as Option 3 (retreat). Council and Mid Coast Water are also beneficiaries, as nourishment incidentally protects Boomerang Drive, stormwater drainage, beach accesses, car parks, and sewer and water lines over the medium term.

Beach nourishment should ideally be funded in partnership between the 13 foreshore landowners who directly benefit from the works, Council, and Mid Coast Water. It is expected that the funding contribution would be weighted towards those parties receiving the most benefit (i.e. the private landowners).

The NSW Government has documented how such programs can be jointly funded across all benefitting parties. Should this option be pursued by Council, it is recommended that OEH be consulted assist in weighting the monetary contribution expected from foreshore residents, Council and the other parties (MCW, and landowners at longer term risk).

4.4.2.2 Option 2: Construct a Seawall

Revetments, or seawalls, are used to protect back beach assets from erosion by holding the shoreline in its current position. Seawalls may be effective at protecting built assets from erosion and wave runup, but substantially reduce beach amenity particularly if built on receding beaches, as the rocky structures remain exposed.

Seawalls cannot be built to protect a single asset or property, as there may be accelerated erosion at the ends of the seawall (termed “edge effects”). NSW legislation requires offsite impacts such as edge effects to be ameliorated, and nourishment and other actions to achieve this must be factored into the cost and design.

This option proposes construction of a sloping rock armour revetment (seawall) from the section of beach adjacent to the car park on Boomerang Beach Rd (approximately at Carramatta Close) to the southern end of the beach (see Figure 4-2). The seawall would extend for about 400 m. The structure should be tied to bedrock at the southern end of the beach. At the northern end, terminating the structure at the car park enables this area to be sacrificial land, in the case where edge effects cannot be ameliorated through nourishment. The structure should be located at the back of the dunes (e.g. equivalent to the immediate hazard line) and within the private property boundary for foreshore residents.

Ideally, seawalls should be built when the beach is in an eroded state, to avoid having to excavate stable dune sands. Following construction, regrading of existing beach sand reserves plus additional sand inputs (estimated at 10,000 m^3) to cover the structure and restore beach amenity shall occur. After erosion events, it is expected that enhanced erosion will occur at the northern end of the seawall (adjacent to the car park). Nourishment should therefore focus upon this location, to ameliorate edge effects and avoid creating enhanced erosion for the public and private land north

of Boomerang Beach Rd. The first nourishment episode to manage edge effects should occur as part of the initial construction of the seawall.

Under the *Coastal Protection Act 1979*, both the cost of construction and ongoing maintenance can be tied to benefitting parties, including private landowners. Under the EPA Act 1979, for Council to approve a seawall, it needs to be a recommended option within a certified CZMP.

Indicative costs for the construction of a ~400 m seawall plus remediation works is $6 M. This is based on an assumed $10,000/m length of seawall, design and approval costs (e.g. EIS), and beach nourishment over and adjacent to the structure, refer Table 4-7.

Ongoing maintenance costs for the seawall and impacts to the beach, required every 10 years or so, are estimated a total of $2.29 M (refer Table 4-7), including:

- $40,000 for the structure, plus
- sand nourishment of 25,000 m^3 at a cost of $1 M to widen the beach by 10 m for 200 m covering the end of the structure (noting this is a coarse estimate, as the true sand volume and cost to remediate edge effects particularly as sea level rises is unknown), and
- sand nourishment to cover the structure, if exposed for an unreasonable length of time. This is estimated to require 20,000 m^3 to cover the structure, equating to $1.25 M.

Assuming four maintenance campaigns (including nourishment episodes) to manage edge effects, this equates to $15.16 M to build and maintain the structure to 2060.

Table 4-7 Cost Estimates for Seawall Option

Seawall Construction	Amount	Rate	Fee
Design & Approvals (REF etc.)			$250,000
Seawall Construction	400 m	$10,000/m	$4,000,000
Re-establish sand across seawall (purchase and placement costs)	10,000 m^3	$50/$m^3$	$500,000
Nourishment for edge effects (purchase and placement of sand)	25,000 m^3	$50/$m^3$	$1,250,000
		TOTAL UPFRONT COST	**$6,000,000**
Maintenance			
Seawall Maintenance[1]		$40,000	$40,000
Re-establish sand across seawall (purchase and placement costs)	20,000 m^3	$50/$m^3$	$1,000,000
Nourishment for edge effects (purchase and placement of sand)	25,000 m^3	$50/$m^3$	$1,250,000
		MAINTENANCE COST	**$2,290,000**
		TOTAL COST to 2060[2]	**$15,160,000**

[1] *Approximated at a rate of 1% construction cost*

[2] *Assumes 4 maintenance campaigns to 2060*

Advantages

- A seawall at southern Boomerang Beach would protect private foreshore properties from erosion at present, and Boomerang Beach Drive, water and sewer lines, stormwater drainage lines, a cycleway, the entrance to Red Gum Avenue, and a further 5 land parcels (4 of which are vacant) over the medium term.
- Under the current climate, a correctly engineered revetment would only be exposed during periods of beach erosion, with the beach sand returning to cover the seawall at other times. This may not be the case over the long term with sea level rise (see “disadvantages” below).

Disadvantages

- Seawalls are very costly structures, with high ongoing maintenance costs.
- A seawall would substantially reduce beach amenity (and associated community and ecological values), because as sea level rises, recession will expose the seawall on an increasing basis, eventuating in a permanently exposed rock seawall. Nourishment episodes to provide for beach amenity will be increasingly required. Overtime, the cost of nourishment may become unviable or the practise ineffective due to future sea levels, resulting in a permanent loss of beach amenity.
- Long term loss of beach amenity could have significant implications for the local economy that relies heavily on the beach and surf driven tourism.
- Accelerated erosion at the northern end of the seawall will increase the risk to public infrastructure and the residential properties there. The risk to the properties is particularly enhanced if remediation of edge effects with nourishment becomes unfeasible (such as due to cost) or ineffective (due to future coastal processes).
- Impacts to beach amenity, surf conditions and the surrounding natural landscape are likely to be considered unacceptable by the community at large.
- Rate payers are unlikely to accept a funding scenario where Council is responsible for the seawall construction and maintenance of a structure that benefits only a few, and at the expense of the public’s beach asset.
- From a coastal processes perspective, construction of a seawall will separate the substantial sand reserves in the existing foredunes from the active beach. With sea level rise, as the beach moves landward to erode the foredunes these reserves would be released into the active beach to buffer the impacts of recession to Boomerang Beach. With a seawall, the foredune sand reserves would no longer be available for this purpose.

Funding Arrangements

This costly option directly benefits a small number of foreshore landowners. The NSW Government has stated clearly that public funding will prioritise projects that benefit the public (see Coastal Management Principle 5 in the CZMP Guidelines), rather than projects to benefit private landowners.

For the seawall option, the wider community is disadvantaged by a loss of beach amenity. Even with nourishment programs to ameliorate such impacts, such programs will become unviable under rising sea levels.

Council and Mid Coast Water are indirect beneficiaries, as the seawall would incidentally protect Boomerang Drive, stormwater drainage, beach accesses, car parks, and sewer and water lines over the medium term.

The funding of the seawall construction, ongoing maintenance and ongoing management of offsite impacts can be split between direct and indirect beneficiaries. The NSW Government provides guidance on how to split the costs of coastal protection structures proportionally for the varying degrees of benefit received from the structure. The Coastal Protection Service Charge function of the *Coastal Protection Act 1979* also enables Council to tie ongoing maintenance costs to property titles (see Appendix A.1 for more details).

Should this option be pursued by Council, it is recommended that OEH be consulted to determine fair negotiation of monetary contributions between the foreshore residents, Council and other beneficiaries (MCW, and landowners at longer term risk).

4.4.2.3 Option 3: Relocation and Retreat

Planned retreat is incorrectly perceived to adversely impact upon the community. However, by removing built assets (public or private) and allowing the beach to freely translocate landwards, the sandy beach amenity is retained for the community over the long term.

The removal and relocation of assets in highly urbanised areas is likely to be unfeasible, but should be the preferred response where there is limited development.

The main issue with the removal of private assets is that of compensation and equity. Adopting a "planned retreat" response does not necessarily oblige government (Council, State or Federal) to purchase the private properties. However, given that this option provides a benefit to the wider community, acquisition of at risk private properties has been assumed as part of this option.

This option proposes a staged process of purchases and asset relocation, in response to erosion and recession impacts over time. The staged process is illustrated in Figure 4-3 and described below.

- Stage 1: acquire 11 foreshore properties at immediate risk on Boomerang Drive. The properties should be subject to a geotechnical assessment to determine when it is no longer safe to inhabit the buildings, in relation to the zone of reduced foundation capacity and erosion escarpment. Acquisitions should also take advantage of property sales, as they arise. It is expected that the properties would be acquired over a period of years. After purchase of the property(s), the houses shall be demolished, the land rezoned to environment protection (to restrict future development), and land rehabilitated.
- Stage 2: purchase a further 2 foreshore properties on Boomerang Drive (at risk by 2060), re-route an ~ 100m section of Boomerang Drive, and accept the loss of the car park adjacent to Boomerang Beach Road (remove sections as impacts occur). Re-routing of Boomerang Drive would require the acquisition of 3-4 vacant lots on the landward side of the road, adjacent to Red Gum Avenue. Stormwater, sewer and water services along the roadway section will also

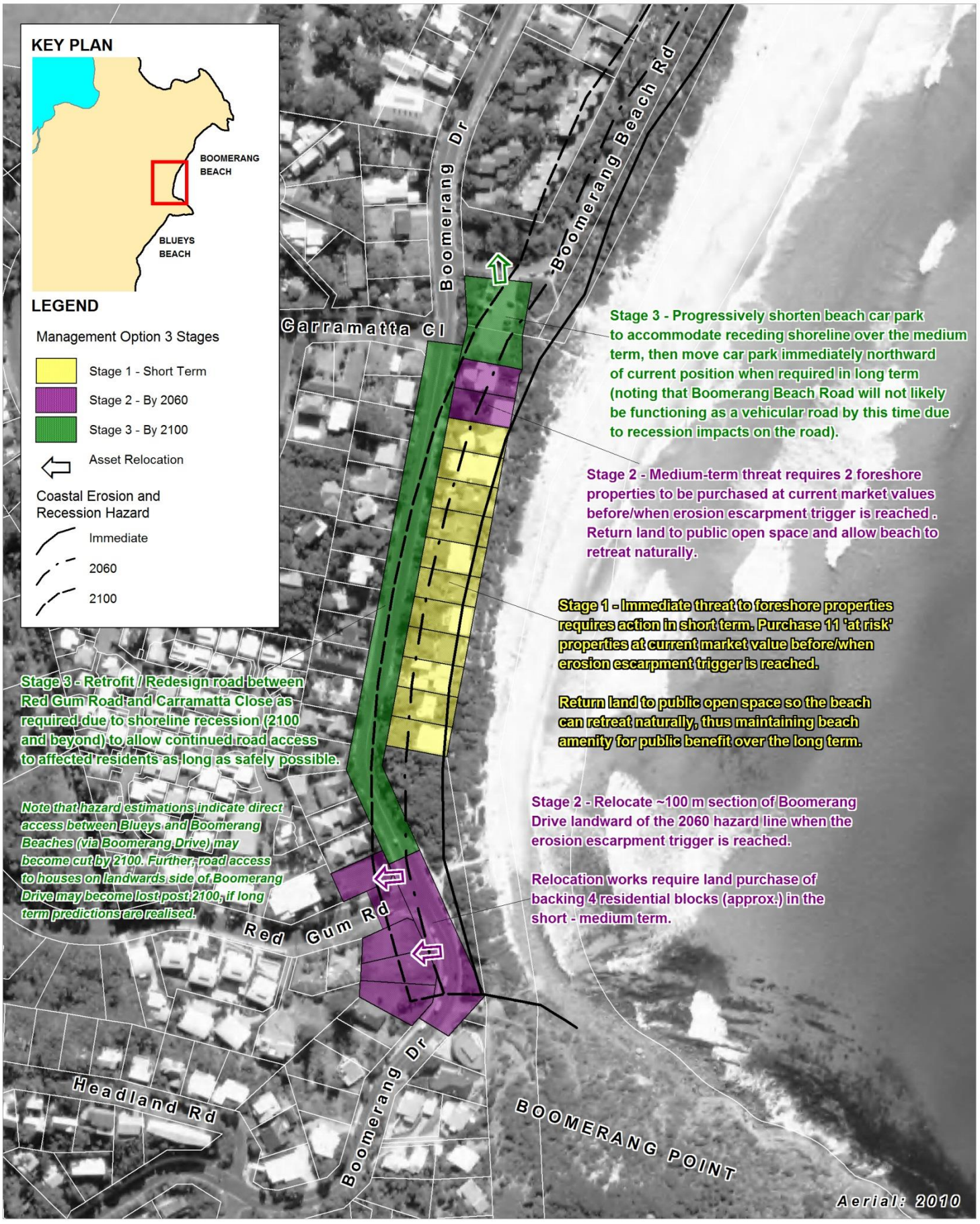
need to be redirected, requiring involvement of MCW. Property acquisitions would occur as for Stage 1.

- Stage 3: By 2100, convert the further 350 m of Boomerang Drive between Red Gum Ave and Carramatta Close to one way, cycleway or private road to enable continued access to private properties on Boomerang Drive. There will also be a need to redirect sewer and water lines that currently extend along the roadway, requiring involvement of MCW. At this time, a long term strategy for vehicular access between Boomerang and Blueys Beaches will also be needed.

Cost estimates for each stage of this option have been calculated in Table 4-8 below. The initial cost of this option is $18.75 M (based upon estimate foreshore property prices at present), with costs to 2060 of more than $27M.

Table 4-8 Cost Estimates for Relocation and Retreat Option

Stage	Action	Cost	Cost Details
Stage 1 (short to medium term)	Purchase 11 foreshore properties at immediate risk	$18,750,000	Based on GLCC land rates
	Total	**$18,750,000**	
Stage 2 (approx. 2060):	Purchase 2 foreshore properties at risk under 2060 timeframe,	$5,500,000	Based on GLCC land rates
	Purchase 4 backbeach properties to allow road relocation	$2,650,000	Based on GLCC land rates for 4 vacant parcels of land landward section of road at risk by 2060
	Relocate ~100 m section of Boomerang Drive	$93,850	Based on GLCC replacement value for this section of road
	Relocate stormwater, sewer, and water services associated with the ~ 100 m of road.	Unknown	
	Accept Loss of southern Boomerang car park	$91,250	Based on GLCC replacement value
	Total	**>$8,335,100**	
Stage 3 (approx. 2100)	Redesign/Retrofit 350 m section of Boomerang Drive (between Red Gum Ave and Carramatta Cl)	$375,385	Based on GLCC replacement value for this section of road
	Relocate/ Retrofit stormwater, sewer, and water services associated with the ~350 m of Boomerang Dr	Unknown	
	Total	**>$375,385**	



Title:

Southern Boomerang Beach
Option 3: Retreat (and maintain the natural beach)

Figure: 3-2

Rev: A

N

0 50 100m

Approx. Scale

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Filepath :

Advantages

- Beach amenity is retained as the beach is able to translocate landwards over time. This in turn supporting the local community, environment and local beach-based economy.

Disadvantages

- The high cost of this option is prohibitive (see Table 4-8).
- There is currently no funding program available for coastal land acquisition of this scale in NSW.
- May be unfeasible to continue to purchase properties and allow retreat to manage recession beyond 2100, because of the number of properties and assets affected at that time.

Funding Arrangements

Acquisition of private properties elsewhere in NSW has been limited, tending to be on a single property basis (such as through the Coastal Lands Protection Scheme). The high cost of properties in Boomerang Beach further obstructs this option.

While this has only been applied to property acquisition for road projects, there may still be value in investigating the use of a Buy Back / Lease Back approach to acquisition (see Appendix E). Purchase of the properties prior to the risk being imminent is required to allow Council to maximise rental returns to offset the cost of acquisition, through a Buy Back / Lease Back arrangement.

4.4.2.4 Southern Boomerang Beach Recommendations

All of the available options are costly, and have advantages and disadvantages. The costs of the options and long term considerations are compared in Table 4-9. A summary of all three options is provided in Table 4-10.

Over the short to medium term, Option 1 Beach nourishment provides the greatest balance between protecting private and public assets (roads, sewer, stormwater) and maintaining beach amenity for local community, tourism and environmental benefits. Furthermore, beach nourishment does not restrict alternative options being pursued in future (be it retreat, seawall or other as yet undiscovered arrangement).

Beach nourishment is not economically feasible for Council alone, but funding arrangements to share the cost between benefitting parties should be investigated. The availability of suitable sand sources will also need to be clarified.

Over the long term, all of the options have significant limitations. Beach nourishment is likely to become ineffective with sea level rise. For the seawall option, the ineffectiveness of nourishment over time also reduces the acceptability of this option. In contrast, while planned retreat provides both beach amenity and equity to the community, it may also be unfeasible by 2100 and beyond where recession impacts upon an increasing number of houses and associated public assets. Indeed, planned retreat is prohibitively expensive at the current time, and Council, State or Federal Government funds are not currently available for this option.

Table 4-9 Southern Boomerang Beach Options Cost Summary

	Option 1 Beach Nourishment	Option 2 Seawall	Option 3 Managed Retreat
Short term costs	$3,400,000	$6,000,000	$18,750,000
Ongoing Costs (up to 2060)	$10,000,000[1]	$9,160,000	>$8,335,100
Total 50 year Costs	**$13,400,000**	**$15,160,000**	**>$27,085,100**
Future considerations	• *Nourishment will become ineffective / unfeasible in long term with sea level rise, requiring alternative management option in future.*	• *Ongoing seawall maintenance and upgrades required post 2060* • *Uncertain that a seawall can be maintained indefinitely, may force continuation of protection along remainder of beach (with associated impacts)* • *Nourishment to offset impacts will become ineffective / unfeasible over time, resulting in permanent exposure of rock wall, with associated loss of beach amenity, environmental values, and associated tourism*	• *If long term hazards are realised, beyond 2100 it may be unfeasible to continue to retreat from impacts due to the number of properties, roads and other assets at risk.*

[1] Assumes 4 maintenance nourishment campaigns by 2060, at $2.5 M each

[2] Assumes 4 maintenance campaigns by 2060, at $2.3 M each

Table 4-10 Summary of Management Options for Southern Boomerang Beach

OPTION 1 PROTECTION: BEACH NOURISHMENT	OPTION 2 PROTECTION: SEAWALL & NOURISHMENT	OPTION 3 RETREAT: SACRIFICE & RELOCATE ASSETS
Option Details		
Undertake Beach Nourishment to Reduce Risk and Protect Foreshore Properties • Undertake regular beach nourishment of southern Boomerang Beach to mitigate impacts of erosion.	***Construct Seawall (plus Beach Nourishment) to Protect Foreshore Properties*** • Construct approximately 400 m seawall to protect southern Boomerang Beach foreshore houses in short - medium term and Boomerang Drive in medium - long term. • Undertake regular beach nourishment of southern Boomerang Beach to mitigate the impacts of seawall.	***Allow Beach to Retreat – Acquire Foreshore Properties & Relocate Road*** • Stage 1 (short to medium term): acquisition of 11 foreshore properties at immediate risk on Boomerang Drive • Stage 2 (approx. 2060): acquire a further 2 foreshore properties on Boomerang Drive, re-route ~ 100m of Boomerang Drive and associated services (requiring acquisition of 3-4 properties), and accept loss of southern Boomerang car park. • Stage 3 (approx. 2100): convert 350 m of Boomerang Drive between Red Gum Ave and Carramatta Close to one way, cycleway or private road to enable continued access to private properties only.
Option Pros and Cons		
Advantages • Protects foreshore houses in short to medium term. • Protects Boomerang Drive in short to medium term. • Maintains beach amenity, in medium term. • Minimal to no environmental or social impacts to Boomerang Beach. • Will accommodate uncertainty in hazard estimations. • Allows for alternate management strategies to be adopted at a later stage, if required/desired. ***Disadvantages*** • Costly option, for both the initial nourishment episode and ongoing nourishment campaigns. • Prohibitively expensive option for Council alone – requires joint funding by beneficiary landowners to be feasible. • Medium to long term source of beach nourishment sands cannot be guaranteed. • Not a long term solution –effectiveness of beach nourishment efforts will reduce with rising sea levels.	***Advantages*** • Protects foreshore houses over medium to long term. • Protects Boomerang Drive over medium to long term. ***Disadvantages*** • Very costly in terms of upfront construction and ongoing maintenance costs for the seawall and nourishment for offsite impacts. • As beach nourishment will become ineffective overtime due to sea level rise, it will not be possible to offset seawall impacts on beach amenity and neighbouring properties indefinitely. • If adequate beach nourishment is not maintained, permanent exposure of the seawall will impact beach amenity; surf conditions; and in turn local beach-based tourism. • If adequate beach nourishment is not maintained, edge erosion effects will impact upon built and natural assets north of the wall, such as a number of residential properties. • Long term source of beach nourishment sands cannot be guaranteed • Prohibitively expensive option for Council alone – requires joint funding by beneficiary landowners to be feasible.	***Advantages*** • Beach retained, as allowed to recede naturally • Existing road network largely retained in medium term • Socially and environmentally acceptable option ***Disadvantages*** • Expensive option, requiring acquisition of up to 17 residential properties over the medium term, including 11 foreshore properties in the short term and 6 residential properties before 2060. • May be unfeasible to continue to purchase properties and allow retreat to manage recession beyond 2100, because of the number of properties and assets affected at that time.

5 Recommended Management Options

5.1 Coastal Asset Risk Registers

Management options recommended for treating intolerable risks at present and future are provided within the coastal asset risk registers. This includes “no regrets” options to be pursued over the short term, and options for consideration for long term high and extreme risks.

The coastal erosion and recession risk register and the corresponding recommended management options are outlined in Table 5-1. The risk register and management options for coastal inundation (wave runup) are provided in Table 5-2. The slope instability risk register is reproduced with new management options for Seal Rocks Road in Table 5-3.

5.1.1 Approach for Low to Medium Risk Assets

For assets that are more likely to be impacted over the life of the plan, the “low” and “medium” risk level inherently means that the consequence of impact to these assets is lower. In accordance with the risk process, the risks to these assets can be accepted. Assets of high consequence would only be classified as “low” risk if the likelihood of impact is low, and so the risk can also be accepted.

Should impacts occur to low and medium risk assets, the recommended approach is to *Accept Impacts* (i.e. loss of land / asset), as follows:

- Remove damaged infrastructure, rehabilitate land and vegetation, and install replacement assets further landward.
- Undertake above action only *if and when impacts* occur.
- Ad hoc dumping of rock or sand bags or other damaging action *should not* be undertaken to manage impacts to low risk assets.

Typically, low to medium risk assets that may be impacted over the life of the plan and to which this action applies includes:

- Minor roads, perpendicular to beach, where the end of the roadway only is affected (noting that minor roads where greater impacts may occur have been flagged for management in the coastal risk registers);
- Parks, Reserves, Public Recreation, Public Open space, Environment Protection Zone (without EECs), and National Parks (land without EECs), where the loss of some land to erosion will not substantially impinge upon the value of the asset as a whole;
- Car Parks, Footpaths, Cycleways, and Beach Accessways as above, but will require some remediation of damages for continued safe use of the remaining asset;
- Camping Grounds; (low key with limited facilities), where some minor facilities within the grounds could be replaced (and relocated) if affected, and campsites re-defined. The loss of some land to erosion will not substantially reduce the value of the site.

5.2 Triggers for Implementation

It is apparent from the risk assessment that some intolerable risks are not expected to eventuate until 2060 or 2100. In this case, implementing a management action now, particularly where the option is difficult or costly, may be premature and cannot account for the uncertainty of when or to what extent the hazard may actually eventuate in the future.

While a decision regarding future intent is necessary at the present timeframe for intolerable risks, the action may not require implementation at present. Fisk and Kay (2010) provide a method for setting triggers for climate change adaptation actions along a time continuum. The trigger points are set to flag the 'level of acceptable change' where more pro-active or decisive actions must be implemented in order to avoid an undesirable impact. The trigger setting method is demonstrated in Figure 5-1.

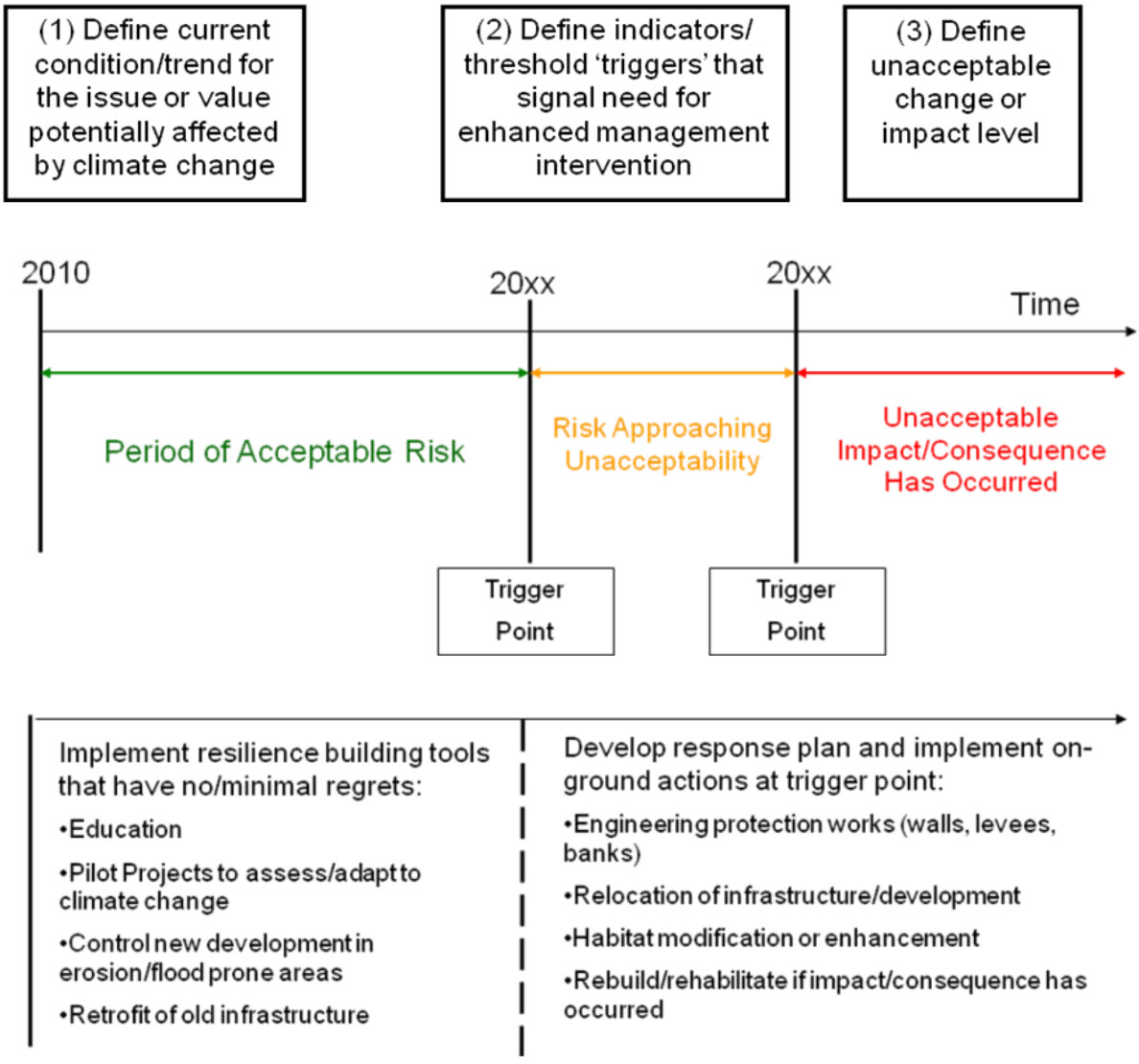

Figure 5-1 Continuum Model for Climate Change Adaptation Action

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

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

For beach erosion and recession, setting the trigger as a measurable distance (in metres) between an erosion escarpment and an asset is recommended. The trigger distance should be set to allow sufficient protection from a typical storm event and a reasonable buffer for an unlikely (infrequent) erosion extent.

A measurable distance for safety for structures is the zone of reduced foundation capacity (ZRFC), which should applied seaward from the structure. This value also varies, depending upon the construction of a building (i.e. foundation piles or otherwise), and the substrate (i.e. presence or otherwise of bedrock). When the ZRFC distance is reached, a geotechnical engineer may inspect the asset to determine the risk of instability of the structure, and either extend the period of habitation or set the timeframe for evacuation, and removal or relocation. Tying the trigger to the zone of reduced foundation capacity provides for public safety (i.e. buildings are checked for stability when the trigger distance is reached) and then, a sufficient buffer to proceed to treatment of the risk (e.g.

The aim is to allow sufficient buffer after a storm event for the desired action to treat the risk to be funded and implement. Using a distance between the shoreline and a structure is very useful for Council, as it does not tie the future action to a specified timeframe. This is particularly relevant to recession impacts due to sea level rise, for which exact timeframes are complicated.

For inundation, setting the trigger requires careful consideration of the tolerability of specific assets to inundation. That is, some assets may become unusable when inundation occurs once a year, others may remain functional with more frequent inundation. The trigger thus needs to be specific to the asset. The trigger may then be defined as a frequency of inundation (e.g. X times per year), which would require monitoring at individual assets. Or, the frequency may be redefined as a depth of inundation, which can be measured and monitored.

Trigger points for action for existing assets at risk are detailed in the Great Lakes CZMP (BMT WBM, 2015).

5.3 Selection of Preferred Management Options

The recommended options given in this report have been taken to the community, Council's Committee and the other state agencies for further discussion and comment. The outcomes of the consultation were used to develop an implementation schedule for actions in the Great Lakes CZMP (BMT WBM, 2015).

Table 5-1 Erosion and Recession Asset Risk Register

Beach	Asset Name	Asset Type	Present Day	2060	2100	Immediate Man't Req'd	No Regrets Actions Implement Now	Option 1 (Recommended)	Option 2
Nine Mile Beach - Tuncurry	Nine Mile Beach	Beaches, Dunes and Foreshore	High	High	Extreme	*Yes*	Monitoring, Coastal Hazard Construction Checklist, Community Education	Accept Impacts (i.e. erosion and loss of land)	
Nine Mile Beach - Tuncurry	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	High	High	Extreme	*Yes*	Dune Management; Heritage Management, Community Education	Accept Impacts (i.e. erosion and loss of land/asset)	
Nine Mile Beach - Tuncurry	Car Park - Nine Mile Beach (South)	Car Park	N/A	Low	Medium		Append Asset Management Plan; Coastal Hazard Construction Checklist		
Nine Mile Beach - Tuncurry	Beach Accessway	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset and Accept Impacts	
Nine Mile Beach - Tuncurry	Beach Accessway (4WD)	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset and Accept Impacts	
Nine Mile Beach - Tuncurry	Environmental Conservation	Environmental Protection Zone	N/A	Low	Low		Dune Management; Heritage Management		
Nine Mile Beach - Tuncurry	Unformed Road	Road Reserve	N/A	Low	Low		Coastal Hazard Construction Checklist		
Nine Mile Beach - Tuncurry	Northern Breakwater	Waterway Infrastructure	Low	Low	Medium		Append Asset Management Plan (inc define roles and responsibilities for breakwaters)		
Main Beach - Forster	Southern Breakwater	Waterway Infrastructure	Low	Low	Medium		Append Asset Management Plan (inc define roles and responsibilities for breakwaters)		Consider Extension of Seawall along remainder of beach (i.e. north to Southern Breakwater)
Main Beach - Forster	Beach Accessway (north of seawall)	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset and Accept Impacts	Consider Extension of Seawall along remainder of beach (i.e. north to Southern Breakwater)
Main Beach - Forster	Dunes and Dune Vegetation (north of seawall)	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Dune Management; Heritage Management, Community Education	Accept Impacts (i.e. erosion and loss of land/asset)	Consider Extension of Seawall along remainder of beach (i.e. north to Southern Breakwater)
Main Beach - Forster	Public Recreation - Pilot Hill	Public Recreation and Open Space	Low	Low	Medium				Consider Extension of Seawall along remainder of beach (i.e. north to Southern Breakwater)
Main Beach - Forster	Cycleway (Base of Pilot Hill)	Walkway / Cycleway	Low	Medium	High		Relocate Asset (if and when impacts occur)	Relocate Asset	Consider Extension of Seawall along remainder of beach (i.e. north to Southern Breakwater)
Main Beach - Forster	Forster Beach Holiday Park	Tourist / Holiday / Caravan Parks	Low	Medium	High		Coastal DCP; LEP Update	Relocate Assets and Accept Impacts, i.e. reconfigure site, allowing sacrifice of eroded land, relocation or replacement of facilities, and re-arrangement of campsites on the site	Consider Extension of Seawall along remainder of beach (i.e. north to Southern Breakwater)
Main Beach - Forster	Footpath (Forster camping area)	Walkway / Cycleway	N/A	Low	Low				Consider Extension of Seawall along remainder of beach (i.e. north to Southern Breakwater)
Main Beach - Forster	Public Recreation (north of seawall)	Public Recreation and Open Space	Low	Low	Medium				Consider Extension of Seawall along remainder of beach (i.e. north to Southern Breakwater)
Main Beach - Forster	Forster Main Beach (north of seawall, in front of seawall)	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Monitoring, Coastal Hazard Construction Checklist, Community Education	Accept Impacts (i.e. erosion and loss of land)	Beach Scraping
Main Beach - Forster	Car Park - Main Beach	Car Park	Medium	High	High		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Beach Accessways (part of seawall)	Community Facilities	Medium	High	High		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	NORTH LANE	Laneway	N/A	Low	Low		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	BEACH ST	Minor Road	Low	Low	Medium		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	NORTH ST	Minor Road	High	Extreme	Extreme	*Yes*	Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Residential Property	Residential Development	Medium	High	Extreme		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Sewer Line - Gravity Main	Sewer Infrastructure - MCW	N/A	Medium	High		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Forster SLSC	SLSC	Low	Medium	High		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Stormwater Drainage Line	Stormwater Infrastructure - GLC	High	Extreme	Extreme	*Yes*	Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Stormwater Outlet	Stormwater Infrastructure - GLC	High	Extreme	Extreme	*Yes*	Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Public Recreation (south of seawall)	Public Recreation and Open Space	Low	Low	Medium		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		

Beach	Asset Name	Asset Type	Present Day	2060	2100	Immediate Man't Req'd	No Regrets Actions Implement Now	Option 1 (Recommended)	Option 2
Main Beach - Forster	Cycleway (Beach St concourse)	Walkway / Cycleway	Medium	High	High		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Cycleway (Beach St/Head - North)	Walkway / Cycleway	N/A	Low	Medium		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Cycleway (North St/End of Med - End Kerb and Gutter LHS)	Walkway / Cycleway	Low	Medium	High		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Cycleway (North St/End of Med - Kerb of Kiosk (C))	Walkway / Cycleway	N/A	Low	Medium		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Footpath (North St/End of Med - End Kerb and Gutter LHS)	Walkway / Cycleway	Low	Medium	Medium		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Footpath (North St/End of Med - Kerb of Kiosk (C))	Walkway / Cycleway	Low	Low	Medium		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Footpath (Beach St/Wallis - Head)	Walkway / Cycleway	N/A	Low	Low		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Water Line - distributor	Water Infrastructure - MCW	High	Extreme	Extreme	*Yes*	Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Water Line - reticulation	Water Infrastructure - MCW	Medium	High	Extreme		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
Main Beach - Forster	Seawall - Forster	Waterway Infrastructure	Low	Medium	Medium		Upgrade Existing Seawall; Append Asset Management Plan to include seawall (if not already done so), for ongoing maintenance scheduling		
One Mile Beach	One Mile Beach	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Monitoring, Coastal Hazard Construction Checklist, Community Education	Accept Impacts (i.e. erosion and loss of land)	Beach Scraping
One Mile Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Revise Hazard Lines Based on Geological Data; Dune Management; Heritage Management, Community Education	Accept Impacts (i.e. erosion and loss of land/asset)	
One Mile Beach	Car Park - One Mile Beach (SLSC)	Car Park	Low	Medium	High		Revise Hazard Lines Based on Geological Data; Append Asset Management Plan; Investigate Future Replacement Action	Relocate Asset and Accept Impacts e.g. reconfigure site and accept some loss of land	
One Mile Beach	Car Park - One Mile Beach (South)	Car Park	Medium	High	High		Revise Hazard Lines Based on Geological Data; Append Asset Management Plan; Investigate Future Replacement Action	Relocate Asset and Accept Impacts e.g. reconfigure site and accept some loss of land	
One Mile Beach	Beach Accessway	Community Facilities	Medium	High	High		Beach Access Management; Revise Hazard Lines Based on Geological Data	Relocate Asset progressively landward	
One Mile Beach	Beach Accessway (4WD)	Community Facilities	Medium	High	High		Beach Access Management; Revise Hazard Lines Based on Geological Data	Relocate Asset progressively landward	
One Mile Beach	Littoral Rainforest (SEPP26)	Ecological Assets	High	Extreme	Extreme	*Yes*	Investigate Habitat Preservation Option (Translocation, Migration, etc); Revise Hazard Lines Based on Geological Data	Base decision on outcomes of No Regrets Action	
One Mile Beach	BURRAWONG PL	Minor Road	N/A	Low	Medium				
One Mile Beach	CLIFF RD	Minor Road	High	Extreme	Extreme	*Yes*	Revise Hazard Lines Based on Geological Data; Append Asset Management Plan; Investigate Future Replacement Action	Relocate Asset (i.e. re-route the roadway)	Retrofit / redesign roadway to withstand impacts
One Mile Beach	KONDA PL	Minor Road	N/A	Low	Medium				
One Mile Beach	PALMGROVE PL	Minor Road	N/A	Low	Medium				
One Mile Beach	STRAND ST	Minor Road	N/A	Low	Medium				
One Mile Beach	Bennetts Head Reserve	Parks and Reserves	Low	Medium	Medium				
One Mile Beach	Collendina Reserve	Parks and Reserves	N/A	Low	Low				
One Mile Beach	Foreshore Reserve - One Mile Beach	Parks and Reserves	Low	Medium	Medium				
One Mile Beach	Palmgrove Park	Parks and Reserves	Low	Medium	Medium				
One Mile Beach	Foster-Tuncurry Golf Course	Public Recreation and Open Space	N/A	Low	Low				
One Mile Beach	Public Recreation	Public Recreation and Open Space	N/A	Low	Low				
One Mile Beach	Residential Property	Residential Development	N/A	Medium	High		Revise Hazard Lines Based on Geological Data; Coastal DCP; LEP Update		
One Mile Beach	Sewer Line - Gravity Main	Sewer Infrastructure - MCW	N/A	Medium	High		Revise Hazard Lines Based on Geological Data; Append Asset Management Plan (MCW)	Relocate Asset	Retrofit / redesign to withstand impacts
One Mile Beach	Water Line - reticulation	Water Infrastructure - MCW	N/A	Medium	High		Revise Hazard Lines Based on Geological Data; Append Asset Management Plan (MCW)	Relocate Asset	Retrofit / redesign to withstand impacts

Beach	Asset Name	Asset Type	Present Day	2060	2100	Immediate Man't Req'd	No Regrets Actions Implement Now	Option 1 (Recommended)	Option 2
One Mile Beach	Stormwater Drainage Lines	Stormwater Infrastructure - GLC	High	Extreme	Extreme	*Yes*	Revise Hazard Lines Based on Geological Data; Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 Recommended); Coastal Hazard Construction Checklist	Relocate Asset (i.e. move outlet landward progressively)	Retrofit / redesign to withstand impacts
One Mile Beach	Stormwater Outlet	Stormwater Infrastructure - GLC	High	Extreme	Extreme	*Yes*	Revise Hazard Lines Based on Geological Data; Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 Recommended); Coastal Hazard Construction Checklist	Relocate Asset (i.e. move outlet landward progressively)	Retrofit / redesign to withstand impacts
One Mile Beach	Cape Hawke SLSC	SLSC	Medium	High	High		Revise Hazard Lines Based on Geological Data; Coastal DCP; LEP Update	Relocate Asset	Retrofit / redesign to withstand impacts
One Mile Beach	Cycleway (One Mile Beach reserve)	Walkway / Cycleway	Low	Medium	High		Revise Hazard Lines Based on Geological Data; Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 Recommended); Coastal Hazard Construction Checklist	Relocate Asset	Accept Impacts
One Mile Beach	Footpath (One Mile Beach reserve)	Walkway / Cycleway	N/A	Low	Low				
One Mile Beach	Footpath (Konda Pl/Underwood - End)	Walkway / Cycleway	N/A	Low	Low				
Seven Mile Beach	Seven Mile Beach	Beaches, Dunes and Foreshore	Low	Medium	Medium		Monitoring, Coastal Hazard Construction Checklist, Community Education	Accept Impacts (i.e. erosion and loss of land)	
Seven Mile Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Medium	Medium		Dune Management; Heritage Management, Community Education	Accept Impacts (i.e. erosion and loss of land/asset)	
Seven Mile Beach	Booti Booti State Rec Camp Ground	Camping Grounds / Reserves	Low	Low	Medium		Coastal DCP; LEP Update		
Seven Mile Beach	Beach Accessway	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset progressively landward	
Seven Mile Beach	Beach Accessway (4WD)	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset progressively landward	
Seven Mile Beach	Littoral Rainforest (SEPP26)	Ecological Assets	High	Extreme	Extreme	*Yes*	Investigate Habitat Preservation Option (Translocation, Migration, etc); Revise Hazard Lines Based on Geological Data	Base decision on outcomes of No Regrets Action	
Seven Mile Beach	Environmental Management	Environmental Protection Zone	Low	Medium	Medium				
Seven Mile Beach	THE LAKES WAY	Major Road	N/A	Low	Medium				
Seven Mile Beach	Ruins Camp Road	Minor Road	Low	Low	Medium				
Seven Mile Beach	Booti Booti National Park	National Park	Low	Medium	Medium				
Seven Mile Beach	Unformed Road	Road Reserve	N/A	Low	Low				
Seven Mile Beach	Sewer Line - Gravity Main	Sewer Infrastructure - MCW	Medium	High	High		Append Asset Management Plan (MCW)	Relocate Asset	Retrofit / redesign to withstand impacts
Seven Mile Beach	Sundowner Tiona Tourist Park	Tourist / Holiday / Caravan Parks	Medium	High	High		Coastal DCP, LEP Update	Relocate Assets and Accept Impacts, i.e. reconfigure site, allowing sacrifice of eroded land, relocation or replacement of facilities, and re-arrangement of campsites on the site	
Elizabeth Beach	Elizabeth Beach	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Monitoring, Coastal Hazard Construction Checklist, Community Education	Accept Impacts (i.e. erosion and loss of land)	
Elizabeth Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Revise Hazard Lines Based on Geological Data; Dune Management; Heritage Management, Community Education	Accept Impacts (i.e. erosion and loss of land/asset)	
Elizabeth Beach	Car Park - Elizabeth Beach (North)	Car Park	Medium	High	High		Revise Hazard Lines Based on Geological Data; Append Asset Management Plan; Investigate Future Replacement Action; Coastal Hazard Construction Checklist	Relocate Asset and Accept Impacts e.g. reconfigure site and accept some loss of land	
Elizabeth Beach	Stormwater Drainage Line	Stormwater Infrastructure - GLC	Medium	High	High		Revise Hazard Lines Based on Geological Data; Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 Recommended); Coastal Hazard Construction Checklist	Relocate Asset (i.e. move outlet landward progressively)	Retrofit / redesign to withstand impacts
Elizabeth Beach	LETHBRIDGE RD	Minor Road	Low	Low	Medium				
Elizabeth Beach	Beach Accessway(s)	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset progressively landward	
Elizabeth Beach	Car Park - Elizabeth Beach (SLSC)	Car Park	Low	Medium	High		Append Asset Management Plan; Investigate Future Replacement Action; Coastal Hazard Construction Checklist	Relocate Asset and Accept Impacts e.g. reconfigure site and accept some loss of land	
Elizabeth Beach	Water Line - reticulation	Water Infrastructure - MCW	High	High	Extreme	*Yes*	Append Asset Management Plan (MCW); ; Investigate Future Replacement Action in combination with Action for Lakeside Crescent (see below)	Relocate Asset (with re-routed roadway, see below)	Retrofit / redesign roadway to withstand impacts
Elizabeth Beach	LAKESIDE CR	Major Road	High	Extreme	Extreme	*Yes*	Append Asset Management Plan; Investigate Future Replacement Action in combination with Action for Water Line - Reticulaion (see above); Coastal Hazard Construction Checklist	Relocate Asset (i.e. re-route the roadway)	Retrofit / redesign roadway to withstand impacts
Elizabeth Beach	Environmental Conservation	Environmental Protection Zone	Low	Low	Medium				
Elizabeth Beach	Booti Booti National Park	National Park	Low	Medium	Medium				

Beach	Asset Name	Asset Type	Present Day	2060	2100	Immediate Man't Req'd	No Regrets Actions Implement Now	Option 1 (Recommended)	Option 2
Elizabeth Beach	National Parks and Nature Reserves	National Park	N/A	Low	Low				
Elizabeth Beach	Elizabeth Creek	Natural Watercourse	Low	Medium	Medium				
Elizabeth Beach	Culvert - Lakeside Cr	Stormwater Infrastructure - GLC	*Unknown*	*Unknown*	*Unknown*		Revise Hazard Lines Based on Geological Data; Append Asset Management Plan; Investigate Future Replacement Action; Coastal Hazard Construction Checklist	Redesign / Retrofit to withstand impacts	Accept Impacts
Elizabeth Beach	Elizabeth Creek	Waterway	*Unknown*	*Unknown*	*Unknown*		Revise Hazard Lines Based on Geological Data; Append Asset Management Plan; Investigate Future Replacement Action	Redesign / Retrofit to withstand impacts	Accept Impacts
Elizabeth Beach	Boat Ramp - Elizabeth Beach (east)	Community Facilities	*Unknown*	*Unknown*	*Unknown*		Revise Hazard Lines Based on Geological Data; Append Asset Management Plan; Investigate Future Replacement Action; Coastal Hazard Construction Checklist	Redesign / Retrofit to withstand impacts	Accept Impacts
Elizabeth Beach	Car Park - Elizabeth Beach (east)	Car Park	*Unknown*	*Unknown*	*Unknown*		Revise Hazard Lines Based on Geological Data; Append Asset Management Plan; Investigate Future Replacement Action; Coastal Hazard Construction Checklist	Redesign / Retrofit to withstand impacts	Accept Impacts
Boomerang Beach	Boomerang Beach (north of Boomerang Beach Road entrance)	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Monitoring, Coastal Hazard Construction Checklist, Community Education	Accept Impacts (i.e. erosion and loss of land)	
Boomerang Beach	Dunes and Dune Vegetation (north of Boomerang Beach Road entrance)	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Dune Management; Heritage Management, Community Education	Accept Impacts (i.e. erosion and loss of land/asset)	
Boomerang Beach	Beach Accessway	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset progressively landward	
Boomerang Beach	Environmental Management	Environmental Protection Zone	Low	Low	Medium				
Boomerang Beach	Open Space - Boomerang Beach (north)	Public Recreation and Open Space	N/A	Low	Low				
Boomerang Beach	Boomerang Beach Road	Minor Road	Low	Medium	High		Append Asset Management Plan; Investigate Future Replacement Action	Convert to a shared cycle/walking path, and Accept Loss, if and when erosion impacts occur.	
Boomerang Beach	Stormwater Drainage Line (3 in total, centre and northern end of beach)	Stormwater Infrastructure - GLC	Medium	High	Extreme		Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 Recommended); Coastal Hazard Construction Checklist	Relocate Asset (i.e. move outlet landward progressively)	Retrofit / redesign to withstand impacts
Boomerang Beach	Residential Property (4 lots on Boomerang Dr, immediately north of entrance onto Boomerang Beach Rd. Includes 8 of the Oceanside Beachfront Apartments)	Residential Development	N/A	Medium	High		Coastal DCP; LEP Update	May incidentally benefit from Beach Nourishment option further south (though wave transport of sand)	Planned Retreat
Boomerang Beach	Car Park - Boomerang Beach (south)	Car Park	Low	Medium	High		Append Asset Management Plan; Investigate Future Replacement Action (refer to Option 1 & 2); Coastal Hazard Construction Checklist	May incidentally benefit from Beach Nourishment option further south (though wave transport of sand)	Relocate Asset and Accept Impacts e.g. reconfigure site and accept some loss of land
Boomerang Beach	Beach Accessway (from southern Car Park)	Community Facilities	Medium	High	High		Beach Access Management	May incidentally benefit from Beach Nourishment option further south (though wave transport of sand)	Relocate Asset progressively landward
Boomerang Beach	Residential Property (southern foreshore = 2 lots on Boomerang Dr, south of Boomerang Beach Road)	Residential Development	Medium	High	Extreme		Coastal DCP; LEP Update	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	Residential Property (southern foreshore = 11 lots on Boomerang Dr, south of Boomerang Beach Road)	Residential Development	High	Extreme	Extreme	*Yes*	Coastal DCP; LEP Update	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	BOOMERANG DR	Major Road	Medium	Extreme	Extreme		Append Asset Management Plan; Investigate Future Replacement Action, in combination with option selected for South Boomerang	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	Water Line - reticulation (southern foreshore, along Boomerang Dr)	Water Infrastructure - MCW	Medium	High	Extreme		Append Asset Management Plan (MCW); Consultation with MCW wrt option for South Boomerang	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	Boomerang Beach (south of Boomerang Beach Rd entrance)	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Monitoring, Coastal Hazard Construction Checklist, Community Education	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.

Beach	Asset Name	Asset Type	Present Day	2060	2100	Immediate Man't Req'd	No Regrets Actions Implement Now	Option 1 (Recommended)	Option 2
Boomerang Beach	Dunes and Dune Vegetation (south of Boomerang Beach Rd entrance)	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Dune Management; Heritage Management, Community Education	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	Beach Accessway (southern foreshore)	Community Facilities	Medium	High	High		Beach Access Management	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	Viewing Platform - Boomerang Beach (far south)	Community Facilities	Low	Medium	Medium		Beach Access Management	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	Sewer Line - Rising Main (southern foreshore, along Boomerang Dr)	Sewer Infrastructure - MCW	Medium	High	Extreme		Append Asset Management Plan (MCW); Consultation with MCW wrt option for South Boomerang	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	Stormwater Drainage Line (southern foreshore, along Boomerang Dr)	Stormwater Infrastructure - GLC	Medium	High	Extreme		Append Asset Management Plan; Investigate Future Replacement Action, in combination with option selected for South Boomerang; Coastal Hazard Construction Checklist	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	RED GUM RD	Minor Road	N/A	Medium	High		Append Asset Management Plan; Investigate Future Replacement Action, in combination with option selected for South Boomerang	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	Residential Property (5 lots, landward side of Boomerang Dr. 4 of these are vacant lots)	Residential Development	N/A	Medium	High		Coastal DCP; LEP Update	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	Sewer Line - Gravity Main (southern foreshore)	Sewer Infrastructure - MCW	Medium	High	Extreme		Append Asset Management Plan (MCW); ; Consultation with MCW wrt option for South Boomerang	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	Cycleway (Boomerang Dr-Headland Rd)	Walkway / Cycleway	Low	Medium	High		Append Asset Management Plan; Investigate Future Replacement Action, in combination with option selected for South Boomerang	Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Boomerang Beach	Footpath (Cnr Red Gum Rd/Boomerang Dr)	Walkway / Cycleway	N/A	Low	Low			Beach Nourishment (See Southern Boomerang Options Assessment in report)	Option 2: Seawall (with nourishment for offsite impacts) Option 3: Planned Retreat See Southern Boomerang Options Assessment in report.
Blueys Beach	Blueys Beach	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Monitoring, Coastal Hazard Construction Checklist, Community Education	Accept Impacts (i.e. erosion and loss of land)	
Blueys Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Dune Management; Heritage Management, Community Education	Accept Impacts (i.e. erosion and loss of land/asset)	
Blueys Beach	Beach Accessway (northern foreshore)	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset progressively landward	
Blueys Beach	Environmental Management	Environmental Protection Zone	Low	Medium	Medium				
Blueys Beach	BLUEYS WAY	Major Road	Low	Low	Medium				
Blueys Beach	VIEW ST	Minor Road	N/A	Low	Low				
Blueys Beach	Residential Property (9 lots)	Residential Development	Medium	High	Extreme		Coastal DCP; LEP Update		
Blueys Beach	Residential Property (37 lots)	Residential Development	N/A	Medium	High		Coastal DCP; LEP Update		
Blueys Beach	SAMUEL ST	Road Reserve	N/A	Low	Low				
Blueys Beach	Stormwater Outlet (northern beach)	Stormwater Infrastructure - GLC	High	Extreme	Extreme	*Yes*	Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 Recommended); Coastal Hazard Construction Checklist	Relocate Asset (i.e. move outlet landward progressively)	Retrofit / redesign to withstand impacts

Beach	Asset Name	Asset Type	Present Day	2060	2100	Immediate Man't Req'd	No Regrets Actions Implement Now	Option 1 (Recommended)	Option 2
Blueys Beach	Sewer Line - Gravity Main (northern foreshore)	Sewer Infrastructure - MCW	Medium	High	Extreme		Append Asset Management Plan (MCW)	Relocate Asset (i.e. westward of foreshore houses)	Retrofit / redesign to withstand impacts. Should this involve protection, must be combined decision with GLC and foreshore landowners who would also benefit from protection works. Protection is not recommended due to significant detrimental impacts to beach and dunes.
Blueys Beach	Water Line - reticulation (northern foreshore)	Water Infrastructure - MCW	N/A	Medium	High		Append Asset Management Plan (MCW)	Relocate Asset	Retrofit / redesign to withstand impacts
Blueys Beach	NEWMAN AVE	Minor Road	Medium	High	Extreme		Append Asset Management Plan; Investigate Future Replacement Action	Relocate Asset (i.e. re-route the roadway). Do in combination with MCW for water and sewer assets	Retrofit / redesign roadway to withstand impacts
Blueys Beach	Stormwater Drainage Line(s) (Newman Avenue)	Stormwater Infrastructure - GLC	N/A	Medium	High		Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 Recommended); Coastal Hazard Construction Checklist	Relocate Asset (do in combination with MCW for water and sewer assets)	Retrofit / redesign to withstand impacts
Blueys Beach	Sewer Pump Station - Newman Avenue	Sewer Infrastructure - MCW	N/A	Medium	High		Append Asset Management Plan (MCW)	Relocate Asset (in combination with Council for road and stormwater assets)	Retrofit / redesign to withstand impacts
Blueys Beach	Sewer Line - Rising Main & Gravity Main (Newman Avenue)	Sewer Infrastructure - MCW	N/A	Medium	High		Append Asset Management Plan (MCW)	Relocate Asset (in combination with Council for road and stormwater assets)	Retrofit / redesign to withstand impacts
Blueys Beach	Water Line - reticulation (Newman Avenue)	Water Infrastructure - MCW	N/A	Medium	High		Append Asset Management Plan (MCW)	Relocate Asset (in combination with Council for road and stormwater assets)	Retrofit / redesign to withstand impacts
Blueys Beach	Beach Accessway (southern foreshore)	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset progressively landward	
Blueys Beach	Car Park - Blueys Beach (south)	Car Park	N/A	Low	Medium				
Blueys Beach	Amenities / Block / Shed - Blueys Beach (south)	Community Facilities	N/A	Low	Medium				
Sandbar Beach	Sandbar Beach	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Monitoring, Coastal Hazard Construction Checklist, Community Education	Accept Impacts (i.e. erosion and loss of land)	
Sandbar Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Dune Management; Heritage Management, Community Education	Accept Impacts (i.e. erosion and loss of land/asset)	
Sandbar Beach	Beach Accessway	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset progressively landward	
Sandbar Beach	Beach Accessway (4WD)	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset progressively landward	
Sandbar Beach	Littoral Rainforest (SEPP26)	Ecological Assets	N/A	Medium	High		Investigate Habitat Preservation Option (Translocation, Migration, etc); Revise Hazard Lines Based on Geological Data	Base decision on outcomes of No Regrets Action	
Sandbar Beach	Environmental Management	Environmental Protection Zone	Low	Medium	Medium				
Sandbar Beach	National Parks and Nature Reserves	National Park	Low	Low	Medium				
Sandbar Beach	Natural Waterways	Natural Watercourse	Low	Medium	Medium				
Sandbar Beach	Smiths Lake	Natural Watercourse	Low	Medium	Medium				
Sandbar Beach	Smiths Lake Entrance	Natural Watercourse	Low	Medium	Medium				
Number One Beach - Seal Rocks	Number One Beach	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Revise Hazard Lines Based on Geological Data inc. extending lines along entire beach; Monitoring, Coastal Hazard Construction Checklist, Community Education	Accept Impacts (i.e. erosion and loss of land)	
Number One Beach - Seal Rocks	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Revise Hazard Lines Based on Geological Data inc. extending lines along entire beach; Dune Management; Heritage Management, Community Education	Accept Impacts (i.e. erosion and loss of land/asset)	
Number One Beach - Seal Rocks	Car Park - Number One Beach	Car Park	Medium	High	High		Revise Hazard Lines Based on Geological Data inc. extending lines along entire beach; Seal Rocks Public Domain Plan / POM		Extend Protection along entire road (not recommended due to significant degradation of beach amenity, eventual loss of beach)
Number One Beach - Seal Rocks	Beach Accessway	Community Facilities	Medium	High	High		Beach Access Management, Revise Hazard Lines Based on Geological Data inc. extending lines along entire beach; Seal Rocks Public Domain Plan / POM	Relocate Asset progressively landward	Extend Protection along entire road (not recommended due to significant degradation of beach amenity, eventual loss of beach)
Number One Beach - Seal Rocks	Environmental Management	Environmental Protection Zone	Low	Medium	Medium				
Number One Beach - Seal Rocks	SEAL ROCKS RD	Major Road	High	Extreme	Extreme	*Yes*	Revise Hazard Lines Based on Geological Data inc. extending lines along entire beach; Investigate Re-aligning Seal Rocks Road; Seal Rocks Public Domain Plan / POM	Re-align Seal Rocks Road.	Extend Protection along entire road (not recommended due to significant degradation of beach amenity, eventual loss of beach)
Number One Beach - Seal Rocks	Seawall - Number One Beach	Waterway Infrastructure	*Unknown*	*Unknown*	*Unknown*		Revise Hazard Lines Based on Geological Data inc. extending lines along entire beach; Investigate Re-aligning Seal Rocks Road; Seal Rocks Public Domain Plan / POM	Remove asset, as part of re-aligning Seal Rocks Road)	Extend Protection along entire road (not recommended due to significant degradation of beach amenity, eventual loss of beach)
Number One Beach - Seal Rocks	Myall Lakes National Park	National Park	Low	Medium	Medium				
Number One Beach - Seal Rocks	Seal Rocks Holiday Park and Camping Reserve	Tourist / Holiday / Caravan Parks	Medium	High	High		Coastal DCP; LEP Update; Seal Rocks Public Domain Plan / POM	Relocate Assets and Accept Impacts, i.e. reconfigure site, allowing sacrifice of eroded land, relocation or replacement of facilities, and re-arrangement of campsites on the site	Extend Protection along entire road (not recommended due to significant degradation of beach amenity, eventual loss of beach)

Beach	Asset Name	Asset Type	Present Day	2060	2100	Immediate Man't Req'd	No Regrets Actions Implement Now	Option 1 (Recommended)	Option 2
Boat Beach - Seal Rocks	Boat Beach	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Monitoring, Coastal Hazard Construction Checklist, Community Education	Accept Impacts (i.e. erosion and loss of land)	
Boat Beach - Seal Rocks	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Revise Hazard Lines Based on Geological Data; Dune Management; Heritage Management, Community Education	Accept Impacts (i.e. erosion and loss of land/asset)	
Boat Beach - Seal Rocks	Boat Ramp - Boat Beach (east)	Community Facilities	Medium	High	High		Append Asset Management Plan; Investigate Future Replacement Action; Coastal Hazard Construction Checklist	Relocate Asset (e.g. move boat access progressively landward)	Investigate protection of Kinka Road, which shall include provision of boat access and parking. (Not recommended due to very high environmental impacts, including "locking up" the sand in substantial dunes behind the beach)
Boat Beach - Seal Rocks	Boat Ramp - Boat Beach (middle)	Community Facilities	Medium	High	High		Append Asset Management Plan; Investigate Future Replacement Action; Coastal Hazard Construction Checklist;	Relocate Asset (e.g. move boat access progressively landward)	Investigate protection of Kinka Road, which shall include provision of boat access and parking. (Not recommended due to very high environmental impacts, including "locking up" the sand in substantial dunes behind the beach)
Boat Beach - Seal Rocks	Environmental Management	Environmental Protection Zone	Low	Medium	Medium				
Boat Beach - Seal Rocks	Beach Access Road	Minor Road	High	Extreme	Extreme	*Yes*	Revise Hazard Lines Based on Geological Data	Relocate Asset (i.e. re-route the roadway)	Investigate protection of Kinka Road, which shall include provision of boat access and parking. (Not recommended due to very high environmental impacts, including "locking up" the sand in substantial dunes behind the beach)
Boat Beach - Seal Rocks	KINKA RD	Minor Road	High	Extreme	Extreme	*Yes*	Revise Hazard Lines Based on Geological Data	Relocate Asset (i.e. re-route the roadway)	Investigate protection of Kinka Road, which shall include provision of boat access and parking. (Not recommended due to very high environmental impacts, including "locking up" the sand in substantial dunes behind the beach)
Boat Beach - Seal Rocks	Unformed Road	Road Reserve	Low	Low	Medium				
Boat Beach - Seal Rocks	Rural Property	Rural Zoned Land	Low	Medium	High		Coastal DCP; LEP Update; Revise Hazard Lines Based on Geological Data		Investigate protection of Kinka Road, which shall include provision of boat access and parking. (Not recommended due to very high environmental impacts, including "locking up" the sand in substantial dunes behind the beach)
Bennetts Beach	Bennetts Beach	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Monitoring, Coastal Hazard Construction Checklist, Community Education	Accept Impacts (i.e. erosion and loss of land)	
Bennetts Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	High	Extreme	Extreme	*Yes*	Dune Management; Heritage Management, Community Education	Accept Impacts (i.e. erosion and loss of land/asset)	
Bennetts Beach	Car Park - Bennetts Beach	Car Park	Low	Medium	High		Append Asset Management Plan; Investigate Future Replacement Action; Coastal Hazard Construction Checklist	Relocate Asset and Accept Impacts e.g. reconfigure site and accept some loss of land	
Bennetts Beach	Beach Accessway	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset progressively landward	
Bennetts Beach	Beach Accessway (4WD)	Community Facilities	Medium	High	High		Beach Access Management	Relocate Asset progressively landward	
Bennetts Beach	Picnic Area - Tea Gardens - Hawks Nest	Community Facilities	Low	Low	Medium				
Bennetts Beach	Beach Rd	Minor Road	Low	Low	Medium				
Bennetts Beach	BOONER ST	Minor Road	N/A	Low	Low				
Bennetts Beach	MIRREEN ST	Minor Road	N/A	Low	Low				
Bennetts Beach	Palilion Reserve	Parks and Reserves	N/A	Low	Low				
Bennetts Beach	Tea Gardens-Hawks Nest SLSC	SLSC	Low	Medium	High		Coastal DCP; LEP Update	Relocate Asset	Retrofit / redesign to withstand impacts
Bennetts Beach	Sewer Line - Gravity Main	Sewer Infrastructure - MCW	Medium	High	High		Append Asset Management Plan (MCW);	Relocate Asset (in association with action for SLSC)	Retrofit / redesign to withstand impacts (in association with action for SLSC)
Bennetts Beach	Stormwater Drainage Line	Stormwater Infrastructure - GLC	Medium	High	High		Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 Recommended); Coastal Hazard Construction Checklist	Relocate Asset	Retrofit / redesign to withstand impacts

Table 5-2 Wave Runup Risk Register

Location	Asset Name	Asset Type	2014	2060	2100	Man't Req'd	No Regrets Actions Implement Now	Option 1 (Recommended)	Option 2
Nine Mile Beach - Tuncurry	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Low	Low				
Nine Mile Beach - Tuncurry	Nine Mile Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
Nine Mile Beach - Tuncurry	Car Park - Nine Mile Beach (South)	Car Park	Low	Low	Low				
Nine Mile Beach - Tuncurry	Beach Accessway	Community Facilities	Low	Low	Low				
Nine Mile Beach - Tuncurry	Beach Accessway (4WD)	Community Facilities	Low	Low	Low				
Nine Mile Beach - Tuncurry	Cycleway (Rockpool Rd/Car Park No.3 (closest to swim area))	Walkway / Cycleway	Medium	High	High		Append Asset Management Plan; Investigate Future Replacement Action	Relocate asset (i.e. re-route the cycleway to avoid impacts)	Retrofit / redesign asset
Nine Mile Beach - Tuncurry	Northern Breakwater	Waterway Infrastructure	Medium	High	High		Append Asset Management Plan (inc define roles and responsibilities for breakwaters, to conduct upgrades on an as needs basis)	Retrofit (i.e. raise) the structure to withstand impacts	
Main Beach - Forster	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Low	Low				
Main Beach - Forster	Forster Main Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
Main Beach - Forster	Southern Breakwater	Waterway Infrastructure	Medium	High	High		Append Asset Management Plan (inc define roles and responsibilities for breakwaters, to conduct upgrades on an as needs basis)	Retrofit (i.e. raise) the structure to withstand impacts	
Main Beach - Forster	Cycleway (Base of Pilot Hill)	Walkway / Cycleway	Medium	High	High		Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 recommended)	Relocate asset (i.e. re-route the cycleway to avoid impacts)	Retrofit / redesign asset
Main Beach - Forster	Cycleway (Southern Breakwall)	Walkway / Cycleway	Medium	High	High		Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 recommended)	Retrofit (in combination with works to raise the breakwater)	
Main Beach - Forster	Public Recreation - Pilot Hill	Public Recreation and Open Space	N/A	Low	Low				
Main Beach - Forster	Public Recreation	Public Recreation and Open Space	Low	Low	Low				
Main Beach - Forster	Beach Accessway	Community Facilities	Low	Low	Low				
Main Beach - Forster	Seawall - Forster	Waterway Infrastructure	Low	Medium	High		Upgrade Existing Seawall		
Main Beach - Forster	Foster Ocean Baths	Community Facilities	Low	Low	Low		Upgrade Existing Seawall		
Main Beach - Forster	NORTH ST	Roadway	Low	Medium	Medium		Upgrade Existing Seawall		
Main Beach - Forster	WEST ST	Minor Road	Low	Medium	Medium		Upgrade Existing Seawall		
Main Beach - Forster	Car Park - Main Beach	Car Park	Low	Low	Low		Upgrade Existing Seawall		
Main Beach - Forster	Residential Property	Residential Development	Low	Medium	High		Upgrade Existing Seawall		
Main Beach - Forster	Second Head Reserve	Parks and Reserves	Low	Low	Low		Upgrade Existing Seawall		
Main Beach - Forster	Sewer Line - Gravity Main	Sewer Infrastructure - MCW	High	Extreme	Extreme	*Yes*	Upgrade Existing Seawall, Append Asset Management Plan (MCW), Materials and Design for Saltwater intrusion		
Main Beach - Forster	Water Line - distributor	Water Infrastructure - MCW	Low	Low	Low		Upgrade Existing Seawall		
Main Beach - Forster	Water Line - reticulation	Water Infrastructure - MCW	Low	Low	Low		Upgrade Existing Seawall		
Main Beach - Forster	Stormwater Drainage Line	Stormwater Infrastructure - GLC	High	Extreme	Extreme	*Yes*	Upgrade Existing Seawall, Append Asset Management Plan, Materials and Design for Saltwater intrusion		
Main Beach - Forster	Stormwater Outlet	Stormwater Infrastructure - GLC	Medium	High	High		Upgrade Existing Seawall, Append Asset Management Plan, Materials and Design for Saltwater intrusion		
Main Beach - Forster	Cycleway (Beach St concourse)	Walkway / Cycleway	N/A	Low	Medium		Upgrade Existing Seawall		
Main Beach - Forster	Cycleway (North St/End of Med - End Kerb and Gutter LHS)	Walkway / Cycleway	Medium	High	High		Upgrade Existing Seawall		
Main Beach - Forster	Cycleway (West St/Head - North)	Walkway / Cycleway	Medium	High	High		Upgrade Existing Seawall		
Main Beach - Forster	Footpath (Forster Ocean Baths)	Walkway / Cycleway	Low	Medium	Medium		Upgrade Existing Seawall		
Main Beach - Forster	Footpath (North St Car Park/Ocean Baths (Opp West St))	Walkway / Cycleway	Low	Medium	Medium		Upgrade Existing Seawall		
Main Beach - Forster	Footpath (North St/End of Med - End Kerb and Gutter LHS)	Walkway / Cycleway	Low	Medium	Medium		Upgrade Existing Seawall		
Main Beach - Forster	Footpath (Second Head)	Walkway / Cycleway	Low	Low	Medium		Upgrade Existing Seawall		
Main Beach - Forster	Footpath (West St/North - Head)	Walkway / Cycleway	Low	Low	Medium		Upgrade Existing Seawall		
Pebbly Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Low	Low				
Pebbly Beach	Pebbly Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
Pebbly Beach	Rocky shoreline	Beaches, Dunes and Foreshore	Low	Low	Low				
Pebbly Beach	Beach Accessway	Community Facilities	Low	Low	Low				

Location	Asset Name	Asset Type	2014	2060	2100	Man't Req'd	No Regrets Actions Implement Now	Option 1 (Recommended)	Option 2
Pebbly Beach	Pebbly Beach Bicentennial Park	Parks and Reserves	Low	Low	Low				
Pebbly Beach	Second Head Reserve	Parks and Reserves	Low	Low	Low				
Pebbly Beach	Cycleway (Pebbly Beach)	Walkway / Cycleway	Medium	High	High		Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 recommended)	Relocate asset (i.e. re-route the cycleway to avoid impacts)	Retrofit / redesign asset
Pebbly Beach	Footpath (Second Head)	Walkway / Cycleway	Low	Medium	Medium				
One Mile Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Low	Low				
One Mile Beach	One Mile Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
One Mile Beach	Car Park - One Mile Beach (SLSC)	Car Park	Low	Low	Low				
One Mile Beach	Car Park - One Mile Beach (South)	Car Park	Low	Low	Low				
One Mile Beach	Beach Accessway	Community Facilities	Low	Low	Low				
One Mile Beach	Beach Accessway (4WD)	Community Facilities	Low	Low	Low				
One Mile Beach	Littoral Rainforest (SEPP26)	Ecological Assets	Medium	High	High		Investigate Habitat Preservation Options (Translocation, Migration, etc)		
One Mile Beach	BURRAWONG PL	Minor Road	N/A	Low	Low				
One Mile Beach	CLIFF RD	Minor Road	N/A	Low	Low				
One Mile Beach	KONDA PL	Minor Road	Low	Medium	Medium				
One Mile Beach	PALMGROVE PL	Minor Road	Low	Medium	Medium				
One Mile Beach	UNDERWOOD RD	Minor Road	N/A	Low	Low				
One Mile Beach	Bennetts Head Reserve	Parks and Reserves	Low	Low	Low				
One Mile Beach	Foreshore Reserve - One Mile Beach	Parks and Reserves	Low	Low	Low				
One Mile Beach	Palmgrove Park	Parks and Reserves	Low	Low	Low				
One Mile Beach	Public Recreation	Public Recreation and Open Space	N/A	Low	Low				
One Mile Beach	Residential Property	Residential Development	Medium	High	High		Coastal DCP; LEP Update, Dune Management (to enhance height of dunes)		
One Mile Beach	Sewer Line - Gravity Main	Sewer Infrastructure - MCW	High	Extreme	Extreme	*Yes*	Append Asset Management Plan (MCW), Materials and Design for Saltwater intrusion	Relocate Asset	Retrofit / redesign to withstand impacts
One Mile Beach	Sewer Line - Rising Main	Sewer Infrastructure - MCW	High	Extreme	Extreme	*Yes*	Append Asset Management Plan (MCW), Materials and Design for Saltwater intrusion	Relocate Asset	Retrofit / redesign to withstand impacts
One Mile Beach	Sewer Pump Station - Palmgrove Pl	Sewer Infrastructure - MCW	High	Extreme	Extreme	*Yes*	Append Asset Management Plan (MCW), Materials and Design for Saltwater intrusion	Relocate Asset	Retrofit / redesign to withstand impacts
One Mile Beach	Cape Hawke SLSC	SLSC	Medium	High	High		Coastal DCP; LEP Update, Dune Management (to enhance height of dunes)		
One Mile Beach	Stormwater Drainage Line	Stormwater Infrastructure - GLC	High	Extreme	Extreme	*Yes*	Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 Recommended), Coastal Hazard Construction Checklist, Materials and Design for Saltwater intrusion	Relocate Asset	Retrofit / redesign to withstand impacts
One Mile Beach	Stormwater Outlet	Stormwater Infrastructure - GLC	Medium	High	High		Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 Recommended), Coastal Hazard Construction Checklist, Materials and Design for Saltwater intrusion	Relocate Asset	Retrofit / redesign to withstand impacts
One Mile Beach	Cycleway (One Mile Beach reserve)	Walkway / Cycleway	N/A	Low	Medium				
One Mile Beach	Footpath (Konda Pl/Underwood - End)	Walkway / Cycleway	Low	Medium	Medium				
One Mile Beach	Footpath (One Mile Beach reserve)	Walkway / Cycleway	Low	Medium	Medium				
One Mile Beach	Water Line - reticulation	Water Infrastructure - MCW	Low	Low	Low				
Burgess Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Low	Low				
Burgess Beach	Beach Accessway	Community Facilities	Low	Low	Low				
Burgess Beach	Littoral Rainforest (SEPP26)	Ecological Assets	Medium	High	High		Investigate Habitat Preservation Options (Translocation, Migration, etc)		
Burgess Beach	Public Recreation	Public Recreation and Open Space	Low	Low	Low				
Burgess Beach	Rocky shoreline	Public Recreation and Open Space	Low	Low	Low				
Seven Mile Beach	Seven Mile Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
Seven Mile Beach	Beach Accessway	Community Facilities	Low	Low	Low				
Seven Mile Beach	Beach Accessway (4WD)	Community Facilities	Low	Low	Low				
Seven Mile Beach	Littoral Rainforest (SEPP26)	Ecological Assets	Medium	High	High		Investigate Habitat Preservation Options (Translocation, Migration, etc)		
Seven Mile Beach	Environmental Management	Environmental Protection Zone	Low	Low	Low				

Location	Asset Name	Asset Type	2014	2060	2100	Man't Req'd	No Regrets Actions Implement Now	Option 1 (Recommended)	Option 2
Seven Mile Beach	Booti Booti National Park	National Park	Low	Low	Low				
Elizabeth Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Low	Low				
Elizabeth Beach	Elizabeth Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
Elizabeth Beach	Car Park - Elizabeth Beach (South)	Car Park	Low	Low	Low				
Elizabeth Beach	Beach Accessway	Community Facilities	Low	Low	Low				
Elizabeth Beach	Boat Ramp - Elizabeth Beach (South)	Community Facilities	Low	Low	Low				
Elizabeth Beach	Booti Booti National Park	National Park	Low	Low	Low				
Elizabeth Beach	Elizabeth Creek	Natural Watercourse	Low	Low	Low				
Elizabeth Beach	LAKESIDE CR	Major Road	Medium	High	High		Append Asset Management Plan; Investigate Future Replacement Action (in combination with assessment to manage coastal erosion risks); Coastal Hazard Construction Checklist	Relocate Asset (i.e. re-route the roadway)	Retrofit / redesign roadway to withstand impacts
Elizabeth Beach	Culvert - Lakeside Cr	Stormwater Infrastructure - GLC	High	Extreme	Extreme	*Yes*	Append Asset Management Plan; Investigate Future Replacement Action (Culvert provides outlet of Elizabeth Creek to beach under Lakeside Cr, combine with action to manage roadway), Coastal Hazard Construction Checklist, Materials and Design for Saltwater intrusion	Relocate Asset (in combination with roadway)	Retrofit / redesign roadway to withstand impacts
Elizabeth Beach	Water Line - reticulation	Water Infrastructure - MCW	Low	Low	Low				
Boomerang Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Low	Low				
Boomerang Beach	Beach Accessway	Community Facilities	Low	Low	Low				
Blueys Beach	Blueys Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
Blueys Beach	Boomerang Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
Blueys Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Low	Low				
Blueys Beach	Car Park - Blueys Beach (south)	Car Park	Low	Low	Low				
Blueys Beach	Beach Accessway	Community Facilities	Low	Low	Low				
Blueys Beach	Boomerang Point Environmental Conservartion Area	Environmental Protection Zone	Low	Low	Low				
Blueys Beach	Environmental Conservation Area	Environmental Protection Zone	Low	Low	Low				
Blueys Beach	Environmental Living	Environmental Protection Zone	Low	Low	Low				
Blueys Beach	Environmental Management	Environmental Protection Zone	Low	Low	Low				
Blueys Beach	AMPAT PL	Minor Road	Low	Medium	Medium				
Blueys Beach	NEWMAN AVE	Minor Road	Low	Medium	Medium				
Blueys Beach	Unnamed Road Reserve / Laneway	Roadway	Low	Low	Medium				
Blueys Beach	Residential Property	Residential Development	Medium	High	High		Coastal DCP; LEP Update, Combined Flood Study		
Blueys Beach	Sewer Line - Gravity Main	Sewer Infrastructure - MCW	High	Extreme	Extreme	*Yes*	Append Asset Management Plan (MCW), Materials and Design for Saltwater intrusion, Combined Flood Study	Relocate Asset	Retrofit / redesign to withstand impacts
Blueys Beach	Sewer Line - Rising Main	Sewer Infrastructure - MCW	High	Extreme	Extreme	*Yes*	Append Asset Management Plan (MCW), Materials and Design for Saltwater intrusion, Combined Flood Study	Relocate Asset	Retrofit / redesign to withstand impacts
Blueys Beach	Sewer Pump Station - Newmans Ave	Sewer Infrastructure - MCW	High	Extreme	Extreme	*Yes*	Append Asset Management Plan (MCW), Materials and Design for Saltwater intrusion, Combined Flood Study	Relocate Asset	Retrofit / redesign to withstand impacts
Blueys Beach	Stormwater Drainage Line	Stormwater Infrastructure - GLC	High	Extreme	Extreme	*Yes*	Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 Recommended), Combined Flood Study, Coastal Hazard Construction Checklist, Materials and Design for Saltwater intrusion	Relocate Asset	Retrofit / redesign to withstand impacts
Blueys Beach	Stormwater Outlet	Stormwater Infrastructure - GLC	Medium	High	High		Append Asset Management Plan; Investigate Future Replacement Action (see Option 1 Recommended), Combined Flood Study, Coastal Hazard Construction Checklist, Materials and Design for Saltwater intrusion	Relocate Asset	Retrofit / redesign to withstand impacts
Blueys Beach	Water Line - reticulation	Water Infrastructure - MCW	Low	Low	Low				
Sandbar Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Low	Low				
Sandbar Beach	Sandbar Beach	Beaches, Dunes and Foreshore	Low	Low	Low				

Location	Asset Name	Asset Type	2014	2060	2100	Man't Req'd	No Regrets Actions Implement Now	Option 1 (Recommended)	Option 2
Sandbar Beach	Beach Accessway	Community Facilities	Low	Low	Low				
Sandbar Beach	Beach Accessway (4WD)	Community Facilities	Low	Low	Low				
Sandbar Beach	Environmental Management	Environmental Protection Zone	Low	Low	Low				
Sandbar Beach	National Parks and Nature Reserves	National Park	Low	Low	Low				
Sandbar Beach	Natural Waterways	Natural Watercourse	Low	Low	Low				
Sandbar Beach	Smiths Lake	Natural Watercourse	Low	Low	Low				
Sandbar Beach	Smiths Lake Entrance	Natural Watercourse	Low	Low	Low				
Number One Beach - Seal Rocks	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Low	Low				
Number One Beach - Seal Rocks	Number One Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
Number One Beach - Seal Rocks	Car Park - Number One Beach	Car Park	Low	Low	Low				
Number One Beach - Seal Rocks	Beach Accessway	Community Facilities	Low	Low	Low				
Number One Beach - Seal Rocks	Littoral Rainforest (SEPP26)	Ecological Assets	Medium	High	High		Investigate Habitat Preservation Options (Translocation, Migration, etc)		
Number One Beach - Seal Rocks	Environmental Management	Environmental Protection Zone	N/A	Low	Low				
Number One Beach - Seal Rocks	SEAL ROCKS RD	Major Road	Medium	High	High		Dune Management (to raise height of dune buffer), Investigate Re-aligning Seal Rocks Road, Seal Rocks Public Domain Plan / POM	Re-align Seal Rocks Road and reconfigure site based on POM outcomes	Accept impacts
Number One Beach - Seal Rocks	Seawall - Seal Rock	Waterway Infrastructure	High	Extreme	Extreme	*Yes*	Investigate Re-aligning Seal Rocks Road; Seal Rocks Public Domain Plan / POM	Remove asset, as part of re-aligning Seal Rocks Road)	
Number One Beach - Seal Rocks	Myall Lakes National Park	National Park	N/A	Low	Low				
Number One Beach - Seal Rocks	National Parks and Nature Reserves	National Park	Low	Low	Low				
Number One Beach - Seal Rocks	Seal Rocks Holiday Park and Camping Reserve	Tourist / Holiday / Caravan Parks	N/A	Low	Low				
Boat Beach - Seal Rocks	Boat Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
Boat Beach - Seal Rocks	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Low	Low				
Boat Beach - Seal Rocks	Boat Ramp - Boat Beach (east)	Community Facilities	Low	Low	Low				
Boat Beach - Seal Rocks	Boat Ramp - Boat Beach (west)	Community Facilities	Low	Low	Low				
Boat Beach - Seal Rocks	Environmental Management	Environmental Protection Zone	Low	Low	Low				
Boat Beach - Seal Rocks	Beach Access Road	Minor Road	Low	Medium	Medium				
Boat Beach - Seal Rocks	KINKA RD	Minor Road	Low	Medium	Medium				
Boat Beach - Seal Rocks	Rural Property	Rural Zoned Land	Low	Medium	Medium				
Lighthouse Beach - Seal Rocks	Lighthouse Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
Lighthouse Beach - Seal Rocks	Myall Lakes National Park	National Park	Low	Low	Low				
Treachery Beach	Treachery Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
Treachery Beach	Beach Accessway	Community Facilities	Low	Low	Low				
Treachery Beach	Myall Lakes National Park	National Park	Low	Low	Low				
Bennetts Beach	Bennets Beach	Beaches, Dunes and Foreshore	Low	Low	Low				
Bennetts Beach	Dunes and Dune Vegetation	Beaches, Dunes and Foreshore	Low	Low	Low				
Bennetts Beach	Beach Accessway	Community Facilities	Low	Low	Low				
Bennetts Beach	Beach Accessway (4WD)	Community Facilities	Low	Low	Low				
Bennetts Beach	Myall Lakes National Park	National Park	Low	Low	Low				
Bennetts Beach	Beach Accessway (4WD)	Public Recreation and Open Space	Low	Low	Low				

Table 5-3 Slope Instability Risk Register

Site Location	Hazard	Property at Risk	Risk Level	Risk of Loss of Life	Mitigation Measures
Boat Beach	Rock fall (1m long boulder)	Boat Beach *No direct damage to property but can facilitate landslips in overlying overburden materials.*	Very Low	6.3×10^{-7}	• Protective measures either side of the gabion wall and control of surface water flow over the gabion wall. • Further inspection of the stability of the slope.
	Debris Slide (15m in length and 75 m^3)	Kinka Road, Gabion Road and Slope *Failure of the gabion wall and undermining of the pavement* *Damage to the Kinka Road and pavement and impacts on buried services in the roadway*	Low	1.26×10^{-5}	
	Debris Slide (25 m in length and 370 m^3)		Moderate	1.1×10^{-5}	
Number One Beach	Soil Creep	Seal Rocks Road *Continued recession from a combination of rainfall, storm water runoff, wave action and sea level and eventually loss of road.*	Moderate	4.5×10^{-7}	Prepare POM for Seal Rocks, and Commence Realignment of Seal Rocks Road.
	Debris Slide (50m^3)	Seal Rocks Road *Loss of ground, damage to fences and retaining structures, cracking of infrastructure on the terraces etc.*	Moderate	4.5×10^{-6}	

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Appendix A Legislation Relevant to the Coastal Zone

A.1 Coastal Protection Act 1979

The NSW Coastal Protection Act 1979 (the CP Act) provides guidance on the use, occupation and development of the coastal zone in NSW. The CP Act was amended in 2002 to better reflect the purpose of the NSW Coastal Policy (1997) and to incorporate the principles of ecologically sustainable development.

The objects of the CP Act provide for the protection of the coastal environment of the State for the benefit of both present and future generations. The objects of the CP Act, along with details of how these objects have been addressed by the Great Lakes CZMP, are presented in Table A-1.

The CP Act allows the Minister for the Environment to direct a council with land within the coastal zone to prepare a Coastal Zone Management Plan, and gives directions as to how such Plans shall be prepared, approved, gazetted and amended where necessary.

The CP Act also requires Coastal Zone Management Plans to incorporate provisions for emergency beach erosion management and to provide for the unobstructed access to the coastline (beaches, headlands, waterways) by the public.

Table A-1 Objects of the *Coastal Protection Act 1979* and How they are Addressed by this CZMP

Specific Objectives of the CP Act	Addressed by this CZMP
(a) to protect, enhance, maintain and restore the environment of the coastal region, its associated ecosystems, ecological processes and biological diversity, and its water quality	Environmental values have been considered and actions developed for restoration and rehabilitation of important habitats.
(b) to encourage, promote and secure the orderly and balanced utilisation and conservation of the coastal region and its natural and man-made resources, having regard to the principles of ecologically sustainable development	The CZMP balances natural and anthropogenic demands on the environment and resources. Sustainability and conservation of environmental, social and economic values is paramount in the development of actions and works.
(c) to recognise and foster the significant social and economic benefits to the State that result from a sustainable coastal environment, including: (i) benefits to the environment, (ii) benefits to urban communities, fisheries, industry and recreation, (iii) benefits to culture and heritage, (iv) benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water,	All relevant values have been considered as part of the risk assessment process, with consequences related to environmental, social and economic factors. Actions within the CZMP include protection and restoration of important habitat areas as well as preservation of social and cultural values.
(d) to promote public pedestrian access to the coastal region and recognise the public's right to access	Extensive existing parklands along the channel foreshore are protected in the CZMP, with associated social values including pedestrian access maintained in the future.

Specific Objectives of the CP Act	Addressed by this CZMP
(e) to provide for the acquisition of land in the coastal region to promote the protection, enhancement, maintenance and restoration of the environment of the coastal region	All significant coastal habitat areas within the Great Lakes coastal zone area are already in public ownership, and are proposed to be preserved and restored.
(f) to recognise the role of the community, as a partner with government, in resolving issues relating to the protection of the coastal environment	Community engagement is to be undertaken as part of the integrated CZMP process incorporating Parts A and B.
(g) to ensure co-ordination of the policies and activities of the Government and public authorities relating to the coastal region and to facilitate the proper integration of their management activities	The gazettal of the CZMP enables local planning instruments to become more aligned and integrated with the relevant State Government policies and directives, reflecting these policies and directives within applicable heads of consideration for future development assessment.
(h) to encourage and promote plans and strategies for adaptation in response to coastal climate change impacts, including projected sea level rise	The Great Lakes Council sea level rise policy has been included within relevant analyses and outcomes therefore account for such changes in the future.
(i) to promote beach amenity	Existing amenity of Great Lakes beaches is maintained within the CZMP.

Section 55C of the Coastal Protection Act 1979 lists the specific matters to be dealt with in coastal zone management plans. These matters are outlined in Table A-2, along with a description of how they have been satisfied by the Great Lakes Coastal Zone Management Plan.

Table A-2 Coastal Protection Act 1979 Section 55C matters to be dealt with in CZMPs

Specific matters to be dealt with in CZMPs	Addressed by this CZMP
a. *protecting and preserving beach environments and beach amenity,*	Foreshore amenity is to be maintained through protection of significant recreation areas and long-term planned retreat.
b. *emergency actions carried out during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event,*	No emergency works are required as areas subject to erosion are public lands. Proposed dune rehabilitation works should improve resilience to storm activity.
c. *ensuring continuing and undiminished public access to beaches, headlands and waterways, particularly where public access is threatened or affected by accretion,*	Access along existing public lands is to be maintained and protected through upgrading of shoreline protection works on an as-required basis.
d. *where the plan relates to a part of the coastline, the management of risks arising from coastal hazards,*	Open coastal hazards have been considered (see other volume – Hazards Study and Risk Assessment)
e. *where the plan relates to an estuary, the management of estuary health and any risks to the estuary arising from coastal hazards,*	Not relevant to this CZMP.

Specific matters to be dealt with in CZMPs	Addressed by this CZMP
f. *the impacts from climate change on risks arising from coastal hazards and on estuary health, as appropriate,*	Climate change, and in particular, sea level rise, has been included in the assessment of coastal hazards (see other volume – Hazards Study and Risk Assessment).
g. *where the plan proposes the construction of coastal protection works (other than temporary coastal protection works) that are to be funded by the council or a private landowner or both, the proposed arrangements for the adequate maintenance of the works and for managing associated impacts of such works (such as changed or increased beach erosion elsewhere or a restriction of public access to beaches or headlands).*	No new coastal protection works are proposed, however, the as-required retrofitting and replacement of existing structures is included to maintain existing environmental, social and economic values. Maintenance of such structures is to be the responsibility of the asset owner. The Plan requires clarification on ownership for foreshore structures.

A.1.1 Changes Occurring Via the Coastal Protection and Other Legislation Amendment Bill 2010

Amendments were made under Part 2A of the CP Act to establish a joint state-local body called the NSW Coastal Panel. The NSW Coastal Panel shall act as a consent authority for coastal protection development applications where a council does not have a certified CZMP and / or requires further technical assistance in assessing such development applications. The Coastal Panel shall also assist the Minister when requested, such as for reviewing CZMPs.

Amendments were made in Section 55M of the CP Act and SEPP (Infrastructure) 2007 (Clause 129A) that permit any person, including private landholders, to carry out development for the purposes of a seawall or beach nourishment with consent (i.e., they must submit a development application), see SEPP Infrastructure 2007 Section 129A(1). Consent for such works is contingent on the application demonstrating that potential offsite impacts can be managed (for example, with beach nourishment). The private landholders who submit such applications would fully fund the coastal protection works, with no requirement for councils or the state to assist with funding. Amendments were made to Part 79C of the Environmental Planning and Assessment Act 1979 (EPA Act) and SEPP (Infrastructure) 2007 (Clause 129A) that require a consent authority, in determining a development application for coastal protection works, to take into consideration the provisions of any coastal zone management plan that applies to the land to which the development application relates (in addition to matters given in Clause 8 of SEPP 71). In this case, development applications may be refused where such works are not stated to be an action in the adopted CZMP. If there is no CZMP in place, the NSW Coastal Panel shall determine the development (see SEPP Infrastructure 2007 Section 129A(2)).

For public authorities (e.g. Council), new coastal protection works (termed waterway or foreshore management activities) are permitted without consent under SEPP (Infrastructure) 2007 (clause 129), provided the public authority considers the provisions of any CZMP relating to the land, or where there is no CZMP, notifies the NSW Coastal Panel and takes into consideration any response received from them within 21 days of notification. Temporary protection works under the meaning of the CP Act are not development to which this clause applies. However, there are no

authorised locations for temporary coastal protection works in the study area for this CZMP (see the Code of Practise for the CP Act).

Amendments were made to Section 553B of the *Local Government Act 1993* (LG Act) to allow local councils to levy a Coastal Protection Service Charge to maintain and repair coastal protection works or to manage the impacts of coastal protection works. The charge covers Council's costs for maintaining the works and restoring the beach if the works cause erosion (which may include beach nourishment). Eligible coastal protection works for the CPSC include:

- works voluntarily constructed by a benefiting landowner (or landowners);
- works constructed jointly by a public authority (e.g. Council) with voluntary contributions from benefiting landowners;
- works that existed before section 496B of the LG Act commenced, where the landowner or a previous landowner voluntarily agree (in writing) to pay the CPSC; and
- works that existed before section 496B of the LG Act commenced, where the landowner has voluntarily agreed to upgrade the works. A pro-rata CPSC then applies, based on the incremental additional costs of maintaining the works and managing their off-site impacts.

Where works are implemented by a Council and the Council chooses to contribute to the cost of the works then the Council also must accept liability for a portion of the future coastal protection service charge for maintenance for the life of the works.

The annual charge is attached to the land title and becomes the responsibility of all future land owners for the life of the protection works. The amount of the charge is regularly reviewed depending on the cost of maintaining the works and in ameliorating any adverse impacts. The *Coastal Protection Service Charge Guidelines* provide further guidance, including how it can be used to fund the protection of private property by those property owners deemed to benefit from the works and how the amount of the rate should be calculated over the design life of the works.

Amendments were made under Part 4C of the CP Act outlining emergency coastal protection works that landholders or public authorities are permitted to carry out. The *Coastal Protection Amendment Act 2012* has now modified the allowances for such works, as detailed below.

All of the above changes provide a mechanism for Councils to allow the construction of protection works on private land to protect private property, and defer the responsibility and costs for construction to the land owners. Further, Councils can ensure that maintenance and amelioration of any adverse impacts is also borne by the land owners into the future, through the Coastal Protection Service Charge. There is no responsibility on local government or State Government to bear any of the cost for protecting private property.

A.1.2 Coastal Protection Amendment Act 2012

This act permitted modifications to Part 4C of the CP Act relating to coastal protection works. The key change was renaming such works from 'emergency' to 'temporary' protection works, to enable authorised landholders to erect such works regardless of the impending occurrence of a storm, in response to coastal erosion. The works are not permitted on estuarine foreshores.

A Code of Practise is associated with the placement of temporary coastal protection works, revised in 2013. The Code of Practise outlines the height, materials and form for the placement of temporary coastal protection works, and the procedure for removal and remediation of such works. The Code of Practise contains a Schedule listing those locations at which temporary works are authorised. It is assumed that temporary works are not permitted at locations not listed in the Schedule.

The Amendment Act 2012 also simplified the process for landholders to gain approval to erect such works. Private landowners are now permitted to place temporary coastal protection works on their land without approval or a certificate from the local council or state government. Private landowners are also permitted to place these works on public land, provided they obtain a certificate for these works, and may keep such works in place for up to 2 years.

The fines for inappropriate placement of sand or sandbags (such as associated with the erection of temporary coastal protection works) have been halved, to reflect the lesser nature of such incidences. The heavy fines for placement of other non-beach materials (e.g. rocks, car bodies, bricks etc.) remain as per the 2010 CP Act amendments.

OEH or Councils (if they have authorised officers for this task) may order the removal of the temporary protection works where it is evident that such works are having detrimental impacts upon adjacent land or on beach amenity.

A.1.3 Guidelines for Preparing Coastal Zone Management Plans

The requirements for the preparation of coastal zone management plans is outlined in the *Coastal Protection Act 1979,* which references the adopted guidelines for preparation for such plans, that being the *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013) (the CZMP Guidelines). This CZMP has been prepared in accordance with these requirements, namely:

- this CZMP addresses the coastal management principles espoused in the CZMP guidelines, as outlined in Table A-3; and
- the minimum requirements for preparation of coastal zone management plans that are documented in the CZMP Guidelines have also been satisfied by this CZMP as outlined in Table A-4.

Under Section 733(4) of the *Local Government Act 1993*, Council is considered to have acted in good faith where decisions are made substantially in accordance with the relevant manual for the hazard, which are in this case the CZMP Guidelines.

Table A-3 Coastal Management Principles addressed by the Great Lakes CZMP

	Coastal Management Principles (OEH, 2013)	Addressed by this CZMP
Principle 1	Consider the objectives of the *Coastal Protection Act 1979* and the goals, objectives and principles of the NSW Coastal Policy 1997	Refer Sections 1.2 and 1.4 of this document.

	Coastal Management Principles (OEH, 2013)	Addressed by this CZMP
Principle 2	Optimise links between plans relating to the management of the coastal zone	For managing hazards, incorporation of existing controls, that is, actions already being undertaken in the coastal zone, is an intrinsic part of the risk assessment process, and is documented in Section 2.4. Likewise, existing controls for community use and ecological threats is detailed in Section 3.4.3 and Chapter 4.
Principle 3	Involve the community in decision-making and make coastal information publicly available	Considerable consultation has been conducted through the course of the preparation of the CZMP, as discussed in Section 1.7.
Principle 4	Base decisions on the best available information and reasonable practise; acknowledge the interrelationship between catchment, estuarine and coastal processes; adopt a continuous improvement management approach	The risk based approach is an internationally recognised framework for natural resources management because it incorporates the best available information and its uncertainty. Management options recognise the overlap between flooding and oceanic processes through estuaries, streamlining management into one approach. The adopted Risk Management Framework intrinsically requires ongoing monitoring of risks and review and tailoring of risk treatments (management options).
Principle 5	The priority for public expenditure is public benefit; public expenditure should cost effectively achieve the best practical long-term outcomes	High level cost benefit analysis for management options has recognised the public benefit as priority for management options.
Principle 6	Adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risk where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions to manage high risks while long-term options are implemented	The CZMP has been prepared using the ISO 31000:2009 Risk Management Principles and Guidelines. Risks to public safety and assets have been analysed and mapped. Evaluation of the tolerability of risks has been evaluated. In certain cases risks that cannot be reasonably treated must be accepted. A trigger based approach to implementation has been applied.
Principle 7	Adopt an adaptive risk management approach if risks are expected to increase over time, or to accommodate uncertainty in risk predictions	The adaptability of management options to future circumstances was a consideration in selection of preferred options. A triggered based approach has been applied that recognises risks that are expected to increase over time.
Principle 8	Maintain the condition of high value coastal ecosystems; rehabilitate priority degraded coastal ecosystems	The CZMP includes actions for rehabilitation of degraded coastal ecosystems, and provision to improve resilience of existing high value ecosystems.

	Coastal Management Principles (OEH, 2013)	Addressed by this CZMP
Principle 9	Maintain and improve safe public access to beaches and headlands consistent with the goals of the NSW Coastal Policy	Public access along foreshore reserves is maintained and protected. CZMP includes actions to incorporate coastal hazards into future plan-making/review for community access plans (i.e. POMs).
Principle 10	Support recreational activities consistent with the goals of the NSW Coastal Policy	Gazettal of the CZMP will provide mechanism for inclusion of coastal hazards and the outcomes of this CZMP when planning for recreational activities within and around the waterway.

Table A-4 CZMP minimum requirements

Minimum Requirement	Addressed by this CZMP
A description of how the relevant Coastal Management Principles have been considered in preparing the plan	Refer to Section A.12 of this document.
A description of the community and stakeholder consultation process, the key issues raised and how they have been considered	Community and stakeholder consultation was conducted in preparing this CZMP as detailed in Section 1.7 of this document. Outcomes of the consultation were used in developing risk priorities and refining recommended management actions in this document. Continued involvement and information sharing during the implementation of this CZMP is recommended in Action: Community Education (refer CZMP document).
A description of how the proposed management options were identified, the process followed to evaluate management options, and the outcomes of the process	Refer to Section 4 of this document.
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 • actions to be implemented through other statutory plans and processes • 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 (section 55C(2) (b) of the *Coastal Protection Act 1979*) • proposed actions to monitor and report to the community on the plan's implementation, and a review timetable	Refer to the Implementation Schedules provided in the CZMP document

Minimum Requirement	Addressed by this CZMP
Plan to be prepared using a process that includes: • evaluating potential management options by considering social, economic and environmental factors, to identify realistic and affordable actions • 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 (section 55E of the *Coastal Protection Act 1979*) • considering all submissions made during the consultation period. The draft plan may be amended as a result of these submissions (section 55F of the *Coastal Protection Act 1979*).	Refer to Section 4 of this document. Community and stakeholder consultation conducted in preparing this CZMP is detailed in Section 1.7 of this document.

A.1.4 Stage 2 Coastal Reforms

The NSW Government has committed to a two-stage coastal reform agenda. Stage one of the reforms is complete, and involved: amendments to the *Coastal Protection Act 1979* (noted above); Code of Practise for temporary coastal protection works; release of a planning circular regarding notations on Section 149 planning certificates; review of the statewide sea level rise benchmarks via the Chief Scientist and Engineers Report (2012) and repeal of the NSW Sea Level Rise Policy Statement 2009; an SES/LGSA Storm Safe Guide for coastal erosion; and extension for CZMP preparation for councils with a Ministerial Direction.

On 13 November 2014 the Minister for Environment announced the stage two reforms, which shall involve three key elements:

- replacing the *Coastal Protection Act 1979* with a proposed new Coastal Management Act;
- new arrangements to better support council decision making, including a decision support framework, a new coastal management manual, and improved technical advice; and
- more sustainable arrangements for funding and financing coastal management activities.

The stage 2 reforms will continue to be overseen by relevant Government Ministers with input from the Coastal Expert Panel.

In addition to the coastal reforms, a Marine Estuary Strategy for all coast and estuary waters of NSW is being prepared by MEMA. A threat and risk assessment will determine the social, economic and environmental benefits and stressors of the marine estate. Upon completion of the Marine Estuary Strategy each marine park will be reviewed in line with the Marine Estate Management Act 2014.

A.2 The NSW Coastal Policy 1997

The NSW Coastal Policy 1997 (the Policy) sets the strategic framework for coordinated, integrated and ecologically sustainable development of the coast. The Policy details nine goals and associated objectives and strategic actions for achieving ecologically sustainable development in

NSW. Preparation of coastal zone management plans is one of the strategic actions given by the Policy, with the plans to be consistent with the Policy's goals and objectives.

This Great Lakes Coastal Zone Management Plan meets the nine goals and objectives of the NSW Coastal Policy as outlined in Table A-5.

Table A-5 NSW Coastal Policy goals and relevance to this CZMP

Coastal Policy Goals	Addressed by this CZMP
To protect, rehabilitate and improve the natural environment	Environmental values are to be protected and important areas rehabilitated through proposed actions of the CZMP.
To recognise and accommodate natural processes and climate change	Strategic planning actions that supports planned retreat are to be considered and investigated further as a response to future climate change and sea level rise once triggers for further action have been reached.
To protect and enhance the aesthetic qualities	Environmental and recreational features of Great Lakes beaches are to be preserved by maintaining and protecting foreshore lands and facilities, including associated aesthetic values.
To protect and conserve cultural heritage	Cultural heritage is recognised through the environmental and social values that have formed essential components of the coastal risk assessment.
To promote Ecologically Sustainable Development (ESD)	The four principles of ESD have been considered in development of the CZMP. ESD is promoted through the preservation of existing environmental and social values and taking a longer-term sustainable focus for strategic planning.
To provide for ecologically sustainable human settlement	Future urban expansion is restricted due to existing development and environmental constraints. The CZMP includes strategic planning for consideration of planned retreat to maintain ecological sustainability in the future.
To provide for appropriate public access and use	Public access and use of facilities along public foreshore lands are to be maintained and protected, with foreshore structures retrofitted and replaced on an as-needed basis to preserve existing amenity.
To provide information to enable effective management	CZMP includes monitoring of environmental conditions and asset conditions to inform future decision making (linked to triggers for further actions). Future re-assessment of risks is included in CZMP to ensure currency in response to monitoring outcomes.
To provide for integrated planning and management	CZMP includes actions for improving the integration of coastal hazards into Council's planning framework, including development controls, policies and plan-making/reviews.

A.3 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EPA Act) is the key NSW legislation for planning and land use. The EPA Act provides a system of environmental planning and assessment for NSW, and involves developing plans to regulate competing land uses, through 'environmental planning instruments'.

The EPA Act establishes three types of environment planning instruments (EPI):

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

The objectives of the EPA Act are to encourage:

- proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment;
- promotion and co-ordination of the orderly and economic use and development of land;
- protection, provision and co-ordination of communication and utility services;
- provision of land for public purposes;
- provision and co-ordination of community services and facilities;
- protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats;
- ecologically sustainable development;
- the provision and maintenance of affordable housing;
- promotion of the sharing of the responsibility for environmental planning between the different levels of government in the State;
- provision of increased opportunity for public involvement and participation in environmental planning and assessment.

Approval processes for “development” and “works” in NSW are provided for in Part 4, Part 5 and Part 5A of the EPA Act. Key provisions are outlined briefly below.

Part 4 – Development Assessment

Part 4 of the EPA Act lays out the legislative regime for the standard process for lodgement and consideration of development applications. Part 4 processes essentially apply where the local authority (Council) is the consent authority. The majority of land based development within the study area will fall within Part 4 of the EPA Act.

The controls and permissibility for development of particular sites and / or uses are found in the Local Environment Plan (LEP) and Development Control Plan (DCP) (see sections below).

Section 79C under Part 4 of the *Environmental Planning and Assessment Act 1979* outlines matters for consideration for a consent authority (e.g. a Council) in determining a development application to include the provisions of any coastal zone management plan (as defined by the *Coastal Protection Act 1979*) that apply to the land to which the development application relates.

Part 5 – Environmental Assessment

Part 5 outlines the requirements for determining authorities to consider the environmental impact of activities, through an environmental assessment for the proposed activity. The environmental assessment shall outline the effect of the activity on critical habitat, endangered fauna, vulnerable species, conservation agreements (under the *National Parks and Wildlife Act 1974*), plans of management, wilderness areas (under the *Wilderness Act 1987*) and joint management agreements and bio-banking agreements under the *Threatened Species Act, 1995*, and any other legislation pertaining to the proposed activity.

Part 5 of the Act applies to proposed activities that are permissible without development consent under Part 4 of the EPA Act but require approval from a Minister or Public Authority, or is proposed to be carried out by a Minister or Public Authority (and Council is classified as a Public Authority).

Part 5 obliges the "determining authority" for the proposal to consider the environmental impact of any activity. A determining authority is the public authority which is required to approve an activity, and can also be the public authority proposing to carry out the activity. For example, Council is permitted to undertake certain environmental management activities under SEPP (Infrastructure) 2007 without development consent, however will still need to complete an environmental assessment (typically, a Review of Environmental Factors) under Part 5 of the EPA Act. In certain cases where an activity is considered to be "designated development", an Environmental Impact Statement (EIS) is required.

Part 5A (Development by the Crown) essentially provides a legislative regime for consideration of Development Applications made by, or for and on behalf of, the Crown.

The remaining parts of the EPA Act relate to: Part 6 – Implementation and Enforcement; Part 7 – Finance and Part 8 – Miscellaneous.

A.4 State Environmental Planning Policy No. 71 – Coastal Protection

State Environmental Planning Policy No. 71 – Coastal Protection (SEPP 71) aims to protect and manage the natural, cultural, recreational and economic attributes of the New South Wales coast. SEPP 71 aims for development in the NSW coastal zone to be appropriate and suitably located, in accordance with the principles of the Ecologically Sustainable Development (ESD). The policy provides for: the protection of and improvement to public access compatible with the natural attributes coastal foreshores; and protects and preserves Aboriginal cultural heritage, visual amenities of the coast, the beach environment and amenity, native coastal vegetation, marine environment of New South Wales, and rocky platforms.

SEPP 71 applies to all lands within the coastal zone of NSW, which is defined on gazetted maps under the SEPP, therefore, all of the land in the study area for this CZMP. SEPP 71 provides matters for consideration in clause 8 that are to be taken into account: by a council when preparing its LEP for land within the coastal zone; and by a consent authority (e.g. council) when determining a development application on land within the coastal zone.

SEPP 71 also outlines the conditions for which the Minister for Planning becomes the consent authority for 'significant coastal development', that is, development on land within 100 metres of and below mean high water mark of the sea, a bay or an estuary. Development applications

received by Council on such lands must be sent to the Director-General of Planning, and Council is required to take any additional matters specified by the Director-General into account when determining the application (in addition to the 'matters for consideration' given in Clause 8).

SEPP 71 also outlines development controls in Part 4 for which consent cannot be granted to applications that, in the opinion of the consent authority:

- will or is likely to impede or diminish to any extent the physical, land based right of access of the public to or along the coastal foreshore;
- where effluent is proposed to be disposed of by means of a non-reticulated system, will or is likely to have a negative effect on the water of the sea or any nearby beach, or an estuary, a coastal lake, a coastal creek or other similar body of water, or a rock platform; or
- will or is likely to, discharge untreated stormwater into the sea, a beach, or an estuary, a coastal lake, a coastal creek or other similar body of water, or onto a rock platform.

A master plan is to be adopted by Minister for Planning (or otherwise waived the need for a master plan as per Clause 18), prior to Council granting consent for subdivision of land:

- within a residential zone or rural residential zone if part or all of the land is in a 'sensitive coastal location'; or
- within a residential zone that is not within a 'sensitive coastal location' into more than 25 lots, or 25 lots or less, if the land proposed to be subdivided and any adjoining or neighbouring land in the same ownership could be subdivided into more than 25 lots; or
- within a rural residential zone that is not identified as a sensitive coastal location into more than 5 lots.

SEPP71 defines 'sensitive coastal location' to mean land within:

- 100 metres above mean high water mark of the sea, a bay or an estuary;
- a coastal lake, or within 100 m of the water's edge of a coastal lake;
- a declared Ramsar Wetland, or within 100 m of a declared Ramsar Wetland;
- a declared World Heritage Property, or within 100 m of a declared World Heritage Property;
- a declared aquatic reserves under the *Fisheries Management Act 1994*, or within 100 m of such;
- a declared marine park under the *Marine Parks Act 1997 (*note: SEPP71 has not been updated since the *Marine Parks Act 1997* was repealed and replaced with the *Marine Estate Management Act 2014)*, or within 100 m of a marine park;
- coastal lakes (which includes all four of Gosford's Coastal lagoons), Ramsar wetlands and World Heritage areas;
- marine parks and aquatic reserves under the *Fisheries Management Act*; land within 100 metres of any of the above;
- within 100 m of land reserved under the *National Parks and Wildlife Act 1974*;

- within 100 m of SEPP 14 Coastal Wetlands; and
- residential land within 100 metres of SEPP 26 Littoral Rainforests.

A.5 SEPP (Infrastructure) 2007

SEPP (Infrastructure) 2007 (SEPP Infrastructure) provides a consistent planning regime for infrastructure and the provision of services across NSW, including consultation with relevant public authorities during the assessment process. The intent of SEPP Infrastructure is to support greater flexibility in the location of infrastructure and service facilities along with improved regulatory certainty and efficiency for the State.

Division 25 of SEPP Infrastructure outlines development permitted with and without consent for the purpose of 'waterway or foreshore management activities', which are defined as:

'(a) riparian corridor and bank management, including erosion control, bank stabilisation, resnagging, weed management, revegetation and the creation of foreshore access ways, and

(b) instream management or dredging to rehabilitate aquatic habitat or to maintain or restore environmental flows or tidal flows for ecological purposes, and

(c) coastal management and beach nourishment, including erosion control, dune or foreshore stabilisation works, headland management, weed management, revegetation activities and foreshore access ways, and

(d) coastal protection works, and

(e) salt interception schemes to improve water quality in surface freshwater systems, and

(f) installation or upgrade of waterway gauging stations for water accounting purposes.

Development for the purpose of waterway or foreshore management activities may be carried out by or on behalf of a public authority (e.g. Council) without consent on any land, which may include:

- construction works;
- routine maintenance works;
- emergency works, including works required as a result of flooding, storms or coastal erosion (noting that this excludes emergency coastal protection works within the meaning of the Coastal Protection Act 1979);
- environmental management works; and
- new coastal protection works on the open coast or entrance to a coastal lake (despite Clause 129A, see below), provided the public authority considers the provisions of any CZMP relating to the land on which the works are proposed, or where there is no CZMP, notify the NSW Coastal Panel and take into consideration any response received from them within 21 days of notification. The 'new coastal protection works' excludes beach nourishment or sand placement, presumably so that councils can undertake beach nourishment without requiring such action to be a stated action in the CZMP or gaining approval from the Coastal Panel.

Thus in the study area, Council is permitted to undertake activities such as beach nourishment, environmental rehabilitation, seawalls (provided this is consistent with the CZMP) etc., provided they undertake a Review of Environmental Factors (REF) (under Part 5 of the EPA Act) and gain any approvals / licences required under any other Acts relating to the land or works (e.g. *Crown Lands Act 1989*, *Fisheries Management Act 1994*, *Water Management Act 2000* etc.).

Under Clause 129A, development for the purposes of a seawall or beach nourishment may be carried out by any person with consent on the open coast or entrance to a coastal lake. In determining the application, the consent authority must consider the provisions of any CZMP relating to the land on which the works are proposed, the matters stated in Clause 8 of SEPP 71, and any guidelines for assessing and managing the impacts of the works issued by the Director-General (noting that preconditions for granting consent for coastal protection works are stated in Section 55M of *the Coastal Protection Act*).

A.6 Great Lakes Local Environment Plan 2014

Great Lakes Local Environmental Plan 2014 (LEP 2014) provides local environmental planning provisions for land in Great Lakes LGA in accordance with the relevant standard environmental planning instrument under Section 33A of the EPA Act. It was prepared under the direction of the State Government to all local councils, as per the *Standard Instrument (Local Environmental Plans) Order 2006*. The LEP was adopted by Council in 2012 as a draft and recently gazetted by the Minster of Environment in April 2014.

In terms of managing coastal hazards, the LEP 2014 contains two specific clauses

The LEP outlines particular aims for the use and development of land in Great Lakes LGA, which is governed by land zoning in the LEP. Those aims that are relevant to coastal hazards are:

“(c) to protect and enhance the environmental, scenic and landscape assets of the area; and

(h) to ensure that development has regard to the capability of the land so that the risk of degradation is minimised.”

The LEP sets out the zonings that are applied to land in the LGA, and the objectives and permitted development (with or without consent) given for each land zone. The LEP also guides the assessment and approval for Development Applications for lands within the LGA. Land use zones specified in the LEP are given in Table A-6. For each of these zones, the LEP specifies:

- Objectives for development within the zone;
- Development that may be carried out without consent;
- Development that may be carried out only with consent; and
- Development that is prohibited.

In terms of managing coastal hazards, the LEP contains two specific clauses.

- ‘Part 5.5. Development within the Coastal Zone’ is a compulsory clause for all LEPs that apply to land within the ‘coastal zone’ (as defined on gazetted maps with the Department of Planning and Infrastructure). Part 5.5 sets objectives and matters for consideration by the consent

authority prior to granting consent to development on land wholly or partly within the coastal zone. The objectives of this Clause include implementing the principles of the NSW Coastal Policy, one of which is to recognise and accommodate coastal processes and climate change. The considerations for developments subject to this clause thus relate to preserving coastal environments, maintaining public access to the shoreline, suitability and impacts on scenic values and amenity, impacts upon coastal biodiversity and ecosystems, cumulative impacts upon the coastal catchment including effluent and stormwater, and the impact of the development on or from coastal hazards.

Table A-6 Land Zones in the Great Lakes LEP 2014

Rural Zones	Residential Zones	Business Zones	Industrial Zones
RU2 Rural Landscape	R2 Low Density Residential	B1 Neighbourhood Centre	IN1 General Industrial
RU3 Forestry	R3 Medium Density Residential	B2 Local Centre	IN2 Light Industrial
RU5 Village	R4 High Density Residential	B4 Mixed Use	IN4 Working Waterfront
	R5 Large Lot Residential	B5 Business Development	
Special Purpose Zones	**Recreation Zones**	**Environment Protection Zones**	**Waterway Zones**
SP2 Infrastructure	RE1 Public Recreation	E1 National Parks and Nature Reserves	W1 Natural Waterways
SP3 Tourist	RE2 Private Recreation	E2 Environmental Conservation	W2 Recreational Waterways
		E3 Environmental Management	
		E4 Environmental Living	

- 'Part 7.4 Coastal Risk Planning' is a non-compulsory clause to enable local provision for managing coastal risks. The clause specifically aims to:
  - (a) to avoid significant adverse impacts from coastal hazards,
  - (b) to enable evacuation of coastal risk areas in an emergency,
  - (c) to ensure uses are compatible with coastal risks.

  The clause applies to land identified as "Coastal Risk" on the Coastal Risk Planning Map (which is gazetted with and accompanies the LEP).

  Under Clause 7.4, development consent must not be granted to development to which this clause applies unless the consent authority has considered whether the development:

  - (a) is likely to be adversely affected by the impacts of coastal hazards; and

- (b) is likely to cause detrimental increases in coastal risks to other development or properties; and
- (c) is likely to alter coastal processes and the impacts of coastal hazards to the detriment of the environment; and
- (d) incorporates appropriate measures to manage risk to life from coastal risks; and
- (e) avoids or minimises potential adverse effects from the impact of coastal processes and the exposure to coastal hazards, particularly if located seaward of the 2060 hazard line; and
- (f) makes provision for relocation, modification or removal of the development to adapt to the impact of coastal processes, coastal hazards and sea level rise planning benchmarks for NSW.

Compared with Clause 5.5, this clause directly addresses the risks associated with coastal hazards. Clause 7.4 aims to ensure that coastal hazards assessment and amelioration or mitigation to manage such risks is undertaken during development of land potentially at risk from coastal hazards.

At present, the Coastal Risk Planning Area maps gazetted with the LEP have only been adopted for Jimmys Beach (including Winda Woppa) and Blueys and Boomerang Beaches. The maps are based upon the latest 2060 Hazard areas for Jimmys, Blueys and Boomerang Beaches including provision for beach erosion, shoreline recession due to sea level rise, and a zone of reduced foundation capacity behind the erosion escarpment.

To accompany this CZMP, the LEP 2014 is being amended to include new coastal risk planning area maps. The new maps cover the remaining council managed beaches in the LGA (i.e. excluding beaches within national parks), including: Tuncurry - Nine Mile Beach (southern end only), Forster Main Beach, Pebbly Beach, One Mile Beach, Seven Mile Beach, (southern end only), Elizabeth Beach, Sandbar Beach, Seal Rocks Number One Beach (covering area of development only), Seal Rocks Boat Beach, Bennetts Beach (southern end only). The new maps are based on the 2060 Hazard area as defined in the Great Lakes Coastal Hazard Study (SMEC, 2013).

Application of both the compulsory and non-compulsory clauses within the LEP provides the strongest coastal hazards control currently permissible within an LEP under the current NSW planning framework. The clauses provide a “heads of consideration” for developments, rather than specific controls, and so are not considered to change the level of risk to existing developments.

A.7 Great Lakes Development Control Plan 2014

The Great Lakes Development Control Plan (DCP 2014) was prepared in conjunction with Great Lakes Local Environmental Plan 2014 (LEP 2014) and came into force when Great Lakes LEP 2014 was published in April 2014.

As part of the environmental matters for consideration within the DCP, sea level rise and coastal erosion are specifically addressed. The Sea Level Rise and Coastal Erosion environmental matters for consideration provide some control upon development for coastal hazards. The controls stated in the DCP 2014 are as follows:

- "For development proposals on land identified as potentially being affected by coastal erosion and/or sea level rise a report from a suitably qualified engineer specialising in coastal marine processes and a geotechnical engineer, shall be required to determine suitable measures for protection of the building against coastal erosion and recession, changes in storm frequency and intensity, and sea level rise.
- Where native vegetation that currently protects a dune system from erosion processes will be affected by proposed development, a Vegetation and Environmental Impact Assessment by a qualified arborist or ecologist may be required.
    - A linear sea level rise of 0.91m to the year 2100 is to be taken into account.
    - For development proposals on land potentially affected by coastal hazards, a report from a suitably qualified geotechnical engineer and an engineer specialising in coastal marine processes shall be required, to determine the geotechnical and physical stability of the land is not compromised and to determine suitable measures for protection of the building against coastal erosion and recession, changes in storm frequency and intensity and sea level rise.
    - Where native vegetation that currently protects the dune system from erosion processes will be affected, a Vegetation and Environmental Impact Assessment by a qualified ecologist may be required".

The current controls above are the same as that listed in the former Pacific Palms DCP, covering Blueys and Boomerang Beaches. The coastal erosion setback specified in the Pacific Palms DCP for beachfront properties on Blueys and Boomerang Beaches has not been replicated in the DCP 2014.

It is noted that Council is currently revising the DCP provisions for coastal risk planning areas, in accordance with recommendations made in this CZMP.

A.8 Crown Lands Act 1989

The *Crown Lands Act 1989* (CL Act) provides for the administration and management of Crown land for the benefit of the people of NSW. The CL Act provides principles for the proper assessment, development, reservation or dedication and conservation of Crown Lands.

Waterbodies such as beaches and foreshores and estuaries / creeks / lagoons below the mean high water mark are designated as Crown Land and managed by the Department of Primary Industries Crown Lands Division (CLD). In addition to this, there are other Crown reserves in the coastal zone for which Council may be the reserve trust manager or trustee appointed by the Minister for Lands to care, control and manage the land in accordance with its public purpose and the principles of Crown Lands management (Section 11 of the Act).

The principles of Crown Land management as defined in Section 11 of the Act are: environmental protection principles be observed in relation to the management and administration of Crown land; natural resources of Crown Land (including water, soil, flora, fauna and scenic quality) be conserved wherever possible; public use and enjoyment of Crown lands be encouraged; where appropriate, multiple uses of Crown land be encouraged; and where appropriate, Crown Land be used and managed in such a manner that the land and its resources are sustained in perpetuity.

In addition to these principles, the objectives of the Coastal Crown Lands Policy 1991 apply to Crown lands within the coastal zone. The policy sets specific objectives for conserving the environmental and cultural qualities of coastal Crown Land, retaining in public ownership coastal lands that are environmentally sensitive and / or required for public purpose, and providing use of coastal crown lands for recreation, tourism, residential and commercial development with due regard to the nature and consequences of coastal processes.

For all Crown land reserves, a Plan of Management (POM) is required to be prepared and adopted (in accordance with Division 6 of the *Crown Lands Act 1989*). The POM shall identify the key attributes and values of the area, general physical improvements to enhance the values and specify the permissible uses for the reserve.

Generic Plans of Management relating to Crown lands in other Great Lakes Beach areas are discussed in relation to the *Local Government Act 1993*. Specific Plans of Management (PoM) adopted for Crown Reserves in the study area are discussed below.

A.8.1.1 Plan of Management for Part of Reserve 53519 for Public Recreation

This Plan of Management was prepared in accordance with the relevant provisions of the *Crown Lands Act 1989* to provide a framework for the future management, use and improvement of the reserved Crown Land known as Seal Rocks Holiday Park. The Holiday Park is situated within Reserve 53519 which is reserved for Public Recreation and was notified on 19th September 1919.

On 25th February 2011, following discussions and negotiation with Council, the Mid North Coast Accommodation Trust was appointed by the Minister for Lands to be responsible for the care control and management of that part of Reserve 53519 for Public Recreation which supports the Seal Rocks Holiday Park. Those parts of the Reserve to the north of Seal Rocks Road and Kinka Road continue to be managed by the Great Lakes Council.

The Mid North Coast Accommodation Trust is the appointed manager of the Reserve Trust and the Holiday Park, and is responsible for the care control and management of five caravan parks in the Great Lakes local government area. While the key focus of the Mid North Coast Accommodation Trust relates to the operation of caravan parks there is a range of wider land management responsibilities addressed.

The purpose of this Plan of Management is to establish objectives, strategies and actions and identify the means the Trust will employ in the management of the land, the Reserve Trust and the Holiday Park. The Plan of Management outlines a management direction for the next 10 years for those areas. The Plan also establishes management strategies and actions to address the needs and expectations of the local and wider community and the travellers who visit and use the Reserve and its facilities.

A.9 Local Government Act 1993

The *Local Government Act 1993* (the LG Act) creates local governments and grants them the power to perform their functions, which involve management, development, protection, restoration, enhancement and conservation of the environment for the local government area. The functions of

the local government are to be performed in a manner that is consistent with and promote the principles of ecologically sustainable development.

The service functions of local councils (defined in Chapter 6 of the Act) includes the classification, use and management of public land, including the objectives for management of the Community Land owned by a Council (i.e. that is not Crown Land).

Plans of Management for Community Land need also to be prepared under Section 35 of the Act. Section 35 of the act provides that community land only be used in accordance with the Plan of Management applying to the parcel of community land; any law permitting the use of the land for a specified purpose or otherwise regulating the use of the land; and the provisions of Division 2 Chapter 6 of the Act.

Community land can be divided into a range of categories under Section 36 of the Act, and each of these categories have their own core objectives specified under the Act. The division of community lands is important as the Act requires Council to only grant a lease, licence or another estate (other than in respect of public utilities) for a purpose consistent with the core objectives of the category of that community land.

A.9.1 Generic Plan of Management Community Land

The Generic Plan of Management Community Land ('the POM') was prepared to comply with the *Local Government Act 1993* and the *Crown Lands Act 1989*. The plan covers Council's community land and land under Council's care, control and management (generally Crown land). This land includes parks and reserves, bushland, foreshores and community facilities, where land is owned or managed by Council.

All community and crown land in the LGA has been categorised, such that is subject to the objectives for that category under *Local Government Act 1993* and the *Crown Lands Act 1989*. A range of Council's adopted policies, procedures and plans are also considered relevant to the management of community land, as listed in the POM.

Within the POM, over 96 areas are classified as 'Natural Area, Foreshore', including the beach areas / reserves of the Great Lakes study area (see Table A-7). Specifying these areas as 'natural areas' under the Local Government Act 1993 restricts the leases, licences, estates and permissible buildings / structures on that land to complementary uses, for example, walkways, observation platforms, signs, and kiosks (information or food), toilets or sheds.

The POM sets out a range of actions, some of which apply to all categories of Community Land (e.g. managing Aboriginal Cultural Heritage, risk and safety, vandalism and theft, fire, beautification and others). For the 'natural area – foreshore' land category, the following objectives are identified:

- to maintain the foreshore as a transition area between the aquatic and the terrestrial environment, and to protect and enhance all functions associated with the foreshore's role as a transitions area; and
- to facilitate the ecologically sustainable use of the foreshore, and to mitigate impact on the foreshore by community use.

The objective to preserve functions associated with the foreshore implies the accommodation of coastal processes. The permitted uses focus upon sustainability of environmental habitats and assets, and coastal hazards management is not explicitly stated. However, the maintenance of vegetation is a key permitted uses, which may additionally provide a buffer for natural coastal processes.

Table A-7 Community Land in the POM Potentially Affected by Coastal Hazards

Site Name	*Lot*	*Owner-ship*	*Crown Res. No*	*Community Land No.*	*Type*	*LEP Zoning*
Beach Street Reserve, Tuncurry	Lot 7323 DP 1142386 Lot 7059 DP 1108450	LPMA	PTR 86532	73	Park	RE1 – Public Recreation
Bennetts Head / North One Mile Reserve	Lot 7134 DP 1081045	LPMA	RES 83666	51	Natural Area, Foreshore	RE1 – Public Recreation
Boat Beach	Lot 7063 DP 1054279	LPMA	PTR 52821	10	Natural Area, Foreshore	E2 – Environmental Conservation
Burgess Beach Reserve	Lot 7033 DP 1026118 Lot 142 DP 31849	LPMA GLC	RES 83666	51 5110	Natural Area, Foreshore	RE1 – Public Recreation
Nine Mile Beach	Pt Lot 7060 DP 1108448	LPMA	RES 86904	80	Natural Area, Foreshore	RE1 – Public Recreation
Number One Beach Reserve	Pt Lot 7302 DP 114237	LPMA	PTR 53519	6	Natural Area, Foreshore	E2 – Environmental Conservation
One Mile Beach	Lot 7134 DP 1081045	LPMA	RES 836666	51	Natural Area, Foreshore	RE1 – Public Recreation
Pebbly Beach & The Tanks	Lot 406 DP 753168	LPMA	RES 84530	60	Natural Area, Foreshore	RE1 – Public Recreation
Blueys Beach	Lot 74 DP 21465	GLC		5214	Natural Area, Foreshore	E3 – Env. Man't
Boomerang / Blueys Headland	Lot 7365 DP 1130058	LPMA	RES 210072	5401	Natural Area, Foreshore	E3 – Env. Man't
Williams Park Blueys Beach	Lot 29 DP 576321 Lot 31 DP 245303	GLC		5001	Natural Area, Foreshore	E3 – Env. Man't
Boomerang Beach Reserve	Lot 1 DP 248650	GLC		1009	Natural Area,	E3 – Env. Man't

Site Name	Lot	Owner-ship	Crown Res. No	Community Land No.	Type	LEP Zoning
	Lot 52 DP 250863				Foreshore	
Boomerang Drive Reserve	Lot 125 DP 200167 Lot 41 DP 200167	GLC		5116	Natural Area, Foreshore	E3 – Env. Man't

A.10 The NSW Coastal Planning Guideline: Adapting to Sea Level Rise

The NSW Coastal Planning Guideline: Adapting to Sea Level Rise (the Planning Guideline) describes how sea level rise should be considered in land use planning and development assessments. The Planning guideline supported the former NSW Government Sea Level Rise Policy Statement (2009), although the provisions within it in remain relevant to any sea level rise projection that may be applied. The Planning Guideline outlines six coastal planning principles for adapting to climate change, including:

- assessing and evaluating the coastal risks accounting for sea level rise;
- advising the public as to coastal risks to facilitate informed land use planning and development decision making;
- avoiding the intensification of land use in coastal risk areas through appropriate strategic and land use planning;
- considering options to reduce the intensity of land use in coastal risk areas;
- minimising exposure of development to coastal risks; and
- implementing appropriate management responses and adaptation strategies that consider the environmental, social and economic impacts of such responses.

In evaluating coastal risk areas, the Planning Guideline defers to the DECCW (2010) *Coastal Risk Management Guideline* (see discussion below). The coastal risk areas should be identified through specific local studies, at which point they should be mapped in LEPs, regardless of current land zoning.

The Planning Guideline advises that strategic land use planning shall discourage intensification of development in coastal risk areas. For example, changing land use from rural to urban or increasing housing density shall be avoided in high risk areas due to the potential future risk to life, property and the environment. As changes to land use may affect the future development potential of an area, the Guideline recommends these changes be applicable to the level of risk. Where possible, new coastal subdivisions and urban developments shall be located outside the 2100 coastal risk area.

The Guideline makes reference to the *Coastal Design Guidelines for NSW* (2003) for strategic land use planning (height, scale and setback), retaining foreshores and headlands in public ownership and protecting from storm events and sea level rise.

A.11 Coastal Risk Management Guide – Incorporating sea level rise benchmarks in coastal hazards assessments

The *Coastal Risk Management Guide – Incorporating sea level rise benchmarks in coastal hazards assessments* (DECCW, 2010) states that the identified risk area for coastal planning is to include the existing coastal hazards region plus an additional area affected by sea level rise.

The guideline also indicates that the defined coastal inundation hazard should include sea level rise projections as part of the assessment. Design Still Water Levels to be used in such assessments are provided in the document. The guidance from that document was largely incorporated into the *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013).

Appendix B Summary of Community Survey Results

B.1 Whole of Coast Community Survey Results

A community survey for Great Lakes Beaches was made available online. A copy of the survey is provided in Table B-3. The survey was designed to gather information about how frequently and what activities Great Lakes beaches are used for. The results of the survey were used to

- gather information about what the community values about the numerous beaches, what they would like to retain as is, and what they would like to change to improve the value of the beaches; and
- assist Council in designing (and replacing) public facilities appropriate to the needs of the community; and
- determine the appropriateness of particular management options for the different beaches.

On face value, these questions may not appear to directly relate to hazards management options, however, understanding the ways in which the community (visiting and residential) use and value the beach formed essential input for determining the values of the coastline and its assets; and the appropriateness of particular management options for these beaches. For example, if the community values naturalness and a lack of development at the beaches, it is likely to be inappropriate to consider hard engineering structures such as seawalls and groynes.

A total of 197 responses were received, and the responses are summarised for each beach in Table B-1 below. These results shows that Forster Main Beach, One Mile Beach, Number One Beach (Seal Rocks), Boat Beach (Seal Rocks), and Bennetts Beach are the most highly visited beaches, with both Bennetts and One Mile Beach being the most regularly visited beaches. Over 40% of respondents were found to visit the beach on a weekly basis, with around 20% each visiting either daily or monthly. A variety of beach based activities were found to be popular, notably including walking and swimming.

In general, the beaches are most highly valued for their natural beauty (including clean water and sand, low key and undeveloped settings etc.), and the various activities for which the beach and foreshore areas provide. These values were supported by generally easy access and safe environment to enjoy the beaches. Looking forward, the overwhelming response from the surveys was that to retain the natural and relatively undeveloped setting of the Great Lakes coastline. The present type and distribution of beach access facilities were also noted as being valued, including the Pebbly Beach foreshore walk. The changes requested to improve the coastal zone included upgrades to the facilities, amenity and accessibility of the beaches and foreshore; improved /expanded management of the natural beach and dunes system, stronger restrictions for beach vehicular use and increased resources (e.g. more rangers) to implement compliance of various issues including 4WD, dogs, litter, illegal tree removal and parking.

Overall, the survey responses provided an important and useful insight into what is valued at Great Lakes Beaches. It is important that the style of management recommended is in keeping with the values and ideals of the local community regarding their beach, wherever possible. While

practicality, cost and so on are important when selecting coastal management actions, community acceptability is also vital for Council and others when implementing the actions.

Table B-1 Summary of the Community Survey

Topic	**Response -** Percentages (and No.)	**Response** - Percentages (and No.)
Beach Visitation	*Which beach(es) do you visit?* • Nine Mile Beach / Tuncurry Beach - 33.5% (66) • Forster Main Beach - 43.7% (86) • Pebbly Beach - 24.4% (48) • One Mile Beach - 40.6% (80) • Burgess Beach - 18.3% (36) • Seven Mile Beach - 21.3% (42) • Elizabeth Beach - 30.0% (59) • Sandbar Beach - 23.4% (46) • Number One Beach, Seal Rocks - 38.6% (76) • Boat Beach, Seal Rocks - 36.0% (71) • Lighthouse Beach, Seal Rocks - 24.9% (49) • Treachery Beach - 25.4% (50) • Bennetts Beach - 35.5% (70) *197 Answered*	*How often do you visit the most?* • Nine Mile Beach / Tuncurry Beach - 8.6% (17) • Forster Main Beach - 8.6% (17) • Pebbly Beach - 2.0% (4) • One Mile Beach - 17.8% (35) • Burgess Beach - 0.5% (1) • Seven Mile Beach - 2.5% (5) • Elizabeth Beach - 8.6% (17) • Sandbar Beach - 5.1% (10) • Seal Rocks, Number One Beach - 4.6% (9) • Seal Rocks, Boat Beach - 9.6% (19) • Seal Rocks, Light House Beach - 2.5% (5) • Treachery Beach - 1.0% (2) • Bennetts Beach - 28.4% (56) *197 Answered*
Beach Visitation	*How often do you visit the beach?* • Daily - 21.8% (43) • Weekly - 40.1% (79) • Monthly - 18.8% (37) • Every 3 months - 10.7% (21) • Yearly - 8.6% (17) *197 Answered*	
Beach Usage / Activities	*What activities do you do at the beach?* • Walking - 85.9% (165) • Swimming - 79.2% (152) • Surfing - 42.7% (82) • Sunbathing - 39.6% (76) • Picnicking / BBQs - 33.3% (64) • Fishing - 35.9% (69) • Running - 26.0% (50) • Sight seeing - 26.6% (51) • Playing with children - 35.9% (69) • Kite surfing - 1.6% (3) • Nature appreciation - 43.8% (84) • Other – 19.3% (37) *192 Answered*	*Which activity do you do most often?* • Walking - 33.9% (63) • Swimming - 28.0% (52) • Surfing - 13.4% (25) • Sunbathing - 2.2% (4) • Picnicking / BBQs - 1.6% (3) • Fishing - 9.1% (17) • Running - 1.6% (3) • Sight seeing - 0.5% (1) • Playing with children - 6.5% (12) • Kite surfing - 0.0% (0) • Nature appreciation - 3.2% (6) • Other 4.2 % (8) *186 Answered*

Topic	**Response -** Percentages (and No.)	**Response** - Percentages (and No.)
Beach use values	*For the Beach you visit MOST often, what is good about this beach?* • Safe for children - 40.3% (75) • Good facilities - 21.5% (40) • Good parking and access - 41.4% (77) • Good surfing - 27.4% (51) • Quiet and undisturbed - 37.6% (70) • Natural beauty - 71.5% (133) • Natural vegetation - 32.2% (60) • Undeveloped backdrop - 36.0% (67) • Clean water and sand - 74.2% (138) • Low key development / lack of commercialisation - 45.2% (84) • Proximity to restaurants/cafés - 6.9% (13) • Off-leash dog walking/dog friendly - 20.4% (38) • Abundance of native of wildlife - 40.3% (75) • Rocky areas for exploring/walking - 30.1% (56) • Fishing - 21.5% (40) • Enjoyment of the beach for its activities (walking swimming etc) - 60.2% (112) • Other – 8.6% (16) *186 Answered*	Of these values, which is the best attribute of the beach? • Safe for children - 10.2% (18) • Good facilities - 1.7% (3) • Good parking and access - 3.4% (6) • Good surfing - 7.4% (13) • Quiet and undisturbed - 6.3% (11) • Natural beauty of the beach - 23.3% (41) • Natural vegetation - 0.6% (1) • Undeveloped backdrop - 5.7% (10) • Clean water and sand - 11.4% (20) • Low key development / lack of commercialisation - 4.6% (8) • Proximity to restaurants/cafés - 1.1% (2) • Off-leash dog walking/dog friendly - 5.1% (9) • Abundance of native of wildlife - 2.8% (5) • Rocky areas for exploring/walking 0.0% (0) • Fishing - 4.6% (8) • Enjoyment of the beach for its activities (walking swimming etc) – 11.9% (21) • Other – 2.8% (5) *176 Answered*
Comm-unity Consult-ation	*How would you like to be consulted?* • Local Newspaper - 46.8% (58) • Council's website - 20.2% (25) • Online survey - 34.7% (43) • Email - 54.0% (67) • Community drop-in session - 11.3% (14) • Community meeting/presentation - 19.4% (24) • Newsletter with rates notices - 26.6% (33) • Signage - 12.9% (16) *124 Answered*	*Which is your preferred method of consultation?* • Local Newspaper - 19.3% (22) • Council's website - 3.5% (4) • Online survey - 12.3% (14) • Email - 49.1% (56) • Community drop-in session - 1.8% (2) • Community meeting/presentation - 5.3% (6) • Newsletter with rates notices - 8.8% (10) • Signage - 0.0% 0 *114 Answered*
Values to keep & room for improve-ment	*What would you like to keep the same about the beaches?* • Naturalness / Undeveloped state – 62.4% (88) • Beach access facilities / opportunities - 22.0% (31) • Coastal walking paths - 12.1% (17)	*What would you like to change to improve those beaches?* • Improved facilities, amenity and accessibility of beaches / foreshores – 52.3% (68) • Beach and dune management – 28.5% (37)

Topic	**Response -** Percentages (and No.)	**Response** - Percentages (and No.)
	• Dogs on beaches – 8.5% (12) • Beach access by vehicles (both for & against) - 6.4% (9) • Everything – 5.7% (8) • Parks / Recreation - 4.3% (6) • Dogs on beaches policies – 3.5% (5) • Surf Life Saving / Safety Facilities – 3.5% (5) • Boat launching facilities – 1.4% (2) *141 Answered*	• Greater restrictions for beach vehicle use – 13.8% (18) • Increased rangers / improved compliance 4WD, dogs, litter, illegal tree removal, parking) – 13.1% (17) • Increased restrictions for dogs on beaches – 5.4% (7) • Improved traffic / road conditions – 3.1% (4) • Improved beach access for vehicles – 2.3% (3) • Beach protection – 2.3% (3) • Relax dogs on beaches restrictions – 0.8% (1) *130 Answered*

B.2 Blueys and Boomerang Beaches Survey Results

A separate, similar community survey was conducted for Blueys and Boomerang Beach, as shown in Table B-4. Over 100 responses were received, and the responses are summarised for each beach in Table B-2 below.

For Blueys beach, dune management (removal of weeds, maintenance and rehabilitation of native species) was the most commonly requested beach improvement, with specific mention given to the success of the Boomerang Beach weed management efforts. Access arrangements were the second most commonly requested improvement, specifically at the northern and southern ends. This included provision of formalised car parking, toilets, accessways, beach shower and viewing platform at the northern access points. For the southern end of the beach, upgrades to the toilet facilities, beach showers, resurfacing and landscaping of the car park, and improved beach access were requested. In general, the community also requested regular maintenance to beach accessways, and improved or additional viewing platforms with seating.

At Boomerang Beach, dune management was also the main improvement noted. This particularly focussed on weed removal, but also beach maintenance for erosion. Other changes requested for Boomerang Beach included improvements to facilities at the far southern end (including car parking, toilets and showers). Respondents were generally very happy with the recently improved facilities at the northern end of the beach (viewing platform, toilets, filtered water taps, picnic tables and parking), with requests for additional picnic tables given the popularity of the facilities. Given the success of the works, other upgrades at Boomerang or Blueys Beach equally styled are likely to be well received. In addition there were general requests to increase the number of beach showers, and maintain or improve beach accessways along the entire beach.

While the issue of beach patrolling was raised at both beaches, it was the second most frequently raised issues at Boomerang Beach. Life guarding was suggested for the summer/school holidays. The issue of litter management particularly during busy holiday periods was also raised for both beaches, particularly Boomerang Beach (equal second most frequently raised issue).

For both beaches, respondents frequently raised the issue of unsafe pedestrian access leading to and between the beaches. It was frequently suggested that a shared walking/cycle path along and between the all of the beaches (Elizabeth, Shelley, Boomerang and Blueys) would significantly improve pedestrian safety, as there is currently poorly connected and patchy provision of footpaths (one respondent even suggested a cycleway linking back to Forster). For Boomerang Beach, a few suggestions were made for the dune access road to be made car-free (i.e. pedestrians only).

The increasing invasion of weed species at Blueys Beach was also raised as an issue of concern, with both Bitou Bush and Lantana noted to be overtaking significant areas of native growth. In addition to weed pressures, the dune vegetation at Blueys Beach is periodically under attack by individuals sawing down and removing tree growth, presumably to improve the views from some foreshore properties.

As with many other beaches in NSW, the issue of "dogs on beaches" was raised by many respondents, in both "for" and "against" positions. This issue is not relevant to the management of coastal hazards, but is recommended that Council monitor the issue to determine if or when changes to current regulations and compliance activities at the beaches are needed. The comments in the survey provide a useful starting point for reviewing regulations. For example, the confusion regarding the areas and hours permitted for off-leash access by dogs and dog owners; and off-leash dogs affecting other beach users, particularly issues of dog faeces on the beach (which may be best managed between dog owners themselves) were raised.

Table B-2 Summary of Blueys & Boomerang Community Survey Results

	Blueys Beach	***Boomerang Beach***
Beach Usage (No. respondents)	• Daily: 13 • Weekly: 21 • Monthly: 21 • Every 3 months: 19 • Yearly: 14	• Daily: 26 • Weekly: 12 • Monthly: 24 • Every 3 months: 21 • Yearly: 3 • Daily during school holidays: 6
Activities	Respondents noted a range of beach uses to be popular, most notably: • Walking • Surfing • Swimming • Fishing • Sight-seeing and nature appreciation • Sunbathing • Playing with children • Running • Dog walking	Respondents noted a range of beach uses to be popular, most notably: • Walking • Swimming • Surfing • Sunbathing • Nature appreciation and sight seeing • Playing with children • Fishing • Running • Picnicking / BBQ-ing • Dog walking (less than Blueys)

	Blueys Beach	***Boomerang Beach***
Values of the beach	In order of preference, the following values were noted: • Natural beauty of beach and surroundings • Quiet and undisturbed • Natural vegetation • Clean water and sand • Enjoyment of the beach for its activities (walking, swimming etc.) • Good surfing • Off-leash dog walking/dog friendly* • Safe for children (on sand only) / family friendly • Low key development (lack of commercialisation) • Abundance of native wildlife (birds, dolphin, whales, fish) • Parking and toilet facilities • Easy access to the beach • Rocky areas for exploring/walking • Fishing • Horse exercising * 2 respondents were not in favour of dog walking	In order of preference, the following values were noted: • Natural beauty of beach and surroundings • Good access, parking and facilities (generally) • Clean water and sand • Good surfing • Quiet and undisturbed • Look-out platform, toilets, parking and other facilities at northern end • Enjoyment of the beach for its activities (walking, swimming etc.) • Low key development (lack of commercialisation) • Natural vegetation • Safe for children (on sand only)/ family friendly • Abundance of native wildlife (birds, dolphin, whales, fish) • Off-leash dog walking/dog friendly* • Rocky areas for exploring/walking • Fishing * 1 respondent was not in favour of dog walking
Things to keep the same	Respondents overwhelmingly requested that the beaches (and the things they value about them) be kept the same. Individual items also requested to be kept the same were: • Natural vegetation, clean sand and pristine environment of the beach itself • Maintaining the low level of development (no high rises, additional shops, buildings, increased density) • Pleased with dog access (7 respondents) • Not pleased with dog access (3 respondents) • Existing access, parking and facilities • Uncrowded and undisturbed • Maintaining no vehicles on the beach	Respondents overwhelmingly requested that the beaches (and the things they value about them) be kept the same. Individual items also requested to be kept the same were: • Maintaining the low level of development (no high rises, additional shops, buildings, increased density) • Natural vegetation, clean sand and pristine environment of the beach itself • Existing access, parking and facilities (especially at north end) • Pleased with dog access (7 respondents) • Not pleased with dog access (5 respondents) • Maintaining no vehicles on the beach • Uncrowded and undisturbed • Maintaining no SLSC patrols • Maintaining no commercial fishing

Table B-3 Great Lakes Community Survey

Great Lakes Coastal Zone Management Plan Community Coastal Values Survey for Various Beaches

Please send your completed form to Verity Rollason via email: verity.rollason@bmtwbm.com.au or by post to PO Box 266 Broadmeadow NSW 2292.

This survey seeks your input to where, how and when you use the different beaches of Great Lakes. Please note that Blueys, Boomerang and Jimmys Beaches are NOT included in this survey, as separate plans are already underway for these locations.

Question 1	***Which beach(es) do you visit?***
Please tick all that apply	☐ Nine Mile Beach / Tuncurry Beach ☐ Forster Main Beach ☐ Pebbly Beach ☐ One Mile Beach ☐ Burgess Beach ☐ Seven Mile Beach ☐ Elizabeth Beach ☐ Sandbar Beach ☐ Seal Rocks – Number One Beach ☐ Seal Rocks – Boat Beach ☐ Seal Rocks – Light House Beach ☐ Treachery Beach ☐ Bennetts Beach
Question 2	***How often do you visit the beach?***
Please tick	☐ Daily ☐ Weekly ☐ Monthly ☐ Every 3 months ☐ Once a year
Question 3	Which beach do you visit the most?

Question 4	***What activities do you do at the beach?***
Please tick all that apply	☐ Walking ☐ Swimming ☐ Surfing ☐ Sunbathing ☐ Picnicking / BBQ ☐ Fishing ☐ Running ☐ Sight seeing ☐ Playing with children ☐ Kite surfing ☐ Nature appreciation (bird watching, whale watching etc) ☐ Other _____. (please specify)
Question 5	Which activity do you do most often?
Question 6	***For the Beach you visit MOST often, what is good about this beach?***
Please tick all that apply	☐ Safe for children to swim/play ☐ Good facilities (picnic, BBQs, toilets, etc) ☐ Good parking and beach access ☐ Good surfing ☐ Quiet and undisturbed ☐ Natural beauty of the beach ☐ Natural vegetation ☐ Undeveloped backdrop ☐ Clean water and sand ☐ Low key development / lack of commercialisation, ☐ Proximity to restaurants/cafés ☐ Off-leash dog walking/dog friendly ☐ Abundance of native of wildlife (birds, dolphins, whales, fish) ☐ Rocky areas for exploring/walking ☐ Fishing ☐ Enjoyment of the beach for its activities (walking swimming etc) ☐ Other (please specify)_____.

Question 7	Please specify which of the above is the best attribute of the beach?
Question 8	***What would you like to keep the same about the beaches?*** Please be as specific as possible and include location, e.g. “walking paths along Pebbly Beach and adjacent headlands”.
Question 9	***What would you like to change to improve this beach?*** Please be as specific as possible and include location, e.g. “improve beach access at Seal Rocks Number One Beach”.
Question 10	***Are there any other comments you would like to make?***

Question 11	***How would you like to be consulted?***
Please tick all that apply	☐ Local Newspaper ☐ Council's Website ☐ Online Survey ☐ Email ☐ Community Drop-in Session ☐ Community Meeting/Presentation ☐ Newsletter with Rates notices ☐ Signage (e.g. at beach, local shopping centre etc).
	Which of these options is your preferred method?

Your Contact Details (optional)
By providing your contact details Council can notify you regarding upcoming community events.

Name: _____

Email: _____

Address/Phone Number: _____

Table B-4 Blueys and Boomerang Beach Community Survey

Boomerang Beach and Blueys Beach Coastal Zone Management Plan Community Coastal Values Survey

Please send your completed form to Verity Rollason via email: verity.rollason@bmtwbm.com.au or by post to PO Box 266 Broadmeadow NSW 2292.

Your Contact Details (optional)

Name: _____

Email: _____

Address/Phone Number: _____

	Boomerang Beach	Blueys Beach
Question 1	***How often do you visit this beach?***	
Please tick	☐ Daily ☐ Weekly ☐ Monthly ☐ Every 3 months ☐ Once a year	☐ Daily ☐ Weekly ☐ Monthly ☐ Every 3 months ☐ Once a year
Question 2	***What activities do you do at this beach?***	
Please tick all that apply	☐ Walking ☐ Swimming ☐ Surfing ☐ Sunbathing ☐ Picnicking / BBQ ☐ Fishing ☐ Running ☐ Sight seeing ☐ Playing with children ☐ Kite surfing ☐ Nature appreciation (bird watching, whale watching etc.) ☐ Other _____ (please specify)	☐ Walking ☐ Swimming ☐ Surfing ☐ Sunbathing ☐ Picnicking / BBQ ☐ Fishing ☐ Running ☐ Sight seeing ☐ Playing with children ☐ Kite surfing ☐ Nature appreciation (bird watching, whale watching etc.) ☐ Other _____ (please specify)

	Boomerang Beach	Blueys Beach
Question 3	***What other things are good about the beach?*** e.g. safe for children to swim/play, good facilities, good parking and access, good surfing, quiet and undisturbed, natural vegetation etc.	
Question 4	***What would you like to keep the same about the beach?***	
Question 5	***What would you like to change to improve this beach?***	
Question 6	***Are there any other comments you would like to make?***	

Appendix C Submissions and Responses on the Draft CZMP – Options Study report

C.1 Table of Submissions on the Draft CZMP: Options Study

A total of 56 formal submissions were received during the exhibition period from 15 December 2015 to 13 February 2015. Of these some 80% came from Pacific Palms beachfront residents, with most of the remainder from One Mile Beach area. A submission was also received from NSW Department of Primary Industries as well as two reports undertaken on behalf of the Boomerang & Blueys Beach Group.

The following table provides a detailed summary of public responses on particular management themes. It is a condensed view of concerns and suggestions across these themes as they appeared in each submission. Respondent numbers however, do not provide a statistical measure of significance in each case, as this was not a controlled survey. Additionally, the material provided from oral presentations at the Strategic Committee of 8 September 2015, has also been collected into this detailed summary.

Abbreviations:

Worley Parsons Report: "Boomerang Beach and Blueys Beach Coastal Processes and Hazard Definition Study", Worley Parsons, July 2011

SMEC Report: "Great Lakes Coastal Hazards Study", SMEC, October 2013

GPR Investigation: "Ground Penetrating Radar Investigation of Blueys and Boomerang Beaches", BMT WBM, June 2014

Coastal Hazard Revision: "Bedrock Based Coastal Hazard Revision for Blueys and Boomerang Beach", BMT WBM, June 2014

(Draft) Options Study: (Draft) "Great Lakes Coastal Zone Management Plan: Options Study", BMT WBM, March 2015

(Draft) CZMP: (Draft) "Great Lakes Coastal Zone Management Plan", BMT WBM, March 2015

LEP 2014: Great Lakes Local Environment Plan 2014

(Draft) DCP: (Draft) Great Lakes Development Control Plan 2014

Theme 1: Coastal Processes - The Science		
Submission	**Response**	**Document/Action**
(36 Submissions) Coastal processes information in Worley Parsons Report is inadequate for preparation of CZMP or determination of hazard lines in LEP with no additional research is unsatisfactory. Assumptions and calculations grossly overstate the risks to property and infrastructure: Sea level rise assumptions of 0.4m (2050) and 0.9m (2100) were excessively conservative. Projections have been based on theoretical calculations rather than local conditions (rocky headlands). Despite recommendations, no additional work including - directional wave data, pre and post storm beach profiling, repeat bathymetric surveys, ongoing aerial photography, photogrammetry profiling and analysis - has been undertaken by Council to address deficiencies prior to preparing the CZMP Options Study. Despite acknowledging that numerical modelling techniques are not able to represent storm erosion volumes and not visiting the site the consultant was able to determine a precise figure of $250m^3/m$ for these volumes.	The content and recommendations of the Boomerang Beach & Bluey's Beach Coastal Processes and Hazard Study (Worley Parsons, 2011 - "Worley Parsons Report") and the Great Lakes Council Hazards Study (SMEC, 2013) used to inform preparation of the Draft Great Lakes Coastal Zone Management Plan: Options Study ("Options Study"). In response to community concerns regarding the 'desktop study' nature of the Worley Parsons report, Council commissioned two additional research studies to clarify subsurface conditions at Boomerang Beach and Blueys Beach: the GPR Investigation and the Coastal Hazard Revision (both BMT WBM 2013 – Coastal Hazard Revision). These studies also informed preparation of the Options Study and subsequent CZMP. All of the identified documents have been subject to peer review and endorsed by Great Lakes Council and the NSW Office of Environment & Heritage (OEH). They have been endorsed as being of industry standard, compliant with relevant legislative and guideline requirements. Regarding the specific concerns: The Guidelines for Preparing Coastal Zone Management Plans (CZMP) (OEH, 2013) require councils to adopt sea level rise projections that are 'widely accepted by competent scientific opinion'. The science underpinning Council's Sea Level Rise Policy has been validated in report by NSW Chief Scientist & Engineer. Revision to sea level rise projections as well as monitoring will be incorporated within the formal CZMP revision cycle over a 5 - 10 year period. Analysis was based on 50 years of air photo record. Photogrammetry is rectified to be consistent with established state survey marks and vegetation is taken into account when calculating volumes. Consequently, the standard of the resulting photogrammetry time series analysis is consistent with industry standards. Storm erosion volume assumption ($250m^3/m$) is conservative, but perhaps consistent with increased ocean storms in the future. It will be reviewed as part of the next revision cycle.	*Concerns raised regarding the validity of the hazard studies are addressed in Section 1.5 of the revised Options Study.* *No further action at this time.*

Theme 1: Coastal Processes - The Science		
Submission	**Response**	**Document/Action**
(36 Submissions) The Bruun Rule has been used to estimate future sand recession due to sea level rise. The Rule does not account for underlying bedrock, reefs and headlands which may affect the transport of sediment as sea levels rise and, therefore, the extent of recession along the beach.	The Bruun Rule assumes uniform sand and does not account for subsurface rock or other durable material unless this extends sufficiently (vertically) above mean sea level. Such substrata were not found at Boomerang and Blueys Beaches in the additional geotechnical investigation completed in June 2014.	*Application of the Bruun Rule is comprehensively dealt with in Section 5.2 of the Worley Parsons Report.* *No further action at this time.*
(36 Submissions) The Study determines 'slumped post storm profile', 'immediate hazard area' and 'zone of reduced foundation capacity' without justifying the underlying assumptions. Decisions also need to be built from locally derived data and from the East Coast Australia including that from Fort Denison (See above).	Hazard zones and underlying assumptions are based on the work of Neilson et al, 1992. Although more than 20 years old this methodology is still regarded as industry standard across Australia for determining the configuration of zones of instability within an active dune system. The Worley Parsons Report (2011) used applicable data from regional and general East Coast sources. This included recorded wave data from Crowdy Head and sea level data from Fort Denison.	*Worley Parsons Report:* *Wave data Section 4.4* *Storm demand: Section 4.6* *Hazard zones: Section 5.7 of the Worley Parsons Report.* *No further action at this time.*

Theme 1: Coastal Processes - The Science		
Submission	**Response**	**Document/Action**
(36 Submissions) The Worley Parsons Report ignores measurable scientific data for Boomerang & Blueys Beaches. Data gaps render the Worley Parsons Report unusable. Boomerang & Blueys Beaches are accreting and this will completely offset sea level rise impacts. Headlands at Boomerang & Blueys will prevent long term beach recession because of relatively contained sediment compartments. Wave data is inappropriate (See above). Sea level data is inappropriate (See above). Council should adopt geotechnical information from individual site investigations rather than rely on broader investigations. Hazard definition methodology, modelling and assumptions are inadequate (See above). Hazards not accurately identified in relation to property boundaries. Longshore transport assumption has no supporting data. Storm demand assumption is not supported by data (See above). Bruun Rule methodology is in error due to beach slope assumptions. No peer review of the Worley Parsons Report.	These are repeated assertions, none of which are supported by the evidence, peer review, OEH or Coastal Panel. Hazard information and CZMP responses will be guided by continued monitoring of coastal behaviour. Identification of data gaps is important in the adaptation and improvement process. The CZMP will improve and adapt over time, however information at hand is regarded as sufficient to commence the process. Beaches are currently stable which is consistent with assumptions in the Worley Parsons Report. Additional geotechnical investigation at Boomerang/Blueys is supported by OEH as the most recent and comprehensive information. Hazards have been mapped within the limits of contour information and the adopted models. This is judged 'fit for purpose' for adaptive planning. Longshore transport assumption is supported by industry experience and is consistent with the loss rates from a semi-contained 'pocket beach' Beach slope (depth of closure) is consistent with industry practice and was based on the bathymetry around Charlotte Head. Peer review was provided by OEH Coastal Expert and Consultant BMT WBM prior to commencing this Options Study.	*Concerns raised regarding the validity of the hazard studies are addressed in Section 1.5 of the revised Options Study.* *No further action at this time.*

Theme 1: Coastal Processes - The Science		
Submission	**Response**	**Document/Action**
(16 Submissions) Council should be monitoring the beaches with a proper long term research program to determine accurate basis for future risk management actions. CZMP must not be finalised without site beach studies and collection of actual data as recommended by Worley Parsons, Professor Short and BBBG. Community members and groups should be involved wherever possible.	Hazard definition and options are based on more than 50 years of photogrammetry. This provides sufficient information to commence adaptive management actions. Ongoing monitoring, including photogrammetry, is a 'no regrets' action that will be undertaken in conjunction with OEH and the community. Additional investigation will target improved bathymetry, geotechnical data and specific inundation, stormwater & catchment flooding interactions. Coastal hazards studies and management plans will be reviewed on a 5-10 year basis. This will also enable the incorporation of new data and assessment techniques into the future.	*Refer to Table 5-1 of Options Study. Ongoing monitoring program supported.* *Community involvement could be improved by establishment of Coastal Stakeholder Groups.*
(2 Submissions) Boomerang and Bluey's Beaches accretion will offset sea level rise effects.	Recent photogrammetry undertaken by OEH indicates that the nominal accretionary trend at Boomerang/Blueys Beaches has stalled and is currently consistent with the zero net accretion assumption in the Worley Parsons Report. If this state of zero accretion continues the full effect of sea level rise will be felt. This will be reviewed as further photogrammetry and other monitoring comes to hand.	*Continue to monitor beaches in conjunction with OEH; incorporate information into future review documents. Refer to Table 5-1 of Options Study.*
(1 Submission) Harder dune strata should be taken into account in hazard studies and coastal management plan projections.	Council commissioned two additional investigations to clarify subsurface conditions at Boomerang & Blueys Beaches: the GPR Investigation and the Coastal Hazard Revision (both BMT WBM, 2014). These studies subsequently informed preparation of the Options Study and subsequent CZMP. The coastal planning areas that were publicly exhibited as amendments to Great Lakes Local Environmental Plan (LEP) 2014 illustrate the realignment supported by the investigation of sub-strata at Bluey's and Boomerang Beaches. Additional investigation and verification of sub-strata is supported for all areas identified within the hazard studies and management plans, as resources are made available.	*Continue to undertake investigations of dunal sub-strata utilising methods such as ground penetrating radar within the identified coastal planning areas. Undertake these investigations in conjunction with OEH and incorporate this information into future review documents.* *Refer to Table 5-1 of Option Study*

Theme 1: Coastal Processes - The Science		
Submission	**Response**	**Document/Action**
(2 Submissions) One Mile Beach should not be classified as an 'open coast beach'	Beach classification has little effect on shoreline response to sea level rise as given by the Bruun Rule. However, it is recognised that the sand budget of One Mile is less susceptible to longshore losses than a long open coast beach such as Nine Mile/Tuncurry. Additional investigation of bathymetry and coastal processes and management are expected to be undertaken over time.	*Review storm bite and sediment transport for individual beaches as resources permit to inform future review of both coastal hazard studies and coastal management plans.*
(4 Submissions) Does sea bed profile affect beach erosion? Bathymetry is incorrect/out of date for One Mile Beach.	Sea bed contours (bathymetry) affect the amount of wave energy arriving at the shoreline. Bathymetry of offshore and surf zone sand will be re-done in the next review cycle with new LiDAR technology that is expected to improve confidence in this data. Little change is expected to bathymetry from that used in the current work.	*Review bathymetry and sediment transport for individual beaches as resources permit to inform future review programs for both coastal hazard studies and management plans.*
(4 Submissions) Risk to utilities along One Mile Beach – phone, power, stormwater, water & sewer	Council has been in discussions with utility providers and government agencies about the recommendations of the coastal hazard studies since their preparation and exhibition. These discussions and on-going co-ordination of these projects by Council with OEH provide the best opportunities for all agencies to plan for the anticipated effects of sea level rise and coastal hazards on public infrastructure within these areas. Coastal Stakeholder Groups are proposed as a means of coordinating relevant authorities alongside general community representation.	*Refer to Table 5-1 of Options Study. Ongoing monitoring program supported.* *Continue dialogue between Council, OEH and relevant public agencies on projected impacts of sea level rise and coastal hazards on public infrastructure.* *Stakeholder and agency involvement could be better coordinated through Coastal Stakeholder Groups.*
(1 Submission) Have flooding and erosion studies within Wallis Lake been undertaken?	The findings and recommendations of the adopted *Wallis Lake Floodplain Management Study & Plan* are being implemented by Council and considered the future impacts of flooding hazards utilising sea level rise benchmarks consistent with the coastal hazard studies.	*No further action at this time*

Theme 1: Coastal Processes - The Science		
Submission	**Response**	**Document/Action**
(2 Submissions) Burrawong Place properties were flooded during a recent storm but this information was not captured. Coastal inundation mapping not reliable.	Local runoff is not necessarily a good indication of coastal wave penetration however, additional investigation into the interaction of coastal inundation and stormwater within critical areas identified within the current hazard studies and management plans is a priority. Additional investigation into interaction of coastal inundation and local stormwater within identified areas has been identified as a priority. Inundation mapping needs to be refined and is currently used in an advisory sense to indicate where additional analysis might be needed in relation to specific developments.	*Expand localised investigations of coastal inundation & stormwater interactions as resources permit, to inform future review programs for both coastal hazard studies and management plans. Refer Appendix page E-19.* *Funding will be sought through OEH grants to undertake this work.*
(3 Submissions) Stormwater erosion and coastal inundation are significant issues in the vicinity of Ampat Place, Bluey's Beach where infrastructure is poorly designed and maintained: Stormwater run-off has significantly escalated with new buildings in the subdivision; Dunes are being eroded by stormwater run-off from development and carpark, not from high tides; Location excluded from "Pacific Palms Study of Water Management and Drainage" (1993). Location identified in the "Smiths Lake Planning Study" (2000) as suitable for development. Previous addresses to Council have included photographic evidence of the instances of flooding as a result of stormwater run-off. No action has been taken by Council to investigate or address these significant issues.	Ongoing problems with existing stormwater infrastructure are acknowledged. Increases in runoff will be addressed in a detailed stormwater and coastal inundation study which has been identified as an action priority for this area. Further development of the catchment will be deferred until this integrated study is completed. Discussions have also been held with OEH regarding works to reduce inundation from the ocean. Funding will be sought from OEH to undertake the inundation study which will include erosion protection works. Remedial work and maintenance will be undertaken in the interim to improve the performance of existing stormwater.	*Undertake interim remedial work.* *Inundation risks are addressed in the Options Study (Table 5.1) through an action to conduct new inundation studies and then extend flood planning controls.* *Plan investigation and risk management study and seek funds to undertake.*

Theme 1: Coastal Processes - The Science		
Submission	**Response**	**Document/Action**
(3 Submissions) The Options Study incorrectly refers to the stormwater drain as a "creek line" and a "small Holocene swamp" of low lying land behind the beach around Ampat Place and Newman Avenue" at Bluey's Beach. The report is also inadequate as there are no contour lines or topographic survey details.	There is considerable geomorphological evidence that prior to construction of Ampat Place and associated filling of allotments that this was an ephemeral watercourse or 'small creek'. The 'small Holocene swamp' also remains evident in the landforms associated with the creek upstream of the Ampat subdivision.	*Refer also to Fig 3.4 of Bedrock Based Coastal Hazard Revision for Blueys and Boomerang Beach (BMT WBM, 2013)*
(2 Submissions) The SMEC Report does not address the last 100 years of beach behaviour and the great amount of local knowledge readily available for this period.	Derivation of hazard lines by SMEC was based on almost 60 years of photogrammetry from 1956. This indicates a minor increase in beach volumes since 1963 including 1974 losses. As a conservative assumption the long term recession rate has been set to zero.	*Community involvement could be improved by establishment of Coastal Stakeholder Groups.*
(2 Submissions) Some geological investigation should be carried out to determine whether there is any underlying rock which might affect the erosion calculation - again this could be done quickly by boring holes along the pathway at One Mile Beach.	Further areas will be selected for improved geotechnical analysis as part of the ongoing revision process. The need to address this particular area will be established through the first revision cycle.	*Refer to Appendix page E-16 of Options Study.* *No further action at this time.*
(2 Submissions) The wave run-up calculations referred to on pages C-14 & 15 of the Options Study are based on a 1 in 1000 year offshore conditions to arrive at local wave run-up height. I question the use of this extreme return interval as an input into the modelling process.	Use of the 1000 year ARI (0.1% AEP) source ocean conditions is standard practice which is translated to conditions at the shoreline. There is a need to clarify and explain the basis of this 'maximum' event modelling and mapping.	*Clarify the rationale of modelling process for wave run-up determination in first revision cycle.*

Theme 2: Community Engagement – People and Process		
Submission	**Response**	**Document/Action**
(7 Submissions) Lack of consideration of previous submissions to Worley Parsons report and continued contempt for matters raised within submissions of Boomerang and Blueys Beach Group (BBBG).	Council acknowledges that direct responses to the submissions (Worley Parsons Report) were not provided. This is usual procedure with such engineering studies. These submissions were nonetheless, taken into account and reflected in the preparation of the Draft Options Study. It is a matter of record that Council has undertaken additional consultation with OEH and the Coastal Panel, peer review and additional geotechnical investigations of Boomerang and Blueys Beaches. This has been in direct response to consultation and submissions (including those of the BBBG). The information contained within these submissions tables, associated Council reports and the CZMP (incl. the Options Study), acknowledges such submissions and endeavours to outline a more comprehensive program of public consultation and engagement for future projects.	*Council will continue to consider all submissions through the finalisation of the current CZMP projects and in future programs. Establishment of Coastal Stakeholder Groups is an important action that will expedite necessary community involvement, ensuring a permanent communication interface.*
(32 Submissions) Council should consult an independent expert in cooperation with the Boomerang & Bluey's Beach Group.	Council is required to manage all its beaches in a transparent manner for all coastal stakeholders. Consultants are selected by funding partners (Council and the OEH) using an open quotation process that ensures independence of the consultant's work. Their work is regularly vetted through technical review by Council staff, OEH and the Coastal Panel. Council has undertaken direct consultation with representatives of the Boomerang and Blueys Beach Group during the community engagement program. Council continues, with the support and guidance of OEH to review and enhance community engagement processes.	*Council will continue to employ independent consultants during the finalisation of the current CZMP projects and in future programs.*
(11 Submissions) Thanks for information, meetings and Drop-In Sessions. We also thank Council for arranging a meeting between BBBG representatives and Council officers on 22 January 2015.	Council is keen to continue to engage with representatives of all community groups and stakeholders particularly on the basis of beach user/stakeholders groups.	*Ongoing community education/engagement is recommended in Table 3.4 and Appendix page E-22 of the Options Study.*

Theme 2: Community Engagement – People and Process		
Submission	**Response**	**Document/Action**
(15 Submissions) Request that further consultation be undertaken with the affected residence in particular those properties that are impacted by the hazard line. Council should engage positively with beach communities to develop potential of groups and businesses to respond. Can the Council work out a way of effective communication to make sure that all residents receive letters/emails to enable them to participate in any future meetings & discussions i.e. a registrar of emails to residents/companies that the study effects.	Council is keen to engage deliberatively with stakeholder and community groups. Council continues, with the support and guidance of OEH to review and enhance its community engagement strategies. New, more effective methods of communicating information to affected landholders and the wider community will continue to be developed by Council and OEH. Residents are also invited to "Have your Say" on current applications and projects via the new Council website at www.greatlakes.nsw.gov.au	*Council supports establishment of Coastal Stakeholder Groups to better coordinate stakeholder and agency involvement. Ongoing community education/engagement is recommended in Table 3.4 and Appendix page E-22 of the Options Study.*
(22 Submissions) Community engagement has been inadequate. Copies of all reports not distributed to everyone affected and the exhibition period was not long enough. I am disappointed no extension of time was granted to enable late submissions. Further consultation and effective communication required.	Over 600 letters were sent to the owners of properties located within the coastal risk areas identified in the CZMP Options Study. These owners of the public exhibition of the Options Study. Council officers ensured that over 1500 land owners were notified of the subsequent exhibition and community engagement program for the the Draft Coastal Zone Management Plan and other associated planning instruments. Letters are sent to property owners at their nominated postal address to ensure non-residents receive appropriate notification. An extensive community engagement program was undertaken which included media releases, local advertising, direct mail and public information sessions. The public exhibition period of over 8 weeks was also in excess of the minimum 3 week requirement of OEH. Distribution of full copies of these documents and associated exhibition materials is cost prohibitive for Council. The publicly exhibited documents are still available on Council's website www.greatlakes.nsw.gov.au. All late submissions have been considered and documented within this submission summary table. Individuals that have made submissions will be updated on progress of the Option Study and subsequent CZMP and advised of opportunities for involvement in option planning and implementation in the future.	*No further action at this time. However, Council supports establishment of Coastal Stakeholder Groups to better coordinate stakeholder and agency involvement.*

Theme 2: Community Engagement – People and Process		
Submission	**Response**	**Document/Action**
(1 Submissions) The forecasts and the reaction of the Great Lakes Council are reasonable. Given the financial constraints of the Council, it appears they have been careful and diligent.	Great Lakes Council is focussed on establishing coastal management practises and actions that are socially, environmentally and economically timely and responsible. At this time, for those beaches identified in the Option Study, the majority of recommendations are for low cost, "no regrets" actions.	*No further action at this time.*
(11 Submissions) Council has not acted in 'good faith'.	Council has continually strived to work in 'good faith' through open and transparent disclosure of coastal management information. Council continues to undertake coastal hazard identification and management planning in conjunction with and in accordance with the recommendations and requirements of OEH and Department of Planning & Environment.	*Council supports establishment of Coastal Stakeholder Groups to better coordinate stakeholder and agency involvement. Ongoing community education/engagement is recommended in Table 3.4 and Appendix page E-22 of the Options Study.*
(15 Submissions) Boomerang/Blueys: CZMP should be halted until community consultation, monitoring and data collection is agreed and 'complete'. In the meantime it is requested that hazard lines are removed from these beaches.	Lack of full complete certainty should not forestall action based upon reasonable identification of risk. Advice from OEH indicates that the existing hazard studies provide sufficient basis from which to proceed, improve and adapt. Community engagement on coastal hazard identification and management will continue into the future but complete consensus is not anticipated, nor is it essential before reasonable action is required of public agencies such as Council.	*No further action at this time.*
(1 Submission) Include all relevant public comments within the documents.	This and associated tables provide a public record of the summary of submissions and Council responses. Wherever possible references to relevant sections of the document are also provided.	*This summary table will be annexed to the adopted document.*
(24 Submissions) National or at least state level coordination is required to ensure transparent and equitable outcomes.	A national approach to coastal management, including a common methodology for valuing coastal assets and services, is regarded as essential in effectively targeting investment.	*Council will continue to lobby at state and federal levels for comprehensive methodologies.*
(2 Submissions) I request, on behalf of myself and other beachfront owners that we be given further opportunity to be involved in discussions before any final decisions are made which would severely devalue our properties.	There will be opportunity to clarify and revisit the hazard mapping process during the first revision cycle. Also the establishment of Coastal Stakeholder Groups could provide an appropriate forum for community engagement in the coastal management process.	*Council supports establishment of Coastal Stakeholder Groups to better facilitate community and agency involvement.*
(2 Submissions) What notification have service providers (i.e. electricity, drainage & sewerage) been given? What are their obligations to this management plan?	Mid Coast Water (water and sewerage) has been engaged in consultation and asset management associated with this project. The CZMP includes an action to foster collaboration between the service providers to manage potential impacts to such assets.	*Refer Appendix page E-5 of Options Study.* *Coastal Stakeholder Groups to facilitate agency involvement.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(8 Submissions) The preparation of these reports at ratepayers' expense has been a waste of limited Council resources – when these resources could have been expended on constructive programs for the benefit of the wider community.	Coastal management projects are developed and funded in partnership with OEH. Additional technical support is provided by NSW Coastal Panel. Effective management and adaptation to coastal hazards will benefit affected land owners, public agencies and the wider community. Council, along with other LGA's are in the process of addressing and co-ordinating available information on coastal risks under the OEH and Department of Planning & Environment requirements.	*No further action at this time.*
(24 Submissions) Council has been placed in an almost impossible situation by the State and Federal Governments attempting to make local government responsible for what is a national issue. National or at least state level coordination is required to ensure transparent and equitable outcomes.	A national approach to coastal management, including a common methodology for valuing coastal assets and services, is regarded as essential in equitably targeting investment.	*Council will continue to lobby at state & federal levels. A Coastal Stakeholder Group is a means of coordinated effort to achieve these things.*
(24 Submissions) Council's actions regarding beachfront properties has resulted in reduced property values and also reduced Council's rate revenue. In its considerations relating to funding coastal protection measures, the Study fails to recognise the past extent of rates contributions made by property owners. If GLC was to continue to ignore the relative weighting of the prior rate payments in relation to its consideration for funding the future control measures, the ratepayers in Newman Avenue will have been hugely disadvantaged because those ratepayers will have not received any relative benefit for their greater contribution.	Council is obliged to act reasonably on available information and has a legal duty to make this public in a timely fashion. There is no role for Council to selectively restrict access to information affecting beachfront properties, or to have oversight of market value. Past rates were set on the basis of property value and rate pegging requirements which are largely outside of the control of Council. Rates are unlikely to be a contributing or determining factor for the establishment of any future funding requirements for coastal management or protection measures. Future costs of coastal management would be distributed on the basis of Guidelines for NSW Coastal Protection Service Charge. Council may be identified as a project beneficiary in certain locations, and would naturally be required to contribute to the costs of such projects (See above). This would require a cost-sharing arrangement between other levels of government, utilities and land owners or other relevant parties consistent with the Guidelines for NSW Coastal Protection Service Charge.	*No further action at this time. Establishment of Coastal Stakeholder Groups is supported as a means to better coordinate stakeholder and agency involvement in a cost sharing scheme.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(1 Submission) What are the implications for our insurance premiums if Council persists in this act of self-destruction of its rate base?	At present, the coastal risks of storm surge, coastal erosion and gradual sea level rise are excluded by most general insurance policies in Australia. Coastal residents are referred to the Insurance Council of Australia with respect to insurance for "actions of the sea": www.insurancecouncil.com.au/issues-submissions/industry-in-focus/coastal-vulnerability-risks	*No further action at this time.*
(22 Submissions) Significant social impacts have occurred as a result of uncertainty and lack of leadership and community engagement. Council should adopt a positive and cooperative approach to Boomerang and Blueys beachfronts and Pacific Palms business and residential community to ensure economic and tourism activities not only preserved but built upon.	Council acknowledges that there have been difficulties in establishing a clear route forward for coastal hazard identification and management, but endeavours to improve engagement and communication in future programs. To this end, Council has committed to regular and periodic review of coastal risks and their management which is facilitated primarily through the Coastal Zone Management Plan. It is anticipated that as critical points are reached - either in terms of an event, policy decision or funding allocation these would be reflected in Council documents including but not limited to: Coastal Zone Management Plans, local environmental plans, development control plans, corporate delivery and operational plans. All of these are public documents, which were previously subject to community engagement activities where community input and participation are encouraged. Similarly, CZMP's are to be regarded as perpetual 'works in progress' to be reviewed, adjusted and refined at regular intervals or as new science/engineering demands.	*Council has a continuing commitment to ongoing community consultation and engagement.* *Council supports establishment of Coastal Stakeholder Groups to better coordinate stakeholder and agency involvement.* *Ongoing community education and engagement is recommended in the Options Study Section 4.3, Table 3.4 and Appendix page E-22.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(22 Submissions) Funding options to achieve positive outcomes should be addressed and embrace state and federal government options. A commitment by Council to work with the community, coastal organisations, bodies, other coastal councils, the State and Federal government to come up with an equitable funding mechanism for defence. Council must also carry out detailed studies of the financial impact of their risk assessment and possible options/combination of options, including impacts on tourism and the local economy. The CZMP process should also ensure equitable outcomes and to achieve this, a contribution from directly affected property owners may be appropriate.	The Options Study was intended to cover all available options across a very broad (LGA-based) coastal area. The cost benefit analysis provided for South Boomerang Beach aimed to give initial and relative separation between the available options. The Options Study provides detailed site specific actions and will be the basis for Council's decision making on the coast. A detailed funding model and response pathways will be required. This will be developed in the future to continue to inform debate and plan actions. In many cases Council itself will be a direct beneficiary of protection projects. Under the NSW Guidelines for Coastal Protection Service Charge, Council will be required to fund the project at a rate commensurate with the established benefit (public good, etc,).	*Council identifies the need for additional cost benefit analyses, funding models and mechanisms in future programs of review.* *Refer Table 3.4 Options Study.* *Develop case study using NSW Guidelines for Coastal Protection Service Charge for informed discussion, refinement and action.*
(9 Submissions) The Options Study does not comply with the guidelines.	The preparation of the Options Study has been subject to peer review by representatives of Council, OEH and the NSW Coastal Panel. These study documents are of industry standard, compliant with relevant legislative and guideline requirements and are therefore provide sufficient information on which to base the Options Study and subsequent Coastal Zone Management Plan (CZMP).	*References in Section 1.4.1 of Options Study.* *No further action at this time.*
(1 Submission) Council should seek advice from OEH and NSW Coastal Panel	As our funding partner OEH provides expert technical support in the identification and proposed management of coastal hazards. The preparation and processing of coastal hazard studies and management plans by Council will continue to be undertaken in conjunction and consultation with OEH and industry experts. The certification of these documents will be undertaken by the Minister for the Environment only on the recommendation of the NSW Coastal Panel.	*Ongoing.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(5 Submissions) By conducting this study, Council has "acted in good faith" and thus receive an exemption from liability for land affected by coastal hazards. Irrespective, the preparation of CZMP's should proceed planning decisions, rely on evidence-based data and include consideration of: What public and private assets are at risk Management should be based on evidence of immediate versus future risk immediate What would the economic consequences to the community be if assets are lost What actions are available to defend assets and research on protections methods, including lobbying the state government for a change to regulations around offshore sand harvesting What is the estimated cost of defence Which assets should be defended When should action to defend be taken How will actions be funded What action is required if an asset will not be defended	Council is obliged to act on identified risks in many areas of operation including floodplain and coastal management. Often land use planning is the immediate means of reducing exposure of life and property to further risk. Completion of the CZMP process is not prerequisite in Council responding to apprehended risks where these are significant in terms of probability and consequence. Protection under Section 733 of the Local Government Act 1993 Is reinforced when reasoned action supports risk management. Public and private assets at high and extreme risk are listed in the CZMP Options Study and CZMP. Approaches to managing immediate versus future risks are also detailed within the Options Study, with the focus being on practices and actions in the next 5 to 10 years. The Options Study specifically focusses on the full range of options available to Council to manage the impact of coastal hazards. The economic, social and environmental consequences of coastal hazards impacts have been assessed and considered as part of this process. The Asset Management Plan in the subsequent CZMP document then outlines a process for deciding future approach to individual assets, in the context of not only their exposure to coastal hazard, but other standard asset replacement considerations.	*Public and private assets are identified in Tables 5-1 to 5-3 in the Options Study.* *Immediate versus future risks are outlined in Section 4.2 of the Options.* *The consideration of asset management, defence and funding are detailed throughout the Options Study.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(5 Submissions) Councils may not be able to make all coastal management decisions simultaneously and pressure should be applied to the state and federal governments to contribute to these issues. Each step in the process where decisions are reached should be available to the public and these decisions should be used to amend and enhance CZMPs and LEPs. These decisions may change over time and therefore any CZMP will need to be flexible to cater for this. Council needs to decide if all or some on Great Lakes beaches are to be conserved if threatened by sea level rise and the CZMP state the Council position whether positive or negative.	Council has committed to regular and periodic review of coastal hazard identification and management. This is facilitated primarily through the Coastal Zone Management Plan. It is anticipated that as critical points are reached - either in terms of an event, policy decision or funding allocation these would be reflected in Council documents including but not limited to: Coastal Zone Management Plans, local environmental plans, development control plans, corporate delivery and operational plans. The preparation and review of these documents is subject to the requirements of state legislation and guidelines and therefore consultation with state and federal government will continue into the future. All of these are public documents, subject to public engagement processes where community input and participation are encouraged.	*Council continue its commitment to the on-going review and revision of coastal hazard identification and management in a transparent and inclusive manner.* *Council continue to lobby state and federal government for strategic guidance on these matters.*
(12 Submissions) The Boomerang and Bluey's Beach Group suggests the following options in preference to the adoption of the current coastal hazard documents: Defer adoption of the CZMP until additional research undertaken. Options of beach nourishment, sea walls and planned retreat together with hazard lines must be removed and replaced with a statement confirming that Boomerang and Blueys are not expected to face any significant coastal erosion in next 10-20 years. The CZMP should set out detailed plan of action regarding collection of beach data, economic studies, research into latest and cheapest options/combination of options to reduce erosion impact should it occur in the future. The CZMP should state when all of the above is completed in consultation with stakeholders, a well-balanced and factual based CZMP will be completed.	The hazard studies undertaken to inform preparation of the Options Study and CZMP provide sufficient basis from which to commence an adaptive planning process. Council has committed to an ongoing program of review and adaptation to maintain the relevance of coastal hazard and management documents. The Options Study aims to outline the range of coastal management actions available to Council and the community. The subsequent CZMP refines this to a range of options available to act upon within the next 5 to 10 years. Removing any of this information would negate the value of preparing strategic and pro-active management documents. The Options Study provides a cost benefit analysis for South Boomerang Beach which aims to give a relative measure of available options for this location. One recommendation is for a more detailed economic and funding model to be developed for options to treat the immediate coastal erosion risk at southern Boomerang Beach. The current documents are considered to be the initial stages of an ongoing program of research, investigation, consultation and review. In this regard, the identification and management of coastal hazards is expected to be a process of ongoing refinement.	*Council will undertake on-going review and revision of coastal hazard identification and management in a transparent and inclusive manner.* *Council supports establishment of Coastal Stakeholder Groups to better coordinate stakeholder and agency involvement and communication.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(2 Submissions) Focus of the document on private properties results is a failure to address wider issues regarding public assets such as roads, sewers, water and schools.	The Options Study and subsequent CZMP do not solely focus on private properties and are aimed at examining management and adaptation options for public and private assets within the coastal planning areas.	*No further action at this time.*
(12 Submissions) The general nature of the Options Study leaves it open for a Council to make *ad hoc* decisions and simply justify their actions by saying it was in the Options Study. In the future Council needs to provide specific studies of each area with a view to minimising hazards or adopting a policy as to what is to be done, with ongoing input from residents before decisions are made.	The Options Study was intended to cover all available options across a very broad (LGA-based) coastal area. It is anticipated that these initial options will be modified and linked to other asset sets as the plan is developed and reviewed over time in collaboration with other government and public agencies. The subsequent CZMP document provides more detailed actions for specific sites, within the 5 to 10 year context of the Plan. For the majority of these sites the current recommendations outline "no regret" actions.	*Council continues its commitment to ongoing community consultation and engagement.* *Council supports the coordination of community input into coastal management programs through the establishment of Coastal Stakeholder Groups.*
(1 Submission) The Options Study outlines a proposal that properties in coastal hazard areas may be acquired if they are not voluntarily sold to Council. These properties could then be leased out, until damaged by an erosion event. This encourages Council to depress beachfront property values; undertake compulsory acquisition; and then benefit from high rental incomes or, sell them for a windfall profit when it is "discovered" that the beaches are not actually eroding.	The Options Study was intended to cover all available options across a very broad (LGA-based) coastal area. The identification of a coastal hazard over a property, similar to the identification of a flooding or bushfire hazard does not trigger any compulsory acquisition requirements. The option to acquire properties and preferentially lease them back to previous owners is one approach that has been undertaken in the United Kingdom (UK) as a means of maximising the useful lifespan of properties for the original owners. Hence the inclusion of this option within the Study. Selection of options is a dynamic process based upon the estimated cost-effectiveness of each. Great Lakes Council is exploring all options that enable the long-term effective management and adaptation of both public and private assets and has not specifically endorsed this option. The primary issues of consideration are the balancing of social, economic and environmental costs and benefits of continued occupation and use in a safe and responsible manner.	*No further action at this time.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(25 Submissions) Boomerang and Blueys Beaches are not a NSW "hot spot" and the discriminatory decision to single them out for study and coastal management was flawed given the stability of these beaches. Council studies appear to significantly overstate the risks to Boomerang and Blueys beaches, the beachfront properties and other infrastructure. Despite regular movement of sand there has been no noticeable change in past 30 years.	The identification of coastal hazards within the Great Lakes has been undertaken with the same methodology as used in the identification of 'hot spots'. Only once hazard studies have been undertaken, exhibited, endorsed by OEH, are they adopted by Council for use in coastal risk management. Prior to 2012 the only studies that had been adopted where those for Boomerang & Blueys Beaches and Jimmys Beach. Now that the Great Lakes Coastal Hazard Study has also been adopted, additional beaches have been identified and appropriate actions and adaptation plans developed. The Coastal Hazard Study and additional geotechnical investigation for Boomerang/Blueys Beaches have confirmed that some areas of Boomerang Beach are currently at risk of erosion from an extreme ocean storm. Apprehension and response by Council to emerging risk is considered to be diligent and reasonable by coastal experts including OEH and the NSW Coastal Council.	*Refer to the GPR Investigation and the Coastal Hazard Revision (BMT WBM,2014)* *No further action at this time.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(9 Submissions) The Great Lakes CZMP only discusses three main ways of providing asset protection, yet surely there are more ways that should be put forward e.g. groynes, offshore reef creation etc. There is currently inadequate information to decide what should be done if a beach becomes threatened. Triggers to implement management options also need to be worked out: they are absent from this plan. But again the evidence base (supra vide) is necessary to inform these decisions. A complete list of management options combined with cost benefit analyses is necessary. A moratorium on implementation until comments 1 and 2 are clarified. There should be a more detailed discussion as to specific options that could be put in place for particular locations involving local community input and advising the community of the effects upon the community as a whole. The option referred to above should not be limited to that as set out in the Option Study. They must be specific and be aimed at achieving a long term goal.	A full list of options for Great Lakes beaches was detailed and assessed in the Options Study. A separate cost benefit analysis was provided in the Options Study for South Boomerang Beach to provide better understanding. Initial options will be modified and linked to other asset sets as the plan is developed further (Note: government agencies and utilities). Review of the CZMP by OEH has indicated the level of detail for the options to be sufficient, and the level of community consultation to be above the level required. A full list of options for the whole Great Lakes coastline was detailed and assessed in the CZMP Options Study. A separate detailed cost benefit analysis was provided in the CZMP Options Study for South Boomerang Beach to provide some overview of available options for this area. One action in the Options Study is for a detailed economic and funding model to be developed for options to treat the immediate coastal erosion risk at southern Boomerang Beach. As this is a whole-of-LGA coast plan, the options refer specifically to asset types, rather than focusing on individual beaches. Through treatment of asset types, combinations of options will be implemented variously and as needed across the different beaches. The full list of options and their analysis is given in Section 4.3 & Table 4.4 of the Options Study. The CZMP approaches actions on the basis of asset type (roads, stormwater etc.), not individual beach locations. This aims to provide streamlining and prioritising of resources via Council's standard service delivery and asset management process.	*Council identifies the need for additional cost benefit analyses, funding models and mechanisms in future programs of review.* *Establishment of Coastal Stakeholder Groups is supported as a means to better coordinate stakeholder and agency involvement in a cost sharing scheme.* *Refer Section 4.3 & Table 4.4 Options Study.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(25 Submissions) Council must not prepare a CZMP that 'sets in stone' possible options based on questionable risks that may not occur for 50-100 years and where there is no evidence for risk in the foreseeable future.	The Options Study suggests a trigger-based approach to managing long term risks (i.e. 2060 and beyond), based on information from the coastal hazard studies. The preparation and review of hazard studies, management and adaptation plans will be an ongoing process which will adapt and improve through future revisions. Management plans are intended to make recommendations for action and implementation over a 5-10 year period only, and therefore options being considered or recommended are not "set in stone". However, similar to flooding and bushfire, Council as a public agency is also required to undertake assessment of current and future risks to public and private assets. For the purposes of public assets the planning horizon is accepted as being 50 to 100 years. The Building Code of Australia also requires Council to assess buildings with an anticipated design life of 50 years. Therefore Council must also provide guidance on the identification and management of potential coastal risks based on the same horizons. Given the long term projections being considered, Council has also committed to regular and periodic review of coastal hazards and their management to ensure the most up to date information is being used to inform actions and recommendations on public and private lands.	*Council continue its commitment to ongoing review and revision of coastal hazard information and management practices and recommendations.*
(1 Submission) Options should address the marine environment, the objective and purposes of the marine park and protection of the ecological values in the report. Council should also account for roles & responsibilities of Marine Parks & Fisheries staff within coastal management plans.	It is acknowledged that this is the first iteration of an Options Study and there may be some gaps in the information and recommendations, with regards to the marine environment. The CZMP process adopts a multi-disciplinary approach to the management of coastal and marine areas. These gaps will be addressed within the revised CZMP.	*The coastal zone management plan is to incorporate the consideration of the marine environment in future review programs.* *Council encourages additional and ongoing consultation with the Marine Park Authority through establishment of Coastal Stakeholder Groups.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(2 Submissions) The cost benefit analysis is too simplistic and not appropriate for the making of long term decisions. In addition, the value of the existing houses to the community and the protection the dunes provide to other non-beachfront properties, have been underestimated.	Analysis in Options Study aimed for initial option identification based on relative benefit not absolute accuracy. Development of a detailed economic funding model will be progressed with the coastal zone management plan and subsequent review programs, in conjunction and consultation with OEH.	*Develop funding model consistent with NSW Coastal Protection Service Charge Guidelines. Economic Impacts: Refer Tables 2.3 & 2.4 of the Options Study.* *Dune Management: Refer Section 2.4.6 and Appendix page E-24 of the Options Study.*
(11 Submissions) We insist that Council review their position to ensure both a fair and equitable outcome for all community stakeholders.	Council cannot guarantee outcomes but has committed to the ongoing consideration of management and adaptation options for coastal planning areas. In doing so Council has also committed to the on-going review and revision of coastal hazard identification and management in a transparent and inclusive manner.	*Council continues its commitment to ongoing community consultation and engagement.* *Establishment of Coastal Stakeholder Groups is supported as a means to coordinate stakeholder and agency involvement in an equitable cost sharing scheme.*
(1 Submission) I would also propose that the final report should include all relevant community comments.	Noted. This is supported, but in the form of summary tables where personal identifying information has been removed in accordance with privacy legislation.	*The submission tables will be appended to the CZMP document for record and completeness.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(21 Submissions) Suggestions of planned retreat or any other 'forced action' would bring significant damage to reputation and desirability of owning or visiting properties at Boomerang and Blueys Beaches. Council needs to take action by implementing measures to help preserve beaches, and property owners should be given the opportunity to take their own measures to safeguard their house, not be forced into something by Council.	The Options Study was intended to cover all available options across a very broad (LGA-based) coastal area. It is anticipated that these initial options will be modified and linked to other asset sets as the plan is developed and reviewed over time in collaboration with other government and public agencies. The subsequent CZMP document provides more detailed actions for specific sites, within the 5 to 10 year context of the Plan. For the majority of these sites the current recommendations outline low cost, "no regret" actions. Private protection initiatives are guided by the Coastal Protection Amendment Act 2012 and its regulations. The approval authority for such works is the NSW Coastal Panel. There is currently no opportunity to embark on one-off protection initiatives without considering other landholders. Council is keen to continue to engage with affected land owners and communities to ensure that when more constructive or material actions are undertaken in the future, they are appropriate in terms of location, hazard, the asset being impacted, funding options and the environmental factors relevant at that time.	*Council continue its commitment to ongoing review and revision of coastal hazard information and management practices in an open and transparent manner.* *Establishment of Coastal Stakeholder Groups is supported as a means to better coordinate stakeholder and agency involvement.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(2 Submissions) Council is obliged to protect beachfront reserve at Blueys Beach and other dunes and pathways on public lands. Between 58 Newman Avenue and Blueys Beach is land (Beachfront Reserve) which is within the control and management of GLC in accordance with its public purpose. Like any property owner, GLC is responsible to ensure that the condition of its property is not altered such that it adversely affects the structures on adjacent properties. There is an inconsistency in the Worley Parsons Report in the number of properties affected by the 2100 hazard lines.	There is no obligation on Council to protect neighbouring properties should natural beach erosion impact upon beachfront reserves in public ownership. An obligation to maintain only applies to public roads under the Roads Act 1993 & Local Government Act 1993 and this is only as long as these actions are financially viable. The requirement to ameliorate impacts to neighbouring properties applies to development applications. There is no obligation on GLC to protect neighbouring properties should natural beach erosion impact upon its beachfront reserve. Further investigation and revision of the hazard lines based upon the location of bedrock and dune sands was undertaken by Council in 2013-14. Inconsistencies in the Worley Parsons Report regarding affected assets have been checked alongside the revised hazard mapping resulting from the investigation reports. Both reports are available from Council's website: www.greatlakes.nsw.gov.au/Environment/Coastal_Management	*Refer to the Coastal Protection Act 1979 (Section 38, Section 55M) and the NSW Coastal Policy 1997.* *Refer also to the GPR Investigation and the Coastal Hazard Revision (both BMT WBM,2015)* *No further action at this time.*
(4 Submissions) Resolve drainage issues at North Blueys and limit access to the beach from private residences. The stormwater drain situated there was originally intended to service a small number of dwellings - subsequent development has far exceeded this. Heightening this concern is the Council's past attempt to have a DA relating to one property in Blueys Way conditional upon the applicant, at his expense, replace and enlarge the pipe, presumably to cater for even greater run off. Such result certainly could not have made for appropriate management of the dune and beach system. A more collaborative approach involving residents is needed.	Reconstruction of the stormwater line is about to commence and pipe capacity is being reviewed. As part of this work an improved energy dissipation structure will be installed on the new outfall. This will reduce sand loss in the immediate area of the outfall. Options for access control will be discussed with Dune Care Group. Advise adjacent residents.	*Refer to Table 5.1 of the Options Study.* *Advise residents of the catchment and pipe capacity results.*

Theme 3: Coastal Management - Options and Risk Management		
Submission	**Response**	**Document/Action**
(3 Submissions) It is suggested that Council reintroduce comprehensive fencing as a permanent dune management option and in general the dune management and beach access management recommendations (pages D24-D25) are supported.	Noted. In certain locations and dune care programs fencing is utilised as a vegetation and sand stabilisation mechanism. In terms of providing a long-term and effective form of erosion protection the use of fencing is limited. However, discussions regarding access management, fencing type, vandalism and maintenance are ongoing between Council and active Dune Care groups.	*Dune Care Groups are valuable environmental stakeholders and will be involved in ongoing consultation programs for coastal management matters.*
(2 Submissions) Page 84: 11 properties on Boomerang Drive are identified as Stage 1 of Retreat Option (Fig 3.2) properties. There is one property immediately to the north which is identified as Stage 2. This house is in a similar location to all others and would be reasonably assumed to also be Stage 1.	Agree, this is a possible oversight in the mapping and related content of the Options Study.	*Clarify Stage 1 (Figure 3.2) with Consultant and ensure that maps and CZMP are updated.*
(1 Submission) Protection of beach amenity should not be the only priority.	Options to preserves beach amenity in the form of a sandy beach have been shown by economic analysis (Gillespie Economics, 2011) to provide the greatest return on investment. Benefits derive from the values and preferences of the community as a whole.	*No further action at this time.*
(2 Submissions) Sea wall construction with resident contributions is the preferred option for Boomerang and Blueys Beaches and is considered to be an effective and sensible solution that would enable the removal of engineered foundation requirements for buildings.	A sea wall is one of several sequential options that might be undertaken over a 50 year planning period. Other options (e.g. beach scraping) may provide initial cost-effective protection for a number of years until more capital intensive protection options, such as a sea wall, are needed.	*Further economic analysis required of options in future review programs.*
(2 Submission) Is there a dune management plan going forward to prevent erosion. Has Council factored in any preventive measures to protect the dunes & walkways? Going forward can Council & the One Mile community work together to evaluate the current sand dune vegetation & have a plan to reinforce the sand dunes.	Yes, dune and access management actions including for One Mile Beach have been included in the CZMP.	*Refer to D-25 of the Options Study.* *Establishment of Coastal Stakeholder Groups is supported as a means to better coordinate community and agency involvement.*

Theme 4: Land Use Planning - LEP and DCP		
Submission	**Response**	**Document/Action**
(11 Submissions) Council has not acted in good faith. We reserve our right to take legal action against Council should the unwanted measures be retained in the LEP, CZMP and associated documents. We hold Council responsible for all damages and losses caused arising from Council's actions, and lack of action, in respect of all issues raised in this and past submissions.	Council is obliged to act reasonably on available information and has a legal duty to make this public in a timely fashion. The identification of coastal hazards within the Great Lakes has been undertaken using the same methodology as used in the management of coastal erosion 'hotspots'. Only once hazard studies have been undertaken, exhibited, endorsed by OEH, are they adopted by Council and made into legislation by the Department of Planning & Environment. Apprehension and response by Council to emerging risk is considered necessary and reasonable by coastal experts including OEH and the NSW Coastal Council. There is no latitude for Council to selectively restrict access to information affecting beachfront properties or their market value.	*Council continue its commitment to the on-going review and revision of coastal hazard information and management in a transparent and inclusive manner.*
(10 Submissions) Coastal Risk Planning Area (CRA) only captures beachfront properties and not lower land behind.	Erosion/recession hazard defines the Coastal Planning Area. Coastal inundation risks are only critical in low areas such as Elizabeth Creek, Elizabeth Beach and Ampat Place, Blueys Beach. Several areas are also identified on the Flood Planning Area maps in Great Lakes Local Environmental Plan 2014 and in certain circumstances these hazards have the potential to intersect and overlap.	*Undertake detailed investigations of coastal inundation, stormwater and flooding in critical locations as resources permit.* *Funding will be sought through OEH grants to undertake this work.*
(9 Submissions) Remove unsubstantiated Boomerang & Blueys hazard lines from the LEP and planning controls, pending proper evidence based research. Clause 7.4 of GL LEP 2014 appears to put Blueys and Boomerang Beach in the unique situation of being the only ocean-side beaches in Australia where any development on the beach must provide for the removal of the development.	At the time of preparation of Great Lakes LEP 2014 the only studies that had been adopted where those for Bluey's, Boomerang and Jimmy's Beaches. Now that the Great Lakes Coastal Hazard Study, Ground Penetrating Radar and Hazard Line Revision Reports for Blueys and Boomerang Beaches have also been adopted, additional beaches have been identified for inclusion in the LEP and the extent of the coastal risk planning areas for Blueys and Boomerang Beach headlands have been confirmed. Provisions in the DCP and maps in the LEP will improve certainty for buyers (and sellers) about what can and can't be done on land within a coastal planning area. Draft DCP amendments aim to extend property lifespan and value and increase options future property improvements.	*Council continue its commitment to the on-going review and revision of coastal hazard identification and management in a transparent and inclusive manner.*

Theme 4: Land Use Planning - LEP and DCP		
Submission	**Response**	**Document/Action**
(12 Submissions) Coastal "zoning" does not: • extend to properties located behind the beachfront that have lower ground levels; • reflect variable nature of risk affecting beaches e.g. Blueys Beach vs. Jimmys Beach. This indicates a discriminatory approach has been taken. All property at risk and time frames relevant to each risk should be identified as part of a 'zone' on a map as part of the LEP. Identification of these coastal hazard zones should be extended to all coastal property in Australia that will be directly or indirectly affected - including denial or restriction of access or services to those properties. This should be considered as soon as possible to eliminate and/or determine Council's litigation exposure.	There are several forms of coastal risks: • Coastal erosion risk increases with proximity to the ocean and is not necessarily related to the level of the land. • Risks from wave over-wash are negated where a high dune barrier protects lower lying land behind it. • Inundation risk relates to the level of the land, and is the subject of a separate study for Elizabeth Creek. The type, timeframe and risk of hazards have therefore been estimated and mapped as part of the Hazards Studies, Options Study and subsequent CZMP. The identification of Coastal Risk Planning Areas within the Great Lakes Local Environmental Plan (LEP) 2014 have been undertaken using the same methodology as the identification of Flood Planning Areas - hazard studies are undertaken, exhibited, endorsed by OEH, adopted by Council before they are used for land use planning purposes. While this process may identify some areas before others that is a result of funding and resource limitations rather than any underlying discrimination. In this regard, Boomerang, Blueys and Jimmy's Beach are no longer the only areas where coastal hazard studies have been undertaken and adopted, hence the identification of other Great Lakes Beaches that may be affected by coastal risks. The identification of the variable nature of coastal risks within the Coastal Hazard Studies is reflected within the Coastal Zone Management Plans but Council is currently unable to identify this within the standard mapping available within Great Lakes LEP 2014. Council will however, endeavour to amend the Draft Great Lakes Development Control Plan (DCP) to provide additional guidance on development requirements in different locations as a result of the variations between exposure to coastal risk.	*Additional amendments to Draft Great Lakes Development Control Plan Objectives and Controls for Coastal Planning Areas to address variations in hazards and development proposals shall be tabled before Council for re-exhibition as a matter of priority.*

Theme 4: Land Use Planning - LEP and DCP		
Submission	**Response**	**Document/Action**
(2 Submissions) 2060 erosion risk and inundation maps in Option Study are significantly different to the Coastal Risk Planning Area in the LEP. Hazard lines should be consistent with maps appended to Options Study as stated in Option Study recommendations on D9 and D16.	The methodology for preparing coastal risk maps in a local environmental plan (LEP) is different to Options Study maps. LEP maps include erosion/recession line plus Zone of Reduced Foundation Capacity behind and relate specifically to 2060 design conditions. Options derive from an incremental risk-based approach. In addition, the maps in the Options Study and subsequent coastal zone management plan are illustrative diagrams of hazards over aerial photography. In comparison, LEP maps are structured as hazards over a cadastral layer which may not necessarily be closely linked to the aerial photography. In this regard, Council's cadastre is obtained from NSW Land & Property Information (LPI). LPI undertake review of cadastre throughout the state as time and resources permit. The purpose of the review is to provide more survey accurate cadastral resources for property management and information systems used by Councils and other public agencies. Since the time of preparation of the Option Study there has been a shift in GIS cadastre in several areas of the Great Lakes. This shift does not affect the anticipated extent of coastal risks and other topographic-based information such as contours, flooding, wetlands and bushfire, but it is acknowledged that this does affect the appearance of some areas on cadastral-based maps used within the Great Lakes LEP and other public agency documents. Council officers have discussed these issues with both representatives of NSW LPI and the Department of Planning & Environment (the Department). These agencies are aware of the issue and have indicated that Council, as with other organisations, is providing the best-available information in accordance with the recommendations and requirements of the Department.	*Council will continue its commitment to providing up to date and accurate information utilising appropriate methodology for the document being produced.* *Council officers will also continue to discuss interpretation and improvement of planning instruments with the Department of Planning and Environment, with the aim of providing clear and accurate information to users of these documents.*
(2 Submissions) Is there a an 88b covenant condition requiring owner to review coastal stability conditions for continued occupancy and possibly demolish building if the outcome is unsatisfactory.	This draft condition was requested by Council in one instance, several years ago and was subsequently modified by consultation with the owner. The Coastal Planning Area provisions in the development control plan should clarify foundation engineering requirements on land within a coastal planning area. The clause in LEP 2014 is based on the standard clause of the NSW Standard Instrument LEP.	*Development control plan to be amended and re-exhibited with clarification of development provisions and when engineering certification is required.*

Theme 4: Land Use Planning - LEP and DCP		
Submission	**Response**	**Document/Action**
(2 Submissions) GLC previously introduced development conditions requiring setbacks from ocean front boundaries and enhanced foundations for new structures. Any condition requiring enhanced building foundations ignores nature of the risk. While the building may survive damage to services and infrastructure would deprive the owner of use of the building. Council could be liable for damage suffered by the landowner. Further GLC required the land owner to encumber their land with a covenant that required the landowner, to prove that the development was not affected by sea level rise at a certain time in the future. Failure to produce that evidence would give GLC power to order the demolition of the development.	Council is continuing to explore all options for management of coastal risks on private property. To this extent, Council is keen to provide flexibility and additional guidance within the Great Lakes Development Control Plan (DCP) so that development that occurs within the coastal risk planning area is designed and built to accommodate and respond to these risks, rather than relying on legal controls and mechanisms. Despite this, it is acknowledged that Council has a legal obligation to require the demolition and removal of unsafe structures under the Local Government Act 1993. This obligation applies irrespective of whether the structure has been damaged by coastal risks, floods or other reasons.	*Development control plan to be amended and re-exhibited with clarification of development provisions and when engineering certification is required.*
(1 Submission) At the time of exhibition of the CZMP Option Study residents became aware of a "suspension of any DA placed on the redevelopment or improvement of any properties on the eastern side of Newman Avenue". This has resulted in uncertainty and reduced property values. The hazard lines will also create a long term economic effect on the Pacific Palms community by reducing new DA applications on the beach front to zero. In the long term this will reduce the quality of residences on the beachfront and tourism to the area. Future planning and building controls adopted by Council need to balance reasonable permissible development, public interest and balanced future projections.	Council did not suspend the processing of any development applications in any of the areas identified within either the draft Coastal Zone Management Plan (CZMP) for Jimmy's Beach or the remaining Great Lakes Beaches. It is intended that the Coastal Planning Area provisions in the Great Lakes DCP will improve certainty for buyers (and sellers) about what can and can't be done on land within a coastal planning area. To this end, Council officers are in the process of amending the Draft Great Lakes Development Control Plan (DCP) to provide additional guidance on development requirements in different locations, to increase confidence to development and redevelop in these areas. It is anticipated that the amended document will be placed on exhibition in the near future to enable additional community consultation on these provisions.	*Development control plan to be amended and re-exhibited with clarification of development provisions and when engineering certification is required.*

Theme 4: Land Use Planning - LEP and DCP		
Submission	**Response**	**Document/Action**
(4 Submissions) Future planning and building controls should balance reasonable development, public interest and consistent future projections	Agreed.	*Development control plan to be amended and re-exhibited with clarification of development provisions and when engineering certification is required.*
(1 Submission) Why use 2060 planning horizon?	Great Lakes Council utilises a rolling 50 year timeframe for planning purposes, hence the use of 2060. This will be revised regularly in association with the program of review and revision of coastal hazard studies and management plans. Council opted not to use the 2100 benchmark (as per the flood planning area map in Great Lakes LEP 2014) due to increased levels of uncertainty with longer term projections with regards to coastal hazards and sea level rise.	*Council continue its commitment to ongoing review and revision of coastal hazard studies, management plans and planning instruments to ensure the best-available information is provided to land owners and the wider community.*
(4 Submissions) In view of the uncertainty of the model and implicit assumptions in the coastal hazard study, I request that the Coastal Planning Area (Hazard) line for 2060 that slightly encroaches the boundary of my property not be used in documentation that would cause a detrimental impact on the value of my property.	The Guidelines for Preparing CZMPs (OEH, 2013) require councils to adopt sea level rise projections that are 'widely accepted by competent scientific opinion'. This remains the benchmarks recommended by the former NSW Government Sea Level Rise Policy Statement and further explanation of this is given in the CZMP report Section 1.5.1.1. This information has been translated into the draft Great Lakes LEP 2014 coastal planning area maps as the most appropriate and readily-accessible public document for dissemination of this information. By providing this information in a non-discriminatory way, Council can ensure that appropriate and consistent decision-making is being undertaken.	*Council continue its commitment to providing best-available information in publicly accessible document such as the Great Lakes LEP 2014 and Great Lakes DCP.*
(1 Submission) The hazard lines are not sufficiently certain to justify the immediate identification of beachfront lots as being at risk of inundation or erosion and recession in the 2060 time frame. The SMEC study for erosion (Table 7 page 35 shows ZSA "10 lots slightly affected along the seaward boundary" and nil ZRFC.)	ZSA (Erosion/Recession Line) is not the basis for planning identification. The landward extent of the ZRFC which identifies land potentially affected by foundation instability is the proper extent of coastal hazard.	*No further action at this time.*
(1 Submission) The draft 2060 erosion and recession map in the BMT report shows the "likely" hazard line to be outside the property boundaries with the front yards affected by medium risk from the "rare" event.	Risk characterisation (extreme > high > medium > low) is a more general means of identifying a coastal planning area. The 'rare event' refers to a risk level analogous to the 1% AEP sea condition. This is consistent with the ZRFC identification of the 2060 timeframe and with hazard identification standards in floodplain management.	*Investigate clarification of risk levels within a more general 'Coastal Planning Area' through reference to OEH and NSW Dept. of Planning.*

Theme 4: Land Use Planning - LEP and DCP		
Submission	**Response**	**Document/Action**
(1 submission) The calculation by SMEC based on the dune system for One Mile Beach being entirely composed of sand, with no contribution to stability from vegetation. I strongly believe vegetation effects would challenge the accuracy of the calculation of "storm bite". The beach recovered quite quickly from the 1974 storm and no loss of sand seemed to occur even though it was estimated to be in the order of a I in 100 year event.	Vegetation has been shown to have very little effect during an extreme ocean event (storm bite). Value of vegetation lies in trapping and retaining a reserve of sand to offset storm and general recession effects.	*Dune/vegetation management is addressed in Sections 2.3.2 and 2.4.6 and Table 3.4 of the Options Study.* *No further action at this time.*
(1 submission) I must question the accuracy of the hazard lines in the identification of land at risk. The number of variables used to arrive at a result and the number of assumptions made is such that it is not truly possible to arrive at a definitive result.	It is agreed that the contribution to total error from methods and assumptions in the calculation process can be significant. Error sources should be addressed in subsequent review of the CZMP in order to improve stakeholder understanding.	*Include an error analysis as a case study for One Mile Beach and Boomerang Beach in the first review.*
(1 submission) There are obligations on Council to protect important environmental values including dunes and vegetation. The obligation to maintain access and foreshore facilities including coastal walkways, confers protection on the land behind, rendering hazard identification on such private land redundant.	Whilst Council agrees with the value of coastal dunes, vegetation and shared pathways, protection can only be undertaken within budgetary capacity. There only obligation to maintain and protect derives from the Roads Act 1993 and Local Government Act 1993 and that obligation only extends as far as its financial practicability.	*No further action at this time.*
There is an assumption that the slope of the ocean floor at One Mile is the same as that at Boomerang Beach measured some 35 years ago. There is no real verification for this assumption.	Coarse bathymetry (hydrographic survey) was used in the case of One Mile Beach. This matter was also identified with other beaches and a general revision of bathymetry should be undertaken. It is unlikely that the error contribution would render the current mapping unusable.	*Refer Table C5 of the SMEC Study. Identify bathymetry review in first revision cycle.*
(1 submission) I strongly believe that as much local data as possible should be collected and applied to verify the assumptions that have been made in calculating the hazard lines before they are applied to the LEP.	Hazard lines by SMEC were based on almost 60 years of photogrammetry from 1956. This indicates a minor increase in beach volumes since 1963 including 1974 losses. As a conservative assumption the long term recession rate has been set to zero.	*No further action at this time.*

Theme 4: Land Use Planning - LEP and DCP		
Submission	**Response**	**Document/Action**
(1 Submission) Has past historical data been recorded & used in this present study. Is there any historical data showing that the sand dunes have been breached in any storm. The measurement of the dunes was done by aerial surveillance. Is it accurate in the sand dune area do to the density of the vegetation & should land surveys be done to verify existing aerial measurements.	Hazard lines by SMEC were based on almost 60 years of photogrammetry from 1956. Photogrammetry is corrected consistent with survey control marks to allow for changes in dune vegetation. More recent aerial laser survey data is processed corrected to display ground level separately from the top of trees, buildings etc.	*Refer to Appendix page E-2 of the Options Study.* *No further action at this time.*
(11 Submissions) Council has not acted in good faith. We reserve our right to take legal action against Council should the unwanted measures be retained in the LEP, CZMP and associated documents. We hold Council responsible for all damages and losses caused arising from Council's actions, and lack of action, in respect of all issues raised in this and past submissions.	Council is obliged to act reasonably on available information and has a legal duty to make this public in a timely fashion. The identification of coastal hazards within the Great Lakes has been undertaken using the same methodology as used in the management of coastal erosion 'hotspots'. Only once hazard studies have been undertaken, exhibited, endorsed by OEH, are they adopted by Council and made into legislation by the Department of Planning & Environment. Apprehension and response by Council to emerging risk is considered necessary and reasonable by coastal experts including OEH and the NSW Coastal Council. There is no latitude for Council to selectively restrict access to information affecting beachfront properties or their market value.	*Council continue its commitment to the on-going review and revision of coastal hazard information and management in a transparent and inclusive manner.*

Marine Estate Management Submission	Response
References to Marine Park Authority must be replaced with Marine Estate Management Authority.	Amended Options Study & CZMP.
References to the Port Stephens - Great Lakes Marine Park must be replaced with Department of Primary Industries - Port Stephens - Great Lakes Marine Park or DPI (Marine Parks)	Amended Options Study & CZMP.
References to the Marine Parks Act 1997 must be replaced with the Marine Estate Management Act 2014.	Amended Options Study.
Table 1-1 references that Great Lakes Beaches will be covered by the CZMP and whether they are within the PSGLMP. The table and PSGLMP has no context and this should be provided.	Amended Options Study & CZMP.
The options should identify how they may impact on the marine environment, the objective and purposes of the marine park and how they protect the ecological values outlined in the report.	Amended Options Study.
Pages 31 and 34 - 'natural assets' does not include a reference to the PSGLMP	Amended Options Study.
Page 44 describes ecological values, but does not consider inter-relationship between values for the 'coast' and adjoining marine environment.	Amended Options Study.
Tables from Page 49 onwards do not account for roles and responsibilities of PSGLMP/Fisheries staff and should also outline all activities that Marine Parks grants permission for in addition to surfing.	Amended Options Study & CZMP.
The document should note that in addition to the coastal reforms, a Marine Estuary Strategy for all coast and estuary waters of NSW is being prepared. A threat and risk assessment will determine the social, economic and environmental benefits and stressors of the marine estate. This will probably include spatial zoning coupled with CAR principles. Upon completion of the Marine Estuary Strategy each marine park will be reviewed in line with the Marine Estate Management Act 2014.	Noted.
NSW community values associated with the marine estate are available at www.marine.nsw.gov.au/key-initiatives/marine-estate-community-survey	Noted.
Terrestrial information is very thorough and will assist in future decision making.	Noted.

Appendix D Summary of Coastal Hazards

D.1 Introduction

The key hazards affecting Great Lakes beaches at present and the future include:

- Beach erosion;
- Shoreline recession;
- Slope Instability; and
- Coastal inundation.

These hazards were mapped for the present (immediate), 2060 and 2100 timeframes in two separate hazards studies.

The Boomerang Beach and Blueys Beach Coastal Processes and Hazards Definition Study (CHDS) was completed by WorleyParsons in 2011. A previous coastal hazards study was completed by the NSW Public Works Department (PWD) in 1985. Findings from that study were included in the coastal hazards assessment provided by WorleyParsons (2011).

The Great Lakes Coastal Hazards Study (GLHS) (SMEC, 2013) provides a detailed coastal hazard assessment of the remaining beaches in the LGA. The GLHS was undertaken using photogrammetric data analysis and analytical assessments. It describes the coastal processes affecting the Great Lakes beaches and the impact of these processes on the areas of the beach where properties or assets are at risk. The report quantifies the observed long-term beach changes along Council's shoreline as well as estimating the shoreline recession that may be caused by projected sea level rise. The risk to property is defined in terms of the present day risk, 2060 planning period and the 2100 planning period (SMEC, 2013).

Sea level rise projections were considered when defining the shoreline recession and coastal inundation hazards. Other minor hazards that were defined but not mapped include: sand drift; and stormwater erosion.

D.2 Beach Morphology

The coastal zone of Great Lakes comprises two compartments that were established by the presence of a centrally located offshore island known as Cape Hawke Island. In the northern compartment, three bay barriers were formed during the late Pleistocene as part of a coastal progradation creating Nine Mile Beach while in the southern compartment the refracted waves have formed a tombolo-like lagoon barrier between Seven Mile Beach and Wallis Lake by joining Cape Hawke to Booti Hill headland (SMEC, 2013).

Sediments within the two embayments were affected by the Holocene and Pleistocene periods. SMEC (2013) notes that the northern embayment is characterised by significant coastal progradation in the Holocene (i.e. since sea levels stabilised around 6,500 years ago), with a broad back barrier comprising around 60 beach ridges. The southern embayment comprises Holocene sediments overlying a low-lying and partly eroded late Pleistocene lagoon barrier (SMEC, 2013).

The Great Lakes coastline comprises long open-coast beaches (e.g. Nine Mile Beach or Seven Mile Beach) and several cliffs or bluffs backing pocket beaches (e.g. Burgess Beach or Pebbly Beach). The beaches of Great Lakes are mostly exposed to the open-coast wave climate. Some erosion is visible on the dunes and foredunes at the various beaches all along the coast. Infrastructure such as beach access has been directly impacted by erosion, although the impacts are relatively minor. Large dune blow-outs (resulting from wind processes) are visible at various locations such as the northern end of Bennetts Beach and the northern end of One Mile Beach.

The coastline is mostly composed of undeveloped beaches with only a few locations where the coastline is backed by urban development (e.g. Forster or Seal Rocks). The majority of development areas within the study area have significant setbacks from the coastline. Public access points are available at many of the beaches.

D.2.1 Blueys and Boomerang Beaches

Boomerang Beach is a sandy beach barrier extending 1400 m between Charlotte Head (around 96 m AHD) and Boomerang Point (60 m AHD). The beach itself is indented some 600 and 300 m from the tip of the headlands at its northern and southern ends respectively (Worley Parsons, 2011).

Boomerang Beach itself comprises a beach berm and incipient dune of varying width, depending upon recent ocean conditions. Large boulders are often exposed on the beach and beneath the dunes at the southern end of the beach. The beach is backed by a high Holocene (<6,000 years old) foredune, of 10 to +20 m in height. Landward of this, the foredune grades to Pleistocene (> 125,000 years old) beach dunes, some sections of which are > 25 m AHD (DPI, 2004, WorleyParsons, 2011). The Pleistocene dunes grade to low-lying swamp and estuarine deposits, which drain to Elizabeth Creek, exiting to the ocean at Elizabeth Beach (Worley Parsons, 2011).

Blueys Beach extends 900 m between Boomerang Point in the north, and Blueys Head in the south. The beach is indented some 400 m from Boomerang Point in the north (Worley Parsons, 2011), and up to 200 m from Blueys Head in the south. Again, the beach comprises a beach berm and incipient dune of varying width and presence, depending on prevailing ocean conditions.

Blueys Beach is backed by a high Holocene foredune, reaching up to 18 m AHD in height (WorleyParsons, 2011). Along the northern half of the beach, the Holocene foredunes grade onto bedrock slopes that rise prominently behind the beach. At its southern end, a small creek exits the beach. The dunes are very low-lying in this region due to the creek entrance. Behind the beach in this location the land is low lying, forming a small Holocene swamp that drains the surrounding hills, immediately landward of Ampat Place.

Wave conditions at Boomerang and Blueys Beaches average 1.6 m. Combined with medium grained sands, the beaches typically display a ‘transverse bar and rip’ beach morphology, with a single sand bar regularly cut by rips (5 +) and topographically constrained rips adjacent to the headlands (Short, 2007).

Both beaches comprise residential development atop the foredune immediately backing the beach (with around three quarters of Boomerang Beach also having a narrow access road between the houses and the beach). There are numerous public access points available at both beaches.

D.3 Wave Conditions

The wave conditions for study area beaches, based upon recorded wave data from Crowdy Head, are as follows (SMEC, 2013, Worley Parsons, 2011):

- for a storm duration of 6 hours, the 100 year Average Recurrence Interval (ARI) wave height is 7.8 m (with an assumed period of 12 s);
- based upon a comparison of hindcast directional wave data from Crowdy Head (1985 to 1997) and measured directional data from Sydney (1992 to 1999), the dominant wave direction is south east and south-south east with over 70% of swell wave occurrences directed from the SE quadrant; and
- larger waves are dominantly from the south-south east sector.

Both SMEC (2013) and WorleyParsons (2011) reviewed the storm history relevant to the Mid North Coast, as summarised from their reports below.

- Storms predominantly occur in summer, autumn and winter, with the most prevalent months for storms being June and March.
- Easterly trough lows (also called east coast lows) and tropical cyclones are the dominant storm types for the study region, which is consistent with the dominant timing of storms noted above. Three such storm events in June 1967 battered the coastline of southern Queensland and northern NSW, generating gale force winds, heavy rains and huge south-easterly swells with a peak significant wave height of around 7.7 m at Great Lakes. The approach direction of the storm caused extensive erosion at the beaches facing north-east such as Elizabeth Beach.
- Large storms occurred during the 1970s and the late 1990s. Those storms included the storms of May-June 1974 whose impacts were the greatest felt on the NSW central coast. Because nearshore waves causing dune erosion are depth-limited, nearshore water levels and wave duration of moderate wave heights become more important factors for dune erosion than peak offshore wave heights of short duration.
- In early March 1995, Cyclone Violet reached a distance of around 400 km from the Great Lakes coastline which caused erosion at north facing beaches.
- A storm in May 1997 lasted more than 3 days between 9 May and 12 May 1997. A significant wave height of around 6.3 m was measured at Crowdy Head during that event.
- Such storms, which occur along the NSW coastline at irregular intervals, are responsible for episodic events of sand transport and beach erosion, which are evident when examining historical beach profile data.

The irregularity of the recurrence of storms is an indication of the variability of the wave climate, and which may also be influenced by larger scale cycles in climatic processes, such as the El Nino Southern Oscillation (ENSO) and the Interdecadal Pacific Oscillation (IPO).

D.4 Extreme Water Levels

Extreme water levels on the coast, which will generate coastal inundation, are influenced by:

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

For the GLHS, extreme water levels used in the calculation of coastal inundation were based upon the tidal and storm surge return periods at Fort Denison, Sydney, which are generally considered representative of the study region.

D.5 Climate Change and Sea Level Rise

The main impact of climate change that will affect coastal processes in NSW is sea level rise. Sea level rises of 0.4 m by 2050 and 0.9 m by 2100 above 1990 mean sea level. An estimate of 0.5 m sea level rise for 2060 was obtained by linear interpolation between 2050 and 2100. These values have been used in calculations for future shoreline recession and coastal inundation by both SMEC (2013) and WorleyParsons (2011).

These projections are based upon the latest reports by the IPCC (2007) and CSIRO (2007), which was used to derive the former *NSW Sea Level Rise Policy Statement* (2009), now repealed. The values are based upon the latest available projections globally (i.e. IPCC) and regionally (i.e. CSRIO). Council has adopted these projections within its own Sea Level Rise Policy.

D.6 Sediment Transport

Wave conditions (during storms and average conditions) may generate longshore and cross-shore sediment transport. In general, storms produce offshore transport and therefore erosion, while calm conditions promote onshore transport, allowing recovery and accretion. Longshore sediment transport is prevalent at all times, and may also enhance the erosion observed on beaches where the wave direction promotes the transport of sand from one end of the beach to the other, or out of the beach compartment (i.e. into the next compartment).

D.6.1 Offshore Sediment Transport

Once 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; this mechanism being called Aeolian sand transport. Longer term, should the amount of sand taken out of the compartment by

alongshore or offshore processes exceed that moved into the compartment from adjacent beaches or other sources, there will be a direct and permanent loss of material from the beach and a deficit in the sediment budget for the beach. This results in a landward migration of the active profile over time, known as shoreline recession (SMEC, 2013).

Following storms, ocean swell transports sand from the offshore bars onto the beach face where onshore winds move it back onto the frontal dune. This beach accretion phase, typically, may span many months to several years. Following the build-up of the beach berm and the incipient foredunes through this accretion, and the re-growth of the sand trapping grasses, it can appear that the beach has fully recovered and beach erosion has been offset by beach accretion. However, in some instances, not all of the sand removed from the berm and dunes during the erosive phase is replaced during the beach accretion phase. Sand can be lost to sediment sinks (estuaries, offshore canyons) or entrapment by reef systems transported beyond the beach compartment limits (offshore or alongshore) by storm processes. Accordingly, long term ongoing recession of the shoreline can occur (SMEC, 2013).

D.6.2 Rip Currents

A key mechanism for offshore sediment transport is rip currents, which are a mechanism for water to flow back offshore once it has been delivered to the shoreline by breaking waves. WorleyParsons (2011) describe the three parts of a rip current, namely: the feeder currents inside the breaker zone flowing roughly parallel to the shoreline; the rip neck where the feeder currents converge and water is transported offshore through the breakers; and the rip head, where the current widens and slackens just beyond the breaker line. Often, sand is deposited at the rip head as the current weakens. Topographically constrained rip currents at headlands assist in the transport of sediment between compartments, by transporting sediment to the outer surfzone at or beyond the bounding headland.

Due to the deeper depths within the rip channel, there is commonly greater erosion at the shoreline adjacent to rips, as the deeper water allows larger waves to reach the shoreline before breaking, then the rip itself quickly transport the sediment entrained by the breaking waves.

Both Boomerang and Blueys Beach are rip dominated beaches. Given that the occurrence and spacing of rip currents is dependent upon wave height and wave direction, rip currents may form at any location along the beach. WorleyParsons (2011) noted that, aside from the topographic rips adjacent to the headlands, there is no “fixed” location for rips at the beaches. Therefore, it was assumed that rips and the enhanced erosion associated with them may form at any location along the beaches.

D.6.3 Longshore Sediment Transport

Net longshore sediment transport, that is, the difference between upcoast and downcoast transport, is generally northwards in NSW, and in general, increases in rate from south to the north along the entire NSW coast.

WorleyParsons (2011) suggested that net northerly transport increases north of Newcastle, and cited a previous PWD (1985) study that assumed a net northerly longshore transport rates of 25,000 to 30,000 m^3/year for Blueys and Boomerang Beaches. In the absence of better additional

data, WorleyParsons (2011) adopted these rates of net longshore sediment transport. It was also noted from examination of 2003 aerial photography that the presence of continuous band of sandy material along the rocky coastline between Bald Hill and Blueys Head that longshore drift is active along this stretch of coastline (WorleyParsons, 2011). Both beaches are fairly embayed by bounding headlands suggesting that net longshore transport is likely to occur episodically as headland bypassing events during storms.

D.6.4 Beach Rotation

Over decadal time scales, changes in wave climate can result in beach rotation. The photogrammetric data for Great Lakes' beaches did not provide evidence for beach rotation (likely due to the sporadic nature of the photography). Instead, potential beach rotation was estimated By SMEC (2013) from analysis of mean wave directions approaching the beach. The estimated beach rotation for each beach was:

- ± 50 m for Nine Mile (Tuncurry) Beach;
- ± 2 m on Forster Main Beach;
- ± 5 m on One Mile Beach;
- ± 40 m on Seven Mile Beach;
- ± 5 m on Number One Beach, Seal Rocks;
- ± 8 m on Lighthouse & Treachery Beach;
- ± 60 m on Bennetts Beach.

While these bounds were identified, beach rotation was not included in the beach erosion hazard definition by SMEC (2013).

D.7 Beach Erosion Hazard

D.7.1 Whole of Coast

Beach erosion was determined for Great Lakes beaches by SMEC (2013) as an estimated equivalent storm erosion volume, representing the amount of sand that may be eroded during a storm event(s). The equivalent storm erosion volume consisted of "the sum of the measured volume difference between pre and post-storm photogrammetric profiles (Volume 1) and the assumed post-storm recovered volume (Volume 2). The equivalent storm erosion volume is said to correspond with the zone of wave impact and erosion plus zone of slope adjustment (i.e. the area of dune slumping following a storm event), defining the immediate erosion hazard (see Figure D-1).

It is very difficult to determine what an "extreme" storm event is on the open coast. While it is relatively straight forward to describe ARI wave heights and water levels, this does not (and has not) always produced the most eroded beach state. In addition to wave height and water level, wave direction and beach orientation, longshore sediment transport differentials and headland bypassing, pre-existing beach state, the formation of rip currents, and storm duration are all factors that affect the extent of erosion observed at any one time on a beach. Furthermore, as agreed by SMEC (2013), numerical modelling techniques are not able to represent storm erosion volumes,

due to the complexity of the beach environment noted above, and varying conditions, such as a series of closely spaced storms that may erode more than a single “design” storm event.

For this reason, a more reliable approach is to assume a particular storm demand volume to describe the beach erosion hazard, eliminating the need to define all of the conditions that contributed to the storm demand. There is very little measured data for storm demand, that is, beach survey immediately before and after a storm event. As noted by SMEC (2013), there is no such data for Great Lakes either. Therefore it is not possible to confirm the ARI for various storm demand values.

For the Great Lakes coast, SMEC (2013) used the most clearly visible storm impact evident in the photogrammetric data to calculate the equivalent storm erosion volume. For each beach, the maximum storm erosion at any one location was applied across the entire beach, to account for rip heads and other complexities, and to provide a conservative storm erosion estimate. Storm demand volumes (as m^3 per m of beach length above 0 m AHD) for each beach and the selected storm event(s) used for the determination of the storm demand at each beach are reproduced here as Table D-1. The storm demand volumes listed in Table D-1 were used to define the Immediate Erosion Hazard Line at relevant Great Lakes beaches.

Gordon (1987) estimated that storm demand for a 100 year ARI event at exposed NSW beaches ranges between 140 and 220 m^3/m for open beaches, with higher values at rip heads possible. On the NSW coast, a storm demand of 250 m^3/m has been commonly adopted for high energy beaches. For Great Lakes, the storm demand erosion estimates identified by SMEC (2013) fit generally within the measurements described by Gordon (1987), providing some reliability to their use as hazard limits. Furthermore, the application of the maximum measurement for each beach across the entire beach length provides a conservative estimate that is suitable for planning purposes.

Table D-1 Design storm bite assessment at the different beaches along Great Lakes coastline (SMEC, 2013)

Beach Name	Design Storm Bite (m^3/m)	Storm event associated with the photogrammetric data date*	Parameter Potentially Influencing Storm Bite
Nine Mile Beach (Tuncurry Beach)	230 ~ 240	Cyclone Violet (March 1995) May 1997 storm	N/A
Forester main Beach	200	Cyclone Violet (March 1995) May 1997 storm	Presence of a seawall at the back of the beach
One Mile Beach	220	May – June 1974 storms	N/A
Burgess Beach	35	May – June 1974 storms	Presence of a coastal bluff at the back of the beach, rock outcrop and underlying rocks
Seven Mile Beach	320 for the southern end; 200 for the main section of the beach	Cyclone Violet (March 1995) May 1997 storm	N/A

Beach Name	Design Storm Bite (m^3/m)	Storm event associated with the photogrammetric data date*	Parameter Potentially Influencing Storm Bite
Elizabeth Beach	150 for southern end; 180 for central and northern end	June 1967 storm	N/A
Sandbar Beach	230	Cyclone Violet (March 1995) May 1997 storm	Presence of Smith Lake Entrance
Number Once Beach	120 for southern end and 90 for northern end	Cyclone Violet (March 1995) May 1997 storm	Presence of rocks at the back of the beach and potential underlying rocks
Boat Beach	30-50 for eastern end; 120 for middle section and 80 for western end	Cyclone Violet (March 1995) May 1997 storm	Presence of rocks at the back of the beach and potential underlying rocks
Bennetts Beach	250	June 2007 storms	N/A
Jimmys Beach	20 - 70	May - June 1974 storms	N/A

* The storm event presented in this table is not the only storm event that has impacted the beach but is the one that is the most clearly visible within the photogrammetric data.

D.7.2 Blueys and Boomerang Beaches

As noted in the previous section, defining an “extreme” storm event is on the open coast is very complicated, and numerical modelling techniques are likewise not able to adequately represent all of the possible conditions that may generate erosion. The more reliable approach, as adopted by WorleyParsons (2011) for Blueys and Boomerang beaches, is to define a particular storm demand volume to describe the beach erosion hazard, eliminating the need to define all of the coastal processes that contributed to the erosion.

There is, however, very little measured data for storm demand, that is, beach survey immediately before and after a storm event. A standard approach for coastal hazards studies has therefore been to apply the standard 250 m^3/m storm demand provided by Gordon (1987) at all similarly exposed beach locations.

WorleyParsons (2011) determined a “crude” estimate of storm demand by calculating the difference between the volume of the 1972 and 1975 photogrammetric profiles. This aimed to capture the 1974 storm events, which are typically found to have been the most erosive events on the Mid North NSW coast. WorleyParsons (2011) calculated volumes ranging between 230 to 280 m^3/m for the 1972 to 1975 period. It was therefore considered appropriate to adopt the standard 250 m^3/m storm demand value along the entire length of Blueys and Boomerang Beaches.

As noted by WorleyParsons (2011), the 250 m^3/m value is an "upper bound allowance for planning purposes in accordance with the precautionary principle." Given the similarity between the coarsely measured erosion values at Blueys and Boomerang Beaches and the standard 250 m^3/m storm demand value, the beach erosion hazard mapping should be considered sufficiently conservative and reasonably adopted at these beaches.

There has been criticism in the general community that the 250 m^3/m beach erosion value was adopted along the entire length of Blueys and Boomerang beaches by WorleyParsons (2011). This criticism is because the events of 1974 eroded the northern end of both beaches to a greater extent than the southern end of the beach, and so, concern was raised that the beach erosion value is too conservative at the southern ends of the beaches. Adopting the erosion value along the entire length of the beach provides a suitable buffer for future events that will not be identical to the 1974 events. As noted above, there are a considerable number of variables that produce beach erosion, most notably, wave direction producing different longshore currents, headland bypassing, pre-existing beach state (e.g. eroded) and so on. Furthermore, rip currents may occur at any location along the beaches, which would enhance the erosion observed. Again, the beach erosion hazard mapping is considered suitable for planning purposes.

D.8 Shoreline Recession Hazard

Shoreline recession is the progressive landward movement of the beach profile over time. Recession will occur where the losses of sediment from a beach are greater than the gains over the long term. In the future, shoreline recession is also expected to occur in response to sea level rise. As the sea level rises, wave, tide and wind related sand transport processes are shifted to a higher position on the beach. This results in a reworking of the beach and dune position landwards, so that the beach and dune are in balance with the new sea level.

Particularly in relation to sea level rise, shoreline recession should not be expected to occur as a gradual landward shift of the beach. Instead it is more likely that following storm erosion events, the beach does not quite recover to its original position. Thus the beach gradually shifts landward, but it may not be obviously distinguishable from episodic erosion events.

D.8.1 Historical Recession

D.8.1.1 Whole of Coast

The two methods used by SMEC (2013) for estimating long term shoreline recession from the photogrammetric data were i) the measurement of eroded sand volumes and ii) the measurement of the translation of the dune face over time. SMEC (2013) notes that further assessments in the future may change the prognosis for long term shoreline recession as more photogrammetry (and ALS) data are collected and analysis techniques improve.

Detailed measurements of the sediment budget for the beaches along the Great Lakes coastline was beyond the scope of the GLHS. However, an assessment of the long term shoreline recession rate was undertaken empirically using photogrammetric data, together with factors that may have influenced the apparent recession rates. The long term recession rates measured by sand volume

changes and foredune location at each beach in the study area, together with the adopted recession rates is reproduced as Table D-2.

Table D-2 Adopted recession rate at different beaches along Great Lakes Coastline (SMEC, 2013)

Beach Name	Adopted Long Term recession rate (m/year)	Measurement of Eroded Sand Volumes[2]	
		Average volume change per year from lines of best fit (m^3/m/year)	Measurement of Translation of Dune Face (m/year)
Nine Mile	1	Nil	Nil
Tuncurry Beach	0.5	Nil	Nil
Main Beach	0.4	0.9	0.4
One Mile Beach	Nil	Nil	Nil
Burgess Beach	Nil	Nil	Nil
Seven Mile Beach	Nil	Nil	Nil
Elizabeth Beach	0.1	0.5	Nil
Sandbar Beach	Nil	Nil	Nil
Number One Beach	0.1	0.8	Nil
Boat Beach	Nil	Nil	Nil
Bennetts Beach North	Nil	Nil	Nil
Bennetts Beach South	0.1	0.4	Nil
Jimmys Beach Pre-nourishment	0.1 ~ 0.9	0.5 ~ 3.8	0.4 ~ 0.9
Jimmys Beach Post-nourishment	Nil to 0.3	Nil to 0.9	Nil to 0.3

D.8.1.2 Blueys and Boomerang Beaches

The previous study conducted by PWD (1985) reviewed the photogrammetric data to that time, which covered dates of 1956, 1964, 1972, 1975 and 1983. From that data, PWD assumed both beaches to be receding, at rates of 0.3 m/year (or around 5,000 m3/year).

The period over which PWD reviewed the photogrammetric data included the 1970s decade that was extremely stormy, producing enhanced erosion on the beaches. It was common in the 1980s for nearly all beaches to be assumed to be receding, because long term results were skewed by the enhanced erosion of the 1970s. Furthermore for Blueys and Boomerang beaches, extensive sand mining and rehabilitation occurred over the period of the 1970s, which would have also skewed the results.

An updated review of the photogrammetric data conducted by WorleyParsons (2011) included additional dates in 1984, 1991, 1994, 1996 and 2006. WorleyParsons (2011) found that

Boomerang and Blueys Beaches accreted substantially between 1975 and 2006, stating rates of 4.4. m/year and 1.8 m/year respectively. It is important to understand that the accretion rates stated by WorleyParsons (2011) from 1975 to 2006 are also skewed: the period prior to the 1970s left the beaches in a highly eroded state, after which natural recovery and accretion of the beach may be misinterpreted as a long term accretionary signal.

A brief review of the individual photogrammetric profiles conducted by BMT WBM for this study found that, for both beaches, the most accreted beach position occurred in the early 1980s (1983 or 1984) and 2006 for the southern and central portion of the beaches, or early 1980s and early 1990s for the northern ends of the beaches. The profiles show accretion through the 1980s, some storm erosion (minor) through the 1990s particularly at the southern ends of the beaches, then accretion and recovery by 2006 to a similar or slightly more accreted position than seen previously. Many beaches in NSW have been observed to have accreted substantially through the 1980s and early 2000s, to beach widths previously unrecorded. Data recorded after 2007 at many other sites have illustrated erosion of the beaches, due to the frequent storms observed since that time.

Therefore, it should be assumed that the beaches are neither receding nor accreting over the long term, but that the beaches overall are stable (that is, they oscillate between erosion and accretion with balance over the long term). WorleyParsons (2011) also recognised this by adopting no historical recession or accretion rate, and assuming both beaches to be stable over time.

D.8.2 Future Shoreline Recession due to Sea Level Rise

Shoreline recession is expected to occur in response to sea level rise. As sea level rises, wave, tide and wind related sand transport processes are occurring at a higher position at the beach face. This results in a reworking of the beach and dune position, shifting them landward to return to equilibrium with the new sea level. That is, there is an upward and landward translation of the beach and dune profile to maintain equilibrium with the prevailing conditions at the new sea level position.

As noted in Section D.5, sea level rises of 0.4 m by 2050 and 0.9 m by 2100 above 1990 mean sea level was adopted for both the SMEC (2013) and WorleyParsons (2011) assessments. Sea level rise for 2060 was interpolated between the 2050 and 2100 sea level planning benchmarks. The assessment of recession was based upon the present day, therefore the sea level rise that has already occurred between 1990 and 2010 was discounted.

D.8.2.1 Whole of Coast

Future recession due to sea level rise was estimated using the Bruun Rule (1962), where recession is equal to the amount of sea level rise multiplied by the inverse slope of the active beach profile. Based upon measured bathymetric data at Boomerang Beach, an active beach profile slope of 1:50 has been adopted for the remaining beaches. Sea level rise of 0.5m by 2060 and 0.9 m by 2100 equates to shoreline recession of 22 m by 2060 and 42 m by 2100 (from present, i.e. the assessment discounted the amount of sea level rise that has occurred to date).

The Bruun Rule (1962) has a number of limitations (see Ranasinghe et al., 2007), in particular, it does not account for underlying bedrock, reefs, headlands, which in turn may limit the transport of sediment as sea level rises, and therefore, the extent of recession along the beach.

Sea level rise modelling conducted by various regions in NSW by BMT WBM has illustrated that for coastlines with a net northerly longshore sediment transport, sea level rise tends to exacerbate the extent of recession at the southern end of the beach. This is because the sediment transport is constricted at intervening headlands due to the higher sea level, and so the southern end of the beach supplies the northern end. For the central portion of the beach, the sea level rise modelling indicated that the Bruun Rule is a reasonable approximation. For this reason, the future recession values adopted for Great Lakes' beaches were considered to be a reasonable first pass assessment for planning purposes.

To derive the 2060 and 2100 Erosion Hazard Lines, the historical and future shoreline recession allowances were added to the immediate beach erosion hazard extent.

D.8.2.2 Blueys and Boomerang Beaches

For Blueys and Boomerang beaches, WorleyParsons (2011) also used the Bruun Rule (1962) to estimate recession due to sea level rise. Limitations associated with the Bruun Rule noted in the previous section also apply here.

An active profile slope of 1:50, determined from the nearshore profile measured out to 40 m water depth off Charlotte Head was used, provided in PWD (1985). This equates to recession of 22 m by 2060 and 42 m by 2100 (from present).

WorleyParsons (2011) also considered the potential recession that has occurred due to sea level rise prior to the present. Worley Parsons (2011) used a 35 mm rise in sea level between 1965 and 2006, which equates to recession of 1.8 m. Given that this rate is extremely small, and likely to have been overprinted by natural shoreline oscillations from storms and calm periods, the recession rate was not included in the hazard assessment.

D.9 Mapping of the Erosion and Recession Hazards

The dune erosion escarpment may slump after the storm once the dune dries out, causing further erosion of the dune. This occurs due to dune sediments losing their apparent cohesive properties that come from the negative pore pressures induced by the water in the soil mass (SMEC, 2013). Both SMEC (2013) and WorleyParsons (2011) used the protocol of Nielsen *et al* (1992) to define the dune erosion hazard, as illustrated in Figure D-1, which describes:

- the zone of wave impact - the area eroded by waves during a storm;
- the zone of slope adjustment - the area of dune behind the erosion escarpment that will slump after the storm to return to a more stable slope for sand, and which combined with the zone of wave impact forms the immediate hazard area;
- the zone of reduced foundation capacity (ZRFC) – the area adjacent to the (slumped) dune erosion slope, which is considered to be of reduced bearing capacity for buildings; and
- the stable foundation zone – the area of dune unaffected by wave erosion and slumping, therefore not requiring special foundation requirements for buildings.

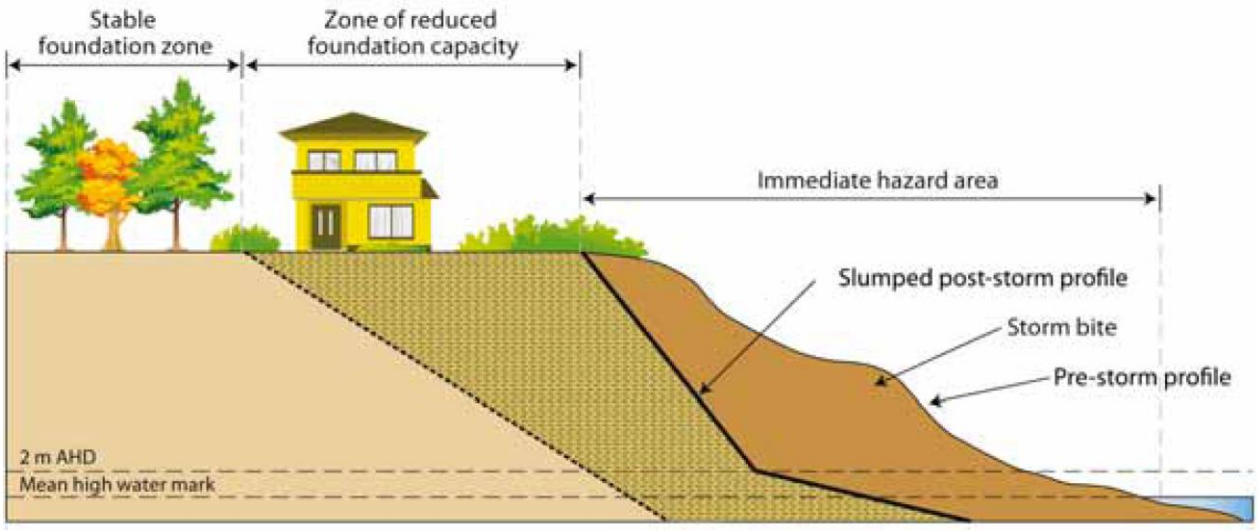


Figure D-1 Idealised schematic of a dune profile depicting the immediate hazard area and zone of reduced foundation capacity, after Nielsen *et al* 1992 (DECCW, 2010)

D.9.1 Whole of Coast

For each planning period, the erosion hazard has been defined by SMEC (2013) as:

- The Immediate Hazard Line delineates the limit of wave impact and dune slumping (Zone of Wave Impact and Slope Adjustment);
- The 2060 and 2100 Hazard Lines delineates the shoreline recession allowances (historical plus future) added to the Immediate Hazard Line; and
- At each timeframe the Zone of Reduced Foundation Capacity, being that area behind the erosion hazard where foundation capacity for buildings is reduced, has been delineated.

The hazard lines were mapped based upon the 2006 aerial laser survey (ALS) data, as this data was considered to avoid the anthropogenic influences present in the photogrammetric data (sand mining, dune works etc.). Anthropogenic influences distort the calculation of “average” beach profiles upon which to measure the erosion hazard.

SMEC (2013) did not map the erosion hazard for the following beaches, because there is no property or infrastructure at risk at these locations:

- Pebbly Beach;
- Burgess Beach;
- Shelly Beach;
- Lighthouse Beach;
- Treachery Beach.

D.9.2 Blueys and Boomerang Beaches

The beach erosion hazard lines were drawn from an “equilibrium” or average beach profile position. This was calculated as the set of photogrammetric profiles that best fit the mean profile volume for each beach, using a least squares fitting technique. The 1996 profile position was used for Boomerang Beach and 1964 position used for Blueys Beach. The 250 m3/m then the Zone of Slope Adjustment was subtracted from each photogrammetric profile in that year, to define the 2010 Hazard Line.

Shoreline recession by 2060 and 2100 was then subtracted from the 2010 Hazard line to define the 2060 and 2100 Hazard Lines. Therefore, for all time periods, the hazard lines define the position of the erosion escarpment after an extreme coastal storm, including subsequent slumping to a stable angle of repose, and including shoreline recession due to sea level rise by 2060 and 2100. The Zone of Reduced Capacity was mapped separately from the above hazard lines, for the immediate and 2060 timeframes only (WorleyParsons, 2011).

D.10 Coastal Inundation Hazard

Coastal inundation refers to the inundation of low-lying land hydraulically connected to the ocean, such as via creek entrances. The high ocean water levels during storms may contribute to the extent of inundation of such back beach areas. The coastal inundation hazard also encompasses wave runup and overtopping of coastal barriers.

The water levels defining the coastal inundation hazard comprise:

- elevated water levels in the ocean during a storm;
- wave runup above the still water level, caused by waves breaking on the shoreline; and
- future sea level rise.

D.10.1 Whole of Coast

Wave runup levels along the Great Lakes coastline were calculated by SMEC (2013) by:

- determining the 0.1% AEP (Annual Exceedance Probability) offshore significant wave height to be 10.2 m, based upon long term wave statistics from Crowdy Head (which is representative of the study region);
- transferring the 0.1% AEP wave from offshore to the beaches using the SWAN wave refraction model;
- calculating the nearshore significant wave height with the SBEACH model, as these will be different due to the different orientations of the beaches along the Great Lakes coastline;
- for the various nearshore wave heights calculated with SBEACH, using the Automated Coastal Engineering Software (ACES) to estimate wave runup; then
- calculating the wave runup level above AHD by adding wave runup (from ACES) with the nearshore water level (which includes wave setup and wind set up) plus the maximum recorded ocean water level of 1.48 m measured at Sydney (which represents a 1 in 100 year ocean water level); and

- to estimate wave runup for future time periods (2050, 2100), adding projected sea level rise to the wave runup levels above m AHD.

The results for the wave runup assessment reported by SMEC (2013) are reproduced as Table D-3.

As the shoreline alignment will be expected to change in the future along sandy shorelines, it is not possible to accurately predict the future limits of inundation due to wave runup. However, an indicative future runup level for 2050 and 2100 was estimated, assuming that the nearshore beach slopes and wave climate are unchanged. SMEC (2013) notes this is only a rough estimate of the extent of future wave runup but provides an indication of infrastructure which may be at risk from future inundation due to wave runup.

Table D-3 Wave runup levels for Great Lakes, 0.1%AEP (1000 year ARI) storm event

Location	Nearshore Water Level (m)	2% Wave Runup from ACES (m)	Maximum Wave Runup from ACES (m)	2% Wave Runup (m AHD)	Maximum Runup (m AHD)	2050 Max Runup (m)	2100 Max Runup (m)	Minimum Dune Height Along Foreshore Frontage (m AHD)[4]
Nine Mile Beach Golf Course	2.0	2.5	3.0	4.6	5.0	5.4	5.9	4.8
Nine Mile Beach	2.3	3.3	4.0	5.6	6.3	6.7	7.2	5.6
Nine Mile Beach South	2.6	3.8	4.7	6.4	7.3	7.6	8.1	5.6
Main Beach North	2.4	4.0	5.0	6.5	7.4	7.8	8.3	6.0
Main Beach South	2.3	2.3	2.7	4.6	5.0	5.3	5.8	6.9
Pebbly Beach	1.7	3.1	3.7	4.8	5.4	5.8	6.3	>10
One Mile Beach North	2.5	3.3	4.0	5.8	6.5	6.8	7.3	8.6
Burgess Beach	2.4	2.8	3.4	5.2	5.8	6.1	6.6	>10
Seven Mile Beach North	2.5	2.4	2.8	4.8	5.3	5.6	6.1	5.6
Seven Mile Beach Caravan Park	2.4	3.0	3.7	5.4	6.1	6.5	7.0	>10
Seven Mile Beach South	2.5	2.6	3.1	5.0	5.5	5.9	6.4	7.1
Elizabeth Beach SLSC	2.6	2.0	2.3	4.5	4.9	5.2	5.7	7.0

Location	Nearshore Water Level (m)	2% Wave Runup from ACES (m)	Maximum Wave Runup from ACES (m)	2% Wave Runup (m AHD)	Maximum Runup (m AHD)	2050 Max Runup (m)	2100 Max Runup (m)	Minimum Dune Height Along Foreshore Frontage (m AHD)[4]
Sandbar Beach	2.5	2.4	2.9	4.8	5.3	5.6	6.1	8.5
Number One Beach North	2.38	4.78	5.98	7.16	8.36	8.8	9.2	>10
Number One Beach South	2.46	2.31	2.75	4.77	5.21	5.65	6.05	8.7
Boat Beach	3.20	2.75	3.39	5.95	6.59	7.03	7.43	7.4
Lighthouse Beach	2.61	3.01	3.65	5.62	6.26	6.7	7.1	8.4
Treachery Beach	2.37	2.04	2.35	4.41	4.72	5.16	5.56	9.0
Bennetts Beach Treatment Plant	2.44	3.90	4.80	6.34	7.24	7.68	8.08	>10
Bennetts Beach Golf Course	2.38	3.18	3.87	5.56	6.25	6.69	7.09	6.8
Bennetts Beach SLSC	2.38	3.36	4.10	5.74	6.48	6.92	7.32	7.3
Bennets Beach South	2.49	2.54	3.04	5.03	5.53	5.97	6.37	5.6
Jimmys Beach East	1.45	2.33	2.77	3.78	4.22	4.66	5.06	4.7
Jimmys Beach Centre-East	1.55	3.72	4.54	5.27	6.09	6.53	6.93	5.4
Jimmys Beach Centre-West	1.57	3.10	3.74	4.67	5.31	5.75	6.15	6.1
Jimmys Beach West	1.58	1.83	2.10	3.41	3.68	4.12	4.52	7.4

Notes:

[3] Ocean water level is that representative of conditions seaward of wave breaking and includes astronomical tide and storm surge.

[4] Minimum dune heights are based on preliminary analysis of LiDAR, small local depressions in the frontal dunes may not be picked up (e.g. beach access ways).

D.10.2 Blueys and Boomerang Beaches

A 100 year ARI design storm elevated water level of 2.7 m AHD for the present period was adopted by WorleyParsons (2011), comprising:

- 1.5 m AHD elevated ocean level (including astronomical tide and storm surge) measured at Sydney (which is widely accepted to be suitable for elsewhere on the NSW coast); plus
- 1.2 m of wave set up (calculated as 15% of the 100 yr ARI 6 hour duration wave height).

Adding sea level rise to this elevated water level gives a design level of 3.1 m by 2050 and 3.6 m by 2100, with 0.4 and 0.9 m of sea level rise at those times respectively.

The 2% wave runup level was calculated using the equations of Hanslow and Nielsen (1995) (that is, the runup level exceeded for 2% of waves). The predicted 100 yr ARI wave 2% runup level was 5.3 m at present, increasing to 6.2 m by 2100 with 0.9 m sea level rise. This was calculated based upon the 6 hour duration 100 yr ARI wave height (7.8 m), a 12 s wave period, plus still water level (excluding wave set up) of 1.5 m (WorleyParsons, 2011).

Given the substantial height of dunes along Boomerang Beach and the northern and central portions of Blueys Beach, WorleyParsons (2011) considered the coastal inundation hazard to be negligible at the present time. This is evident in the hazard mapping that illustrates wave runup to be retained within the immediate foreshore, seaward of the main foredune.

For the southern end of Blueys Beach where the dunes are below 5 m AHD and across the creek entrance, oceanic storm water levels plus wave runup may penetrate through the creek entrance, causing inundation of low-lying land behind the beach around Ampat Place and Newman Avenue. An indicative hazard area of inundation plus a ‘potential minor inundation due to wave action’ has been illustrated in the coastal inundation hazard mapping (WorleyParsons, 2011).

The elevated still water level alone is likely be a significant, as it may infiltrate and inundate the creek upstream, causing flooding of low lying land around the creek at Ampat Place. The elevated ocean water levels would also preclude the outflow of water from the creek, enhancing any catchment flooding coincident at that time. Catchment flooding is not accounted for when defining and mapping the extent of the coastal inundation hazard.

Worley Parsons (2011) did not map the future coastal inundation hazard, with hazards mapping based upon the height of the existing dune barrier only. For future time periods, WorleyParsons (2011) postulated that the present dune barrier may disappear due to shoreline recession, with the future land level based upon the existing topography landward of the present foredune. Alternatively, the existing dune barrier may “roll back” with shoreline recession. The future height and position of dunes following recession due to sea level rise has not been concluded amongst the coastal science community, precluding the definition of the future coastal inundation extent.

With regards to wave runup generally, WorleyParsons (2011) recommended that the hazard may only be realised where dune heights are at or less than 6 m AHD. Any waves that overtop the dune barrier are likely to be quickly dissipated by spreading out and infiltrating the sandy area beyond the dune crest. WorleyParsons (2011) estimated that velocity and depth of runup would be significantly reduced within 10 m of the foredune crest. Furthermore, the runup levels are calculated for the peak of the tide and elevated water levels, and so will be substantially reduced as the tide ebbs. The duration of inundation and wave overtopping is expected to be less than 2 hours (WorleyParsons, 2011).

D.11 Slope Instability Hazard

Slope instability was identified as a significant issue at specific sites at Seal Rocks, namely:

- Boat Beach, specifically between Kinka Road (crest of the slope) and the beach (toe of the slope); and
- Number One Beach, specifically between Seal Rocks Road (crest of the slope) and the beach (toe of the slope).

Potential failure triggers that may affect the stability of coastal bluffs include (SMEC, 2013):

- undercutting of the slope by sea storms (waves);
- wave action removing fallen debris, preventing the headland reaching the state of natural repose;
- periodic wetting up and salt spray by sea waves onto slope material, leading to frequent repeated cycles of wet/dry conditions as well as variation in temperature;
- prolonged rainfall with water percolating into rock mass defects causing washout of fines and reduction of rock mass strength;
- high winds and the effects of sand blasting, aiding the infiltration of salt spray into defects etc; and
- earthquakes.

One or a combination of these conditions may result in a landslide failure event. The most commonly occurring slope instability hazard at the sites was debris slides (from 25 m^2 to 350 m^2) and potentially rock falls at Boat Beach.

Risk assessments for slope instability hazards are conducted in accordance with the method set out in the *Landslide Risk Assessment Procedures* in Australian Geomechanics, Volume 42, Number 1, March 2007 ('AGS 2007'). The outcome of the landslide risk assessment is to identify a risk to property and a risk to loss of life. The Landslide Risk Assessment process differs from that described for the other coastal hazards in this report (in Section 2.1), but in essence, both assessments require the consequence and likelihood of the hazard to define the level of risk.

Risk assessments were undertaken on those potential failures deemed significant in terms of potential to cause property damage or risk to life. The qualitative risk assessments undertaken for property, predominantly public infrastructure such as roads varies from very low to moderate. SMEC (2013) adopted AGS 2007 guidelines for assessing (quantitatively) the risk to life which revealed that debris slides resulting in loss of life has a risk varying between 1.1 x 10^{-5} and 4.5 x 10^{-7}. The risk of loss of life from rock falls was 6.3 x 10^{-7}.

The AGS 2007 recommendation of tolerable risk to life on existing developed slopes is 10^{-4} and 10^{-5} on slopes where existing landslides exist. For the two sites at Seal Rocks a value of 10^{-5} has been used as the tolerable level. For both sites the risk of loss of life is tolerable (SMEC, 2013).

The slope instability hazard at Boat Beach and Number One Beach is shown in Table D-4.

Table D-4 Risk Assessment Results, Slope Instability Hazard (SMEC, 2013)

Site Location	Hazard	Risk to Property	Risk of Loss of Life	Mitigation Measures
Boat Beach	Rock fall (1m long boulder)	No direct damage to property but can facilitate landslips in overlying overburden materials.	6.3×10^{-7}	• Protective measure either side of the gabion wall and control of surface water overflow the gabion wall. • Further inspection on the stability of the slope.
	Debris Slide (1 5m in length and 75 m^3)	• Failure of the gabion wall and undermine the pavement • Damage to the Kinka Road and pavement and affect the buried services in the roadway	1.26×10^{-5} 1.1×10^{-5}	
Number One Beach	Soil Creep	Continued recession from a combination of rainfall, storm water runoff, wave action and sea level and eventually loss of road.	4.5×10^{-7}	• Protective measures such as geotextile layer to prevent further erosion of existing failure scars • Control of surface water runoff on to the slope • Stop public parking above the slope and accessing the slope • Further inspection on the stability of the headland
	Debris Slide ($50m^3$)	Loss of ground, damage to fences and retaining structures, cracking of infrastructure on the terraces etc.	4.5×10^{-6}	

D.12 Wind-Driven Dune Instability Hazard

This hazard (also referred to as a sand drift hazard) relates to the wind transport of sand from the active beach profile. It can cause a minor nuisance where low sand volumes are lost and affect back beach property, or a major hazard where the transport by wind involves the permanent loss of large volumes of sand from the active beach. Windborne sediment transport can also result from destruction of dune vegetation. The sand in the disturbed area is further destabilised by the wind, leading to a dune "blowout".

This phenomenon has been observed at a minor scale at the southern end of Nine Mile Beach and at wider scale at One Mile Beach, Lighthouse Beach, Treachery Beach and Bennetts Beach. Dune blowouts are causing the dune transgression towards the private dwelling located behind the dune

at the northern end of One Mile Beach and Mungo Brush Road behind Bennetts Beach (SMEC, 2013).

For Blueys and Boomerang Beaches, the current losses of sediment through sand drift are said to be negligible over contemporary timeframes (WorleyParsons, 2011). Current dune management practises have increased the density and coverage of vegetation, which has assisted to capture wind blown sand, retaining it in the active beach system. Through the capture of sand, dune management also reduces the nuisance hazard of sand drift for back beach property and infrastructure. WorleyParsons (2011) recommended that dune management be maintained into the future.

D.13 Stormwater Erosion Hazard

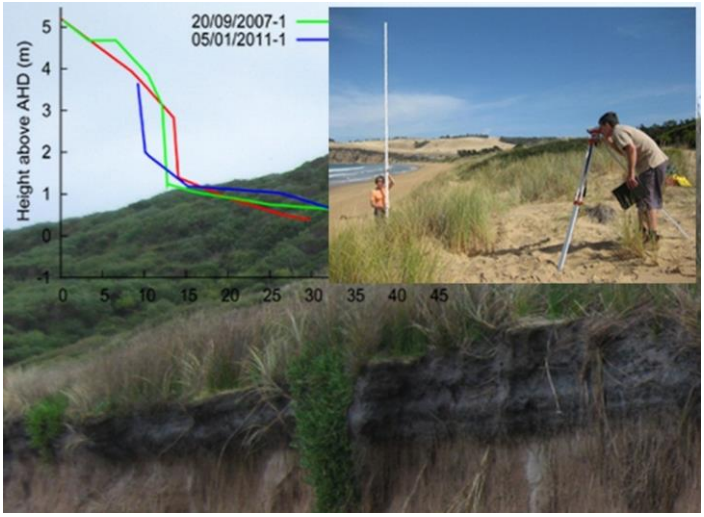
The discharge of water from stormwater outlets on the beach can exacerbate the extent of erosion locally around the outlet. The hazard is considered negligible at Boomerang Beach, as the urban area landward from the foredune crest drains towards Elizabeth Creek and Elizabeth Beach.

At Blueys Beach, there exists a 600 mm pipe at the northern end of the beach. Some localised erosion is observed around the outlet, with minor rock rip rap works to stabilise the outlet completed by Council. While localised works may be necessary to maintain the beach and outlet at this location, the outlet is not considered to significantly contribute to or enhance the beach erosion hazard to nearby properties at this location. The stormwater outlet at the southern end of the beach discharges to the creek, and so should be considered part of the coastal inundation hazard at this location.

Appendix E Coastal Management Options

Monitoring

Collect long term baseline and storm event data for beach condition and erosion volumes, and storm inundation level / frequency to determine when risks approach unacceptable levels; and to improve data for review of hazard estimates.



Monitoring of erosion escarpment movement (TASMARC)

Type of Option

No Regrets / Preliminary Action: Existing Development

Details

Monitoring can be conducted for multiple purposes with regards to managing coastal risk.

The general approach adopted for the management of existing assets and infrastructure at risk is to wait until the risks have materialised to a level that is no longer considered tolerable (i.e. it reaches a 'trigger' level) before acting. Monitoring of key indicators is therefore necessary in order to determine when the 'trigger' has been reached.

Monitoring of beach profiles and volumes is necessary to determine likely beach erosion extents in response to storms and to identify any underlying recession signals. In addition, monitoring of triggers at specific assets should be undertaken and reviewed regularly to determine when a trigger is reached.

The results of monitoring should be published, for example, in yearly State of the Environment reports and with reviews of the CZMP (every 5 – 10 years). When the CZMP is reviewed, monitoring results also provide suitable data to re-run the risk assessment and revise management responses if the risk level changes (i.e. an increase or decrease in level of risk) or where a management action has not been effective.

Recommended Program for Beach Erosion Monitoring

- Survey profiles should be established at regular intervals (~100 m) along key section of foreshore and/or in front of significant assets (e.g. roads, foreshore dwellings, SLSCs). The profiles must run perpendicular to the beach/shoreline with regular survey points measured to the waterline (refer to TASMARC Survey Instructions – Levelling (2012) for example guidance). Preferably, profile measurements should coincide with the existing photogrammetry profiles at the beaches.
- For asset monitoring (e.g. roads) the survey profile data should be used to calculate the distance between the erosion escarpment and the asset. Monitoring of triggers at specific assets should be immediately analysed upon collection of beach survey data, to determine if and when a trigger is reached.
- The beach profile monitoring should be augmented with 2-3 yearly LiDAR data collection runs (priority) and 1-2 year aerial photography (secondary). The survey profiles can be used to extract topographic information from both datasets, for comparison with the land based surveys.

- Initially, surveying of profiles every 6-12 months plus after storms is recommended. Depending upon the trends identified in the monitoring, the regularity for profile surveys could be reduced to storm event only (i.e. offshore H_s > 3 metres), with LiDAR processed to provide baseline monitoring.

Community Monitoring Points for Educational Purposes:

There is an opportunity to utilise monitoring programs as a community education tool. This should include:

- placing survey markers (e.g. posts or stakes with signage), or utilising existing coastal structures as visible markers around which the community can see changes to the beach after seasonal and storm fluctuations, and sea level rise induced recession in the future.
- Council taking photographs of prominent foreshore structures over time, for example, stormwater outlets, Forster seawall, beach access points, and/or foreshore dwellings (e.g. at southern Boomerang Beach). The photos should be taken from the same aspect every 6-12 months, and after storms. The photos should then be stored on a Council managed database that is accessible to the public (for example, through the use of free programs such as Google maps), with an advertised link from Council's website. Community groups such as dune care, foreshore residents and/or school groups should also be encouraged to collect photographs for the database. Overtime, the photo database will provide compelling public educational material regarding the short and long term changes in beach state.

Recommended Program for Wave Runup Monitoring

- Event based monitoring for wave runup is recommended. Immediately following large storm events, survey should be conducted along any debris lines that are preserved. Such data will provide good information regarding the actual extent of run up events which can be used to verify the estimated runup hazard extent.
- Long term tidal gauges are already managed and analysed by Manly Hydraulics Laboratory. Council should access this local information regarding both long term sea level change and short term oceanic inundation events. The information should be incorporated into community educational material to demonstrate the occurrence of sea level rise to date. They may also be value in providing a graph of sea level rise on Council's website, or other link to existing measurement sites.

Advantages of Option	Disadvantages of Option
Monitoring provides essential data regarding coastal processes, to assess the likelihood of coastal impacts particularly at key beaches / assets (for triggers).	Monitoring may be costly and time consuming
At the time for review of the CZMP, monitoring results will provide key data to re-run the risk assessment to determine changes to risk levels (increase or decrease) and revise risk treatment.	
Monitoring results enable Council to determine the effectiveness / appropriateness of management actions to manage coastal risks over time	
Monitoring provides an opportunity to educate the community regarding coastal processes	

Potential Applications

Regular Surveys, Storm event surveys for erosion:

- Boomerang Beach, particularly southern end,
- Blueys Beach,
- One Mile Beach,
- Elizabeth Beach,
- Tuncurry – Nine Mile Beach, and
- Forster Main Beach.

Community Monitoring Points

SLSCs (Forster Main, One Mile, Elizabeth)

Erection of survey markers, photo posts at key beach accessways, on the urban beaches, aligning with the survey profiles.

Storm event surveys for Wave Runup

- Blueys Beach southern end (adjacent to creek / Newmans Avenue),
- One Mile Beach,
- Elizabeth Beach (e.g. at culvert/adjacent to boat ramp for Elizabeth Creek)

Append Asset Management Plan

Document in Council's Asset Management Plan the hazard type (erosion/recession, inundation, wave runup) and timeframes for impact (immediate, 2060, 2100) for all assets in coastal hazard zones. Use hazard likelihoods as part of calculating asset replacement costs and timeframes.

Type of Option

No Regrets / Preliminary Action: Existing Development

Details

Councils Asset Management Plan shall be updated to make note of which assets lie within a coastal hazard area, detailing: the **type of hazard** i.e. erosion / recession, or inundation / overtopping; and the **estimated risk over each timeframe** (i.e. immediate, 2060, 2100). This information shall then be included as part of prioritising asset replacement and developing maintenance schedules. In this manner, the most appropriate management action is implemented at the time of asset replacement or, asset replacement may be brought forward where impacts are imminent.

There are likely to be a number of smaller scale assets that are currently not part of any plan. While the CZMP recommends that these assets can realistically be replaced further landward after hazards impacts occur, it is recommended that these assets be added to the Asset Management Plan, and this approach (i.e. replacement landward after impacts) be noted, to ensure that the assets are not unnecessarily protected or otherwise "over engineered" for coastal risks.

Any suggested future management options (i.e. Option 1, Option 2) in the Coastal Risk Asset Registers in the CZMP should be noted upon the Asset Management Plan, for inclusion in asset replacement calculations. The Asset Management Plan shall also include outcomes from the Investigate Future Replacement option (see below) that will further identify appropriate management for high / extreme risk assets, i.e. "relocate", "redesign", "relocatable", or "manage to fail". For example, local roads that are specified as sacrificial by the CZMP/Audit would be noted as "manage to fail".

At the present time, the management of assets does not take into consideration the risk to an asset from coastal hazards when prioritising asset replacement or maintenance, nor are replacement assets flagged as requiring redesign to accommodate coastal hazards. Implementing this action will be particularly important for the larger, more costly assets such as stormwater infrastructure, sewer and water infrastructure and public buildings, where sufficient prior planning (e.g. 3 – 10 years+) is required to secure adequate funding for asset replacement.

Maintenance for assets in the short term prior to sacrifice/ relocation (e.g. to provide continued services to residences) must avoid the use of hard protection works (e.g. dumping of rock, use of concrete, etc.) that will negatively affect beach amenity. The requirement for use of soft protection works (e.g. geotextile sand bags) should also be noted in the Asset Management Plan.

Advantages of Option	Disadvantages of Option
Easy to implement as the hazard information is already available to Council	
Enables coastal hazard to be flagged in Council's decision making processes	
Ensures funds are not ill spent in at risk locations / assets	
This preliminary step is required prior to understanding best future management approach (i.e. redesign, relocate, manage to fail)	

Potential Applications

- Roads
- Car Parks
- Stormwater assets (pipes, outlets)
- SLSCs
- Tourist Parks
- Walkway / Cycleways
- Amenities
- Sewer Assets (MCW)
- Water Assets (MCW)
- smaller Council assets should be added to the asset management plan, and appropriate management of hazards specified (e.g. viewing platforms, picnic shelters, walkways, footpaths, etc)

Recommended

- Council should facilitate this action for Mid Coast Water who manages the sewer line and water supply services, such as providing hazards and risk register information.

Investigate Future Replacement Action

To augment above action, determine suitable future action for assets at high risk (which may include relocation, retrofit/redesign or manage to fail). Document preferred action in Asset Management Plan for implementation, either when the asset is due for replacement, or a hazard impact occurs.

Boomerang Beach Road and beach lookout facilities

Type of Option

No Regrets / Preliminary Action: Existing Development

Details

This option shall determine the most suitable future action to address coastal risks for Councils assets and specify this in the Asset Management Plan. In addition to including coastal hazards as part of Asset Management prioritisation, it will be important to investigate the constraints upon the site or asset to determine the appropriate replacement option, that being to either:

- **relocate** the asset outside of hazard zone;
- **replace** the asset in its current location with a redesigned or relocatable asset; or
- **accept** loss of the asset without replacement (i.e. manage to fail).

The replacement option (i.e. “relocate”, “redesign/retrofit”, “replace” or “manage to fail”) should be signalled in the Asset Management Plan, so that appropriate approvals and funding can be sourced well in advance of either the occurrence of a hazard impact or when asset replacement is due. It may also be the case that for some assets consideration of the entire network link will be necessary, for example the wastewater network, or roadways at Boomerang Beach.

In general, it is recommended that relocation of an asset be implemented in preference to other options. This is because relocation permits the beach to naturally retreat so that the sandy beach is retained. Furthermore, relocation of an asset does not impact upon or constrain the approach to managing adjacent assets, which may include private assets, public reserves, important habitat or the beaches themselves. For less costly assets such as beach viewing platforms, accepting that the structure is sacrificial or relocatable (after or before a storm event, respectively) may also be cost effective solution that permits future beach retreat and does not constrain options for adjacent assets.

Constraints upon the replacement option will include:

- the availability of land in an alternative location for the asset (particularly for roadway assets; particularly for roadway assets, this may require consideration of battle-axe arrangements or alternatives to provide rear-lane access facilitated through Council) or;

- the need for proximity to the coast for the asset (e.g. stormwater outlet);
- the foundation capacity of the site, to provide suitable foundations to withstand erosion;
- the floor level height required to withstand wave overtopping; and
- the ability to provide the same service from the asset with a relocatable instead of permanent structure.
- the coast of the structure such that damage can be accepted and a replacement structure built, as a cost effective alternative solution compared with providing foundation stability (for example, this is likely to be a suitable approach for a beach viewing platform etc.).

Advantages of Option	Disadvantages of Option
Provides preliminary information required to determine more substantial management actions (i.e. relocate vs retrofit).	
Low cost option, which may save money for future investments.	
Ensures substantial public investments are not made in high risk locations	

Potential Applications

Most Suited

- Wastewater, stormwater and water infrastructure assets at high or extreme risk by 2060,
- Substantial / expensive public buildings / assets at high or extreme risk by 2060 (e.g. roads), and
- Those assets at any risk level by 2060 likely to be replaced or built within next 10 years that have a long expected lifespan (> 50 years).

Possibly Suited

- Where Council's resources are available, the audit could be extended to include those assets at high or extreme risk by 2100.

The Coastal Asset Risk Registers indicate those assets at high and extreme risk by 2060 and 2100.

LEP Update

Update LEP Coastal Risk Planning Area maps (as per current amendment; and overtime as hazards information is reviewed).

Consider rezoning of land to provide retreat buffers for migration of beach and other coastal ecosystems (if/where necessary).

At risk vacant land may be suitable for rezoning

Type of Option

No Regrets / Preliminary Action: Existing Development

Details

Local Environment Plan (LEP) updates are undertaken on a regular basis. Two key elements of the LEP can assist with coastal management: Coastal Risk Planning Area maps and associated development considerations; and rezonings of land, if necessary, to provide buffers for migration of the beach and other important coastal ecosystems likely to be affected by sea level rise.

At present, an amendment is already in progress to update the Coastal Risk Planning Area Maps to include hazard areas identified in the Great Lakes Coastal Hazards Study, and amend hazard zones at Boomerang Beach and Blueys Beaches, relating to the presence (or otherwise) of bedrock to constrain hazards extents. This action is supported by this CZMP. As hazards information is revised in future (for example, through findings of the Revise Hazard Lines Based on Geological Data action, see below), the LEP Coastal Risk Planning Area maps should continue to be amended to reflect the new information.

In terms of land zonings, this action suggests reviewing the coastal zone, including important wetlands and estuaries, to determine if vacant land surrounding beaches and coastal ecosystems is appropriately zoned to avoid future development. Where appropriate zones exist, Council shall endeavour to preserve such zonings. Council should also identify opportunities to change zonings to preclude development, and submit the rezoning(s) with future LEP amendments.

Advantages of Option	Disadvantages of Option
Avoids inappropriate development of high risk vacant land.	Compensation of existing landholders may be required where rezoned land is not in government ownership.
Low cost option as is conducted as part of normal Council business.	There is limited undeveloped, government owned land within Blueys and Boomerang Beaches at risk from coastal hazards.
Reduces the overall level of risk to land by reducing the potential for intensification of land value.	

Potential Applications

Coastal Risk Planning Area maps, and appropriate land for rezoning should be reviewed as hazards information is revised over time.

Coastal Hazard DCP Chapter

Apply controls to new- and re-developments, which are appropriate to type of development and likely hazard over lifespan of development.

Controls would seek to avoid development of unsuitable land, but not unnecessarily sterilise land prior to impacts occurring.

Type of Option

No Regrets / Preliminary Action: Existing and Future Assets

Details

A Coastal Hazard chapter of the Great Lakes Development Control Plan (DCP) aims to manage future development, and re-developments of existing land. Development applications may consist of either:

- complete redevelopment of an existing structure, including subdivision;
- major alterations or refurbishments to existing structures; or
- subdivision and / or new developments on previously undeveloped land (few remaining opportunities in Great Lakes LGA).

The re-development of existing land offers an opportunity to apply development controls that mitigate or accommodate coastal risks, and should be done in a manner consistent with the expected lifespan of the development and the level of risk over that lifespan.

The Coastal Hazard DCP clause may control the expansion (or even require a reduction) in development footprints (including. extensions or renovations, subdivision, change of use) for redevelopments in high hazard areas, thereby avoiding the intensification of risk over time. It does not prohibit existing landholders from remaining on their land until such time as an impact occurs.

The Coastal Hazard DCP chapter is aimed at managing the coastal erosion, recession and wave runup hazards. The backwater inundation component of the coastal inundation hazard can be managed through existing floodplain development controls, as the hazards are similar in impacts. Erosion and recession impacts are different to flooding impacts, and so cannot be managed by existing floodplain controls.

The following recommendations are made for preparing a Coastal Hazards DCP chapter.

Determine Controls Applicable to the Level Of Risk over the Expected Life of a Development.

The Coastal Hazards DCP section will apply to all land specified in the Coastal Risk Planning Area maps in the LEP, which is based upon the 2060 coastal risk area. It is recommended that the criteria specified within

the DCP be applicable to the level of risk to the land in a manner consistent with the expected lifespan for the type of development proposed.

Development controls apply to the entire Coastal Risk Planning Area, but land within this will have varying likelihood of hazard, just as the consequence of impact varies with the type of development. Applying controls in a manner consistent with the level of risk aims to avoid unnecessarily sterilising land, and avoid unsuitable land being (re-)developed inappropriately. For example:

- A **residential subdivision** may be expected to exist for up to 100 years. Therefore, the hazard extent expected by 2100 should apply.
- **Essential facilities and infrastructure** such as sewer, water and stormwater assets may also be expected to exist for 100+ years and by its very nature needs to be conservatively sited for coastal risks. Again, the hazard extents by 2100 should apply.
- A surf club refurbishment may have an expected design life of 40 -50 years, thus the 2060 hazard extent is applicable. It is recommended that the club house be sited further landward (ie 2060) so that it can be utilised for other activities (function centres, restaurants, cafes and so on), then supported by lifeguard towers that are relocatable or sacrificial closer to the shoreline in a higher risk zone.
- Lifeguard towers must necessarily be located close to the shoreline in order to meet their purpose. Such structures can be designed to accommodate erosion risks, for example, being designed to be sacrificial (i.e. simple structures that are expected to be damaged, then replaced swiftly when impacts occur) or relocatable (i.e. can be moved prior to a storm event, but are equipped with power, water and so on).

Suggested Assessment or Performance Criteria for Developments

A DCP may provide guidance, specific development standards, prescriptive controls or performance criteria for achieving the requirements of the Coastal Risk Planning Area clause in the LEP. It is recommended that the criteria specified within the DCP be applicable to the development type and level of risk to the land.

Suggested criteria include the following.

- **Setbacks for development** landward of either a specified hazard zone (e.g. immediate hazard line, 2060 hazard line, 2100 hazard line, depending on the development), proposed seawall alignment or other line (e.g. a Foreshore Building Line);
- **Temporary, sacrificial or re-locatable structures** only to be permitted seaward of the specified setback. Such alternative building designs are likely to be most suitable for minor facilities (lifeguard towers, cabins in caravan parks), but are also an acceptable solution for residential developments, provided conditions of consent are attached specifying when the structure needs to be relocated;
- **Foundations piled to the Stable Foundation Zone**, with a geotechnical assessment to design the depth and type of foundation piles to reach the stable foundation zone or bedrock, increasing the ability of the structure to withstand erosion and wave processes;
- **Trigger-Based Development Approvals**, which provide new developments / redevelopments consent until an event based trigger is reached. The conditions of consent would specify the trigger, actions once the trigger is reached, and requirements for removal or relocation of the structure and rehabilitation of the land at that time the consent lapses.

A suitable trigger would be the zone of reduced foundation capacity (ZRFC), as measured from the development/structure in a seaward direction.

When the trigger is reached, the safety of the building for habitation with respect to the ZRFC should be assessed (by a suitably qualified geotechnical engineer). The engineers' report may recommend either an extension to the development consent (i.e. where the structure is considered safe relative to the erosion escarpment), or lapse of the consent, requiring the development to be removed / relocated and rehabilitated in accordance with the development consent.

Using the ZRFC distance as a trigger has the following advantages:

- The ZRFC is a discreet distance relating to the stability of the land, not the occurrence or otherwise of unpredictable erosion volumes; and
- The ZRFC can be measured coarsely where the subject development has not obtained a geotechnical report (refer to Nielsen *et al* 1992); or can be site specific where the subject development has obtained a geotechnical report, and can then account for any measures undertaken to found the development to the stable foundation zone (piles etc).

- **Minimum floor levels**, and guidance on either filling of land or use of foundation piles to accommodate current and future hazard from wave runup or inundation;
- **Maximum floor area** for alterations and additions located within a hazard area; and
- **Permissibility of ancillary structures (pools, fences, decks etc) seaward of the hazard setback**.

Advantages of Option	Disadvantages of Option
Facilitates the use of land parcels in an appropriate form until such time as hazard impacts manifest (i.e. land is not unnecessarily sterilised where impacts may not manifest for many years; or rebuilding may be restricted where damage from coastal processes has occurred)	May be difficult to implement for redevelopments where owners have an expectation of same rights for a new building as they had with the old.
For Distance/Event Trigger-based Approvals, the property owners are aware of lifespan and risk to their development, so there is no need for compensation. This is low cost to the general community.	May be difficult for owners to abandon property with trigger-based approvals when required (e.g. new owners not aware of the conditions of consent, development has lasted for such a long time such that the consent was forgotten, etc.).
Facilitates a reduction in the intensity of development and therefore risk levels overtime.	Time-based development consents have been overturned by the Land and Environment Court at other locations in Great Lakes LGA, and so may be difficult to implement.
The development controls can be revised in the future in line with improved estimation of coastal risk.	
Allows for translation of the beach, preserving it into the future.	
Applying controls does not affect future ability to retreat from (or protect) properties.	
Low cost option for general community and Council. Costs for implementing controls are borne by the property owner, but are included as properties are redeveloped, which is likely to be lower in cost than retrofitting or retreating from a development.	

Advantages of Option	Disadvantages of Option
Life of developments is prolonged as the development controls aim to be compatible with the risk level.	
Does not prohibit existing landholders from remaining on their land until such time as an impact occurs.	

Potential Applications

- All land within the 2060 coastal hazard area.
- May also be applied to new subdivisions and critical infrastructure on land subject to hazards by 2100.

Coastal Hazard Construction Checklist

Prepare a checklist / policy for internal use by Council for replacing, repairing, protecting or building new infrastructure in the coastal zone. The checklist shall augment the self-assessment (REF) process. The checklist shall identify:

- Other Council officers to be consulted for activities in the coastal zone;
- Other agencies required to give concurrent consent (e.g. Crown Lands, MEMA, NPWS);
- Where to access hazard mapping / information; and
- Controls / measures to reduce coastal risk to the new construction (could be based upon DCP), for example, setbacks appropriate to design life of asset.

Type of Option

No Regrets / Preliminary Action: Existing and Future Development

Details

It is important that the potential for coastal hazards impacts is taken into consideration when Council conducts works where development consent is not required (for example, works under SEPP (Infrastructure) 2007, or environmental assessments such as REFs). This is also the case for strategic planning and major infrastructure design (e.g. major upgrades or new additions to road, stormwater networks and so on), and preparation of Plans of Management and Masterplans.

This strategy involves the following actions:

- **Prepare a checklist to capture the following activities by Council when they occur in the coastal zone:**
  - Council works not requiring development consent (e.g. SEPP (Infrastructure) 2007 activities) and Part 5 assessments (e.g. REFs);
  - Preparation and revision of Community & Crown Land Plans of Management, Masterplans and DCPs;
  - Council's strategic planning (e.g. designing new road networks, stormwater networks)
- **Conduct internal training to educate the different Council departments about coastal hazards zones, the CZMP, and internal policy/checklist** to support greater consideration of coastal hazards and development controls in GLC planning, engineering works and other activities;

Advantages of Option	Disadvantages of Option
Easy to implement as the hazard information is already available to Council	
Low cost option, as conducted as part of normal GLC activities	
Ensures funds are not ill spent in at risk locations / assets	
Avoids actions that are inconsistent with the intent of the CZMP, for example, seawall construction in inappropriate locations.	

Potential Applications

- All of Council Assets, including:
- larger Council assets such as roads, stormwater infrastructure, buildings; and
- small Council assets such as car parks, beach viewing platforms, amenities etc.

Revise Hazard Lines Based on Geological Data

Snapshot of Hazard Lines, Number One Beach

Using geophysical assessment and interpretation of geological data, update the hazard lines to tie into stable bedrock, particularly at the ends of beaches. For Number One Beach, this action shall include extending the hazard lines along the remainder of the beach.

Type of Option

No Regrets / Preliminary Action: Existing (and Future) Development

Details

A key limitation of most hazards assessments is that there is typically little to no geotechnical information regarding depth to bedrock along the beaches. Bedrock at suitable depth may either constrain the extent of erosion, or provide for suitable foundations for existing or future structures.

This option shall involve:

- assessment of the location and extent of bedrock particularly at the ends of the beaches, then
- update of the existing hazard lines to tie into stable bedrock at the ends of the beaches, and along the remaining length of Number One Beach, Seal Rocks.

The existing Great Lakes hazard lines (from SMEC, 2013) end before the bedrock ends of the beach. As such, there are likely to be assets that lie outside of the hazard zones, but which do have a level of coastal risk (e.g. Boat Ramp at Elizabeth Beach, Seal Rocks Rd, Number One Beach). The information shall also be used to constrain the hazard lines for future revisions of the coastal hazards assessment.

Appropriate methods for determining the location and depth of bedrock may include:

- Geophysical survey, such as using ground penetrating radar, seismic or resistivity techniques
- Review of existing geological data, particularly the available coastal quaternary geology dataset
- Ground truthing to confirm assumptions and to clarify materials in areas unable to be resolved through geophysical survey or existing data.

This option will not replace the need for site-specific geotechnical assessments for development applications, but may provide useful information use within Council, to cross-check against the site-specific geotechnical assessments.

Advantages of Option	Disadvantages of Option
Provides preliminary information required to determine more substantial management action (i.e. relocate vs retrofit).	

Advantages of Option	Disadvantages of Option
Low cost option, which may save money for future investments	
Provides enhanced information for use in defining the erosion and recession hazard	

Potential Application

High Priority:

- Number One
- One Mile
- Elizabeth
- Boat

Medium Priority:

- Forster Main
- Pebbly
- Seven Mile

Low Priority:

- Sandbar
- Bennetts
- Nine Mile (Tuncurry).

Commence Process to Re-align Seal Rocks Road

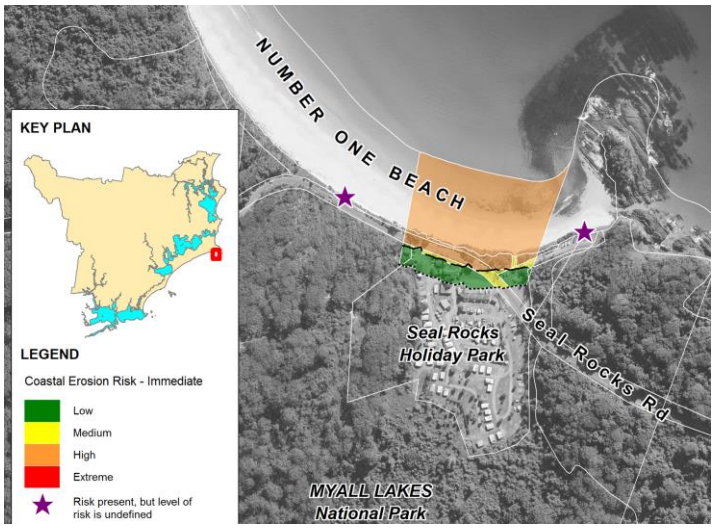
Commence gaining permissions from NPWS and Crown Lands to re-route Seal Rocks Road, and rehabilitate existing road corridor to appropriate public use.

Type of Option

Planned Retreat: Existing assets

Details

This option involves Commencing the process of negotiations by Council with NPWS and Crown Lands to re-route Seal Rocks Road through the existing NPWS and Crown reserves west of the Seal Rocks Holiday Park. In considering a new road corridor, use of the existing but unused Crown Land road easement (west of the Seal Rocks Holiday Park) should be investigated.



Risk is undefined for section of road at risk

The existing road section west of the Seal Rocks Holiday Park shall then be removed (including recent seawall construction) and land rehabilitated, as part of a POM, public domain plan or similar (see Number One Beach Local Area Plan option in Non-Hazards Management options).

Any future facilities replacing the current roadway must be of a sacrificial nature. This is vital to ensure that recession of the sandy beach can progress unimpeded into the large transgressive dunes behind the current roadway. Allowing erosion of the dunes may supply substantial sand reserves to Number One Beach that could slow the progress of recession and provide for a continued sandy beach asset.

Advantages of Option	Disadvantages of Option
Allows natural retreat of the beach unimpeded, to access large sand reserves in transgressive dunes backing the beach.	May be time consuming due to the negotiations and legal / approval issues between the relevant authorities.
Provides an area of public open space on the former road corridor, which is highly sought after.	
Enables the (recent) rock protection works along the road on the beach to be removed, and beach remediated.	

Potential Application

- Seal Rocks Road on Number One Beach, section west of the Seal Rocks Holiday Park.

Combined Flood Studies

Update or commence flood studies at all catchments that are impacted by coastal inundation (particularly catchments with development / assets at risk) to determine the combined impact of elevated ocean water levels and catchment rainfall and determine flood planning levels.

The creek entrance at southern Blueys Beach is affected by wave runup during large storm events. The combined impact of runup and catchment flooding is unknown.

Type of Option

No Regrets / Preliminary Action: Existing and Future Assets

Details

This option involves the following steps:

- Conduct a Flood Study assessment for the combined impact of catchment flooding and oceanic water level events (storm surge, wave set up, wave runup etc.) and sea level (i.e. benchmarks adopted by Council);
- Use the outcomes of the combined flood modelling to amend the Floodplain Risk Management Plan mapping and flood planning levels for development in the LEP and DCP; and
- Apply development controls to the Flood Planning Area based upon existing Flood Risk Precinct development controls, or new controls prepared for the individual catchment (i.e. through the Floodplain Risk Management Plan process).

Advantages of Option	Disadvantages of Option
Relatively low cost option (compared with cost of flood damage of new developments)	Given the small size of the creek catchment at southern Bluey Beach, the combined flooding impacts are likely insignificant. As such, the time and resources required for such a study may be better invested elsewhere.
Provides more accurate information to residents regarding inundation risks from the ocean and / or rainfall, plus sea level rise	
Provides more accurate information for planning to control development of flood prone land – due to coastal inundation or rainfall	

Potential Applications

- Unnamed creek at southern Blueys Beach (in the vicinity of Ampat Place).
- Elizabeth Creek (exiting to Elizabeth Beach).

Infrastructure Design Elements

Stormwater Outlet on Blueys Beach

Investigate appropriate designs and materials for services affected by saltwater (inundation, spray), such as stormwater, water and wastewater infrastructure.

Type of Option

No Regrets / Preliminary Action: Existing Development

Details

This option aims to support the replacement of stormwater, wastewater and water assets (as specified through Council's or Mid Coast Water's Asset Management Plan) with structural elements that are better able to withstand the effects of seawater. The option should be implemented with the following steps:

- Investigate the height/level within stormwater pipes connected to the ocean (i.e. via outlets) to determine the extent within the pipe system of permanent inundation with sea level rise; and periodic inundation with storms plus sea level rise (i.e. those levels specified WorleyParsons, 2011; SMEC, 2013).
- Update Asset Management Plan, particularly asset replacement timeframes and costs, based on timeframes for inundation impacts (especially stormwater systems that may become unviable due to permanent inundation) and degradation of elements due to seawater (including the outside of wastewater and water pipes and pump stations).
- Identity appropriate materials for use in stormwater, wastewater and water assets that better withstands seawater impacts, and use when assets require replacement. This will include the use of tidal flaps.

It should be noted that the extent to which stormwater and other infrastructure connected with the ocean may be permanently inundated by sea level, plus storms, has not been mapped in the existing hazards studies for Great Lakes, as this is outside the scope of such studies.

Advantages of Option	Disadvantages of Option
Assessment is targeted towards managing seawater impacts to materials	
Seawater inundation impacts within systems are assessed	
Cost savings are achieved for replacing an asset with appropriate design elements, rather than after an impact occurs	

Potential Applications

Stormwater, wastewater, water assets within the coastal zone (say, 2100 erosion prone area, as a starting point). This option would need to be implemented by both GLCC and Mid Coast Water who manage these assets.

Heritage Management (Aboriginal and Non-Indigenous)

Develop a decision support tool (or similar) for managing known and unknown Aboriginal and other heritage items uncovered by coastal hazards. May include mapping of known sites, where possible.

Midden exposed in dune from wave and wind erosion, TAS

Type of Option

No Regrets / Preliminary Action: Existing and Future Assets

Details

In cooperation with local Aboriginal Groups NPWS and OEH, prepare a Decision Framework for managing heritage sites and items that are uncovered by erosion or affected by inundation. The decision framework should provide for previously unrecorded sites. Mapping of known sites (such as from the AHIMS database) would assist this option also. Such sites (e.g. middens) may become uncovered within dune systems due to recession. The framework should provide clear direction as to the consultation and approvals required and options relevant to the type of item. This may include relocating the item, burying the item (for example as is done for midden sites), sacrificing the item or protecting the item (as is done for midden sites also). This option requires the following steps:

- consultation with Local Aboriginal Groups as to the preferred methods for managing different types of heritage assets (middens, burials, rock/cave art, places of significance, etc.), and known sites where they lie within a coastal hazard zone; and
- development of a decision framework that outlines a clear pathway of action and approvals to manage sites as they are uncovered by hazards impacts.

It is noted that all aboriginal sites are protected under the National Parks and Wildlife Act 1974, whether known or unknown.

Advantages of Option	Disadvantages of Option
Option enables pre-planning and consideration of appropriate management response for different asset types, well in advance of impacts.	Unable to provide preventative / pre-emptive asset management, as assets may not be found until impacts occur.
Enables appropriate actions to be smoothly implemented at the time assets are uncovered.	

Potential Applications

Most Suited

- All beaches.

Community Education

Build acceptance and resilience for coastal risk management in the community by providing ongoing information regarding coastal hazards, risks, monitoring and implementation of actions.

Type of Option

No Regrets / Preliminary Action: Existing and Future Assets

Details

To support the implementation of actions within the CZMP, ongoing community education is needed about coastal risks, their likelihood and consequence, how such risks may change in the future with sea level rise, and how Council and others propose to manage the impacts. Education should be repeated frequently (e.g. every 1 – 2 years).

A key action within this strategy is the establishment of Coastal Stakeholder Groups. The groups would be beach stakeholder based and would include OEH, Council, property owners, local beach users from the wider area, community organisations (such as Boardriders and Dunecare), tourism, utilities (sewer and water, electricity, telecommunications, etc.), Department of Planning and other relevant state agencies.

Community education activities should utilise the outcomes of beach monitoring (photo posts, survey points) and sea level rise information, to build the community's understanding of coastal processes. There may be many years before impacts eventuate. Over that time, the community should be informed about the risks from coastal hazards, consulted about the management options and their costs and benefits, so they understand the reasons for selecting a particular management action. This will be particularly important when the action will be challenging to implement but provides the best long term outcome. Through education, difficult or costly management actions will have been signalled many years in advance, so the community will be better prepared to accept and implement the action at the time it is required.

Advantages of Option	Disadvantages of Option
Improves resilience and preparedness of community for future when impacts do occur.	
Improves acceptability of more difficult or costly actions, as community will have had time to understand the options, their costs / benefits, and the reason for the selecting a particular action.	
Improves the implementation of appropriate options in the future by preparing community (thereby avoiding reactive management decisions)	

Potential Applications: Entire LGA

Investigate Habitat Protection Options

For important habitat remnants, determine translocation, facilitated migration or other feasible option to preserve the remnant, where possible. This may include a trial of methods e.g. for littoral rainforest, saltmarsh etc.

Type of Option

No Regrets / Preliminary Action: Existing Assets

Details

This option involves combining coastal hazards mapping with ecological habitat / vegetation mapping, to:

- Identify important flora/fauna species that, due to their limited distribution, will need to be translocated;
- Consider protection of valuable habitats where natural migration is prevented (e.g. by back beach development) and alternative nearby habitat is not available;
- Prioritise rehabilitation requirements based upon the relative threat to distributions from coastal hazard impacts, to ensure lower risk distributions are protected and enhanced;
- Identify and protect buffers around important habitats that will enable migration in response to hazard impacts (for example, undisturbed land landward of dune habitats); and
- Update planning controls to incorporate additional allowance in buffers, for migration of habitats with to sea level rise.

The outcomes of the audit should also feed into existing biodiversity). Hazard impacts investigated should include permanent inundation, increased frequency of oceanic inundation and recession due to sea level rise.

Advantages of Option	Disadvantages of Option
Ensures prioritisation for habitat management and considers potential impacts of sea level rise and coastal hazards.	
Focuses finite environmental management resources towards habitats as appropriate to their level of resilience to climate change.	
Identifies buffers, which are a relatively low cost action for improving the resilience of habitats.	

Potential Application

Littoral Rainforest remnants at Seven Mile Beach; Sandbar Beach, One Mile Beach.

Dune Management

Implement dune care / revegetation programs, with new programs in locations where vegetation is degraded, and support for existing successful programs.

Type of Option

Protect / "No Regrets": Existing Assets over short term

Details

Dune care programs allow for ongoing retention of sand by dune vegetation, which may otherwise be blown out of the beach system. This retains sand volumes on the beach to buffer landward areas from erosion during storm events over the short term. The increase of dune height which occurs as dune species capture sediments within the beach system additionally provides a higher barrier to mitigate wave runup and overtopping. Dune rehabilitation incidentally resolves and prevents issue relating to sand drift.

The option involves the establishment of dune care programs (voluntary and non-voluntary) on high priority beaches without existing dunecare programs. Council should consider using the environmental levy to fund such activities. The option should also encourage inspection of dunes after erosion events, to remediate storm impacts.

The existing program at Boomerang Beach has proven to be particularly successful in restoring the dune ecology of foreshore dunes which in turn has helped capture wind-blown sands to retain as a sand buffer and manage sand drift, as well as replace weed species such as bitou bush with native species. The dune care programs should be accompanied by community education regarding the role of dunes and dune vegetation to provide a buffer to storms, in addition to ecological benefits.

Advantages of Option	Disadvantages of Option
In short term, ensures sand is retained in beach system to buffer from storm erosion	Short term only - will not manage long term recession as dunes will continue to erode. Recession will outpace dune building over the long term.
Additional environmental benefits where native species are used	
No irreversible long term impacts	
Can form part of other solutions (e.g. stabilising sands placed as beach nourishment, or from beach scraping).	

Potential Applications

- Highest Priority: Blueys; One Mile
- Continue Programs: Boomerang Beach
- Medium Priority: Remaining Council managed beaches

Beach Access Management

Rationalise, improve and maintain beach access ways to protect beach / dune health and providing a high quality and safe public access to the beach.

Quality Design Elements for Beach Access Points: Durable and versatile ground cover with effective dune fencing

Type of Option

Protect / "No Regrets": Existing Assets

Details

This option involves managing beach access paths to minimise the impacts of pedestrian and 4WD traffic on the dunes. It also includes reducing the public safety risks that occur at degraded beach accesses (notably following erosion events).

This option shall include:

- *Collating an inventory of accesses and add this into Council's Asset Management Plan*. The inventory should make note of the location (e.g. through GPS/GIS), the construction materials, and condition.
- *Formalising and upgrading the beach access paths*. Beach access points should be designed and constructed to reduce the environmental impacts of pedestrian traffic on the beach / dune landscape, and where possible, to become more resilient to storms. Use of adequate and versitile ground cover materials minimises erosion gullies forming from the concentrated pedestrian use of the path Dune fencing is required to reduce trampling and subsequent degradation and erosion of adjacent dunes and dune habitat. This is particularly important after storms where accessways have been blocked off for safety, informal access around the blocked accessway can create further erosion issues. Provision of beach showers may also encourage use of formal paths;
- *Removing of unnecessary and informal access points*. Reducing any surplus formal or informal beach access paths will act to minimise the environmental impacts of pedestrian/4WD traffic on the dunes. This will also allow Council to be better target their beach access management resources;
- *Negotiate shared paths for beachfront residents*. At some urban beaches, there are numerous private access paths, which reduces the integrity and performance of the dune system. Council should negotiate with private landowners, to provide shared paths and remove the additional private accesses.
- *Regular monitoring of beach access condition*. This should be undertaken after storms or otherwise on a yearly basis. Monitoring should prioritise repairs to accessways. Use of internet/smart phone/tablet based packages to log inspections and upload to the Asset Management Plan should be considered. This may be an effective tool for collecting data, to assist in works crews repairing damage particularly after storms.

Advantages of Option	Disadvantages of Option
Reduces environmental impacts of pedestrian and 4WD pressure on beach / dune system, thus improving the beaches resilience to erosion events	
Manages public safety risk associated with degraded access conditions, such as those typically occurring following large storms	
Ensure the beach amenity is maintained and the continued provision of quality public beach access	

Potential Applications

High Priority

- Blueys Beach (private accesses)
- Number One Beach (linking to POM option)
- One Mile Beach
- Boomerang Beach
- Boat Beach

Medium Priority

- Remaining Council managed beaches.

Land Acquisition

High risk private properties are bought at market prices then demolished to become public land.

Type of Option

Planned Retreat: Existing assets

Details

This option involves the purchase of private property at risk by Council / State / Federal governments, where funding is made available for the purchase. Once the property is purchased, it is demolished and returned to public land, regardless of timeframe before hazards may occur. Acquisition can be voluntary or compulsory. The purchase price shall be based on market value. This means that should the owners wait until erosion impacts manifest before accepting the offer, the purchase price may be lower (for voluntary acquisitions).

The sacrifice of private properties allows beach amenity to be retained because the shoreline can retreat without obstruction. This is the most effective option for retaining a beach over the long term. Furthermore, this option enables owners to be appropriately compensated.

Advantages of Option	Disadvantages of Option
The public retains a sandy beach and gains public land Residents and visitors (including tourism industry) benefit from continuing access to sandy beaches	The public (Council / State Govt.) must fund full purchase price up-front This is unlikely to be possible for multiple properties (see Other Considerations)
Private property owners are adequately compensated	Rate payers may consider it unfair to spend public funds on private property
Particularly suitable for individual properties (where adjacent land uses would otherwise be permitted to retreat to retain beach amenity)	Many freehold coastal land owners will never accept the arrangement voluntarily. There is a preference to protect freehold land
Provides a long term solution	Land acquisition at this location is highly unlikely due to the cost of private properties

Other Considerations

- The Coastal Lands Protection Scheme has been used to purchase isolated residential blocks but is predominantly used for rural land repurchase and addition to national park estate. The scheme does not typically target acquisition of lands due to coastal hazards, instead being used to improve public foreshore access, or protect scenic or ecological values.

- NSW Government annual funding for the Coastal Lands Protection Scheme is limited to $3 M/year, and the Coastal Program is also limited in funding. The schemes are not sufficient for purchase of multiple properties in any one year.
- This option has been offered in other locations along the NSW coastline with limited success. While the option provides an incentive to relocate outside of the hazard area, coastal land is typically viewed as too valuable and the risks too remote at present.

Potential Applications

- Considered as part of Option 3 for southern Boomerang Beach (see main body of report).

Buy Back / Lease Back

Private properties at highest risk are bought at market rates, then rented out at market rates, until the hazard impact is imminent (years). When hazard is imminent, the property is demolished and land returned to the public.

Type of Option

Planned Retreat – Existing Assets long term solution

Details

This option would involve Council applying for funding through typical mortgage arrangements to acquire affected property(s) at market rates, on a voluntary or compulsory basis. The property would then be leased out at market rates until such time as the hazard impact is imminent. At that time, the development shall be demolished and land returned to Community Land, to enable continued retreat of shoreline and for use by the community. Council would absorb any profit/loss over that period.

By offering the market rate for a property, the purchase price shall be discounted in accordance with the length of time remaining before the property becomes uninhabitable due to erosion. This is necessary because the option is dependent upon Council leasing the property at market rates to assist loan repayments in the period prior to erosion impacts. Therefore, those owners who sell earlier will be better compensated than those who wait until impacts are imminent. The existing owners may lease back their property from Council until the hazard is imminent, and continue to enjoy the benefits of their coastal property without bearing the risk from coastal hazards. A mechanism for enabling Council “first right of refusal” when properties are put on the market (i.e. Council has the first option to purchase the property), would assist in implementation of this strategy.

The sacrifice of private properties allows beach amenity to be retained because the shoreline can retreat without obstruction. This is the most effective option for retaining a beach over the long term. Furthermore, this option enables owners to be appropriately compensated.

Advantages of Option	Disadvantages of Option
The public retains a sandy beach and public land. Residents and visitors (including tourism industry) benefit from continuing access to a sandy beach	The public (Council / State Govt.) must fund full purchase price up-front This is unlikely to be possible for multiple properties (see Other Considerations).
Private property owners are adequately compensated	Rate payers may consider it unfair to spend public funds on private property
Particularly suitable for individual properties (where adjacent land uses would otherwise be permitted to retreat to retain beach amenity)	Many freehold coastal land owners will never accept the arrangement voluntarily. There is a preference to protect freehold land

Advantages of Option	Disadvantages of Option
Provides a long term solution	

Other Considerations

- State or Federal assistance, such as through providing low interest loans and deposit payments to councils, is required to assist Council in purchase of multiple properties in key locations.
- Low interest loans would enable the majority of the mortgage repayments to be funded by rental return.
- Further negotiations with State and Federal governments, such as through a case study scenario, is required to implement this option on a larger scale / across many properties.
- At the present time, this option has not been tested in the context of coastal zone management (although, properties are regularly purchased by RTA and rented out well in advance of highway developments).
- Should no action be taken at present, it is likely that State or Federal government funding to assist in the full purchase of properties in the future may not exist, as such funds will be under high demand across the country as sea level rise impacts occur.

Potential Applications

This option provides a technically feasible outcome that can cater for environmental provisions and meets community concerns regarding potential future land devaluation as the shoreline starts to recede. For financial reasons, however, this option is unlikely to be practically implemented by Council given limitations on finances and suitable government grant funding.

Accept Impacts

Accept loss of land or assets affected by a hazard event (i.e., once affected, the assets or land is not replaced or relocated). Allows beach to translocate landward, retaining a sandy beach over time.

House intended for demolition after abandonment, USA

Type of Option

Planned Retreat: Existing Assets

Details

Planned retreat such as by sacrificing the land or assets affected by recession is the most effective option for retaining a beach over the long term. This is because the beach can move landward without obstruction. Repairs and removal of assets as they are damaged forms part of this option, to ensure ongoing public safety and beach access.

This option may be particularly suitable for the following land uses.

- **Parks, public open space and coastal dunes**, as the remaining land is still able to be used even if it is reduced in size through erosion. Existing recreational infrastructure such as picnic shelters, footpaths, BBQs and amenities buildings would be relocated as impacts occur.
- **Local roads** or **car parks** where alternative routes and access to residential property is available, allowing the road to be lost to erosion.
- For **creek / lagoon entrances**, the impact of erosion and recession due to sea level rise upon the entrance is best managed by allowing the system to respond naturally, without intervention. This will manifest as increasing flood levels behind a closed entrance. Constraints upon entrance changes (e.g. landward migration of the berm) due to surrounding land uses should also be managed.

Economic analysis has shown that the asset of greatest economic value to a locality is the beach itself (Gillespie Economics, 2011). There are many intangible economic benefits associated with both resident and visitor use of the beach, including cafes, restaurants, kiosks, accommodation and many other activities (surfing lessons and tours, fishing tours and so on) adjacent to the beach. Tourism is a particularly important industry for the Great Lakes (e.g. at Pacific Palms, Seal Rocks), and most tourism centres around access to and enjoyment of the beach. In this case, the cost of sacrificing assets and land adjacent to the beach as the shoreline retreats is far outweighed by the economic as well as social and environmental gains from ensuring a sandy beach is retained.

Advantages of Option	Disadvantages of Option
The sandy beach asset is retained because it can recede naturally	Private landholders are not compensated for the loss of land or property
Residents and visitors (including the tourism	The community may lose other public facilities or

Advantages of Option	Disadvantages of Option
industry) benefit from continuing access to a sandy beach	land
Particularly suitable for park land and low cost facilities (e.g. access ways, walkways)	
Provides a long term solution	

Potential Applications

Land within

- Tourist Parks
- Camping Grounds
- Car Parks
- Parks and Reserves
- National Parks
- Public Open Space

The option may be the only alternative for private residences where ‘protection’ or ‘accommodation’ options are unfeasible. The issue of compensation for property owners where land and/or assets are sacrificed can be addressed through consideration of other retreat options such as acquisition and buy-back / lease-back, subject to available funding.

Relocate Assets

Relocate structure / service / asset outside of hazard zone. For minor facilities, relocate and/ or replace asset landward of immediate impact area, if and when damages occur. For major assets where land is available, relocate landward of 2060 or 2100 hazard zone, either at a trigger point before impact, or when asset replacement is due.

Type of Option

Planned Retreat: Existing Assets

House being relocated out of hazard area

Details

The relocation of assets allows beach amenity to be retained because the shoreline can retreat without obstruction. This is the most effective option for retaining a beach over the long term.

Relocation will be suitable for:

- Easily relocatable structures (e.g. houses on piers);
- Assets with a value far lower than the value of beach amenity (e.g. public amenities building);
- Locations where it is technically and financially impractical to design a structure to withstand erosion / inundation, for example, for pump stations or water pipelines; and
- Infrastructure such as stormwater outlets, where the outlet may need to be relocated further landward to avoid ongoing damage from wave action and erosion of surrounding land

Relocation would be undertaken either:

- when an asset needs to be replaced; or
- when the hazard impact is imminent (as determined through monitoring), whichever occurs sooner.

Implementing this option when public asset replacement is required enables rejuvenation of a failing asset for the public in combination with the reduction of risk from coastal hazards. This is a “win-win” solution for community. Plus, the cost of mitigating erosion impacts through relocation is shared with the cost of asset replacement. This reduces the overall cost compared with relocating an existing asset that has remaining life / functionality.

Maintenance for roadway or other assets in the short term prior to relocation must avoid the use of hard protection works (e.g. dumping of rock, use of concrete, etc.) that will negatively affect beach amenity. Soft protection works (e.g. geotextile sand bags) are to be utilised.

Advantages of Option	Disadvantages of Option
The sandy beach is retained because it can recede naturally.	A suitable alternative location must exist
Residents and visitors (including the tourism industry) benefit from continuing access to a sandy beach	Private landholders must pay for the relocation of private buildings (and which may not yet need replacement / are still functional)
The relocation can mean a brand new building / road / facility in replacement of an old one	
Provides a long term solution	

Potential Applications

Most Suited

- Beach car parks.
- Roads
- Sewer
- Stormwater
- Water
- SLSCs
- Minor community facilities: picnic tables, viewing platforms, amenities, cycleways, footpaths

Least Suited

- Road sections required to provide residential access, with no feasible alternatives available.

Redesign or Retrofit

Make modifications to an existing structure or rebuild a structure with suitable design to withstand hazard impacts.

Type of Option

Accommodate – short of long term, existing assets

Details

Where relocation of a structure is not possible due to other site constraints, further redesign or retrofit options may need to be considered. Retrofit refers to modifications to an existing structure, while redesign refers to replacement of an existing structure in its present location with a structure that has been designed to withstand coastal hazard impacts. Thus, the redesign or retrofit should include provisions for managing wave overtopping and inundation, as well as erosion and recession impacts.

Aspects that may be included in the retrofit or redesign of a structure may include:

- **Foundation piles to bedrock** (done retrospectively or as structure is built);
- **Floor levels** (raising of an existing structure, or as new structure is built);
- **Changing of site use** to ensure lower floors may withstand occasional wave inundation and occupied / inhabited areas are elevated; and
- **Relocatable structures**, such as lifeguard towers, caravan park cabins, beach viewing platforms etc., that are designed to be moved prior to storms, but still provide water, power, sewer etc.

Redesign or retrofit is applicable to structures where it is not appropriate or possible to relocate the structure further landward. Similarly, stormwater infrastructure, beach access structures or major road redesign where there are no alternatives for redirection of the road, may also be suitable for redesign or retrofit in their current location.

In some cases this option can be implemented when asset replacement is required, enabling a rejuvenation of a failing asset in combination with the reduction of risk from coastal hazards (e.g. improved roadway, new stormwater outlet). The cost of mitigating erosion impacts through redesign may be shared with the cost of asset replacement. This reduces the overall cost now and in the future, as retrofitting an existing asset is far more costly than implementing the risk treatment as it is being built.

Relocatable structures are relatively inexpensive, especially compared with hard structures (e.g. foundation piles to bedrock). Ongoing monitoring is essential to ensure that later changes (renovations, supply of services, ancillary structures/landscaping etc.) do not compromise the speedy and efficient removal/return of the structure during and following storm events.

A mix of relocatable structures and solid structures outside the hazard zone may provide the best outcome, e.g. a relocatable viewing platform and beach car park located landwards of the hazard zone etc.

Advantages of Option	Disadvantages of Option
Allows extended life for existing assets or replacement assets.	Over the long term, modification will not be able to reduce likelihood that impacts will occur.
Does not limit the ability to retreat and remove structure in future – i.e. the option is adaptable to future scenarios.	Increased frequency of impacts in future may still require retreat at some point in future.
	Design modification may be more expensive than retreat and remove the asset – this should be determined through Asset Management Planning (see Option) for public buildings / infrastructure.

Potential Applications

Most Suited

- Roads
- Sewer
- Stormwater
- Water
- SLSCs (Forster Main)
- Should be investigated if suitable land for relocation is not available

Possible Suited

- Roadways (depending on availability, or otherwise, of alternate sites); and
- Residential properties (depending on site constraints and design or existing/future dwellings).

Not Suited

- This option is not suitable for residential dwellings at high risk in the immediate timeframe.

Beach Scraping

Beach scraping or nature assisted beach management.

Beach Scraping at Byron (New Brighton Beach), NSW

Type of Option

Protect: Existing Assets over short term

Details

The option involves managing beach sands through re-contouring and scraping sand into the upper beach. The objective is to redistribute sand from areas of accretion to depleted areas or areas at risk, to assist in the accumulation of sand within dunes. Re-contouring of dunes should be undertaken to a level that also mitigates wave overtopping, where possible. For example, low areas along a dune barrier could be re-contoured to increase the height, providing a consistent shoreline barrier.

Beach scraping is carried out when the beach begins to recover following beach erosion events, as sand is accreted in thin layers above the intertidal zone and moved above the area of fair weather wave action (i.e. into dunes). The dunes then form a buffer against storm erosion and wave overtopping. Beach management should be undertaken in combination with dune revegetation (see option) to minimise wind-blown sand losses.

Activities to re-contour eroded dune escarpments following storm erosion for public safety are not part of this management option, but rather, form emergency action subplan works.

Advantages of Option	Disadvantages of Option
Relatively cost effective and unobtrusive – single scraping events are ~ $5,000 - $10,000.	Short term solution - beach scraping does not add to overall sand volumes on the beach, and is costly.
Does not limit the ability to shift structure in future – i.e. the option is adaptable to future scenarios.	Increased frequency of impacts in future may still require retreat at some point in future.
Over the short term, promotes the building of dunal buffers behind the beach.	Design modification may be more expensive than retreat and remove the asset – this should be determined through Asset Management Planning (see Option) for public buildings / infrastructure.
	Community debate on the impact of sand scraping upon surf conditions, as sand is removed from the daily active beach to build sand dunes that are only accessed in storms.

Potential Application

Suitable at Boomerang (especially southern end) and Blueys Beach, if effectiveness can be demonstrated.

Beach Nourishment

Placement of sand in the surf zone, on the upper beach face or dunes, to re-establish or enlarge an existing sandy beach.

Nourishment of beach with sand at Burleigh Heads, Qld.

Type of Option

Protect: Existing Assets

Details

Beach nourishment often involves placement of beach sands on the upper beach face and dunes, to re-establish a sandy beach after a storm event and to provide a sediment supply for subsequent storm events. Nourishment can also involve the placement of sands offshore of a beach within the surf zone, where it is reworked naturally onto shore by swell waves. Nourishment can address wave overtopping in the design profile adopted for placement of sand in dunes. Another option for nourishment (currently untested) is building a large dune barrier (to provide a future sand buffer and sediment input.

Where the objective is to increase the overall beach width, the whole profile must be nourished from the offshore base of the profile (10 – 15 m water depth) to the dune. Nourishment costs have been estimated at around $\$25/m^3$, with typical volumes of up to 200 m^3/m length of beach required to restore or widen the beach (equating to a cost of at least $5,000/m).

Suitable sand sources need to be available in the local area for large scale beach nourishment, otherwise, costs may be significantly higher than estimates above. This option may be limited to localised spots or to protect individual assets on an as needs basis. The first nourishment event is typically larger, followed by ongoing smaller nourishment episodes (as required to maintain the agreed level of protection/amenity). As sea level rises and the shoreline attempts to retreat, if the beach alignment and width is to be maintained in its current form, nourishment requirements and therefore cost will substantially increase (particularly if a local inexpensive sand source is not available).

Advantages of Option	Disadvantages of Option
Retains a sandy beach in current position	Very expensive option ($1- 2 million for first episode, $1 million for ongoing episodes), with typical costs of $\$25/m^3$ of sand.
Largely retains beach amenity	Needs to be continually repeated (i.e. every 5-10 years now, may be once a year by 2100 due to shoreline retreat in response to sea level rise).
	Suitable sand sources need to be available in the local area, otherwise the option is not economically viable.

Other Considerations

- In NSW, there has historically been a government stance against the sourcing of sand from offshore, and sand for nourishment must be sourced from licensed sand extraction operations on land.
- Under NSW legislation, Council can apply a Coastal Protection Service Charge to landholders who directly benefit from this action where private property (e.g. residences) or state-owned assets (e.g. RTA road, State railway) is being protected by nourishment or the nourishment is addressing the impacts of a protective structure on beach amenity or adjacent property. The percentage of the levy individuals can be required to pay for this option relates to the extent of property protected. Council may also contribute where the community is considered to benefit from retaining the sandy beach.

Potential Applications

Most Suited

- Southern Boomerang Beach – See Option 1 of report.

Possibly Suited

- Entire beaches (e.g. Blueys, Boomerang), if affordable sand sources become available in the future

Seawalls

Construction of a permanent revetment at the back of the beach to hold the shoreline in position.

Rock seawall at Stockton Beach, Newcastle, showing the lack of beach at high tide.

Type of Option

Protect: Existing Assets

Details

A seawall can be built along an entire beach embayment, or a section of the beach. If built for a section of beach, the seawall design must be "tied" to bedrock to minimise erosion at the end(s) of the structure.

Seawalls can be constructed from a variety of materials, particularly rock, concrete armour units or sand filled geotextile bags. The most effective designs are sloped with a rough surface, which minimises wave run up and overtopping. The design can incorporate other elements such as walkways / cycleways, steps and seating, and parapets.

Rock armour seawalls are the most common because they are well understood from a design perspective, easy to construct, typically absorb wave events bigger than the design condition with comparatively little damage, the slope and roughness of the rock placement reduces wave run up and overtopping, and repairs and upgrading are relatively straightforward. This design type would therefore be recommended, however, the final design and materials would be selected during the detailed design process.

Seawall costs are of the order of $5,000 - $10,000 per metre length of wall, not including the costs of beach nourishment, ongoing maintenance and future upgrading. If the seawall is intended to be abandoned at some time in the future, the costs for removal and repair of the beach must also be considered as part of this option. Restrictions on re-development (i.e. DCP) should be applied until protection works are in place.

Advantages of Option	Disadvantages of Option
Holds shoreline in current position over medium term. (i.e. the land behind the beach is protected at the sacrifice of the beach)	Loss of the sandy beach as sea levels rise and the shoreline retreats – there is no beach.
May be appropriate where the land and assets behind the beach are more valuable (economically or otherwise) than the beach in front.	Expensive capital outlay ($ millions) plus ongoing maintenance. Maintenance costs will also include redesign in the future to accommodate to sea level rise. Beach nourishment is needed in future to provide a sandy beach, increasing cost of the option. However economically feasible long term sources of sand for nourishment cannot be guaranteed. Beach amenity will become severely degraded if beach maintenance ceases under increased sea level rise conditions.

Advantages of Option	Disadvantages of Option
	Cannot be built at an individual property scale because the beach and land will continue to erode next to a seawall section. Must be built along lengths/major segments of beach.
	In cases where private property is protected, it may be considered unreasonable to spend public money on protection of private property, especially if the public beach amenity will be sacrificed due to the seawall.

Other Considerations

- Recent changes to NSW legislation enable private property owners to submit applications to construct seawalls. The applicant must show that adverse impacts (e.g. edge erosion effects, erosion of beach in front of the wall) will be remediated. The seawall must be constructed on the applicant's land.
- Council can apply a Coastal Protection Service Charge in perpetuity to the property land title that is protected by the wall (i.e. the private or public property owner), to fund ongoing maintenance of the seawall (including beach nourishment).
- Recent NSW legislation clearly indicates seawalls that protect private property shall be funded by those landholders benefiting from the wall. This may include state agencies, e.g. RMS Roads etc. The NSW Government places a low priority on allocating funding to protection options for private property.
- Council may choose to fund those sections of wall that protect Council-owned assets (road ends, reserves, public buildings and infrastructure) in partnership with other benefiting owners (which may include private residents).
- Protect of a roadway or service infrastructure (e.g. sewer, water) may be required to keep a private residence serviced, in which case, the seawall should be funded by the private property owner, even though it may be constructed on public property in agreement with Council.

Potential Applications

Possible Suited

- Southern Boomerang Beach, to protect at risk foreshore houses and Boomerang Drive (~400 m seawall length), see Option 2 in the report.

Artificial Breakwaters

Construct a nearshore artificial reef or breakwater in the surfzone to reduce shoreline wave impacts.

Example emergent breakwater in UK, where the lower energy environment is more suited to such options

Type of Option

Protect: Existing Assets

Details

Artificial reefs can be submerged (such as multi-function reefs) or emergent (such as detached breakwaters or islands, see adjacent photo). They can be constructed from a range of materials and in a range of shapes, sizes and locations depending on the outcome required. Emergent reefs effectively block wave energy, absorbing wave impact on their seaward side. They create a lower wave energy environment on the beach immediately in the lee of the reef, thus sand will accrete and form a salient (or wider 'bump') along the beach. They are rarely favoured in Australia due to their obtrusive appearance and interference with beach surf conditions.

Submerged reefs act to refract waves and cause waves to break in the lower water depths over the reef, also reducing wave energy on their leeward (landward) side. They are less effective than an emergent reef as they do not block the waves entirely. During storm events, water depths over a submerged reef may be sufficient to allow waves up to several metres in height to pass over the reef without breaking, reducing their effectiveness in protecting the beach from erosion. They do offer the opportunity for other objectives such as creating marine habitat and improving surfing conditions. An example of an artificial submerged reef is at Narrowneck, Gold Coast.

Both types of structures are more suited to embayed coastlines where there is little to no alongshore sediment transport, to reduce the potential for impacts on the beach further downdrift of the structure. They are difficult to design and operate effectively across a range of wave directions and conditions and varying water levels.

Advantages of Option	Disadvantages of Option
Suitable to protect short section of shoreline only (salient only forms behind reef).	Very expensive to build and maintain ($ millions…) because the structure must be built in a high energy wave environment.
The location of bedrock close to the surface provides opportunity to reduce scour and slumping of the reef once constructed, reducing maintenance costs.	Multi-function (e.g. surfing reefs) have not been successful in other locations because the design for surfing is different to the design needed to protect the shore during storms.

Advantages of Option	Disadvantages of Option
	Will not stop impacts of sea level rise unless the reef is continually raised, meaning ongoing expense, more $$ (ability of reef to dissipate waves is reduced due to higher water levels over the reef with sea level rise).
	Substantially change in nature and appearance of the beach – emergent breakwaters in particular are obtrusive.

Potential Applications

Breakwaters are not recommended for the Great Lakes LGA.

Groynes / Artificial Headlands

Groyne field, Portugal

Construct a groyne or series of groynes approximately perpendicular to the shoreline to capture longshore sediment transport and build a beach.

Type of Option

Protect: Existing Assets

Details

Groynes are shore normal structures constructed from the beach through the surf zone to a sufficient depth to stop or restrict the movement of sand around the end of the structure. They can be constructed from a range of materials and in a range of shapes, sizes and locations depending on the outcome required.

They are usually employed on high littoral drift coastlines to trap sand on the updrift side to provide a sand buffer to protect property and assets behind the beach. However, the groyne will cause erosion on the downdrift side until full bypassing of the groyne occurs. A number of groynes (in a 'groyne field') may be needed along the beach, to continually trap longshore drifting sands and reduce erosion effects at the end of the groyne field. This substantially changes the nature and appearance of the beach.

On coastlines with little or no longshore sediment transport, the groynes need to be closely spaced and (usually) nourished to provide the required sand buffer between the groynes. As such they are obtrusive and expensive by comparison with seawalls or nourishment options.

Advantages of Option	Disadvantages of Option
Retains a sandy beach in current position over the short term	Substantially change in nature and appearance of the beach - groynes are obtrusive.
	Very expensive to build ($ millions), as groynes need to be built in the surfzone. Cost is well beyond the means of individual or local Council. Such structures elsewhere in Australia and around the world are constructed as a part of a regional strategy with Local, State or National funding.
	Unlikely to be effective for long term sea level rise (groynes don't increase sediment budget for beach)

Potential Applications

Longshore transport rates are not high enough on the Great Lakes coast for groynes to be feasible.