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GOSFORD CITY COUNCIL

Gosford Beaches

Coastal Zone Management Plan

301015-03417 – 003

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Infrastructure

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Disclaimer

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NOTE: On 12 May 2016 the *Local Government (Council Amalgamations) Proclamation 2016* was made, which had the effect of amalgamating the Gosford and Wyong local government areas to form the Central Coast local government area, dissolving both the Gosford City Council and the Wyong Shire Council, and forming the Central Coast Council. This Coastal Zone Management Plan ("CZMP") was prepared by WorleyParsons at various times prior to 3 April 2017, on instructions from Gosford City Council for all times prior to 12 May 2016 and thereafter on instructions from the Central Coast Council. This CZMP includes minor drafting artefacts as a result of most of its preparation being undertaken under instruction from the former Gosford City Council prior to 12 May 2016. Those drafting artefacts are adequately addressed if the following approach is taken to the interpretation of this CZMP:

- References to "Gosford local government area", "Gosford LGA" or "the LGA" are read as "the former Gosford local government area".
- References to "the beaches of Gosford" or "Gosford beaches" are read as "the beaches of the former Gosford local government area".
- References to "Gosford City Council" or "Council" that refer to actions taken or circumstances that occurred prior to 12 May 2016 are read as "the former Gosford City Council".
- References to "Gosford City Council" or "Council" that refer to actions or circumstances that occurred on or after 12 May 2016, or will occur in the future, are read as "Central Coast Council".

PROJECT 301015-03417 - GOSFORD BEACHES

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
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FOREWORD

The Gosford Local Government Area presents a diverse and spectacular coastline encompassing beaches, coastal lagoons and estuaries. These environments provide a major attraction to visitors and residents alike.

Gosford is bound by approximately 14 kilometres of exposed beaches extending from Patonga in the south, to Forresters Beach in the north, with these being amongst the most dynamic beaches on the east coast of Australia.

Coastal processes have shaped the coastline over many thousands of years and will continue to do so. Over recent decades, significant erosion has occurred on several occasions. This has resulted in the loss of several buildings and threats to beachfront development, public assets and beach amenity.

Council has a strong tradition of planning for natural hazards. Council takes its responsibilities for planning seriously and has sought to bring together experts, planners and the community to deal with the complex issues. However, these issues are not certain, nor does planning ensure perfect outcomes.

Council is working on a range of planning activities which aim to provide a balanced long-term management framework for the ecologically sustainable use of our coast and estuaries.

These planning activities require a connected community that has the capacity to understand the role of government and the part we all play to ensure the effective long term management and protection of the coastal zone.

This revised and improved Coastal Zone Management Plan complements the development of Plans for the Lower Hawkesbury River Estuary (2009), Brisbane Water (2012), Pearl Beach Lagoon (2014) and Gosford's Coastal Lagoons (2015). Consecutively Council also works to minimise current and future risk from flooding in foreshores and catchments across the Gosford area.

Over many decades Gosford City Council has worked with other government bodies, industry and community in undertaking management of our beaches and coastal catchments. Residents living near coastal and marine environments need to understand the complexity of these systems and also develop their capacity to identify the importance of on ground rehabilitation projects and other aims associated with these key plans.

The updated Coastal Zone Management Plans will provide, amongst other things, a strategic policy framework for coordinated, integrated and ecologically sustainable development of sections of the coastline affected by the identified hazards, and the protection of fragile coastal environments into the future.



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EXECUTIVE SUMMARY

This report documents the Coastal Zone Management Plan (CZMP) for Gosford's Open Coast and Broken Bay Beaches.

This CZMP has been prepared in accordance with the *Guidelines for Preparing Coastal Zone Management Plans* (OEH 2013) and its development has been supported by funding under the NSW Coastal Management Program.

The primary purpose of this Plan is:

"to describe proposed actions to be implemented by Gosford City Council, other public authorities and by the private sector to address priority management issues in the coastal zone between 2015 and 2025. These issues include:

- ***managing risks to public safety and built assets***
- ***pressures on coastal ecosystems, and***
- ***community uses of the coastal zone."***

The primary objective of this Plan is:

"to protect and preserve the beach environments, beach amenity, public access and social fabric of the Open Coast and Broken Bay beaches while managing coastal hazard risks to people and the environment".

The *Guidelines for Preparing Coastal Zone Management Plans* (OEH 2013) outlines minimum requirements for the CZMP planning process and outcomes. The minimum requirements are for CZMPs to contain:

- a description of:
 - how the relevant Coastal Management Principles have been considered in preparing the Plan
 - the community and stakeholder consultation process, the key issues raised and how they have been considered
 - how the proposed management options were identified, the process followed to evaluate management options, and the outcomes of the process
- 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



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- 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.

CZMPs are 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).

CZMPs are to achieve a reasonable balance between any potentially conflicting uses of the coastal zone.

Coastal Management Principles

As noted in OEH (2013), ten Coastal Management Principles have been developed to inform strategic considerations in coastal management, including the preparation of CZMPs. These principles are:

- **Principle 1** : Consider the objects of the *Coastal Protection Act 1979* and the goals, objectives and principles of the NSW Coastal Policy 1997;
- **Principle 2** : Optimise links between plans relating to management of the coastal zone;
- **Principle 3** : Involve the community in decision-making and make coastal information publicly available;
- **Principle 4** : Base decisions on the best available information and reasonable practice; acknowledge the interrelationship between catchment, estuarine and coastal processes; adopt a continuous improvement management approach;
- **Principle 5** : The priority for public expenditure is public benefit; public expenditure should cost-effectively achieve the best practical long-term outcomes;
- **Principle 6** : Adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risks where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions to manage high risks while long-term options are implemented;



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- **Principle 7** : Adopt an adaptive risk management approach if risks are expected to increase over time, or to accommodate uncertainty in risk predictions;
- **Principle 8** : Maintain the condition of high value coastal ecosystems; rehabilitate priority degraded coastal ecosystems;
- **Principle 9** : Maintain and improve safe public access to beaches and headlands consistent with the goals of the NSW Coastal Policy; and
- **Principle 10** : Support recreational activities consistent with the goals of the NSW Coastal Policy.

A description of how these Coastal Management Principles have been considered in developing this CZMP is provided in Section 1.

Community and Stakeholder Consultation Process

As part of the development of this Plan, a Coastal Process and Hazard Definition Study (WorleyParsons 2014) was initially developed and endorsed by Council in March 2014. The second phase of the planning process involved the development of a Coastal Zone Management Study (WorleyParsons 2015) which was publicly exhibited between 15 January and 15 February 2015.

Council held a series of community forum sessions in early February 2015 for people interested in learning more about the Gosford City coastline and how it is managed. These sessions aimed to gauge community attitude to management options, before the preferred options were presented in more detail via this CZMP.

This Coastal Zone Management Plan itself was publicly exhibited over a six week period between 21 August and 2 October 2015 prior to being formally adopted. Public Notices were placed in the Central Coast Express Advocate on 21 August and 4 September 2015 to inform the public of the place at which, the dates on which, and the times during which, the draft coastal zone management plan may be inspected by the public.

As part of the consultation process, a series of community drop-in forum sessions were held for each of the locations, to seek public feedback on the proposed management actions.

The planning process has been undertaken in liaison with a Coastal Sub-committee which includes beachfront residents from all beaches identified in this CZMP, community representatives from other locations across Gosford, special interest groups, NSW Government officers and Council staff.

As required under Section 55C of the *Coastal Protection Act 1979* Council undertook separate consultation with relevant public authorities in regard to the inclusion of management actions or activities which are proposed to be carried out by the public authority or relating to any land or other assets owned or managed by the public authority. Public authorities and other organisations which were consulted include:

- NSW Department of Primary Industries (DPI - Lands)



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- NSW Planning & Environment
- NSW Office of Environment & Heritage (National Parks & Wildlife Service)
- NSW Department of Primary Industries (NSW Fisheries)
- NSW Roads & Maritime Services
- Greater Sydney Local Lands Services
- Darkinjung Local Aboriginal Land Council
- Guringai Aboriginal Tribal Links

A full description of the public consultation process for this CZMP is provided in Section 1.4.

Identification and evaluation of proposed management options

Management actions have been recommended for each beach based on the specific coastal hazard risks identified along each beach, the values in the study area, the effectiveness of the existing coastal management measures, and specific issues of importance identified by the local community and in previous studies. In addition to the site-specific management actions, more general management actions have been included that apply on an LGA-wide basis.

The list of management actions presented in this Plan have been further developed and refined based on feedback from the public exhibition process, with the refined list of management actions for each beach based on those presented in the Coastal Zone Management Study.

Indicative costs have been determined for each management option and presented in the Coastal Management Study, together with the advantages and disadvantages of the options described in terms of economic, social and environmental benefits and disbenefits of each option.

Each option has been assessed based on a cost benefit analysis, which describes the economic aspects of the options, as well as consideration of the environmental and social aspects of the options.

For each beach, feedback received from Council's Coastal Sub-committee and the community submissions have allowed further refinement of the list of management actions (i.e. intangible benefits, acceptance by the community etc.).

Additional actions have been suggested in community submissions and these have been included in the list of management actions included in the CZMP where appropriate.

The process for identifying, developing and evaluating the management actions in this CZMP is discussed in the Coastal Management Study (Appendix 1) and in Section 3 of this document.



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Implementation Schedule

Section 3 of this document provides an Implementation Schedule for the proposed management actions over the CZMP's implementation period. This is included in tabular format for each precinct in the Study area. Responsibilities, proposed funding arrangements for all actions, including any private sector funding are provided in the tables and described in the text of Section 3.5.

The Implementation Schedule includes:

- A list and description of all management actions for each beach in the Study Area
- Allocation of responsibility for management action
- Timetable for implementation (short, medium, long term)
- Possible sources of funding for implementation
- Allocated budget cost for implementation of the action within the next 10 year timeframe, intended to cover the period until the next scheduled review of the Plan (longer term options will have no cost allocation within the next 10 years).

Minimum requirements for Coastal Risk Management

The *Guidelines for Preparing Coastal Zone Management Plans* (OEH 2013) stipulates the minimum requirements for CZMPs in addressing coastal risks. CZMPs are to include:

- a description of:
 - coastal processes within the plan's area, to a level of detail sufficient to inform decision-making
 - the nature and extent of risks to public safety and built assets from coastal hazards
 - projected climate change impacts on risks from coastal hazards (section 55C(f) of the *Coastal Protection Act 1979*), based on council's adopted sea level rise projections or range of projections. Councils should consider adopting projections that are widely accepted by competent scientific opinion
 - suitable locations where landowners could construct coastal protection works (provided they pay for the maintenance of the works and manage any offsite impacts), subject to the requirements of the *Environmental Planning and Assessment Act 1979*, and
 - property risk and response categories for all properties located in coastal hazard areas.
- proposed actions in the implementation schedule to manage current and projected future risks from coastal hazards, including risks in an estuary from coastal hazards. Actions are to



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focus on managing the highest risks (section 55C(d) and (e) of the *Coastal Protection Act 1979*)

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

The above requirements have been addressed in the following supporting documents or within this CZMP document:

- **Coastal Processes** - these have been described in the Coastal Process and Hazard Definition Study (WorleyParsons 2014) and summarised in the Coastal Management Study (WorleyParsons 2015);
- **Risks to public safety and built assets from coastal hazards** - these have been described in the Coastal Process and Hazard Definition Study (WorleyParsons 2014) and summarised in the Coastal Management Study (WorleyParsons 2015);
- **Projected climate change impacts on risks from coastal hazards** - these have been described in the Coastal Process and Hazard Definition Study (WorleyParsons 2014) and summarised in the Coastal Management Study (WorleyParsons 2015). Council has updated its climate change projections since production of the Coastal Process and Hazard Definition Study and this updated has been reflected within the management actions proposed under this CZMP;
- **Suitable locations where landowners could construct coastal protection works** – these include both long-term protective measures as well as temporary protection works in accordance with the Code of Practice under the *Coastal Protection Act 1979*. Areas where temporary and long term protection works may be constructed have been defined in the Emergency Action Subplan for Wamberal Beach (Appendix 2) and within the implementation schedule for each precinct in the Study Area;
- **Property risk and response categories for all properties** – these have been defined within Section 5 of this document which provides recommendations for updating Gosford's Development Control Plan (DCP Chapter 6.2 "Coastal Frontage");



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- **Actions in the implementation schedule for managing current and future risks from coastal hazards** – this is provided in Section 3 of this document;
- **Proposed arrangements for the adequate maintenance of coastal protection works** – these are described in Section 3 of this document and within the Implementation Schedule;
- **An Emergency Action Subplan** - this has been developed and publicly exhibited for Wamberal Beach and is provided in Appendix 2.

Minimum requirements for community uses of the coastal zone

The *Guidelines for Preparing Coastal Zone Management Plans (OEH 2013)* stipulate the minimum requirements for CZMPs to address community uses of the coastal zone. CZMPs are to include

- proposed actions in the implementation schedule that protect and preserve beach environments and beach amenity, and ensure continuing and undiminished public access to beaches, headlands and waterways, particularly where public access is threatened or affected by accretion (section 55C(c) of the *Coastal Protection Act 1979*).
- a description of:
 - the current access arrangements to beaches, headlands and waterways in the plan's area, their adequacy and any associated environmental impacts
 - any potential impacts (e.g. erosion, accretion or inundation) on these access arrangements, and
 - the cultural and heritage significance of the plan's area
- proposed actions in the implementation schedule to manage any environmental or safety impacts from current access arrangements, and to protect or promote the culture and heritage environment.

The above requirements have been addressed in the following supporting documents or within this CZMP document:

- Actions which protect and preserve beach environments and amenity as well as ensuring continuing and undiminished public access to beaches, headlands and waterways are described for all precincts in the Implementation Schedule in Section 3.6;
- A description of the current access arrangements to beaches in the plan's area, their adequacy and associated environmental impacts is provided in mapping for each precinct in Appendix 5 ;
- A description of potential impacts on existing access arrangements and the cultural and heritage significance of the plan's area has been provided in the Coastal Management Study (Appendix 1, WorleyParsons 2015);



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- proposed actions in the implementation schedule to manage any environmental or safety impacts from current access arrangements, and to protect or promote the culture and heritage environment are described for all precincts in the Implementation Schedule in Section 3.6.

Process for developing CZMP

This CZMP has been developed on the basis of the coastal risk assessment, community uses of the coastal zone and evaluation of management options as presented in the Coastal Management Study (Appendix 1). A large range of management options were identified in that Study and were evaluated by considering social, economic and environmental factors, to identify realistic and affordable actions.

The options were refined into a defined set of actions following the community and stakeholder consultation process undertaken under the Coastal Management Study (Appendix 1), which summarises the submissions received and provides responses to those submissions.

Each of the actions to be incorporated into the final CZMP have considered such issues as the effectiveness of each option in removing the coastal hazard risk, the compatibility of the option with the principles of ecologically sustainable development (ESD), and the likely community acceptance of each option.

This CZMP was publicly exhibited for a minimum of three weeks. Submissions received during the exhibition period were considered and the draft CZMP was amended as a result of these submissions.



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1 INTRODUCTION

This section describes the purpose and objectives of the Coastal Zone Management Plan (CZMP) and the ten Coastal Management Principles. It describes how these Principles have been taken into account in developing this CZMP, and the process followed to develop this CZMP.

This section describes also the community and stakeholder consultation that has been carried out to date as part of the development of this CZMP. It addresses the minimum CZMP requirement of describing the community and stakeholder consultation process, the key issues raised and how they have been considered. It also addresses the requirement of Coastal Management Principle 3 which is to involve the community in decision-making and make coastal information publicly available.

The Gosford City Council Local Government Area (LGA) is located on the Central Coast of New South Wales, approximately 50 km north of Sydney. The LGA is bounded, to the east, by 14 km of coastal beaches extending from Patonga (within Broken Bay) in the south to Forresters Beach on the open coast in the north. The study area is shown in **Figure 1**.

Historically, coastal processes have threatened sections of the coast within the study area. Damage to public assets and recreational amenity has been experienced at the beaches in the Gosford area.

Gosford City Council has been directed by the then NSW Minister for Climate Change and the Environment to complete a Coastal Zone Management Plan (CZMP) for Terrigal/Wamberal Beach. At the time the Direction was given, Council had commenced the development of a CZMP for all open coast and Broken Bay beaches.

The *Guidelines for Preparing Coastal Zone Management Plans* (OEH 2013), have been adopted by the then Minister for Climate Change and the Environment as Guidelines under Section 55D of the *Coastal Protection Act 1979*, and Councils are required to prepare draft plans in accordance with these Guidelines. The NSW Government have been undertaking ongoing reform of coastal management planning frameworks since 2010. These reforms continue through the development and finalisation of this CZMP.

The *Coastal Zone Management Plan for the Open Coast and Broken Bay Beaches* (the Plan) is documented herein.

1.1 Minimum Requirements for Coastal Zone Management Plans

The minimum requirements for CZMP preparation identify that CZMPs are to contain:

- a description of:



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- *how the relevant Coastal Management Principles have been considered in preparing the plan (this has been included in Section 1.2 of the CZMP)*
- *the community and stakeholder consultation process, the key issues raised and how they have been considered (this has been included in Appendix 6)*
- *how the proposed management options were identified, the process followed to evaluate management options, and the outcomes of the process (this has been included in Section 3.3)*
- proposed management actions over the CZMP's implementation period in a prioritised implementation schedule (included in Section 3.6) 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.

1.2 Purpose of the Plan

The primary purpose of this Plan is:

“to describe proposed actions to be implemented by Gosford City Council, other public authorities and by the private sector to address priority management issues in the coastal zone between 2015 and 2025. These issues include:

- ***managing risks to public safety and built assets***
- ***pressures on coastal ecosystems, and***
- ***community uses of the coastal zone.”***

The primary objective of this Plan is:

“to protect and preserve the beach environments, beach amenity, public access and social fabric of the Open Coast and Broken Bay beaches while managing coastal hazard risks to people and the environment”.

Based on Section 55C of the *Coastal Protection Act 1979*, a CZMP must make provision for (among other matters):

1. protecting and preserving beach environments and beach amenity;



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2. 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;
3. ensuring continuing and undiminished public access to beaches, headlands and waterways, particularly where public access is threatened or affected by accretion;
4. where the plan relates to a part of the coastline, the management of risks arising from coastal hazards; and,
5. where the plan proposes the construction of coastal protection works (other than temporary coastal protection works¹) 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).

These items are of great importance for Coastal Zone management planning and the recently completed Coastal Process Hazard Definition Study provides the baseline risk assessment investigation to enable Council to meet the provisions as identified within Section 55C of the *Coastal Protection Act 1979*.

¹ "Temporary coastal protection works" has a specific meaning in relation to the *Coastal Protection Act 1979*, generally being sand or sandbags temporarily placed on a beach to reduce beach erosion impacts.



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Figure 1: View of the Gosford LGA Coastline



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1.3 Coastal Management Principles

As noted in OEH (2013), ten Coastal Management Principles have been developed to inform strategic considerations in coastal management, including the preparation of CZMPs. These principles are:

- **Principle 1** : Consider the objects of the *Coastal Protection Act 1979* and the goals, objectives and principles of the NSW Coastal Policy 1997;
- **Principle 2** : Optimise links between plans relating to management of the coastal zone;
- **Principle 3** : Involve the community in decision-making and make coastal information publicly available;
- **Principle 4** : Base decisions on the best available information and reasonable practice; acknowledge the interrelationship between catchment, estuarine and coastal processes; adopt a continuous improvement management approach;
- **Principle 5** : The priority for public expenditure is public benefit; public expenditure should cost-effectively achieve the best practical long-term outcomes;
- **Principle 6** : Adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risks where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions to manage high risks while long-term options are implemented;
- **Principle 7** : Adopt an adaptive risk management approach if risks are expected to increase over time, or to accommodate uncertainty in risk predictions;
- **Principle 8** : Maintain the condition of high value coastal ecosystems; rehabilitate priority degraded coastal ecosystems;
- **Principle 9** : Maintain and improve safe public access to beaches and headlands consistent with the goals of the NSW Coastal Policy; and
- **Principle 10** : Support recreational activities consistent with the goals of the NSW Coastal Policy.

Council submitted the draft CZMP to the Minister administering the *Coastal Protection Act 1979* for certification under the Act. When the draft CZMP was submitted, the Minister made an assessment of whether to certify the CZMP by considering whether it meets the requirements of the *Coastal Protection Act 1979* and the minimum requirements in the OEH (2013) guidelines.

This CZMP describes the following, as proposed in *the Guidelines for Preparing Coastal Zone Management Plans* (OEH 2013):

- how the relevant Coastal Management Principles have been considered in preparing the Plan;



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- how the proposed management options were identified, and the process followed to evaluate management options;
- proposed management actions over the CZMP's implementation period in a prioritised implementation schedule which contains proposed funding arrangements for all actions, 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, proposed actions to monitor and report to the community on the Plan's implementation, and a review timetable;
- the outcomes of the evaluation of the management options based on feedback received from the community during the public exhibition process, feedback from the Catchments and Coast Committee and other key stakeholders;
- priorities and timeframes for potential management options, and options for funding arrangements for all actions, including any private sector funding; and
- actions that could be implemented through other statutory plans and processes and actions that could be carried out by a public authority or relating to land or other assets it owns or manages (in accordance with section 55C(2) (b) of the *Coastal Protection Act 1979*).

The management options have considered the requirement to achieve a reasonable balance between any conflicting uses of the coastal zone.

It should be noted that the planning horizons to be adopted for the management actions need to be appropriate for different categories of decisions, based upon their economic life and the degree of flexibility. For example, different planning horizons may be appropriate for a Council land use plan, development control over a private residence, design and location of major infrastructure, and planning of recreational areas.

1.3.1 Consideration of Coastal Management Principles

This CZMP has been prepared considering the ten Coastal Management Principles. The Principles have been considered in the following ways:

Principle 1: Consider the objects of the Coastal Protection Act 1979 and the goals, objectives and principles of the NSW Coastal Policy 1997.

The *Coastal Protection Act 1979* (CP Act) provides a statutory mechanism to protect, maintain, enhance and restore the environment of the coastal region, associated ecosystems, ecological processes, biological diversity and its water quality.

The objects of this Act are to provide for the protection of the coastal environment of NSW for the benefit of both present and future generations and, in particular:

- 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, and*



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- 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, and*
- 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, and*
 - ii. benefits to urban communities, fisheries, industry and recreation, and*
 - iii. benefits to culture and heritage, and*
 - iv. benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water, and*
- d. to promote public pedestrian access to the coastal region and recognise the public's right to access, and*
- 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, and*
- f. to recognise the role of the community, as a partner with government, in resolving issues relating to the protection of the coastal environment, and*
- 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, and*
- h. to encourage and promote plans and strategies for adaptation in response to coastal climate change impacts, including projected sea level rise, and*
- i. to promote beach amenity.*

The NSW Coastal Policy is based on the four principles of Ecologically Sustainable Development (ESD) contained in the Intergovernmental Agreement on the Environment in 1992. The principles are:

- **Conservation of biological diversity and ecological integrity.** This refers to the need to conserve the variety of all life forms, especially the variety of species, and to ensure that the productivity, stability and resilience of ecosystems is maintained.
- **Inter-generational equity.** This requires that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. Social equity considerations, in terms of equal access opportunities to resources, are inherent in the concept of inter-generational equity.
- **Improved valuation, pricing and incentive mechanisms.** This requires environmental factors, such as the value of ecosystems, polluter pays principles etc., to be incorporated into the valuation of assets and services and considered in decision making processes.



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- **The precautionary principle.** Requires a risk averse approach to decision making. Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty is not to be used as a reason for postponing measures to prevent environmental degradation.

The Policy has adopted nine goals within this framework which include:

- Protecting, rehabilitating and improving the natural environment of the coastal zone.
- Recognising and accommodating the natural processes of the coastal zone.
- Protecting and enhancing the aesthetic qualities of the coastal zone.
- Protecting and conserving the cultural heritage of the coastal zone.
- Providing for ecologically sustainable development and use of resources.
- Providing for ecologically sustainable human settlement in the coastal zone.
- Providing for appropriate public access and use.
- Providing information to enable effective management of the coastal zone.
- Providing for integrated planning and management of the coastal zone.

Management actions have been proposed within this CZMP which are consistent with the objects of the *Coastal Protection Act 1979* and the goals, objectives and principles of the NSW Coastal Policy 1997. In particular:

- Management actions have been chosen and assessed such that the environment of the coastal region, its habitat and ecosystems are protected and enhanced, recognising and accommodating the natural processes of the coastal zone. This has been achieved by providing for dune vegetation management at all beaches as well as through the application of development controls which do not allow intensification of development within zones impacted by natural coastal processes;
- In defining management actions for each precinct in the study area, a balance has been sought between utilisation and conservation of the coastal region and its natural and man-made resources. This balance has been achieved through analysing and recognising the social, economic and environmental values of each precinct in the study area as well as through public consultation and consultation with key stakeholders;
- The management actions aim to preserve public pedestrian access to the coastal region by allowing for the sustainable management of beach foredunes and maintenance of formal pedestrian accessways at each beach into the future. Improvements to access existing arrangements have been suggested where warranted.

The role of the community as a partner to the NSW Government in resolving the issues relating to protection of the coastal environment has been recognised in developing this CZMP, through the community and stakeholder consultation process. The management actions have been chosen based



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on a strategic approach to coastal climate change adaptation, as well as to preserve and promote beach amenity for all members of the community.

Information to enable effective management of the coastal zone has been provided to the community as part of the process for developing this CZMP, and through proposed management actions which promote public education on coastal zone management. The actions of local community organisations in promoting community education on coastal zone management matters have been recognised and supported through management actions designed to support and provide resources to enhance the ongoing work of these organisations, as well as direct actions to enhance the understanding of the local community on coastal zone management.

In developing this CZMP, the NSW Coastal Policy 1997 has been considered in terms of the four Principles of Ecologically Sustainable Development, in the following ways:

- **Conservation of biological diversity and ecological integrity** – management actions have been included to enhance and protect the biological and ecological integrity of the coastal dune environment which exists along much of the foreshore environment of Gosford's beaches, even in areas where residential development encroaches onto the frontal dunes;
- **Inter-generational equity** – The planning timeframes presented in this CZMP consider the impact that today's management of the coastal zone will have on future generations. Management actions have been defined taking into account the coastal risks, asset life and the way that these have been projected to change over time at each beach, such that future generations can enjoy the same level of beach amenity and access to the coastal zone that is enjoyed by the community today.
- **Improved valuation, pricing and incentive mechanisms** – in developing the management actions for this CZMP, environmental factors have been taken into account in evaluating the management actions and these are described in the Coastal Management Study (WorleyParsons 2015).
- **The precautionary principle** – In determining management actions for this CZMP, a risk averse approach to decision making has been proposed. The management actions and review of the Development Control Plan have been based on a risk assessment for Gosford's beaches which represents a low probability of exceedance within the defined planning horizon for this CZMP and as articulated in the Coastal Process and Hazard Definition Study (WorleyParsons 2014). This CZMP has applied a reasonable and acceptable level of risk in formulating management actions, based on a 1% annual exceedance probability storm event, with the planning horizon and implementation schedule for each particular action defined by the economic life of the assets and environmental values for which the management action will apply.



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Principle 2: Optimise links between plans relating to management of the coastal zone

This CZMP has been developed in consideration of other management planning processes within Gosford LGA, including:

- Coastal Zone Management Plan for Gosford's Coastal Lagoons (includes Wamberal, Terrigal, Cockrone and Avoca Lagoons (2015)
- Pearl Beach Lagoon Coastal Zone Management Plan (August 2014)
- Coastal Zone Management Plan for Brisbane Water (2012)
- Avoca Lagoon Floodplain Management Plan (2008)
- Avoca Stormwave Inundation Study (2007)
- Brisbane Water Foreshore Flood Study (2010)
- Cockrone Lagoon Floodplain Management Plan (2008)
- Lower Hawkesbury River Flood Study (1997)
- Middle Creek Pearl Beach Floodplain Risk Management Plan (2008)
- Green Point Creek Pearl Beach Floodplain Management Plan (1992)
- Pearl Beach Flooding & Drainage Investigation (1992)
- Pretty Beach Drainage Study – Final Report (2003)
- Turo Creek Pretty Beach Floodplain Management Plan (2007)
- Terrigal Trunk Drainage Study & Plan (1991)
- Terrigal Lagoon Floodplain Management Plan (2001)
- Kahibah Creek Floodplain Management Plan (1996)
- Wamberal Lagoon Floodplain Management Plan (2001).

Several of the Council plans identified above deal with exposure to actions of the sea and present initiatives and strategic direction to address a number of common issues and physical processes associated with risks from natural hazards in the coastal zone.

While each plan deals with natural hazards within a confined locality (i.e. Brisbane Water, coastal lagoons and the Gosford beaches), it is equally important to understand the magnitude of cumulative impacts from significant meteorological events and future impacts (through projected sea level rise for instance) across the Gosford area. Once the true scope of the potential threat (and impact) is assessed, Council and lead support agencies will be best placed to build capacity and community resilience.

Climate adaptation and emergency management planning processes will enhance preparedness and response measures required. Climate change adaptation should be seen as a whole of government approach. Key principles should be agreed in an overarching framework that encompasses



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Floodplain Risk Management Plans, Estuary Management Plans, Coastal Zone Management Plans and Asset Vulnerability. This should ensure that any co-ordinated response through planning, education, research, mitigation and compliance would meet the aims and objectives of common goals.

The coastal management actions for specific areas are compatible with those actions identified in the existing relevant management plans as listed above.

In addition to the coastal management plans applying to specific areas, the CZMP takes into account the following development controls that apply to the coastal zone within Gosford City, and recommends changes to these controls where required:

- Development Control Plan 2013 (Chapter 6.2 focuses upon Coastal Frontage)
- Gosford City Local Environment Plan.

Principle 3: Involve the community in decision-making and make coastal information publicly available

The community has been involved in decision-making relating to coastal zone management through the public and stakeholder consultation process carried out during the development of this CZMP. Stakeholder and public consultation has been carried out as part of the coastal zone management process to date and this is described in Section 1.4.

Principle 4: Base decisions on the best available information and reasonable practice; acknowledge the interrelationship between catchment, estuarine and coastal processes; adopt a continuous improvement management approach

The best available information has been used in developing the actions described in this CZMP. In developing the risk assessment that underpins the coastal zone management actions, the most recent available data has been used to assess coastal hazards, as well as the most recent information on climate change projections. Coastal zone management actions have been formulated to ensure that they are compatible with catchment, estuarine and coastal processes – this is especially relevant at the numerous estuary entrances within the Gosford LGA.

A continuous improvement management approach has been adopted as part of this CZMP. The CZMP is intended to be a living document that will be subject to review and updated approximately every 10-15 years. Further information on Plan review can be found in Section 6.



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Principle 5: The priority for public expenditure is public benefit; public expenditure should cost-effectively achieve the best practical long-term outcomes

Funding under the NSW Coastal Management Program is limited, and funding priorities are for works that improve public safety and protecting valuable publicly-owned assets, and then to private land.

For the actions described within this CZMP, funding sources have considered apportioning costs toward the parties who would benefit most. For example, where the CZMP has recommended management actions to benefit the environment, beach amenity, public safety and protection of public assets and infrastructure, the CZMP suggests that funding for these actions be sourced from public expenditure. Where there is benefit to both public and private infrastructure, it is suggested that the funding mechanism includes a provision for cost-sharing for the management action and associated maintenance between both public and private sources that would directly benefit from the management action.

Further information on funding sources for management actions can be found in Section 3.5.

Principle 6: Adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risks where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions to manage high risks while long-term options are implemented

In accordance with this Principle, where the risks can be reasonably avoided, management options considered for the coastline are to be consistent with the key objective of finding reasonable risk avoidance strategies.

The appropriate management actions for each beach within the LGA depend on the level of risk to public safety, public and private assets and infrastructure. The risk is usually defined as the product of *likelihood* and *consequence* at each location.

The Coastal Process and Hazard Definition Study for Broken Bay and the open coast beaches of Gosford assessed the risk of coastal erosion, inundation and slope instability for each beach, in the present day, 2050 and 2100 timeframes. For these timeframes, the *likelihood* of the risk has been assessed for a storm event having an annual probability of exceedance (AEP) of 1%.

The *consequence* of the risk is a function of the value of assets exposed to the hazards, whether there are any management measures in place already to deal with the hazards, and the resilience of the coastline and assets exposed to the hazard.

The Guidelines for Preparing Coastal Zone Management Plans (OEH 2013) discuss several categories of management options that can be adopted for each beach, within a risk management framework. These option categories include:



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- Avoiding the risk (i.e. building setbacks, planning/development controls, infrastructure setbacks and building design criteria)
- Changing the *likelihood* (i.e. coastal protection works, beach nourishment, compliance action on illegal works on beaches)
- Changing the *consequence* (i.e. building and infrastructure modification or relocation, access control and public education)
- Sharing the risk with another party (i.e. insurance)
- Retaining the risk by informed decision (i.e. emergency management).

The risk management hierarchy above has been applied in considering the management actions in this CZMP whereby risk avoidance is the key objective.

Principle 7: Adopt an adaptive risk management approach if risks are expected to increase over time, or to accommodate uncertainty in risk predictions

The Guidelines for Preparing CZMPs (OEH 2013) stipulate the following management approach which has been adopted for this CZMP:

- Management of high public safety risks takes priority over risks to built assets;
- if risks from a hazard are low, maintain this level of risk through appropriate land-use, development approval and infrastructure planning decisions;
- if the risks from a hazard are high:
 - avoid further development in the area or ensure the development can accommodate the hazard, including any likely increase in the severity of the hazard over time (e.g. due to projected sea level rise)
 - ensure appropriate emergency management arrangements are in place, and
 - consider works to reduce risk levels, focusing on the highest risks.

The management actions have considered this approach through the application of development controls which take into account the change in coastal hazards over time. These controls are subject to regular review through the regular 10-year review timetable set under the CZMP, to incorporate changing information about coastal hazards, improved data collection techniques and an improvement in our understanding around the science of climate change.

Principle 8: Maintain the condition of high value coastal ecosystems; rehabilitate priority degraded coastal ecosystems



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This CZMP has incorporated management actions to maintain the condition of high value coastal ecosystems and rehabilitate priority degraded coastal ecosystems. This CZMP covers the open coast and Broken Bay beaches of Gosford, where the key ecological habitat is the beach itself, intertidal zone, coastal dunes and associated vegetation.

Areas in the study area where the coastal dunes are degraded have been identified in the Coastal Management Study and actions have been formulated for those areas to protect the dune habitats and vegetation, as well as empower community organisations with a key interest in the dune habitats to undertake management of these areas more effectively. Key management actions also include:

- the development of a Gosford beaches water quality improvement plan;
- dune management and beach scraping strategy;
- rocky shore habitat inventory & management strategy;
- development of a comprehensive coastal education program; and
- incentives to landowners so that the ecological value of dune areas under private management can be enhanced.

Principle 9: Maintain and improve safe public access to beaches and headlands consistent with the goals of the NSW Coastal Policy; and

The CZMP has recommended management actions to ensure that safe public access to the beaches is maintained or enhanced. For example, management actions have been suggested to improve the public safety of beach access in certain areas where steep dune escarpments are present, and in other areas, disabled access to the beaches has been recommended to be improved. In light of the coastal erosion and inundation hazards facing certain areas, coastal protection works may be required in certain areas to enable continuing public access to these areas into the future.

The NSW Coastal Policy goals include a commitment to the following:

- **Protecting, rehabilitating and improving the natural environment of the coastal zone** – management actions have been included to protect, improve and rehabilitate the natural environment of the beaches.
- **Recognising and accommodating the natural processes of the coastal zone** – these processes have been recognised in formulating the management actions and have been accommodated by allowing the processes to continue unabated within the coastal zone as far as possible within an urban context, and not locating any new infrastructure such that it would interfere with the processes.
- **Protecting and enhancing the aesthetic qualities of the coastal zone** – management actions have included enhancing and preserving the dune environments and beach amenity.



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- **Protecting and conserving the cultural heritage of the coastal zone** – management actions include public education on cultural heritage issues.
- **Providing for ecologically sustainable development and use of resources** – development is allowed to continue in accordance with the principles of ecologically sustainable development.
- **Providing for ecologically sustainable human settlement in the coastal zone** – human settlement is allowed to continue in the coastal zone where it will as far as practicable not interfere with the coastal processes and not expose occupants to an unreasonable risk.
- **Providing for appropriate public access and use** – management actions have been included whereby public access onto the beaches is maintained and enhanced.
- **Providing information to enable effective management of the coastal zone** – management actions have been included to provide public education programs for effective management of the coastal zone, resources for community-based coastal management organisations and monitoring of the coast to inform future management.
- **Providing for integrated planning and management of the coastal zone** – this has been done by provision of recommendations for an updated Development Control Plan for the coastal zone, ensuring management actions are consistent with those of other management plans that apply in Gosford and a suite of management actions with clear priorities, timeframes and regular schedule for future review.

While the goals of the policy relate to three key areas of conservation, human activities and implementation, it is important that the policy be viewed holistically. Its application depends on the whole policy, not on components in isolation. All nine goals are inter-related. No one is more or less important than another. It is fundamental when using the policy that a specific goal is placed in the context of the other eight goals.

Principle 10: Support recreational activities consistent with the goals of the NSW Coastal Policy.

In this CZMP, management actions have been recommended to support the continuing recreational use of the beaches consistent with the goals of the NSW Coastal Policy.

The beaches of Gosford are extremely popular – in the 2014-15 season between September 2014 and April 2015, over 2.1 million visits to the Gosford beaches were recorded. The most popular beaches in terms of visitor numbers in 2014-15 were Umina, Terrigal and Avoca. Detailed beach usage information has been provided by Council for all the beaches and is presented in the Coastal Management Study in Appendix 1.



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Management actions have been formulated in Section 3 to support and enhance the continued recreational use of all the beaches, but in particular at those beaches which have been the most popular in terms of visitor numbers.

1.4 Public Exhibition and Consultation

Community consultation is an essential component of the coastal zone management planning process. A quality Coastal Zone Management Plan will depend largely on the knowledge, involvement and support of the local community. Accordingly, community consultation and participation is an integral element of the coastal planning process.

This section describes the community and stakeholder consultation that has been carried out to date as part of the development of this CZMP. It outlines how the planning process has met the minimum CZMP requirement by describing the community and stakeholder consultation process, the key issues raised and how they have been considered. It also addresses the requirement of Coastal Management Principle 3 which is to involve the community in decision-making and make coastal information publicly available.

1.4.1 Community Engagement Strategy

Council developed and endorsed a Community Engagement Strategy (CES) in November 2013. The Strategy outlined an approach for engaging the local community in the development of Gosford Beaches Coastal Zone Management Plan to ensure that community is provided with the opportunity to gain an understanding of the planning process, coastal management issues and ensure concerns and aspirations are appreciated and considered during the planning process. This was achieved by:

- Providing avenues for productive participation by the community
- Seeking input from the community to ensure decisions made are for the long term benefit and sustainability of the community
- Taking the opportunity to educate the community on the complexities and limitations to proposed management options

The Beaches CES established community engagement parameters to foster realistic expectations by considering legislation, geographic boundaries, technical input, human resources, and budget. It also ensured that all steps in the planning process were considered from an engagement context and prior to selecting appropriate community engagement techniques. The objectives of the Beaches Community Engagement Strategy were to:

- Ensure that the Community understands the process undertaken in the development of a Coastal Zone Management Plan
- Provide a summary of what has been achieved to date and what is required to complete the process



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- Design a process that assists in making sustainable decisions that reflect the aspirations of the local community
- Ensure that the community engagement process provides opportunities for the widest possible participation particularly for those groups who are traditionally disengaged from these processes
- Inform the community about the process, problems and potential solutions to managing coastal hazards affecting Gosford open coast and Broken Bay beaches
- Identify how Council will involve the community in Council's planning and reporting responsibilities
- Identify how the community can provide feedback and suggest solutions through collaboration
- Ensure the process allows for ongoing communication to the public on how their input has been included in decision making
- Describe the timing and focus of engagement activities throughout the development of the Gosford Beaches Coastal Zone Management Plan.

The Community Engagement Strategy identified the following key communication messages:

- Gosford's coastline is vulnerable to coastal hazards with property development, public assets and recreational amenity threatened on several occasions over recent decades.
- The impacts of coastal hazards are likely to be exacerbated into the future as a result of postulated climate change impacts and projected rises in mean sea-level.
- Council has a relatively strong tradition in planning for hazards through the development of coastal management plans in 1990s. Coastal Zone Management Planning is underpinned by evidence based decision-making.
- Council is reviewing the existing Coastal Management Plans to incorporate an improved understanding of current and future risk coastal processes and ensure planning remains in line with NSW Government requirements.
- Council has a duty of care to ensure property assessment minimises risk to private and public assets from coastal hazards.
- Engagement with community networks and interest groups is essential as Council adapts and responds to become more resilient to the impacts of coastal hazards.
- Council will be open and transparent with the community on how their feedback is being incorporated into the overall planning process; however the final decision on priorities and levels of service provision will be made by Council.



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- The coastal management planning process is an integrated approach incorporating the environmental, economic, social and technical factors affecting our community. None of these areas exist in isolation and the plan will reflect this.

The Community Engagement Strategy was developed in consultation with Council's Coastal Sub-committee.

1.4.2 Council Advisory and Coastal Sub-committee

The coastal zone management planning process was guided by Councils Coast & Estuary Management Committee (at the commencement of the project) and Catchments & Coast Committee following the Council election in September 2012.

The principal role of the committee has been to assist council in the development and implementation of coastal and flood risk management plans for the areas under its jurisdiction. However, the committee also assisted in:

- ensuring that current community values are considered in the development of local floodplain risk and coastal zone management planning;
- Promoting linkages and co-operation between the community, Council, State and Federal Governments, and other key stakeholders in the development and implementation of floodplain and coastal zone management studies and plans;
- Monitoring and assessing effectiveness of the local floodplain and coastal risk management plan after its implementation;
- Identify the flood, coastal and estuary health problem areas to be assessed and provide input into known hazard behaviour;
- In undertaking the Committee's duties, include sustainable climate change adaptation actions based upon widely accepted competent scientific opinion. In the implementation of this duty ensure consistency with Council's Climate Change Policy;
- Reviewing and advising Council of appropriate interim development controls for use until the management plan is completed, approved and implemented;
- Support and promote public education and other community focussed programs essential to the long-term viability of the flood and coastal zone risk management plans;
- Support, promote and liaise with relevant authorities in the development of emergency management and catchment management strategies;
- Assist Council in advocating on behalf of the community in relation to relevant government plans, strategies and legislation.

Council further established a Coastal Sub-committee in early 2010 following the distribution of letters to all property owners across coastal frontage areas in January 2010. The correspondence informed



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property owners of the coastal planning project and sought nominations for representatives from each beach between Patonga and Forresters. Following receipt of nominations preference was given to individuals that:

- Form a link between the Committee and the local population in the coastal risk area. They therefore needed to be able to effectively inform the affected community of the deliberations of the Committee and so foster a wider understanding of the process;
- Provide historical advice on local and perceived solutions;
- Consider in detail implications of matters which may impact on the local community; and
- Facilitate formal representations to the Committee on behalf of the public.

The Committee representation experienced some minor changes over the planning process and included beachfront residents from all embayment's of focus in this CZMP. Community representatives from other locations across Gosford, special interest groups, NSW Government officers and Council staff were also attendees at meetings. The Committee was established to inform Councils Catchments & Coast Advisory Committee (formerly the Coast & Estuary Management Committee). Meetings of the Sub-committee were held as follows:

- 27 April 2010 (Combined with main Committee)
- 23 August 2011
- 20 November 2013
- 26 November 2013
- 1 April 2014
- 19 November 2014
- 27 February 2015
- 25 August 2015
- 14 October 2015.

In addition to meetings, periodic emails and telephone contact further enabled Sub-committee members to remain informed of project status, milestones and upcoming consultation opportunities.

The input and representation of the Coastal Sub-committee greatly assisted Council in guiding development of the CZMP, planning community consultation and refining the list of preferred management options included in this CZMP.

Additional meetings were held with representatives from individual beaches prior to the opening of the public exhibition and comment phase of the Draft Coastal Zone Management Study. During these meetings specific management options were discussed for each beach along with key priorities of Sub-committee representatives (and the groups they represent). All documented management



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options were discussed in detail including the prioritisation process and consideration of social, economic and environmental impacts.

The Committee process assisted in building a comprehensive understanding of the challenges and opportunities that the development of the Coastal Zone Management Plan presents to the coastal communities.

The meetings took 2-3 hours and assisted communities to refine submissions which were presented to Council during the public comment phase.

1.4.3 Terrigal-Wamberal Emergency Action Sub Plan consultation

While the Coastal Protection Act 1979 does not specifically stipulate the requirement for public consultation in the development of an EAS the relevant NSW Government Guideline states that “*these subplans are to be prepared with direct consultation with landowners affected by the subplan*”.

Due to the relatively small number of landowners to which the Subplan applies, Council wrote to each landowner to:

- inform them of the public exhibition period for the draft Emergency Action Subplan;
- provide a copy of the draft Emergency Action Subplan;
- provide a copy of the NSW Government’s *Guide to the Statutory Requirements for Emergency Coastal Protection Works*
- invite landowners to book for an appointment with Council staff for a one-on-one discussion during the exhibition period, and
- contact details of Council staff for general enquiries.

The draft EAS was placed on public exhibition for 42 days between 25 June 2012 and 3 August 2012. Comments from property owners were accepted until 3 September 2012.

Council extended the exhibition to general community and special interest groups. During consultation seven property owners contacted Council via telephone or through face to face meetings. Meetings were also held with representative of Coastal Residents Inc. and the Central Coast Community Environment Network. Eleven (11) written submissions were received during the exhibition phase.

1.4.4 Coastal Zone Management Study consultation

The second phase of the planning process (following the initial coastal risk assessment) involved the development of a Coastal Zone Management Study. The Study presents a series of management options for the beaches between Forresters and Patonga. Options have been selected through consideration of coastal hazards, community feedback, and the requirement to achieve a reasonable balance between any conflicting uses of the coastal zone.



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Council actively sought input from affected property owners and the wider community in the development of the Study. Feedback obtained through formal and peripheral engagement activities provided direction on preferred management approaches, and assisted to ensure all relevant factors were sufficiently considered and integrated into the planning process.

In summary, consultation activities carried out to date relating to the Coastal Zone Management Study included:

- Draft Coastal Management Study document made available for community review between 15 January and 15 February 2015.
- The Draft Study document was made available in hardcopy format at Council's Erina, Gosford, Kincumber and Woy Woy customer service centres during normal business hours.
- The Draft Study document was also available in the Items on Exhibition section of Council's webpage during exhibition.
- Letters sent to 949 property owners identified as being affected by DCP Chapter 6.2 (Coastal Frontage) on 17 December 2014.
- Media Release distributed (week of 12 January 2015)
- Promotion of exhibition in Central Coast Express Advocate via Gosford Connect – general info on exhibition (week of 19 January 2015)
- Media alert (week of 26 January 2015)
- Promotion of exhibition in Central Coast Express Advocate via –specific info on exhibition to include detail/timing of exhibition events (week of 26 January 2015)
- Council held a series of five community forum sessions in early February 2015 for people interested in learning more about the Gosford City coastline and how it is managed. These sessions aimed to gauge community attitude to management options, before the preferred options were presented in more detail via this CZMP. More than 270 people attended these community forums.

The outcomes of that community consultation process and descriptions of how formal submissions were addressed are provided in the Coastal Management Study.

1.4.5 Coastal Zone Management Plan consultation

A Draft Coastal Zone Management Plan was publicly exhibited over a six week period between 21 August and 2 October 2015 prior to being formally adopted. Consultation activities carried out as part of the exhibition of the Coastal Zone Management Plan included:

- Draft Coastal Management Plan document made available for community review between 21 August and 2 October 2015.
- The Draft Plan document was made available in hardcopy format at Council's Erina, Gosford, Kincumber and Woy Woy customer service centres during normal business hours.



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- The Draft Plan was also available in the Items on Exhibition section of Councils webpage during exhibition.
- Letters sent to 949 property owners identified as being affected by DCP Chapter 6.2 (Coastal Frontage) on 14 August 2015.
- Emails sent to more than 170 groups and individuals on the project contacts database informing them of exhibition details.
- Public Notices were placed in the Central Coast Express Advocate on 21 August and 4 September 2015 to inform the public of the place at which, the dates on which, and the times during which, the draft CZMP could be inspected by the public.
- Media Release distributed (5 August 2015)
- Promotion of exhibition in Central Coast Express Advocate via Gosford Connect – general info on exhibition (14 August 2015)
- Council held a series of five community drop-in sessions were held to seek public feedback on the proposed management actions for residents to have a say and find out more about how coastal hazards will be managed now and into the future. There were 85 people recorded in attendance during these sessions.

A total of 19 formal submissions were received during the exhibition period. A summary of CZMP consultation feedback and details on how consultation feedback has been considered in developing this CZMP is included in Appendix 6.

1.4.6 Public Authority consultation

Council undertook separate consultation with relevant public authorities in regard to the inclusion of management actions or activities which are proposed to be carried out by the public authority or relating to any land or other assets owned or managed by the public authority. As required under Section 55C of the Coastal Protection Act 1979 the following 'public authorities' and other key stakeholders were directly consulted:

- NSW Department of Primary Industries (DPI - Lands)
- NSW Planning & Environment
- NSW Office of Environment & Heritage (National Parks & Wildlife Service)
- NSW Department of Primary Industries (NSW Fisheries)
- NSW Roads & Maritime Services
- Greater Sydney Metropolitan Local Land Services
- Darkinjung Local Aboriginal Land Council
- Guringai Aboriginal Tribal Links



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1.4.7 Factsheets & Poster Displays

Council staff worked with members of the Coastal Sub-committee to develop a set of community education factsheets and correlating poster displays. The factsheets aimed at building community understanding of coastal hazards and management relevant to the Gosford LGA. Topics covered by the factsheets include:

- The coastal zone management planning process
- Coastal processes – overview of the processes operating on our coast
- Coastal hazards – simple explanation of the risks posed to our coast from coastal processes
- Risk assessment outcomes – what does it mean for the Gosford coastline?
- Coastal management options– environmental planning, development controls, dune management/nourishment, protection etc.
- What is the (economic, environmental and social) value of our coast?

A copy of these factsheets is provided in Appendix 4.

1.4.8 Online information

Council's webpage was periodically updated throughout the project to ensure broad information was provided to community. Information provided included:

- Coastal vulnerability in Gosford
- What influence will climate change have on coastal areas of Gosford?
- What is Gosford Council doing to minimise the impact of coastal processes on coastal developments?
- Existing Coastal Management Plans
- NSW Coastal Management Framework
- Identification of Hazard Lines in Coastal Areas
- Development Control Plan - Chapter 6.2 Coastal Frontage
- Coastal Processes & Hazard Reassessment (including Technical Report and mapping)
- Coastal Zone Management Study

1.4.9 Periodic email circulars to contacts database

From project initiation, Council collated a list of interested parties, including property owners potentially impacted by coastal hazards who would like to be kept informed of the project.



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Periodic emails were provided directly to more than 170 groups and individuals who registered an interest in the project via Council's project contacts database. The information replicated that provided online.

1.5 Developing the Gosford Beaches Coastal Zone Management Plan

The process for development of the CZMP for the Gosford Beaches has been defined by the following phases:

- Undertake **Coastal Risk Assessment** to identify coastal hazards, management issues and their severity;
- Undertake a **Coastal Zone Management Study** to identify and evaluate potential management options to address current and future coastal risk, including climate change (this Study);
- Undertake a **Coastal Zone Management Plan** that proposes management actions in accordance with the management options identified during the Coastal Zone Management Study process and a set timeframe for their implementation;
- **Implementation** of the Coastal Zone Management Plan, whereby actions identified in the Coastal Zone Management Plan are implemented over a 10 – 15 year timeframe.

The phases in the process and references to the relevant supporting documents are described in more detail below.

1.5.1 Undertake Coastal Risk Assessment

A coastal risk assessment has been undertaken to describe the coastal processes and associated hazards that impact the Gosford coastline and provide an assessment of the risks to life and property posed by these hazards. Council endorsed the Open Coast and Broken Bay Beaches Coastal Processes and Hazard Definition Study (CPHDS) report on 25 March 2014.

The risk assessment forms the initial phase of the planning process and applies the latest information (including Council's adopted sea level rise scenarios), modelling and engineering methodologies, to provide an understanding of the coastal processes that operate within the study area. The NSW Government requires that risks need to be assessed with consideration of current and future conditions (2050 and 2100) to include the natural processes that occur on our beaches and the impacts of projected climate changes. The risk assessment examines the coastal processes and hazards that impact the coastline between Patonga and Forresters Beach.

The coastal processes considered within the CPHDS include:

- wave climate;
- elevated water levels;



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- wave runup;
- coastal storms;
- sediment transport;
- climate change; and
- lagoon entrance processes.

The coastal hazards discussed, considered and evaluated as part of the risk assessment include:

- beach erosion hazard;
- shoreline recession hazard;
- sand drift hazard;
- coastal inundation hazard;
- stormwater erosion hazard;
- climate change; and
- slope and cliff instability hazard.

1.5.2 Undertake Coastal Zone Management Study

Having defined the type, nature and significance of coastline hazards, the Coastal Zone Management Study (endorsed by Council on 26 May 2015) was the next step to be undertaken to identify options relevant to the environmental planning and management of the area.

The outcome of the Study was a defined and prioritised set of coastal management options, supported by informed reasoning considering the uncertainties of sea level rise to address specific management issues for each beach in the Study area.

The Study considered all feasible management options to address current and future coastal risk (including climate change). It assessed the social, economic, aesthetic, recreational and ecological issues associated with land use along the coastline.

Assessment of management options has considered the complexities of:

- implications of existing land ownership, future development and planning controls,
- the local economy, including the local employment market,
- the preservation of areas of aesthetic or ecological significance,
- the protection or enhancement of recreational amenity,
- the opportunity for and management of tourism.



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A range of management options were identified including, emergency responses such as emergency warnings, evacuation, emergency protection works and barricading dangerous areas to longer term management options including, environmental planning, development control conditions, dune management, beach nourishment and the construction of protective works.

As part of the assessment of management options, the likely advantages, disadvantages, potential environmental, social and economic impacts and indicative costs were considered. Estimates of capital and maintenance costs for protection works are also prepared.

The 'do nothing' option was also considered to assist in undertaking a damages assessment. This is based on the value of coastal property and indicative costs for public infrastructure that would be lost or damaged if management strategies were not adopted.

The Coastal Zone Management Study assisted Council in developing appropriate planning provisions and in applying the criteria for proposed development through revision of the appropriate section of the Development Control Plan.

The management options identified in the Coastline Management Study have been subject to a community and stakeholder consultation process. Key issues that have been raised during this process have been considered in producing this Plan.

1.5.3 Prepare Coastal Zone Management Plan (this document)

The next stage in the process is to develop a Coastal Zone Management Plan (CZMP).

The planning process aims to ensure an appropriate long term balance in the utilisation and conservation of the coastline. This will facilitate a compatibility of uses with hazards by reducing private and public losses from hazard damage and protect the recreational amenity of beaches. Plans generally include:

- a description of the objectives of the Plan;
- a discussion of issues, problems, special features and values specific to the area of the Plan;
- a schedule of specific management measures aimed at achieving the objectives; and
- a description of the means and timing of implementation of these measures.

In addition to the above, this CZMP includes an Emergency Action Subplan for Terrigal-Wamberal Beach (Appendix 2), which describes:

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



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The development of the CZMP requires that a number of considerations be taken into account, including:

- implications of coastal planning policy and guidelines;
- the type and nature of coastline hazards, including risk and potential damage to coastal developments and amenity;
- aesthetic, recreational and ecological values of Gosford's coastline;
- social factors, including the needs and desires of the community, the social disruption and other intangible costs of potential damage, and the physical and psychological effects of damage;
- long term considerations of climate change; and
- an economic analysis of proposed or existing development, including expected costs and benefits to both the public and private based on options to develop, redevelop or leave undeveloped an area of the coast.

Upon finalisation of the CZMP Council will review and update the relevant section(s) of the Gosford LEP (2014) and Development Control Plan (2013).

1.5.4 Implement Coastal Zone Management Plan

Once a CZMP has been adopted, the next step is to implement (within a 10 – 15 year timeframe) the management measures listed within the Plan. Certain measures can be implemented quickly, such as development and building controls, hazard education, public awareness and dune management programs. However, it is unlikely that any management plan could be implemented immediately in its entirety. For example, availability of funding will determine when certain options can be implemented (e.g. structural measures, voluntary purchase of property). Consequently, a strategy needs to be developed to implement the Plan over time. The strategy should include the staging of measures that are dependent on availability of funds, the adoption of interim measures, protection priorities, etc.

Relevant time periods will include the long-term planning horizon (e.g. 50 to 100 years to set strategic directions for coastal hazard areas), the period for implementing proposed management actions (e.g. 5 to 10 years) and the period for reviewing the CZMP (e.g. towards the end of the implementation period). The timeframe to be adopted should reflect the appropriate planning horizons based upon the economic life and the degree of flexibility associated with a particular coastal management issue. For example, the Australian Tax Office allows the entire construction cost of a residential rental property to be deducted over a period of 40 years. From this, it can be inferred that the economic life of a dwelling is 40 years. Based on this, the 2050 planning horizon may be an appropriate planning horizon to adopt for new residential developments.

A summary of the information included in each section of this report is listed below:



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- **Section 2** outlines the coastal risk management framework for the Plan, as well as the spatial and temporal scales for application of the management actions;
- **Section 3** contains a list of management actions, as well as an implementation schedule for each management action at each precinct in the study area and a budget allocation and possible funding sources for each management action.
- **Section 4** contains a summary of the budget allocation at each location and over the lifetime of the Plan;
- **Section 5** contains a summary of the landuse and development issues in the study area and a framework for the review of the existing Gosford Development Control Plan Chapter 6.2 Coastal Frontage;
- **Section 6** outlines the proposed actions to monitor and report to the community on the Plan's implementation, and a review timetable.



2 COASTAL RISK MANAGEMENT

This section describes the how the Minimum Requirements for Coastal Zone Management Plans are met to address coastal risks. It summarises the risk management approach used in developing this CZMP and provides the basis for the temporal and spatial scales for application of the management actions.

2.1 Introduction

The *Guidelines for Preparing Coastal Zone Management Plans* (OEH 2013) stipulate the minimum requirements for CZMPs in addressing coastal risks. CZMPs are to include:

- a description of:
 - coastal processes within the plan's area, to a level of detail sufficient to inform decision-making
 - the nature and extent of risks to public safety and built assets from coastal hazards
 - projected climate change impacts on risks from coastal hazards (section 55C(f) of the *Coastal Protection Act 1979*), based on council's adopted sea level rise projections or range of projections. Councils should consider adopting projections that are widely accepted by competent scientific opinion.
 - suitable locations where landowners could construct coastal protection works (provided they pay for the maintenance of the works and manage any offsite impacts), subject to the requirements of the *Environmental Planning and Assessment Act 1979*, and
 - property risk and response categories for all properties located in coastal hazard areas
- proposed actions in the implementation schedule to manage current and projected future risks from coastal hazards, including risks in an estuary from coastal hazards. Actions are to focus on managing the highest risks (section 55C(d) and (e) of the *Coastal Protection Act 1979*)
- 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 (section 55C(g) of the *Coastal Protection Act 1979*), and
- an emergency action subplan, which is to describe:
 - intended emergency actions to be carried out during periods of beach erosion such as coastal protection works for property or asset protection, other than matters dealt



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with in any plan made under the *State Emergency and Rescue Management Act 1989* relating to emergency response (sections 55C(b) and (g) of the *Coastal Protection Act 1979*)

- any site-specific requirements for landowner temporary coastal protection works, and
- the consultation carried out with the owners of land affected by a subplan.

The above requirements have been addressed in the following supporting documents or within this CZMP document:

- **Coastal Processes** - these have been described in the Coastal Process and Hazard Definition Study (WorleyParsons 2014) and summarised in the Coastal Management Study (WorleyParsons 2015);
- **Risks to public safety and built assets from coastal hazards** - these have been described in the Coastal Process and Hazard Definition Study (WorleyParsons 2014) and summarised in the Coastal Management Study (Appendix 1, WorleyParsons 2015);
- **Projected climate change impacts on risks from coastal hazards** - these have been described in the Coastal Process and Hazard Definition Study (WorleyParsons 2014) and summarised in the Coastal Management Study (WorleyParsons 2015). Council has updated its climate change projections since production of the Coastal Process and Hazard Definition Study and this update has been reflected within the management actions proposed under this CZMP;
- **Suitable locations where landowners could construct coastal protection works** – Locations where placement of temporary coastal protection works are identified in the *Code of Practice under the Coastal Protection Act 1979* (2013) and associated technical advice. These have been defined in the Emergency Action Subplan for Wamberal Beach (Appendix 2) and within the implementation schedule for each precinct in the Study Area;
- **Property risk and response categories for all properties** – these have been defined within Section 5 of this document which provides recommendations for updating Gosford's Development Control Plan (DCP Chapter 6.2 "Coastal Frontage");
- **Actions in the implementation schedule for managing current and future risks from coastal hazards** – are provided in Section 3 of this document;
- **Proposed arrangements for the adequate maintenance of coastal protection works** – these are described generally in Section 3 of this document and for location specific management options within the Implementation Schedule;
- **An Emergency Action Subplan** - this has been developed and publicly exhibited for Wamberal Beach and is provided in Appendix 2.

This Coastal Zone Management Plan describes proposed actions to be implemented by Council, other public authorities and potentially by the private sector to address priority management issues in



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the coastal zone. The categories of available management options are discussed below, with reference to a risk management approach.

2.2 Risk Management Approach

The appropriate management actions for each beach within the LGA depend on the level of risk to public safety, public and private assets and infrastructure. The risk is usually defined as the product of *likelihood* and *consequence* at each location.

The Coastal Management Principles (OEH 2013) include Principle 6 which is to “adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risks where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions to manage high risks while long-term options are implemented.” In accordance with this Principle, where the risks can be reasonably avoided, management options considered for the coastline are to be consistent with the key objective of finding reasonable risk avoidance strategies.

The Coastal Process and Hazard Definition Study for Broken Bay and the open coast beaches of Gosford assessed the risk of coastal erosion, inundation and slope instability for each beach, in the present day, 2050 and 2100 timeframes. For these timeframes, the *likelihood* of the risk has been assessed for a storm event having an annual probability of exceedance (AEP) of 1%.

The design horizon for built assets is nominated as 40 years. While a 1% AEP event could occur twice in a 40 year period, statistically, a storm with an annual exceedance probability of 1% has a probability 30% of being exceeded within the nominated 40 year design horizon (Figure 2). Based on this, the use of a 1% AEP storm event for planning purposes is considered to represent an acceptable level of risk. It is noted also that Council’s adopted Sea Level Rise Planning Level is based on a medium sea level rise projection as defined in an Independent Report, and is considered to have a likelihood of 50% of being exceeded. In addition, the Guidelines for preparing Coastal Zone Management Plans (OEH 2013) stipulate that beach erosion be assessed against minimum criteria of a 100 year average recurrence interval (1% AEP) storm event.



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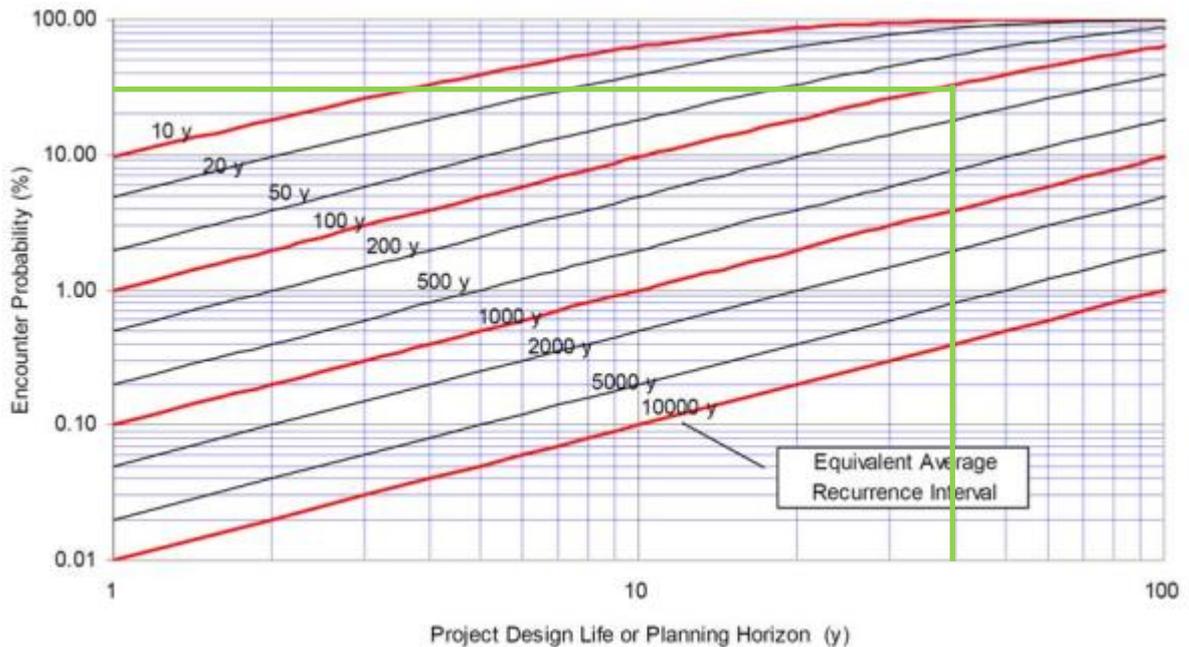


Figure 2 - Design event encounter probability vs. Project Design life or planning horizon

The *consequence* of the risk is a function of the value of assets exposed to the hazards, whether there are any management measures in place already to deal with the hazards, and the resilience of the coastline and assets exposed to the hazard.

For the coastal hazards of beach erosion, shoreline recession, slope instability and coastal inundation, the following consequences on natural and built assets are considered:

- **Beach erosion** – Consequences of beach erosion can include social impacts (loss of beach access, impacts on beach amenity), ecological impacts (beach and dune ecology), and economic impact (damage to infrastructure). During cyclical erosion associated with major storm events, direct damage can occur to built assets such as dwellings, water and sewer infrastructure, roads, fencing, accessways and public amenities. Direct damage could be catastrophic, such as the destruction of dwellings or loss of life; or could be less serious, such as the temporary loss of services or damage to dune fencing, which can be restored for a known monetary cost. A loss of beach amenity can occur on a temporary basis due to beach erosion, which can have a direct impact on the economy or perceived values at the locality. Direct damage to natural assets such as beach dune ecology can also occur as a result of beach erosion – these systems are often resilient and may recover fully over time as the eroded dune system is restored under natural beach processes.
- **Shoreline recession** – Increases the likelihood that built or natural assets may be subject to catastrophic damage as the shoreline recedes. As for the beach erosion hazard, consequences of beach erosion can include social impacts (loss of beach access, impacts on



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beach amenity), ecological impacts (beach and dune ecology), and economic impact (damage to infrastructure, loss of property values, impact on tourism and loss of income from rates/taxes). The magnitude of shoreline recession has itself a varying likelihood of occurrence at each beach. This hazard may be exacerbated by future incremental sea level rise.

- **Slope stability** – Damage to buildings not piled into the *Stable Foundation Zone* may occur in areas subject to reduced foundation capacity, where there is a reduced factor of safety for heavy structures (buildings) located within the *Zone of Reduced Foundation Capacity*. However, some types of infrastructure such as roads, services, dune fencing etc. and natural assets located in the *Zone of Reduced Foundation Capacity* would not be subject to an immediate risk of damage as they are not within the erosion hazard zone.
- **Coastal Inundation** – Built assets subject to inundation may not necessarily suffer catastrophic damage – for dwellings, inundation may cause damage to furniture, carpets, masonry, etc. depending on the depth and duration of the inundation; however, in most cases built assets would be able to recover from this damage, or the inundation risk can be managed by applying certain design criteria to the building. Assets such as sewer and water pipelines may not be damaged or adversely impacted by coastal inundation, and dune ecology may be relatively adapted to occasional inundation. Inundation due to wave runup may pose a threat to public safety and the consequence could be injury or loss of life. There may also be consequences to the local economy due to temporary loss of access to properties as a result of coastal inundation.

Other coastal hazards such as stormwater erosion may cause damage in a localised area, which may affect both natural and built assets. Sand drift may also be a localised issue within the study area. However, the consequence of this hazard is less severe than the consequence of direct hazards such as beach erosion or inundation.

The *Guidelines for Preparing Coastal Zone Management Plans* (OEH 2013) discuss several categories of management options that can be adopted for each beach, within a risk management framework. These option categories include:

- Avoiding the risk (i.e. building setbacks, planning/development controls, infrastructure setbacks and building design criteria)
- Changing the *likelihood* (i.e. coastal protection works, beach nourishment, compliance action on illegal works on beaches)
- Changing the *consequence* (i.e. building and infrastructure modification or relocation, access control and public education)
- Sharing the risk with another party (i.e. insurance)
- Retaining the risk by informed decision (i.e. emergency management).



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Many of these management measures are already in place at some locations in the study area but their effectiveness needs to be reviewed in light of the updated coastal risk determined for each location.

In examining these options the Guidelines for Preparing CZMPs (OEH 2013) stipulate the following management approach:

- Management of high public safety risks takes priority over risks to built assets;
- if risks from a hazard are low, maintain this level of risk through appropriate land-use, development approval and infrastructure planning decisions;
- if the risks from a hazard are high:
 - avoid further development in the area or ensure the development can accommodate the hazard, including any likely increase in the severity of the hazard over time (e.g. due to projected sea level rise)
 - ensure appropriate emergency management arrangements are in place, and
 - consider works to reduce risk levels, focusing on the highest risks.

2.3 Spatial scale for application of Management Actions

It is considered that the management actions are best defined at a scale representing each beach or locality. While some management options defined in the CZMP are to be applied city-wide (for example, changes to general planning controls in the DCP, emergency response etc), and others at a local scale (for example, repair of a particular stormwater outlet on a particular beach), it is considered that the more significant management actions under the CZMP would require input from the wider community at a particular beach and have been defined on a beach-by-beach basis. In this Plan, risks and management options have been defined on a precinct basis, where each beach has been divided into separate precincts based on physical attributes, natural boundaries and level of risk identified in each precinct.

2.4 Temporal scale for application of Management Actions

Management actions can be applied in the short-term (e.g. 0 – 5 years), medium term (e.g. 5 – 20 years) or long term (e.g. greater than 20 years). This Plan is intended to outline actions to be carried out within the short to medium term, with longer term actions included to guide strategy and regular review of the Plan approximately every 10 years to incorporate changing understanding of the science and future changes in State Government policies and legislation.

The temporal scale for a particular action would depend upon how the risk is changing over time, as well how quickly they can be implemented from a regulatory and financial perspective. There is also a time scale associated with the planning, actual implementation and construction of a particular



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management option. For example, the option to build protective structures may be required in the medium term but may take over 5 years in the planning, design, approval and funding phases.

In this Plan, the following timescale has been applied:

- **Short Term (0 – 5 years)** – describes urgent or ongoing actions required to manage coastal risk at a particular precinct, actions which have already been commenced or actions which can be implemented under existing financial and regulatory frameworks;
- **Medium Term (5 – 20 years)** – actions that would be initiated within the lifetime of this Plan but that cannot be implemented immediately due to regulatory or financial constraints,
- **Long Term (20 + years)** – actions that would not be implemented within the lifetime of this Plan but which can guide longer term coastal strategy and can be reviewed in accordance with the schedule for regular review of the Plan.

For funding allocation purposes within the lifetime of this Plan, funding allocations for proposed actions have been divided into:

- Immediate (Year 1)
- Short term (Year 2 – 5)
- Medium term (Years 5 – 10).

Timing for commencement of each management option is determined from the time the CZMP becomes certified by the Minister.



3 MANAGEMENT ACTIONS

This section describes the recommended management actions to be implemented under this CZMP. It summarises the process used to select the management actions, describes potential funding sources for management actions and presents the actions in a prioritised implementation schedule for each precinct within the Study Area as required by the Minimum Requirements for CZMPs.

3.1 Introduction

Management actions have been recommended for each beach based on the specific coastal hazard risks identified at each beach, the values in the study area, the effectiveness of the existing coastal management measures, recommendations of previous studies and specific issues of importance identified by the local community.

The list of management actions presented in this Plan has been further developed and refined based on feedback from the public exhibition process, with the refined list of management actions for each beach based on those presented in the Coastal Zone Management Study (Appendix 1, WorleyParsons 2015).

3.2 Landuse and Development Issues

The major challenges for coastal management across Gosford's beaches relate to land use and development.

Coastal adaptation options have been developed for each beach within the study area. These management options align with four broad strategies for managing coastal risk into the future being:

- **Defend (protect):** Protect portions of the coastline identified as being vulnerable to storm tide inundation or erosion risks. Coastal defence often combines long-term structural strategies and maintenance with regenerative options such as beach nourishment and dune management activities. The implementation of defence strategies may enable the maintenance of existing use or intensification of development on the land.
- **Accommodate:** Maintain the current level of use within coastal hazard areas and raise the tolerance to periodic storm tide inundation or erosion events by means of innovative designs for buildings and infrastructure (e.g. elevating, strengthening or change in use). This entails undertaking actions that will reduce the impacts from coastal hazards to an acceptable level.
- **Retreat:** Includes actions to remove the assets at risk from the area impacted by the coastal hazard. This option could be achieved by ensuring future development is not placed at risk of coastal hazards while enabling development on existing land parcels (where possible). Other mechanisms such as relocating the community (e.g. through a land swap/ voluntary purchase



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arrangements) or abandoning the area (e.g. through buy back mechanisms or rezoning the land to an open space or recreational use) are also available for consideration.

- **Maintain the Status Quo:** Maintaining the status quo refers to a continuation of the existing use in an area while not supporting any further intensification of those uses. It does not restrict land owners from defending their own land (e.g. collaboratively with adjoining landowners) or accommodating the impact of coastal hazards. Maintaining the status quo would need to be supported by actions such as:
 - Planning scheme modifications (e.g. in the LEP/DCP) to reflect the decision not to intensify land use;
 - Ongoing monitoring and review of hazards;
 - Targeted public education on hazards;
 - Appropriate hazard notations on Property Certificates;
 - Regular review of the emergency plan of the Local Disaster Management Plan to recognise the changing risk profile; and
 - Regular update of the Council's infrastructure plan to reflect longer term intentions regarding services and infrastructure in the area as the risk profile changes.

3.3 Options Selection

Based on the degree of hazard relevant to sections of each beach (as determined in the Coastal Process and Hazard Definition Study), the options were then further considered as follows:

- **Protection** – What are the approximate capital and maintenance costs? Who pays? When will it be needed? Impact on environment? Impact on community/social acceptance? How long will protection be afforded when considering future risk?
- **Development Controls** – 2050 or 2100 planning horizon? How does asset life impact options selection? Do existing controls need to be changed? Should subdivisions be allowed?
- **Retreat** – How can orderly development continue on existing parcels? Is voluntary property purchase appropriate/beneficial? When and if compulsory property purchase may be required? Triggers for implementation? Provision of alternative access?
- **Monitoring/Do nothing** – Accept the existing risk, reassess in the future.

A combination of these approaches may be required at each beach. The overarching long term strategy is to reduce the overall risk to coastal development, beach amenity, the environment and public safety over time.

Specific actions have been developed for each precinct within each beach in the study area, addressing particular coastal management issues and hazards of concern.



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Indicative costs have been determined for each action within a 10 year timeframe. The advantages and disadvantages of the options described in terms of economic, social and environmental benefits and disbenefits of each option have been described in detail in the Coastal Management Study, as part of the process used to develop the management actions to be taken forward into this Plan.

Each option has been assessed at each beach based on a cost benefit analysis in the Coastal Management Study, which describes the economic aspects of the options, as well as consideration of the environmental and social aspects of the options.

For each beach, feedback received from Council's Coastal Sub-committee and the community submissions have allowed further refinement of the list of management actions (i.e. intangible benefits, acceptance by the community etc.).

Additional actions have been suggested in community submissions and these have been included in the list of management actions included in the CZMP where appropriate.

Each of the actions to be incorporated into the CZMP have considered such issues as the effectiveness of each option in removing the coastal hazard risk, the compatibility of the option with the principles of ecologically sustainable development (ESD), and the likely community acceptance of each option.

Scope and resourcing limitations did not allow for full-scaled detailed socio-economic or environmental analysis to take place for all identified options. Further and more rigorous analyses will be undertaken in the implementation process for large scale individual actions. Additionally, various planning approvals may also be required to address environmental, social and heritage considerations.

3.3.1 Economic Factors

For the assessment of the economic factors, a high-level cost-benefit analysis was carried out on all the options at the Coastal Zone Management Study phase. The economic costs of each option were assessed in terms of net present value to 2050 and compared against the economic benefits, with the analysis presented as a benefit-cost ratio for each option. The quantifiable benefits of the alternative coastal management options relate to protecting housing, land and associated infrastructure and improving (or maintaining) beach amenity relative to maintaining the status quo. The benefits are, hence, often the avoidance of costs that would occur under the existing beach management strategy. If the economic benefits outweigh the costs (i.e. the benefit-cost ratio is greater than 1), then the option is considered to be economically viable. If, however, the economic costs far outweigh the benefits, then the option is considered to be not economically viable. "No regrets" options have been identified also which describes options which have a high benefit (which may be an intangible social or environmental benefit) for little or no cost and where the options are in accordance with current practice.



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While many options can be excluded based purely on the economic benefit-cost ratio, the benefits and costs of many of the options, such as the social and environmental benefits and costs, are intangible and are difficult to measure in currency. The environmental factors have been described in the “Advantages” and “Disadvantages” columns in the options tables in Section 3 of the Coastal Zone Management Study.

3.3.2 Social and Cultural Factors

Examples of social factors that were considered in deciding on the options to be included in the final CZMP include:

- **Visual Impact** – options that have a positive visual impact are given a higher priority than options having a negative impact on the visual aspect.
- **Impact on recreational amenity and safety** – options which improve beach amenity, beach access and public safety are given a higher priority than those which detract from or provide only a marginal benefit to recreational amenity and safety.
- **Disruption to the community** – options that result in the least disruption to the community (e.g. low construction impact) are favoured over those which would cause a greater degree of disruption. This factor captures both the impact of construction and changes to the character and amenity of the existing beach area.
- **Acceptance by the community** – This factor captures the likely acceptance of the option by the community, based on feedback received during the public exhibition period of this Study.

These factors have been considered throughout the process of developing and refining the list of management options for the CZMP in conjunction with the Coastal Sub-committee and refined based on submissions received from the community.

It is noted that waterways, coastal lagoons, open coast and beach landscapes on the Central Coast are very rich in Aboriginal Cultural Heritage. These landscapes are of significance to Aboriginal people not only for the resources they provide or for the cultural heritage sites they contact but, very importantly, for the spiritual values they hold. These aquatic and marine settings hold the stories of Aboriginal past history and ancestral creation beings that made these places.

Any threat to sustainability of waterways, coastal lagoons, open coast and beach landscapes are also a threat to any Aboriginal cultural heritage sites and places within these areas. Impacts that cause landscape and waterway degradation, loss of native vegetation, erosion to foreshores and beaches (including sea level rise) is a major concern for the maintenance and protection of Aboriginal cultural heritage sites, places and spirituality.



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3.3.3 Environmental Factors

Examples of environmental factors that were considered in deciding which options are to be included in the final CZMP include:

- **Disruption to Coastal Processes and preservation of natural beach system** – this is a measure of to what degree the option would disrupt the natural coastal processes – options that disrupt the natural coastal processes in a detrimental way and detract from the natural character of the beach are given a lower priority than those that work with or do not disrupt the natural coastal processes and improve the natural character of the beach.
- **Ecological impacts** – this is a measure of the impact of the proposed option on the local ecology of the area. Options that have a detrimental impact on the local ecology of the area are given a lower priority than options with a positive impact.

These factors have been considered throughout the process of developing and refining the list of management options for the CZMP in conjunction with the Coastal Sub-committee and refined based on submissions received from the community.

3.4 Included Options for Coastal Zone Management Plan

Based on feedback received from the public exhibition, individual submissions from members of the community and workshops held with Council's coastal sub-committee, a set of recommended management actions for each precinct at each beach has been developed.

These management actions are based on those presented in the Coastal Zone Management Study, but have been further refined based on feedback received during the public exhibition. Several additional options have been suggested by the community to address specific issues, as well as the omission of particular options due to their unacceptable economic, social or environmental impact, or the clear preference of the community of particular options over others. The list of management actions recommended for each precinct at each beach is presented in Section 3.6.

In addition to the site-specific management actions, Council would benefit from developing and implementing the Beaches-wide management options identified in Table 1. Council is primarily responsible for the undertaking of these management options which may attract supporting funding through State Government and other resourcing opportunities. These general management measures can be implemented locally by Council and project partners. Some may also require support from the NSW Government at the state-wide policy level.



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Table 1 – Beaches-wide management options

Management Action	Description	Timing	Cost	Source of Funding
Beaches Water Quality Improvement Plan	This will assist Council in identifying pollutant (stormwater, sewage etc) sources and implementing management response through works, catchment controls, compliance and education activities across the LGA on a priority and integrated approach.	Short (yr. 1)	\$40,000	Council, State and partners
Coastal Zone Education Program	Development and implementation of continuing public education program on coastal management issues and cultural heritage values of the Gosford coastal zone.	Short (yr. 2-5)	\$20,000/year	Council, State and partners
Coastal Erosion & Inundation Emergency Response Plan	Development of emergency action processes which align with relevant combat agencies, statutory planning and expands approaches present within the Terrigal/Wamberal Emergency Action Plan across all beaches.	Short (yr. 1)	Internal Budget	Council
Geotechnical database	Establishment of a centralised repository/information system for geotechnical information relevant to coastal frontage development. Individual development proponents will continue to provide geotechnical information in line with DCP requirements. There is an opportunity to collate existing and future information for use in coastal management planning processes to assist in building understanding of geotechnical attributes across coastal hazard areas.	Short (yr. 1)	Internal Budget	Council
Beach Nourishment Strategy	While beach nourishment studies for parts of Gosford LGA and for other areas along the NSW coastline have been undertaken previously, more detailed work needs to be undertaken to identify LGA wide requirements, sand sourcing and a budget for beach nourishment works.	Short (yr. 2-5)	\$50,000	Council/ State
Dune Management and Beach Scraping Strategy	Develop a city wide strategy for Dune Management and Beach to include: <ul style="list-style-type: none"> Dune vegetation mapping, weed mapping and vegetation profiling; Developing a works program for individual beaches Preparation of environmental assessment and obtaining relevant licences. investigation of reactive scraping following storm events and proactive scraping to build dune while there is sand available on the beach community engagement and involvement of dunecare/bushcare teams. 	Short (yr. 2-5)	\$210,000	Council/ State
Beach & Public Infrastructure	Develop and implement an ongoing beach and infrastructure monitoring program including:	Short (yr. 1)	Internal Budget	Council



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Management Action	Description	Timing	Cost	Source of Funding
Monitoring Program	<ul style="list-style-type: none"> systematic visual inspections and data collation of beach profile and public asset management; photographic record and survey of wave run up levels following storm events to enable improved comparative analysis 			
Rocky shore habitat Inventory & management Strategy	Undertake an inventory and management strategy of rocky shore habitats across the study area. This information will contribute to the sustainable management of key sites in liaison with relevant state government stakeholders.	Short (yr. 2-5)	\$25,000/year	Council, State and partners

3.4.1 Temporary Coastal Protection Works

In addition to the specific management actions defined for each precinct in the study area, the *Guide to the Statutory Requirements for Temporary Coastal Protection Works (2013)* allows temporary coastal protection works² to be placed at selected authorised locations. Authorised locations for placing works and associated beach access locations are named in the *Guide to the Statutory Requirements for Temporary Coastal Protection Works (OEH 2013)* and the *Code of Practice under the Coastal Protection Act 1979*. In the study area, authorised locations where works can be placed and beach access points include:

- Avoca Beach (south), South Avoca (South Avoca Surf Life Saving Club carpark)
- North Avoca Beach, North Avoca (View Street)
- Forresters Beach (Kalakua Avenue, opposite Henrys Road)
- Copacabana – MacMasters Beach, MacMasters Beach (Gerda Road and Del Monte Place)
- Patonga Beach, Patonga (Brisk Street)
- Pearl Beach (Coral Crescent, Pearl Parade, Gem Road); and
- Wamberal Beach (adjacent to Wamberal Surf Life Saving Club, Dover Road).

According to the *Guide*, landowners may also apply to construct other types of coastal protection works of a larger scale than temporary coastal protection works and which include long-term protection works or alternate temporary or short-term protection works. Areas where these types of works have been suggested are included in the implementation schedule. These works would need approvals under various Acts, including the *Environmental Planning and Assessment Act 1979*. The landowners will need to demonstrate that they (and their successors in title) commit to maintaining the works and managing any off-site erosion impacts.

² "Temporary coastal protection works" has a specific meaning in relation to the *Coastal Protection Act 1979*, generally being sand or sandbags temporarily placed on a beach to reduce beach erosion impacts.



3.5 Funding sources for Management Actions

Sustainable funding and financing arrangements for coastal management options will be established in consultation with key stakeholders. It is expected that guidance on identifying effective and affordable management options that deliver net benefits to the community will be provided by the NSW Government via a revised Coastal Management Manual.

It is recognised that the costs of coastal management actions often exceed councils' capacity to pay, and currently there is no clearly agreed approach to identify who should be expected to contribute to those costs.

To address this, the new State Government delivered arrangements will be based on a set of cost sharing principles to fairly and transparently identify who benefits from proposed coastal management actions, and therefore who should contribute to the costs. These principles will ensure that cost sharing arrangements:

- fairly apportion the costs of coastal management actions between the beneficiaries of those actions
- include the full capital and ongoing expenditure associated with coastal management actions
- encourage the most efficient and effective way to deliver actions
- are simple to administer
- are decided in consultation with relevant parties, are transparent and reviewed regularly
- are aligned with local and strategic objectives.

A number of Local/State/Federal Government and funding mechanisms are currently available to support the implementation of actions outlined in the CZMP and to assist in recovery following storm events.

Funding programs are regularly changing and Council will maintain an awareness of appropriate funding opportunities as they arise. Each funding program has limited funding available and applications must meet stringent guidelines prior to being assessed on a competitive basis. Key current funding opportunities are detailed in the following section.

3.5.1 Council Funding Mechanisms

In addition to external grant funding, Council may fund coastal management actions from their own revenue generated by ordinary rate income, special rate variations or a coastal protection service charge. Council's discretionary operational budget provides for ongoing provision of assets management and key services along our coast.



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The NSW Integrated Planning and Reporting (IP&R) framework recognises that most communities share similar aspirations: a safe, healthy and pleasant place to live, a sustainable environment, and opportunities for social interaction, opportunities for education and employment, and reliable infrastructure. The difference lies in how each community responds to these needs. It also recognises that council plans and policies should not exist in isolation - that they are inter-connected. This framework allows NSW councils to draw their various plans together, understand how they interact and get the maximum leverage from their efforts by planning holistically and sustainably for the future.

Gosford City Council, like many other public organisations and authorities, is responsible for the acquisition, operation, maintenance and disposal of an extensive range of physical public assets. These assets include, land, buildings, parks, seawalls, access ways, roads, footpaths, water and sewage networks, drainage systems and associated operating assets.

While being an investment in the community's economic and social well-being, these assets are also a potential source of significant liabilities for present and future generations. The level of service delivered by these assets is largely determined by the manner in which they are maintained and managed. Failure to effectively plan for the replacement of existing assets and the development of new assets will result in infrastructure assets not meeting the needs of community now, and in the future.

Council recognises the importance of infrastructure asset management planning in the delivery of agreed levels of service to the community. The preparation of the Infrastructure Asset Management Strategy and City Asset Management Plan sets out a framework to guide the planning, construction, maintenance and operation of the infrastructure assets essential to provide services to the community.

Additionally, Council supports the provision of a range of services including lifeguards, beach services, bushcare, environmental education, natural resource and hazard management, heritage conservation, ecological research, waste management, compliance, monitoring and reporting.

Funding of services and assets on our beaches is first identified in strategic planning processes (such as this CZMP) before being integrated into operational planning processes and resourcing strategies. Individual management actions are assessed for implementation in competition with competing community needs across the Local Government Area.

3.5.1.1 COUNCIL-WIDE SPECIAL RATE VARIATIONS

Special variations provide an opportunity for councils to vary general income by an amount greater than the annual rate peg. Councils may apply for a single year increase under Section 508(2) of the *Local Government Act 1993*, or a multi-year increase (of between 2 and 7 years) under Section 508A.



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Councils may seek a special rate variation in order to undertake environmental works, fund town improvements, redevelop community and civic facilities, address maintenance backlogs and maintain or improve existing service provision. Beach nourishment could be considered as an environmental work that benefits all beach users, with the main aim of providing a wider beach (or maintaining beach width under sea level rise) to enhance or maintain beach amenity.

The Independent Pricing and Regulatory Tribunal (IPART) will assess and determine special variation applications by councils under powers delegated by the Minister for Local Government. These powers include:

- setting the annual rate peg based upon an IPART-published Local Government Cost Index and productivity factor; and
- assessing and determining applications for special variations.

The Council must include details of its intention to apply for a special variation in its draft delivery program and operational plan and must consider any submissions received from the public. If a Council's application is approved, IPART will specify the percentage by which the council may increase its ordinary rate income. IPART must assess special variation applications against the following criteria: demonstrated need for the rate increase, demonstrated community support for the special variation, reasonable impact on ratepayers, sustainable financial strategy consistent with the principles of intergenerational equity, productivity improvements achieved and planned, and implementation of the Integrated Planning and Reporting framework.

The Office of Local Government (the Office) establishes guidelines for applying for special variations. These guidelines set the criteria against which applications will be assessed and provide information on how and when to apply.

3.5.1.2 SPECIAL RATE ON PARTICULAR PROPERTIES

Section 495(1) of the *Local Government Act 1993*, identifies that a “*council may make a special rate for or towards meeting the cost of any works, services, facilities or activities provided or undertaken, or proposed to be provided or undertaken, by the council within the whole or any part of the council's area, other than domestic waste management services*”.

Based on Section 495(2) of the *Local Government Act 1993*, “the special rate is to be levied on such rateable land in the council's area as, in the council's opinion:

- a) benefits or will benefit from the works, services, facilities or activities, or
- b) contributes or will contribute to the need for the works, services, facilities or activities, or
- c) has or will have access to the works, services, facilities or activities”.



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Therefore, if Council chose to financially contribute to upgrading or providing new protective works adjacent to private property then a special rate on beachfront landowners (who would be the main beneficiaries of these works) could be considered to assist in funding these works.

3.5.1.3 COASTAL PROTECTION SERVICE CHARGE

The coastal protection service charge (CPSC) is a charge that councils can levy on a parcel of rateable land where either the current or previous owner has voluntarily:

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

The CPSC covers councils' reasonable costs of providing coastal protection services to the land on which the charge is levied. The CPSC will provide for maintaining and repairing the works and mitigating any impacts (such as replacement of eroded beach sand).

Section 496B(1) of the *Local Government Act 1993* provides for the making and levying of the annual coastal protection service charge, as follows:

A council may, in accordance with this Act and the regulations, make and levy an annual charge for the provision by the council of coastal protection services for a parcel of rateable land that benefits from the services, being services that relate to coastal protection works constructed:

- a) by or on behalf of the owner or occupier (or a previous owner or occupier) of the parcel of land, or*
- b) jointly by or on behalf of:*
 - (i) the owner or occupier (or a previous owner or occupier) of the parcel of land, and*
 - (ii) a public authority or a council.*

Based on Section 553B(1) of the *Local Government Act 1993* "an annual charge for coastal protection services may not be levied on a parcel of rateable land in relation to existing coastal protection works unless the owner (or any previous owner) of that land has consented in writing to the land being subject to such charges". That is, the CPSC can only be applied if a landowner agrees to it.

The CPSC cannot be used to fund construction of new works or upgrade works, only maintenance and repair of existing protection works that have been voluntarily constructed or financially contributed to by a benefiting landowner (or landowners) or where a landowner has agreed to pay a CPSC for maintenance and repair of existing protection works that they did not financially contribute to.

A coastal protection service charge may have potential application in situations where consent for future development has been granted subject to upgrade and maintenance of an existing seawall or



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construction and maintenance of a new seawall. If agreed with the landowner, conditions of this consent could include payment to Council of a CPSC associated with Council's maintenance of the seawall on behalf of the landowner to provide greater certainty that satisfactory arrangements have been made for ongoing maintenance of the seawall works in accordance with Section 55M of the *Coastal Protection Act 1979*.

However, Council does not have to provide this maintenance service and does not intend to enter into these types of arrangements. Council's position is that it is the landowner's responsibility to maintain and repair any protective works that the landowner has constructed or upgraded to protect private property (or that were pre-existing prior to their purchase) and that Council's resources should only be used for protection of public assets.

Guidance on the application of the coastal protection service charge is also provided in the *Coastal Protection Service Charge Guidelines (2010)*.

3.5.2 NSW Government Funding Mechanisms

3.5.2.1 NSW COASTAL MANAGEMENT PROGRAM

Under the Coastal Management Program, the NSW Government provides coastal management grants to support local government in managing the risks from coastal hazards, such as coastal erosion, and restoring degraded coastal habitats.

Grants under the NSW Coastal Management Program are administered by the Office of Environment and Heritage (OEH) and provide up to 50% of project costs. Projects which can be subsidised under the program include:

- preparation (or updating) of coastal zone management plans and associated technical studies (including coastal hazard assessments);
- action to manage the risks from coastal hazards;
- action to implement environmental repairs, including habitat restoration and conservation projects;
- pre-construction activities for projects that are eligible and are likely to proceed to construction; and
- development of management tools (such as education projects).

The Funding program typically provides up to \$2 million per annum. However, this funding level has stayed approximately the same in dollar terms for decades, so in real terms has been dropping. Grants worth \$0.8 million were awarded to a total of 12 projects under the 2014-15 Program.

Under the Stage 2 Coastal Reforms, additional funding mechanisms are being explored. While these investigations haven't been finalized, there is a move for the beneficiaries of coastal zone management measures to contribute to capital and maintenance costs.



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3.5.2.2 NSW ESTUARY MANAGEMENT PROGRAM

Under the Estuary Management Program, the NSW Government provides estuary management grants to support local government work to improve the health of NSW estuaries. Grants under the NSW Estuary Management Program are administered by the OEHL and provide up to 50% of project costs. Projects which can be subsidised under the program include:

- preparation (or updating) of coastal zone management plans and associated technical studies (including coastal hazard assessments)
- action to manage the risks from coastal hazards (noting that for identified hotspot* locations, these actions must be listed as a priority in a Coastal Zone Management Plan certified by the Minister)
- action to implement environmental repairs, including habitat restoration and conservation projects
- pre-construction activities for projects that are eligible and are likely to proceed to construction
- development of management tools (such as education projects).

The 2014-15 Estuary Management Program provided grant funding to 36 projects worth a total of \$2.68 million.

3.5.2.3 NSW FLOODPLAIN MANAGEMENT PROGRAM

The NSW Government's floodplain management grants support local government to manage flood risk.

In the 2014 Program a total of \$16,338,131 million funding was announced for 51 projects to local councils and other authorities to undertake priority projects to assess the risks and reduce the impacts of flooding in NSW.

The funding for these projects comes from two programs, the NSW Floodplain Management Program and the Floodplain Risk Management Grants Scheme (jointly funded by Ministry of Police and Emergency Services and the Commonwealth Government).

Grants under the NSW Floodplain Management Program are also administered by OEHL to support councils in their management of flood risk. Grants provided under the program typically comprise payment of \$2 from OEHL for every \$1 provided by councils.

3.5.2.4 NSW NATURAL DISASTER ASSISTANCE SCHEMES

In the event of a severe natural disaster (including hazards including storm, storm surge, cyclone and tsunami), Councils are able to apply for financial assistance from the NSW Government for emergency work and restoration of damaged public assets. This funding is only made available if a Natural Disaster Declaration has been issued by the NSW Premier, Treasurer or their delegate. A



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Natural Disaster Declaration is only considered if the damage to an affected community (including damage to public assets, and other eligible costs incurred by the local community) exceeds \$240,000.

Separate grants can be issued by NSW Roads and Maritime Services (RMS) for damage to roads and NSW Public Works for restoration works other than those involving roads. In addition, grants are also available from the Natural Disaster Resilience Program.

3.5.2.5 NATURAL DISASTER RELIEF AND RECOVERY ARRANGEMENTS (NDRRA)

Under the joint Australian Government-State Natural Disaster Relief and Recovery Arrangements (NDRRA), assistance is provided to alleviate the financial burden on states and territories in the event of a major natural disaster, such as a major coastal storm event. It also supports the provision of urgent financial assistance to disaster affected communities. Actions that could be funded under this scheme include repair of public infrastructure such as roads or services damaged by coastal erosion. Under these arrangements, the NSW government determines which areas receive NDRRA assistance and what assistance is available to individuals and communities.

3.5.2.6 NSW ENVIRONMENTAL TRUST

Funding under the NSW Environmental Trust for management actions designed to enhance the environment - this an independent statutory body established by the NSW Government to fund a broad range of organisations to undertake projects that enhance the environment of NSW. The Trust is empowered under the Environmental Trust Act 1998, and its main responsibility is to make and supervise the expenditure of grants. The Trust is administered by the Office of Environment and Heritage (OEH). Some of the actions to be funded under this program may be run by local Dunecare groups and be part-funded by partnerships with organisations such as Coastcare or Landcare.

3.5.2.7 PUBLIC RESERVES MANAGEMENT FUND

Grant and loan funding can be applied for through the Public Reserves Management Fund Program (PRMFP). The PRMFP provides financial support for the development, maintenance and improvement of public reserves. Managers of any NSW Crown reserve, as well as freehold showgrounds, schools of arts and commons, may be eligible to apply for funding.

The PRMFP is a self-sustaining program that is supported by income generated from loan interest, leases and licences on Crown land.

Gosford City Council is eligible to apply for funding under the DPI - Lands administered PRMF for works proposed on Crown land under the management of Council. However, it should be noted that this is a competitive process and funding applications are assessed and prioritised across the State with no guarantee of project funding.



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3.5.2.8 PUBLIC AUTHORITY CONTRIBUTIONS

Funding may also be sourced from a public authority which owns land that would benefit from a particular management action. For example, NSW Department of Planning & Environment who own five land parcels on Wamberal Beach and/or Department of Primary Industries - Lands as a major landowner in the coastal zone. If utilities are to be moved landward, for example telephone or electricity, the relevant utility company would be responsible for implementing that management action.

3.5.3 Federal Government Funding Mechanisms

During 2009, various Commonwealth programs for disaster mitigation works were replaced by the National Partnership Agreement on Natural Disaster Resilience (NPA).

The NPA provides approximately \$27 million per year to states and territories to enhance the resilience of communities against the impact of natural disasters. The NPA consolidates the former Bushfire Mitigation Program (BMP), the Natural Disaster Mitigation Program (NDMP) and the National Emergency Volunteer Support Fund (NEVSF).

A key aim of the NPA is to enhance Australia's resilience to natural disasters through mitigation works, measures and related activities that contribute to safer, sustainable communities better able to withstand the effects of disasters, particularly those arising from the impact of climate change.

The NPA is a partnership with states and territories where jurisdictions provide direct administration of the funding and submit an annual implementation plan to the Attorney-General.

Funding for projects is prioritised by states and territories in the context of their natural disaster risk priorities. This recognises that different jurisdictions have different priorities and that these may change over time. Each state and territory will as certain eligibility for funding against their risk priorities when applications are called for.

3.5.4 Private, Landowner and other funding sources

Funding or part-funding by private landowners is considered appropriate for the implementation of management actions which directly benefit the landholder – e.g. a contribution toward funding for coastal protection works where these are to directly benefit private land through both development potential and value. The challenge is to establish a mechanism to identify and apportion costs across various beneficiaries as outlined in the introduction to this Section.

Actions involving monitoring of beaches and infrastructure can be implemented at little or no cost or under existing programs which already have budget allocations, and may fall within the responsibilities of Council or OEH officers.

Funding involving research programs or data collection can involve partnerships with universities or other research organisations as well as community entities.



3.6 Implementation Schedule

The Implementation Schedule includes:

- A list and description of all management options for each beach in the Study Area
- Allocation of responsibility for management option
- Timetable for implementation (short, medium, long term)
- Possible sources of funding for implementation
- Allocated budget cost for implementation of the option within the next 10 year timeframe, intended to cover the period until the next scheduled review of the Plan (longer term options will have no cost allocation within the next 10 years).

The Implementation Schedule for this CZMP is provided in the Tables below.



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Table 2 – Patonga Beach Management Actions

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate risk of erosion damage to main carpark (fronting the shops) and Patonga Drive access	Pa1 Monitor performance of erosion protection works and monitor beach profile at main carpark (fronting the shops)	<ul style="list-style-type: none"> Undertake inspections and monitoring of performance of works after major storm events Undertake engineering assessment of adequacy of works should future inspections indicate damage. 	Council	Short term/ongoing	Within existing Council budget	Council
	Pa2 Repair damage to carpark should storm erosion occur	<ul style="list-style-type: none"> Re-instate carpark, pedestrian pathway and beach berm should erosion occur using erosion resistant pavements 	Council	As required	\$150,000 to \$200,000	Council, State Government, Federal Government
		<ul style="list-style-type: none"> Subject to gazettal of Council as appointed Reserve Trust Manager, complete rehabilitation of the carpark on the foreshore servicing the Patonga boat ramp by: <ul style="list-style-type: none"> - Importing road base, spreading and filling potholes 	DoI Lands (one-off)	Before end September 2017		State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		<ul style="list-style-type: none"> - Reinstating drainage at the back of the carpark - Resurfacing the carpark with a two-coat bitumen seal and - Making good the site. - (Refer Table 2 Figure 1 for extent of carpark) <ul style="list-style-type: none"> • Note - Council has accepted appointment as Reserve Trust Manager for part of Reserve 66087 – refer Management Action Pa7 				
	Pa3 Investigate feasibility of placement of sand sourced from western beach and shoals at creek entrance to provide buffer against storm erosion	<ul style="list-style-type: none"> • Sand to be scraped along beach by over-land equipment from western end of beach adjacent to training wall, sand could also be sourced from maintenance dredging at the creek entrance. 	Council	Investigation/approvals Year 1, works after Year 5, then repeat as required	Initial investigation into dredging, approvals and design \$150,000. Works \$300,000 to \$500,000 (to be allocated after Year 5)	Council, State Government



Table 2 Figure 1 – Extent of Carpark (refer Management Action Pa2)



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate risk of erosion damage to main carpark (fronting the shops) and Patonga Drive access	Pa4 Beach scraping	<ul style="list-style-type: none"> Sand could be scraped across the beach from the shore line up to the carpark, or along the beach from the large sand supply available at western end of beach adjacent to training wall, which would also help manage shoaling at the entrance to Patonga Creek. 	Council	As required after storms	Cost for initial environmental assessment/approvals \$9,000 - \$12,000 (Year 1) then cost of works as required	Council, State Government
	Pa5 Future relocation of carpark and associated infrastructure to an area landward of the coastal hazard area	<ul style="list-style-type: none"> Close the existing carpark and replace asphalt with grassed area or dune vegetation. Create a new carpark in a suitable nearby location chosen in conjunction with local stakeholders. 	Council	Long term (> 20 years)	None within next 10 years.	Council
	Pa6 Stabilisation of dunes in with vegetation and fencing	<ul style="list-style-type: none"> Plant dune vegetation on sandy area at playground to arrest wind erosion Action would be integrated into LGA-wide dune management strategy 	Council	Short term	\$20,000 to \$30,000 initially then \$10,000 p.a. maintenance cost	Council, State Government
Immediate erosion risk to	Pa7 Monitor and assess	<ul style="list-style-type: none"> Undertake inspections and 	Council	Short term/ongoing	Within existing	Council, State



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
boat ramp and access road	existing erosion protection works	<p>monitoring of performance of works after major storm events</p> <ul style="list-style-type: none"> • Undertake engineering assessment of adequacy of works should future inspections indicate damage. • Council has accepted appointment as Reserve Trust Manager for part of Reserve 66087 including the boat ramp and access road.(refer Table 2 Figure 2 for extent of Proposed Reserve area) • Refer Management Action Pa2 			Council budget	Government
	Pa8 Relocate access road as erosion occurs	<ul style="list-style-type: none"> • Remove sections of the existing asphalt access to the boat ramp, reinstate sandy beach in this area, and improve existing access and parking area. 	Council	Long term	None within next 10 years, \$100,000 to \$150,000 once implemented	Council, State Government, Federal Government



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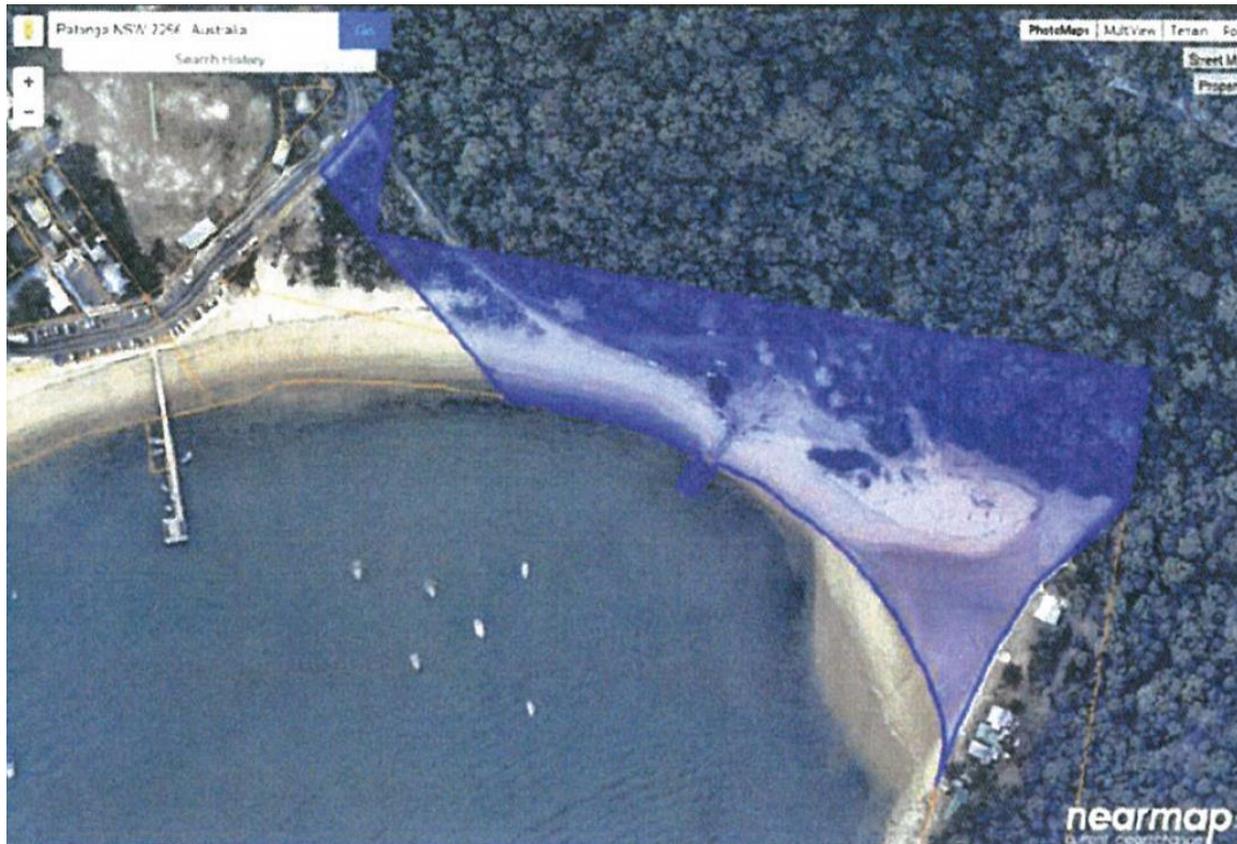


Table 2 Figure 2 – Extent of proposed reserve area (refer Management Action Pa7)



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate erosion risk to boat ramp and access road	Pa9 Periodic nourishment of area with sand sourced from Patonga Creek entrance	<ul style="list-style-type: none"> Sand could be scraped along the beach by land-based equipment or dredged from the shoals at the creek entrance 	Council, OEH, RMS	Investigation/approvals Year 1, works if required within next 10 years, then repeat as required	Initial investigation into dredging, approvals and design budget included in option Pa3. Works budget to be lumped together with Option Pa3.	Council, State Government
	Pa10 Monitor beach profiles	<ul style="list-style-type: none"> Photogrammetric, LIDAR and land survey 	Council, OEH	Short term/ongoing	Within existing budget allocations.	Council, State Government
	Pa11 Upgrade seawall	<ul style="list-style-type: none"> Replace existing seawall structure with improved design Finalise maintenance repair work that stemmed from the June 2016 storms. 	DoI - Lands	End September 2017	\$200,000 construction + 1% p.a. maintenance	State Government
Inundation due to wave runup	Pa12 Ensure floor levels for new Development Applications are above inundation levels	<ul style="list-style-type: none"> Specify minimum allowable floor levels in the DCP 	Council	Short term/Ongoing	N/A	N/A
	Pa13 Upload flood/inundation	<ul style="list-style-type: none"> Upload flood/inundation information onto Council's website for access by 	Council	Short term	Within existing budget allocations – use	N/A



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Inundation due to wave	information onto Council's website for access by property owners	property owners			existing available information	
	Pa14 Beach scraping and dune management to maintain crest level of dune above wave runup level	<ul style="list-style-type: none"> Sand could be scraped across the beach from the shore line up to the carpark, or along the beach from the large sand supply available at western end of beach adjacent to training wall. Dune vegetation to be maintained and enhanced to assist in stabilising dune. 	Council	As required after storms, linked to action Pa4	Cost for initial environmental assessment/approvals \$9,000 - \$12,000 (Year 1) then cost of works as required. Included in Action Pa4.	Council, State Government
	Pa15 Continue and enhance dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Dune vegetation to be maintained and enhanced to assist in stabilising dune Action would be integrated into LGA-wide dune management strategy 	Council	Ongoing	\$20,000 to \$30,000 initially then maintenance cost	Council, State Government
	Pa16 Undertake survey of	<ul style="list-style-type: none"> Undertake survey of existing floor 	Council to undertake	Medium Term	\$10,000 survey cost.	Private



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
runup	floor levels of existing buildings	levels to inform inundation risk – raising buildings could be examined as an action under a local floodplain management plan. Landowners would be responsible for the raising of the floor levels.	survey		Cost to individual property owners should they choose to raise floor levels.	
Erosion in front of cottages at Dark Corner	Pa17 Monitor and assess existing erosion protection works	<ul style="list-style-type: none"> Undertake inspections and monitoring of performance of works after major storm events Undertake engineering assessment of adequacy of works should future inspections indicate damage. 	Council	Short term/ongoing	Under existing Council budget allocations	Council
Erosion in front of cottages at Dark Corner	Pa18 Implement erosion control works in front of cottages in accordance with Patonga Draft Plan of Management Crown Reserves and Dark Corner Cottages 2013	<ul style="list-style-type: none"> Design and construct new erosion protection works in accordance with recommendations in Patonga Draft Plan of Management Crown Reserves and Dark Corner Cottages 2013. Note that an initial upgrade was undertaken by DoI Lands following the April 2015 storms and minor repair works are currently proposed 	DoI Lands	Medium Term	\$30,000 design cost, \$400,000 - \$600,000 construction cost	State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		to repair the works following storms in June 2016.				
Shoaling at entrance channel of Patonga Creek	Pa19 Investigate periodic maintenance dredging of sand from the creek entrance	<ul style="list-style-type: none"> Investigate the possibility of dredging the entrance to Patonga Creek to improve navigation access 	OEH	Short term	Initial investigation into feasibility included in Action Pa3	State Government
	Pa20 Investigate lengthening existing entrance breakwater	<ul style="list-style-type: none"> Investigate the design of the existing breakwater at the creek entrance to improve sand trapping efficiency and reduce shoaling of creek entrance 	Council/OEH	Medium-long term	Initial investigation into breakwater can be combined with Action Pa19	Council, State Government
Scour from stormwater and creek flows at eastern end of beach	Pa21 Investigate installation of stormwater energy dissipation to reduce discharge velocities at outlet	<ul style="list-style-type: none"> Dissipate energy in front of stormwater outlet by installing energy dissipation blocks, rock apron, or by other method to reduce velocity of outflows from stormwater outlet 	Council	Short term	Initial investigation into feasibility within existing budget allocations; works cost \$50,000 + maintenance costs	Council
	Pa22 Post storm beach scraping to assist natural recovery of the dune and repair scour caused by stormwater discharge	<ul style="list-style-type: none"> Undertake beach scraping to repair the scour hole caused by stormwater discharge 	Council	As required	Estimate \$10,000 - \$20,000 annually. Annual maintenance cost may be reduced by implementation of	Council



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
					Action Pa21	
All issues	Pa23 Complete a vegetation profile for Patonga Beach and support the natural vegetation profile.	<ul style="list-style-type: none"> Profile the natural vegetation for Patonga Beach and ensure that planting of dune vegetation is consistent with the natural vegetation profile and with the use of low-growing vegetation Action would be integrated into LGA-wide dune management strategy 	Council, Dunecare	Short term	\$50,000 to be allocated city-wide	Council, State Government
	Pa24 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> Works may comprise similar design to existing adjacent works Works could be considered to be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private
	Pa25 Investigate feasibility of swimming enclosure at Patonga	<ul style="list-style-type: none"> Investigate feasibility of swimming enclosure – this may comprise timber piles with netting 	Council	Short to medium term	Within existing budget allocations	Council



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Table 3 – Pearl Beach Precinct 1 (south of Green Point Creek) – Management Actions

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion and reduced foundation capacity to four properties and sewage infrastructure Coastal inundation of lots south of Green Point Creek entrance	Pe1 Erosion Protection works to be allowed for four properties south of Green Point Creek entrance as well as for sewage pumping station and sewer line at end of Gem Road and south from Gem Road extending to protect infrastructure	<ul style="list-style-type: none"> • Works may comprise similar design to existing adjacent works • Coordinated buried terminal protection funded jointly by landowners, Council and State Government through Coastal program 	Council, NSW Govt., landowners, works to provide benefit to protect sewer infrastructure and adjacent properties	Short to medium term (0 – 20 years), two of these properties already have protection installed	Design Year 1 \$20,000; works years 5 - 10 \$450,000 to \$600,000	Council, State Government, Private
	Pe2 Monitor performance of existing erosion works at properties south of Green Point Creek entrance	<ul style="list-style-type: none"> • Monitor effectiveness of existing works in a future storm event 	Council	Short term/ ongoing	Within existing budget allocation	Council
Immediate and future risk of erosion and reduced foundation capacity to four properties and	Pe3 Relocate sewer infrastructure and pumping station further landward	<ul style="list-style-type: none"> • Sewer currently located at the seaward end of the properties – this option would involve investigating the feasibility of moving the sewer landward 	Council	Short term (0 – 5 years)	Investigation \$20,000 (year 1), works if implemented \$400,000 to \$500,000 (not	Council



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
sewage infrastructure Coastal inundation of lots south of Green Point Creek entrance		out of the hazard area along the entire street frontage of Gem Road and Green Point Road			required if Action Pe1/Pe3 implemented)	
	Pe4 Investigate feasibility/sources of sand for beach nourishment	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Medium term (5 – 20 years)	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Government
	Pe5 Beach scraping to build dune in front of residences, Gem Road and restaurant	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council/OEH	After storm events as required	\$10,000 to \$13,000 plus maintenance cost	Council, State Government
	Pe6 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> Works may comprise similar design to existing adjacent works 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already	None allocated in CZMP	Private



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		<ul style="list-style-type: none"> Works could be considered to be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act 		have protection installed		
Immediate and future risk of erosion and reduced foundation capacity to four properties and sewage infrastructure	Pe7 Continue dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Ongoing	\$100,000 - \$150,000 within next 5 years	Council, State Government
Coastal inundation of lots south of Green Point Creek entrance	Pe8 Develop entrance management guidelines for mechanical opening of Green Point Creek	<ul style="list-style-type: none"> Formulate an entrance management policy whereby Green Point Creek entrance can be opened at a defined trigger water level and at a defined location on the beach 	Council	Short term	\$3,000	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		berm to prevent scour in front of the dunes				
Immediate and future risk of erosion and reduced foundation capacity to four properties and sewage infrastructure Coastal inundation of lots south of Green Point Creek entrance	Pe9 Development controls as per existing DCP i.e. defined building line with new buildings to be founded into 2100 Stable foundation Zone. Residences and restaurant to be above inundation levels on redevelopment of properties	<ul style="list-style-type: none"> Define a building line and development controls for development within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council
	Pe10 Investigate “tripper” structure to control opening location of creek	<ul style="list-style-type: none"> Investigate a short buried training wall using reno mattresses or other suitable materials to prevent creek from meandering in front of properties at southern end of beach 	Council	Short term	Initial design/investigation \$10,000; works cost \$50,000 – \$100,000	Council, State Government, Private
	Pe11 Identify floor levels to determine degree of	<ul style="list-style-type: none"> Survey floor levels and compare against wave runup 	Council	Short term	\$10,000	Council



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
	inundation hazard	levels				
All issues	Pe12 Complete a vegetation profile for Pearl Beach and support the natural vegetation profile.	<ul style="list-style-type: none"> Profile the natural vegetation for Pearl Beach and ensure that planting of dune vegetation is consistent with the natural vegetation profile. Applies to all precincts of Pearl Beach. Action would be integrated into LGA-wide dune management strategy 	Council/Dunecare	Short term	\$50,000 to be allocated city-wide for all beaches	Council, State Government
Beach amenity/heritage	Pe13 Monitor rock pool for storm damage and repair if required	<ul style="list-style-type: none"> Monitor rock pool by regular Council staff inspections, can be done when pool is emptied for cleaning 	Council	Short term/ Ongoing	Monitoring within existing budget allocations; allocate \$5,000 p.a. for repairs	Council, State Government



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Table 4 – Pearl Beach Precinct 2 Management Actions – Between Green Point Creek and Middle Creek entrances

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion to playground area	Pe14 Repair of playground area, toilet block, beach accessways and landscaping works following erosion in a large storm event	<ul style="list-style-type: none"> Restore public reserve and playground area if damaged by future storm erosion 	Council	As required	No capital cost likely to be incurred within the next 10 years; cost \$200,000 - \$250,000 if event occurs	Council, State Government, Federal Government
	Pe15 Beach scraping following storm event to build dune crest level and revegetation	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council	After storm events as required	Included within Action Pe5	Council, State Government
	Pe16 Continue dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Ongoing	Included in budget for Action Pe7	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion to playground area	Pe17 Develop entrance management guidelines for mechanical opening of Middle Creek	<ul style="list-style-type: none"> Formulate an entrance management policy whereby Middle Creek entrance can be opened at a defined trigger water level and at a defined location on the beach berm to prevent scour in front of the dunes 	Council	Short term	\$3,000	Council
	Pe18 Long term removal and relocation of playground should erosion escarpment move landward in future	<ul style="list-style-type: none"> Find an alternative location for the playground at such time as it is damaged by erosion from a future storm event and cannot be reinstated in the same location 	Council	Long term (>20 years)	None by 2025	N/A
Future risk of erosion to Pearl Parade and associated services	Pe19 Future installation of erosion protection works once erosion escarpment reaches set trigger distance from road edge; or Future closure of road and installation of alternative access (e.g. rear lane access to properties along Pearl Parade)	<ul style="list-style-type: none"> Design erosion protection works to protect Pearl Parade and properties on the landward side from future erosion risk, could be implemented once erosion escarpment reaches set trigger distance from edge of road. Likely not to be required for several years 	Council/OEH	Long term (> 20 years)	None required prior to 2025	N/A



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
	Pe20 Repair and restoration of Pearl Parade should it be damaged by a future storm	<ul style="list-style-type: none"> Repair and restore Pearl Parade roadway using damage resistant pavements following a large erosion event. Not likely to be required for many years. 	Council/OEH/RMS	Long term (>20 years)	None prior to 2025	N/A
Future risk of erosion to Pearl Parade and associated services	Pe21 Landward relocation of water supply and electricity should it be damaged by future erosion	<ul style="list-style-type: none"> Landward relocation of services should they be located in the erosion hazard area in the future 	Council/OEH/RMS/s ervices providers	Long term (>20 years)	None prior to 2025	N/A
	Pe22 Development controls as per existing DCP i.e. defined building line for this section of beach with new buildings to be founded into 2100 Stable foundation Zone	<ul style="list-style-type: none"> Define a building line and development controls for development within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council
	Pe23 Monitor performance, upgrade/repair existing erosion protection works at the restaurant	<ul style="list-style-type: none"> Monitor effectiveness of existing works in a future storm event 	Landholder	Short term and ongoing	N/A	Private



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Table 5 – Pearl Beach Precinct 3 Management Actions – Between Middle Creek and Pearl Beach Lagoon outlet

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate erosion risk to dune	Pe24 Encourage and assist Dunecare group to maintain and revegetate dune after a storm	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm Action would be integrated into LGA-wide dune management strategy 	Council	Ongoing	\$15,000 - \$20,000 p.a.	Council, State Government
	Pe25 Post storm beach scraping to assist natural recovery of the dune and repair scour caused by breakout from Pearl Beach Lagoon and Middle Creek	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Repair of scour on the beach berm caused by lagoon breakout 	Council	After storm events as required	Included within Action Pe5	Council, State Government
	Pe26 Formalise entrance management guidelines for mechanical opening of Middle and Pearl Beach	<ul style="list-style-type: none"> Formulate an entrance management policy whereby lagoon entrance can be opened at a defined trigger water level and 	Council	Short term	\$3,000	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate erosion risk to dune	Lagoon entrances	at a defined location on the beach berm to prevent scour in front of the dunes. Needs to be consistent with requirements in Pearl Beach Lagoon CZMP				
	Pe27 Monitor effectiveness of concrete wall on northern bank of outlet	<ul style="list-style-type: none"> Monitor the existing concrete wall following a breakout event to assess any damage or movement 	Council	Short term	Within existing Council budget allocation	Council
	Pe28 Continue dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Ongoing	Included in budget for Action Pe24	Council, State Government



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Table 6 – Pearl Beach Precinct 4 Management Actions – Coral Crescent Beachfront properties

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future erosion risk to Coral Crescent properties	Pe29 Development controls as per existing DCP i.e. defined building line with new buildings to be founded into 2100 Stable foundation Zone	<ul style="list-style-type: none"> Re-define a building line and development controls for development within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council
	Pe30 Post storm beach scraping to assist natural recovery of dune	<ul style="list-style-type: none"> Build up sand from the beach berm to provide toe protection to the erosion escarpment and assist natural recovery of the beach 	Council	After storm events as required	Included within Action Pe5	Council, State Government
	Pe31 Investigate feasibility of terminal protection e.g. once erosion escarpment reaches trigger distance from defined building line	<ul style="list-style-type: none"> Design erosion protection works to properties from future erosion risk, could be implemented once erosion escarpment reaches set trigger distance from building line. Likely not to be required for 	Council	Long term (> 20 years)	No budget allocated prior to 2025	Council, State Government, Private. No budget allocated prior to 2025



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		several years				
Immediate and future erosion risk to Coral Crescent properties	Pe32 Encourage and assist Dunecare group to maintain and revegetate dune after a storm using appropriate endemic vegetation	<ul style="list-style-type: none"> • Provide support and education to local Dunecare groups and local residents to maintain dune as required and repair after a storm • Action would be integrated into LGA-wide dune management strategy 	Council	Ongoing	\$15,000 - \$25,000 p.a.	Council, State Government
	Pe33 Investigate beach nourishment to increase buffer against storm erosion	<ul style="list-style-type: none"> • Investigate source of sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion. Not likely to be feasible at this location. 	Council/OEH	Medium term (5 – 20 years)	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Government
	Pe34 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> • Works may comprise similar design to existing adjacent works • Works could be considered to 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection	None allocated in CZMP	Private



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act		installed		
Immediate and future inundation risk to Coral Crescent properties	Pe35 Post storm beach scraping to assist natural recovery of dune and to maintain crest level of dune above wave runup level	<ul style="list-style-type: none"> Build up sand from the beach berm to provide toe protection to the erosion escarpment and assist natural recovery of the beach. Build this high enough to provide protection against wave inundation. 	Council	As required, once sufficient sand has built up onto the beach	Included within Action Pe5	Council, State Government
Immediate and future inundation risk to Coral Crescent properties	Pe36 Encourage beachfront residents to maintain crest level of dune and vegetate dune on private property in accordance with dune management practice (e.g. community education, provision of free plants)	<ul style="list-style-type: none"> Provide support to local beachfront residents to assist them to maintain the dune in front of their properties 	Council	Short term, ongoing	\$5,000 to develop education materials	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
	Pe37 Development controls as per existing DCP i.e. requirement for floor levels to be above wave runup level and be compatible with inundation hazard	<ul style="list-style-type: none">• Ensure consistency in DCP	Council	Short term	Existing budget allocations	Council



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Table 7 – Ocean Umina Beach Management Actions – Precinct 1 (south of Ettalong Creek)

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion and reduced foundation capacity to four properties and estuary entrance instability	O1 Erosion Protection works to be allowed for four properties and carpark south of Ettalong Creek entrance	<ul style="list-style-type: none"> Coordinated terminal protection constructed along existing embankment funded by landowners Council funded portion to protect carpark Works may comprise engineered revetment placed along existing eroded embankment on seaward side of properties 	Council/OEH/landowners	Short to medium term (0 – 20 years)	\$600,000 - \$800,000	Council, State Government, Private
	O2 Monitor performance of existing training wall works along northern side of Ettalong Creek entrance	<ul style="list-style-type: none"> Monitor effectiveness of existing works in a future storm or flood event 	Council/OEH	As required	N/A	N/A
	O3 Monitor storm run-up levels and dune erosion	<ul style="list-style-type: none"> Survey/observations to be taken post-storm 	Council/OEH	Short term/ongoing	\$5,000 annual budget allocation	Council
	O4 Future relocation of residence on No.8 Berrima Crescent landward of immediate hazard area within same lot on	<ul style="list-style-type: none"> On redevelopment, building to be located landward of hazard zone Property currently has application in place for seawall protection with NSW Coastal Panel which would negate the 	Property owner	On redevelopment as per DCP	No budget allocated	Private



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion and reduced foundation capacity to four properties and estuary entrance instability	redevelopment if revetment wall is not constructed	need for relocation				
	05 Investigate feasibility of beach nourishment	<ul style="list-style-type: none"> Import of sand into this portion of the beach to increase buffer against beach erosion 	Council/OEH	Long term (>20 years)	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Government
	06 Beach scraping to build dune in front of residences at Berrima Crescent	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council/OEH Landowners	Short term and as required (0-5 years)	Environmental approvals \$20,000, works \$4,000 - \$7,000 p.a.	Council, State Government, Private
	07 Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation and consolidation of beach access at southern end of beach	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Action would be integrated into LGA-wide dune management strategy 	Council	Ongoing	\$15,000 - \$25,000 p.a.	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion and reduced foundation capacity to four properties and estuary entrance instability	O8 Develop entrance management guidelines for mechanical opening of Ettalong Creek	<ul style="list-style-type: none"> Specify entrance management guidelines for opening of Ettalong Creek to encourage the creek to open in a direction away from the residences at Berrima Crescent 	Council	Short term (0-5 years)	\$3,000	Council, State Government
	O9 Voluntary purchase of portion of at risk property	<ul style="list-style-type: none"> Purchase of portion of 8 Berrima Crescent seaward of hazard zone. Resume at-risk portion of land with fair compensation to be negotiated with landowner. Return resumed portion of land to public space e.g. parkland, carparking, beach dune Property currently has application in place for seawall protection with NSW Coastal Panel which would negate the need for purchase 	NSW Govt./Council	Short – medium term	Up to \$1 million but subject to agreement with landholder	Council, State Government
	O10 Development controls on redevelopment of properties within hazard area	<ul style="list-style-type: none"> Future development to be located landward of the coastal hazard area and floor levels above inundation level 	Council/landowners	Short term	N/A	N/A
Immediate and	O11 Construct “tripper”	<ul style="list-style-type: none"> Construct a short buried training wall to 	Council/OEH	Short term	Initial design/	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
future risk of erosion and reduced foundation capacity to four properties and estuary entrance instability	structure to control opening location of creek	prevent creek from meandering in front of properties at southern end of beach			investigation \$10,000; works cost \$50,000 – \$100,000 plus maintenance	
Coastal inundation of lots south of Ettalong Creek entrance	O12 Development controls for residences to be above inundation levels on redevelopment of properties	<ul style="list-style-type: none"> Future development to be located landward of the coastal hazard area and floor levels above inundation level 	Council/landowners	Short term	N/A	N/A



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Table 8 – Ocean Umina Beach Management Actions - Precinct 2 (between Ettalong Creek and Umina Beach surf club)

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion to dunes and Umina Beach surf club carpark; Windblown dune erosion; dune ecology	O13 Monitor existing erosion protection works in front of surf club	<ul style="list-style-type: none"> Monitor effectiveness of existing works in a future storm or flood event 	Council, OEH, SLSC	Short term and following storms as required	N/A	N/A
	O14 Monitor storm run-up levels and dune erosion	<ul style="list-style-type: none"> Visual observations during storm events; survey marks of debris line 	Council, SLSC	Short term and following storms as required	Within existing budget allocations	Council
	O15 Repair of beach accessways and revegetation of dune following erosion in a large storm event	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Consider consolidation of beach accessways along Umina Beach Action would be integrated into LGA-wide dune management strategy 	Council, OEH	Short term and following storms as required	\$200,000 to \$500,000 to cover entire beach from Ettalong Point to Ettalong Creek	Council, State Government, Federal Government
Immediate and future	O16 Beach scraping following	<ul style="list-style-type: none"> Push sand from the beach berm 	Council	After storm events as	Environmental	Council, State



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
risk of erosion to dunes and Umina Beach surf club carpark; Windblown dune erosion; dune ecology	storm event to build dune crest level and revegetation	to the toe of the dune escarpment		required	approvals \$20,000, works \$110,000 - \$140,000	Government, Federal Government
	O17 Install sand trapping fencing or other appropriate controls in beach access points where sand blowout occurs and in the vicinity of the SLSCs.	<ul style="list-style-type: none"> Installation of sand trapping fencing where required as part of dune management activities 	Council/Dunecare	Short term	\$10,000 plus maintenance	Council, State Government
	O18 Complete a vegetation profile for Umina and Ocean Beach and support the natural vegetation profile.	<ul style="list-style-type: none"> Profile the natural vegetation for Umina and Ocean Beach and ensure that planting of dune vegetation is consistent with the natural vegetation profile Action would be integrated into LGA-wide dune management strategy 	Council/Dunecare	Short term	\$50,000 to be allocated city-wide for all beaches	Council, State Government
Community participation and	O19 Increase information signage near surf clubs on the	<ul style="list-style-type: none"> Provide signage which is not visually obtrusive 	Council	Short term	\$2,500	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
beach amenity	ecology and history of Umina/Ocean Beach	<ul style="list-style-type: none"> A separate city-wide coastal zone education program will investigate and implement communication of coastal zone management issues throughout the LGA. 				
	O20 Improve shade areas around the grassed areas and car parks near the SLSCs	<ul style="list-style-type: none"> Tree planting and/or picnic shelters 	Council	Short term	Within existing budget allocations	Council
Community participation and beach amenity	O21 Maintain current signage and facilities on a regular basis	<ul style="list-style-type: none"> Maintenance of existing facilities and upgrade where required 	Council	As required	\$10,000 - \$20,000 for design and installation	Council
	O22 Encourage and assist Dunecare group to maintain and revegetate dune after a storm using appropriate endemic vegetation	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Action would be integrated into LGA-wide dune management 	Council/OEH	Short term/ongoing	Part of allocation for Action O7	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		strategy				
	O23 Development of local area (Umina/Ocean Beach) online fact sheets and encourage local educational programs in schools regarding the dunes	Action would be incorporated into LGA-wide Coastal Education Strategy	Council/OEH	Short term/ongoing	\$10,000	Council, State Government
Community participation and beach amenity	O24 Work with the Central Coast Surf Life Saving organisation to look at ways to support Surf Life Savings Australia's EcoSurf policy in the region – including Ocean and Umina Surf Life Saving clubs.		Council	Short term	Within existing budget allocations	Council



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Table 9 – Ocean Umina Beach Management Actions – Precinct 3 (between Umina Beach and Ocean Beach surf clubs)

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion to dunes and Ocean Beach surf club carpark; Windblown dune erosion; dune ecology	O25 Monitor existing erosion protection works in front of surf club	<ul style="list-style-type: none"> Monitor effectiveness of existing works in a future storm or flood event 	Council, OEH, SLSC	Short term and following storms as required	N/A	N/A
	O26 Monitor storm run-up levels and dune erosion	<ul style="list-style-type: none"> Visual observations during storm events; survey marks of debris line 	Council, SLSC	Short term and following storms as required	Within existing budget allocations	Council
	O27 Repair of beach accessways and revegetation of dune following erosion in a large storm event	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Consider consolidation of beach accessways along Umina Beach Action would be integrated into LGA-wide dune 	Council, OEH	Short term and following storms as required	\$20,000 p.a. for two beach accessway overhauls.	Council, State Government, Federal Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		management strategy				
Immediate and future risk of erosion to dunes and Ocean Beach surf club carpark; Windblown dune erosion; dune ecology	O28 Beach scraping following storm event to build dune crest level and revegetation	<ul style="list-style-type: none"> • Push sand from the beach berm to the toe of the dune escarpment 	Council	After storm events as required	Within budget allocation for action O16	Council, State Government, Federal Government
	O29 Install sand trapping fencing or other appropriate controls in beach access points where sand blowout occurs and in the vicinity of the SLSCs.	<ul style="list-style-type: none"> • Installation of sand trapping fencing where required as part of dune management activities • Action would be integrated into LGA-wide dune management strategy 	Council/Dunecare	Short term	Within budget allocation for action O17	Council, State Government
	O30 Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation and consolidation of beach access	<ul style="list-style-type: none"> • Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). • Action would be integrated 	Council/OEH	Short term	Within budget allocation for Action O7	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		into LGA-wide dune management strategy				
Scour due to stormwater outlet at all stormwater outlets including at Ocean Beach Surf Club and Berith St.	O31 Investigate installation of stormwater energy dissipation to reduce discharge velocities at outlet	<ul style="list-style-type: none"> Dissipate energy in front of stormwater outlet by installing energy dissipation blocks, rock apron, or by other method to reduce velocity of outflows from stormwater outlet 	Council	Short term	\$50,000 plus maintenance	Council, State Government
	O32 Post storm beach scraping to assist natural recovery of the dune and repair scour caused by stormwater discharge	<ul style="list-style-type: none"> Undertake beach scraping to repair the scour hole caused by stormwater discharge in the area in front of the surf club 	Council	As required	\$10,000 to \$20,000	Council, State Government
Community participation and	O33 Increase information signage near surf clubs on the ecology and history of Umina/Ocean Beach	<ul style="list-style-type: none"> Provide signage which is not visually obtrusive Action would be incorporated into LGA-wide Coastal Education Strategy 	Council	Short term	\$40,000 to be allocated city-wide for all beaches	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
beach amenity	O34 Improve shade areas around the grassed areas and car parks near the SLSCs	<ul style="list-style-type: none"> Tree planting and/or picnic shelters 	Council	Short term	\$10,000 - \$20,000 for design and installation	Council
	O35 Maintain current signage and facilities on a regular basis	<ul style="list-style-type: none"> Maintenance of existing facilities and upgrade where required 	Council	As required	Within existing budget allocations	Council
	O36 Construction of a disabled beach access point outside Ocean Beach SLSC	<ul style="list-style-type: none"> Beach access ramp at required grade and able to be accessed by wheelchairs 	Council	Short term	\$10,000 plus maintenance	Council, State Government, Private
	O37 Encourage and assist Dunecare group to maintain and revegetate dune after a storm using appropriate endemic vegetation	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Action would be integrated into LGA-wide dune 	Council/OEH	Short term/ongoing	Part of allocation for Action O7	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		management strategy				
Community participation and beach amenity	O38 Development of local area (Umina/Ocean Beach) online fact sheets and encourage local educational programs in schools regarding the dunes	Action would be incorporated into LGA-wide Coastal Education Strategy	Council/OEH	Short term/ongoing	Part of allocation for LGA-wide Coastal Education Strategy	Council, State Government
	O39 Work with the Central Coast Surf Life Saving organisation to look at ways to support Surf Life Savings Australia's EcoSurf policy in the region – including Ocean and Umina Surf Life Saving clubs.		Council	Short term	Within existing budget allocations	Council



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Table 10 – Ocean Umina Beach Precinct 4 Management Actions – East of Ocean Beach surf club to Ettalong Point

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion to dunes; public safety due to steep erosion escarpments; Windblown dune erosion; dune ecology	O40 Monitor storm run-up levels and dune erosion	<ul style="list-style-type: none"> Visual observations during storm events; survey marks of debris line 	Council, SLSC	Short term and following storms as required	Within existing budget allocations	Council
	O41 Repair of beach accessways and revegetation of dune following erosion in a large storm event	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Consider consolidation of beach accessways along Umina Beach Action would be integrated into LGA-wide dune management strategy 	Council, Dunecare	Short term and following storms as required	Within budget allocation for Action O15	Council, State Government, Federal Government
	O42 Beach scraping following storm event to build dune crest level and revegetation	<ul style="list-style-type: none"> Push sand from the beach berm to the toe of the dune escarpment 	Council	After storm events as required	Within budget allocation for action O16	Council, State Government, Federal Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion to dunes; public safety due to steep erosion escarpments; Windblown dune erosion; dune ecology	O43 Collapse steep eroded escarpment and revegetate following erosion events	<ul style="list-style-type: none"> Temporarily fence off beach section to prevent public access, use excavator to collapse dune escarpment, then revegetate in accordance with the techniques of the Coastal Dune Management Manual (DLWC 2001). 	Council	Short term and as required	\$5,000 for excavator hire per event	Council, State Government, Federal Government
	O44 Investigate feasibility of beach nourishment to increase erosion buffer at Ettalong Point	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion. Undertake as required Undertake scraping of sand along beach from areas with excess sand as an interim measure. 	Council	Immediate action for scraping of sand along beach from areas with excess sand as an interim measure. Investigation/approvals Year 1, works immediately after in combination with dune management activities	\$50,000 for interim works; \$50,000 for investigation and approvals for nourishment works, \$350,000 p.a. recurrent cost depending on method of nourishment	Council, State Government, Federal Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
	O45 Undertake erosion protection works to protect The Esplanade at Ettalong Point	<ul style="list-style-type: none"> Works may comprise engineered rock revetment works constructed along roadway for a length of around 100 m 	Council/OEH	Short term (0 – 5 years)	\$40,000 design cost, \$1 million at \$10,000/m, \$10,000 p.a. maintenance cost	Council, State Government, Federal Government
	O46 Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation and consolidation of beach access	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Short term	Within budget allocation for Action O7	Council, State Government
Scour due to stormwater outlet at all stormwater outlets	O47 Investigate installation of stormwater energy dissipation to reduce discharge velocities at stormwater outlets	<ul style="list-style-type: none"> Dissipate energy in front of stormwater outlet by installing energy dissipation blocks, rock apron, or by other method to reduce velocity of outflows from stormwater outlet 	Council	Short term	\$50,000 plus maintenance	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
	O48 Post storm beach scraping to assist natural recovery of the dune and repair scour caused by stormwater discharge	<ul style="list-style-type: none"> Undertake beach scraping to repair the scour hole caused by stormwater discharge in the area in front of the surf club 	Council	As required	Within allocation for Action O16	Council, State Government
Community participation and beach amenity	O49 Development of local area (Umina/Ocean Beach) online fact sheets and encourage local educational programs in schools regarding the dunes		Council/OEH	Short term/ongoing	Within budget allocation for Action O23	Council, State Government



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Table 11 – Putty-Killcare Beach Management Actions

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate risk of erosion and inundation damage to Killcare surf club and carpark	K1 Geotechnical investigation of surf club area	<ul style="list-style-type: none"> Geotechnical drilling to investigate subsurface conditions for surf club. Geotech investigation to confirm condition of surf club footings/piles. 	Council/SLSC	Short term	\$20,000	Council, Private
	K2 Erosion Protection works at surf club if required based on outcome of geotechnical investigation	<ul style="list-style-type: none"> Works may comprise engineered revetment placed along existing embankment on seaward side of surf club 	Council/SLSC	Short to medium term (0 – 20 years)	\$40,000 design cost to be allocated in years 2 – 5, \$700,000 - \$1 million to be allocated after future review of CZMP	Council, State Government, Private
	K3 Repair damage to surf club carpark should storm erosion occur	<ul style="list-style-type: none"> Restore carpark using damage resistant pavement should it be damaged in a future storm event 	Council/SLSC	As required	\$65,000 to \$130,000	Council, Private



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate risk of erosion and inundation damage to Killcare surf club and carpark	K4 Investigate feasibility of beach nourishment in front of surf club	<ul style="list-style-type: none"> Import of sand into this portion of the beach to increase buffer against beach erosion 	Council/OEH	Short to medium term	Investigation of feasibility \$10,000. Could be done as part of a city-wide study	Council, State Government
	K5 Beach scraping to build vegetated dune in front of surf club above the wave runup level with vegetation and/or fencing	<ul style="list-style-type: none"> Scrape sand to build a dune in front of the surf club and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council/OEH	Short term and as required (0-5 years)	Environmental approvals \$20,000, works \$5,000 - \$8,000 p.a.	Council, State Government
	K6 Future relocation of surf club and associated infrastructure to an area landward of the coastal hazard area if required	<ul style="list-style-type: none"> Relocate surf club to an area outside the erosion hazard zone e.g. adjacent to the main carpark Offer to purchase surf club and provide new 	Council/SLSC	Long term (>20 years)	None required prior to 2025	N/A



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		site, funded by State Government or jointly with Council at market value				
Immediate risk of erosion and inundation damage to Killcare surf club and carpark	K7 Redevelop surf club on deep piled foundations on future redevelopment	<ul style="list-style-type: none"> On future redevelopment of surf club, reconstruct on deep piled foundations. Existing surf club foundations comprise of piles grout injected socketed into underlying bedrock. 	Council/SLSC	Long term (>20 years)	None required prior to 2025	N/A
	K8 Continue dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Provide support and education to local Dunecare groups and local residents to maintain dune as required and repair after a storm Action would be 	Council	Ongoing	\$15,000 - \$25,000 p.a.	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		integrated into LGA-wide dune management strategy				
	K9 Complete a vegetation profile for Putty/Killcare Beach and support the natural vegetation profile.	<ul style="list-style-type: none"> Profile the natural vegetation for Putty/Killcare Beach and ensure that planting of dune vegetation is consistent with the natural vegetation profile Action would be integrated into LGA-wide dune management strategy 	Council/Dunecare	Short term	\$50,000 to be allocated city-wide for all beaches	Council, State Government
Future risk of erosion damage to main carpark	K10 Move carpark landward in future	<ul style="list-style-type: none"> Move carpark landward as erosion threat increases in future 	Council	Long term (>20 years)	None required prior to 2025	N/A
Stormwater erosion hazard	K11 Improve stormwater outlet by installing energy dissipation	<ul style="list-style-type: none"> Install energy dissipation e.g. rocks at outlet to 	Council	Short term	\$50,000 + maintenance	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
	to minimise scour and prevent sand ingress into outlet	reduce scour caused by stormwater flow				
	K12 Regrade/repair scour caused by stormwater outlet	<ul style="list-style-type: none"> Regrade beach profile to repair scour caused by stormwater outlet 	Council	After storms as required	Within existing budget allocations	Council
Future erosion damage to Putty Beach camping area	K13 Future relocation of camping area infrastructure to an area landward of the coastal hazard area	<ul style="list-style-type: none"> Undertake pre, during and post storm actions when trigger for action is reached 	OEH (NPWS)	As required	None expected prior to 2025	State Government
All issues	K14 Monitor beach for erosion in front of surf club and camping area	<ul style="list-style-type: none"> Undertake monitoring of the beach to establish erosion risk to surf club and camping infrastructure 	Council/NPWS/SLSC	Short term/ongoing	N/A	N/A



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Table 12 – MacMasters Beach Precinct 1 – Management Actions

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion and reduced foundation capacity to MacMasters Beach Surf Club and Marine Parade	M1 Erosion Protection works for Surf Club	<ul style="list-style-type: none"> Works may comprise engineered rock revetment works constructed along face of existing embankment in front of surf club 	SLSC/Council/OEH	Short term (0 – 5 years)	\$40,000 design cost, construction varies with design - up to \$1 million. Can be staged and included within budget for Action M3	Council, State Government, Private
	M2 Monitor performance of existing erosion works around base of Norfolk Island Pine trees and at surf club at southern end of beach and replace/improve as required	<ul style="list-style-type: none"> Monitor effectiveness of existing works in a future storm event 	Council, OEH, SLSC	Short term and following storms as required	Within existing budget allocations	Council
	M3 Erosion protection works for Marine Parade	<ul style="list-style-type: none"> Works may comprise engineered rock revetment works constructed along face of existing embankment at Marine 	Council/OEH/RMS/SLSC	Short term (0 – 5 years)	\$40,000 design cost can be included within allocation for	Council, State Government, Federal Government, Private



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion and reduced foundation capacity to MacMasters Beach Surf Club and Marine Parade		Parade and could be a continuation of a revetment provided at the Surf Club. Could be implemented as an emergency or temporary measure.			Action M1, \$2.0 - \$3.0 million + maintenance can be shared between all responsible parties	
	M4 Investigate feasibility of beach nourishment in front of surf club and Marine Parade	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Medium term (5 – 20 years)	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Government
	M5 Beach scraping to build dune in front of Surf Club, eroded pine tree roots and Marine Parade in the interim until erosion protection works are constructed	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council	After storm events as required	\$20,000 environmental approval, works \$20,000 to \$25,000	Council, State Government
Immediate and future risk of erosion and reduced foundation capacity to	M6 Undertake geotechnical investigation of area behind Marine Parade	<ul style="list-style-type: none"> Geotechnical drilling to investigate subsurface conditions on landward side of Marine Parade to inform location of 	Council	Short term	\$30,000 but higher if undertaken individually by local	Council, State Government, Private



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
MacMasters Beach Surf Club and Marine Parade		landward limit of Zone of Reduced Foundation Capacity			landowners	
	M7 Development controls for residences to be on piled foundations on redevelopment of properties based on defined building line criteria and with new buildings to be founded into 2100 Stable foundation Zone	<ul style="list-style-type: none"> Define a building line and development controls for development within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council
	M8 Landward relocation of sewer infrastructure along Marine Parade if erosion protection works not implemented	<ul style="list-style-type: none"> Reconstruct sewer line on landward side of Immediate Zone of Slope Adjustment line 	Council	Short term (0 – 5 years)	Investigate feasibility \$5,000, works cost \$100,000 to \$200,000 if erosion protection works not implemented	Council, State Government, Federal Government
Immediate and future risk of erosion and reduced foundation capacity to MacMasters Beach Surf	M9 Repair damage to Marine Parade should it be	<ul style="list-style-type: none"> Repair damage to the road using damage resistant pavements should it 	Council/RMS	As required	\$150,000 - \$200,000 to 2020	Council, State Government, Federal



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Club and Marine Parade	damaged by future erosion if erosion protection works not implemented	<p>be impacted by erosion (i.e. accept existing risk)</p> <ul style="list-style-type: none"> Undertake repairs to the road as a post-storm emergency measure 				Government
Scour due to stormwater outflow	M10 Improve energy dissipation at stormwater outlets	<ul style="list-style-type: none"> Two stormwater outlets – one at Marine Parade Carpark and one draining the reserve near corner of Marine Parade and Gerda Road – provide energy dissipation to reduce impact of scour on beach 	Council	Short term (0 – 5 years)	\$50,000 - \$100,000 + maintenance	Council, State Government
	M11 Periodic beach scraping to repair damage caused by scour from stormwater outlet	<ul style="list-style-type: none"> Scrape sand from beach berm to repair areas scoured by stormwater outflow 	Council	After storm events as required	Environmental approval cost included in Action M6, works cost \$10,000 - \$20,000 p.a.	Council, State Government
Dune vegetation management/ beach amenity	M12 Encourage and assist Dunecare group to improve dune vegetation	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in 	Council	Ongoing	\$15,000 - \$25,000 p.a.	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
	management using appropriate endemic vegetation	<p>accordance with the Coastal Dune Management Manual (DLWC 2001).</p> <ul style="list-style-type: none"> Action would be integrated into LGA-wide dune management strategy 				
	M13 Improve pedestrian access onto beach from carpark and minimise scour caused by beach shower	<ul style="list-style-type: none"> Improve pedestrian access onto beach by constructing in accordance with relevant Australian Standard 	Council	Short term (0 – 5 years)	\$20,000	Council, State Government
	M14 Monitor rock pool for storm damage and repair if required	<ul style="list-style-type: none"> Monitor rock pool by regular Council staff inspections, can be done when pool is emptied for cleaning 	Council	Ongoing	Monitoring within existing budget allocations; allocate \$5,000 p.a. for repairs	Council, State Government



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Table 13 – MacMasters Beach Precinct 2 Management options (south of Cockrone Lagoon entrance)

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion and reduced foundation capacity to properties along seaward side of Tudibaring Parade	M15 Geotechnical investigation and stability of cliff between 45 and 65 Tudibaring Parade	<ul style="list-style-type: none"> Geotechnical investigation of cliff stability, risk to life assessment 	DoI-Lands Council	Short term	\$30,000	Council, State Government
	M16 Development controls for residences on Tudibaring Parade to be on piled foundations on redevelopment of properties based on a defined building line	<ul style="list-style-type: none"> Define a building line and development controls for development within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council
	M17 Not allowing further subdivision of properties on seaward side of Tudibaring Parade	<ul style="list-style-type: none"> Not allow further subdivision of properties on the seaward side of Tudibaring Parade as the seaward side of these lots is subject to unacceptable coastal risk 	Council	Short term	Within existing budget allocation	Council
	M18 Investigate feasibility of beach nourishment to increase erosion buffer in this area	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against 	Council/OEH	Medium term (5 – 20 years)	Investigation of feasibility \$50,000. Could be done as part	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion and reduced foundation capacity to properties along seaward side of Tudibaring Parade		storm erosion			of a city-wide study	
	M19 Encourage and assist Dunecare group and local residents to maintain and revegetate dune	<ul style="list-style-type: none"> Provide community education program and material assistance to encourage residents to maintain dune in front of their properties 	Council/OEH	Short term (0 – 5 years)	\$15,000 - \$25,000 p.a	Council, State Government
	M20 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> Works may comprise similar design to existing adjacent works Works could be considered to be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private
Risk of erosion due to lagoon entrance instability	M21 Seaward extension of existing training wall along southern side of entrance	<ul style="list-style-type: none"> Extend existing training wall along southern side of entrance to prevent erosion of toe of dune at southern end of entrance. Links to action M23. 	Council/OEH	Medium term (5 - 20 years)	Investigation cost \$30,000, works and approvals cost \$400,000 - \$500,000	Council, State Government
	M22 Undertake review of	<ul style="list-style-type: none"> Updated CZMP for Gosford 	Council	Short term (0 - 5	\$5,000 for review,	Council, State



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
	entrance management procedure as recommended by Gosford Coastal Lagoons CZMP. Implement management actions as required	Lagoons includes specific entrance management measures relating to Cockrone Lagoon		years)	\$12,000 p.a. ongoing lagoon opening cost	Government



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Table 14 – Copacabana Beach Management Actions – Precinct 3

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Windblown erosion of dune	C1 Encourage and assist Dunecare group and local residents to maintain and revegetate dune	<ul style="list-style-type: none"> • Provide community education program and material assistance to encourage residents to maintain dune in front of their properties • Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Short term (0 – 5 years)	\$15,000 - \$25,000 p.a.	Council, State Government, Federal Government
Risk of future erosion damage to Del Monte Place, services/ utilities and Copacabana surf club	C2 Erosion Protection works for Copacabana Beach Surf Club	<ul style="list-style-type: none"> • Terminal protection for Copacabana surf club. Surf club is constructed on piles so terminal protection would not improve erosion protection for the building itself but for surrounding land 	Council/SLSC	Medium term (5 - 20 years)	No budget allocated as part of this CZMP, \$600,000 to \$800,000 if required in future	N/A
	C3 Reconstruct SLSC on deep pile foundations on redevelopment of the club	<ul style="list-style-type: none"> • Copacabana surf club. Surf club has been recently redeveloped and reconstructed on piles so redevelopment not likely to be required in the short to medium term 	Council/SLSC	Long term	N/A	N/A
Risk of future erosion damage to Del Monte	C4 Erosion protection works for Del Monte Place to be installed	<ul style="list-style-type: none"> • Not likely to be required for several years as road not within Immediate 	Council/RMS	Long term (> 20years)	Medium term design investigation	Council and/or Private



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Place, services/ utilities and Copacabana surf club	once erosion escarpment reaches set trigger distance from edge of road	Zone of Slope Adjustment <ul style="list-style-type: none"> Engineered buried terminal protection structure to be implemented in the future once roadway subject to immediate erosion hazard risk, or piled seawall on seaward side of road similar to that at Terrigal 			\$40,000. No budget allocated for construction as part of this CZMP	
	C5 Landward relocation of sewer and water infrastructure as well as other utilities along Del Monte Place	<ul style="list-style-type: none"> Not likely to be required for several years as services not within Immediate Zone of Slope Adjustment 	Council and relevant services providers	Long term (> 20years)	No budget allocated in this CZMP, investigations into feasibility to be done under existing allocated budgets	N/A
Risk of future erosion damage to Del Monte Place, services/ utilities and Copacabana surf club	C6 Investigate beach nourishment in front of surf club and Del Monte Place	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Long term (>20 years)	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Government
	C7 Repair damage to Del Monte Place, Surf Club and surrounding land should it be	<ul style="list-style-type: none"> Undertake repairs to the road using damage-resistant pavements as a post-storm emergency measure 	Council/RMS	Medium term and as required (> 5 years)	\$300,000 to \$400,000 per event but low probability of	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Risk of future erosion damage to Del Monte Place, services/ utilities and Copacabana surf club	damaged by future erosion				occurrence. Budget to be allocated after 2020.	
	C8 Long term narrowing, removal and relocation or provision of alternative access for Del Monte Place if erosion protection works are not implemented	<ul style="list-style-type: none"> Long term narrowing of Del Monte Place to a single lane, relocation of services, followed by purchase of an alternative access easement at the rear of the properties for provision of access to properties along Del Monte Place 	Council/RMS	Long term (> 20 years)	No budget allocation within this CZMP	N/A
	C9 Development controls for residences and commercial premises to be on piled foundations on redevelopment of properties based on a defined building line	<ul style="list-style-type: none"> Define a building line and development controls for property within this hazard zone at this portion of beach 	Council	Short term	Within existing budget allocation	Council
	C10 Geotechnical investigation around surf club area and on landward side of Del Monte Place to confirm level of bedrock and reduced foundation capacity hazard	<ul style="list-style-type: none"> Undertake geotechnical drilling to determine the nature of the material under the beach near Surf Club, to determine whether buildings landward of Del Monte Place would be subject to reduced foundation 	Council	Short term (0 – 5 years)	\$30,000	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		capacity				
Risk of erosion damage to properties fronting the dune	C11 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> Works could be considered to be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private
Scour and water quality issues due to stormwater management near Copacabana surf club	C12 Improve energy dissipation at stormwater outlet	<ul style="list-style-type: none"> Major stormwater outlet adjacent to surf club 	Council	Short term (0 – 5 years)	\$50,000 + maintenance	Council, State Government
	C13 Improve existing outlet control structures to prevent scour of the base of the dune	<ul style="list-style-type: none"> Construct a short buried training wall using rock, reno mattresses or geotextile bags to prevent stormwater/creek flows from meandering in front of dune at northern end of beach 	Council	Short term (0 – 5 years)	\$10,000 design/approval costs \$50,000 construction + maintenance costs 1% p.a.	Council, State Government



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Table 15 – Avoca Beach Management Actions – Precincts 1 and 2

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate risk of inundation to Avoca Beach SLSC and carpark	A1 Construct seawall to protect water and sewer infrastructure and improve beach access/amenity in front of the surf club	<ul style="list-style-type: none"> Vertical seawall to be implemented to protect water and sewer infrastructure, in accordance with concept presented in Avoca Beach Southern Foreshore Masterplan 	Council	Short term	\$3 million including design and environmental approval + maintenance	Council, State Government
	A2 Survey floor levels to determine degree of inundation hazard	<ul style="list-style-type: none"> Undertake survey of existing floor levels – raising buildings could be examined as an action 	Council	Short term	\$5,000	Council
Immediate and future risk of erosion and inundation damage to the surf club carpark	A3 Repair damage to carpark and other infrastructure should storm erosion occur	<ul style="list-style-type: none"> Restore carpark using damage-resistant pavements should it be damaged in a future storm event 	Council	As required, less likely to be required if action A1 implemented	\$150,000 to \$180,000	Council, State Government, Federal Government
	A4 Beach scraping to build vegetated dune in front of	<ul style="list-style-type: none"> Scrape sand to build a dune in front of the carpark and 	Council	Short term (0-5 years)	\$20,000 environmental approval, works	Council



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion and inundation damage to the surf club carpark	carpark	vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001).			\$5,000 p.a.	
	A5 Monitor performance of existing rock works in front of surf club and carpark following a large storm	<ul style="list-style-type: none"> Assess post-storm damage to existing rock protection at Surf Club and carpark to determine level of protection provided and design upgrade if necessary 	Council	Short term and as required, in interim until Action A1 implemented	N/A	Council
Immediate and future risk of erosion to properties on Avoca Drive and undermining of Norfolk Island pines	A6 Development controls based on a defined building line with new buildings to be founded into 2100 Stable Foundation Zone	<ul style="list-style-type: none"> Define a building line and development controls for property within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council
	A7 Erosion protection works to be allowed for properties for emergency protection	<ul style="list-style-type: none"> Works may comprise similar design to existing adjacent works Works could be considered to 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection	None allocated in CZMP	Private



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act		installed		
Immediate and future risk of erosion to properties on Avoca Drive and undermining of Norfolk Island pines	A8 Investigate beach nourishment to increase erosion buffer in this area	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Medium term	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Government
	A9 Beach scraping to build dune in front of residences	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual. (DLWC 2001). 	Council	Short term (0 - 5 years, ongoing)	Approvals cost included in Action A4, works cost \$50,000	Council, State Government
	A10 Repair of beach accessways and revegetation of	<ul style="list-style-type: none"> Undertake dune management as per standard dune 	Council, Dunecare	Short term and following storms as	\$30,000 - \$40,000 plus maintenance	Council, State Government, Federal



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
	dune following erosion in a large storm event	<p>management practice in accordance with the Coastal Dune Management Manual (DLWC 2001).</p> <ul style="list-style-type: none"> Action would be integrated into LGA-wide dune management strategy 		required		Government
Immediate and future risk of erosion to properties on Avoca Drive and undermining of Norfolk Island pines	A11 Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Short term	\$20,000 p.a. plus maintenance	Council, State Government
	A12 Monitor Norfolk Island pine stability	<ul style="list-style-type: none"> Undertake regular inspection of Norfolk Island Pines to ensure root system not unduly damaged by erosion 	Council/OEH	Short term and ongoing	Within existing budget allocations	Council, Private



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of inundation to properties (south of Austral Avenue)	A13 Development controls for residences to be above inundation levels on redevelopment of properties	<ul style="list-style-type: none"> As per existing DCP 	Council	Short term	N/A	N/A
Erosion risk to stormwater outlets	A14 Erosion protection works in front and around the stormwater outlet should storm erosion occur	<ul style="list-style-type: none"> Work may comprise a suitable apron or rock protection in front of the outlet 	Council	Short term	\$100,000 plus maintenance	Council
	A15 Improve energy dissipation at stormwater outlets	<ul style="list-style-type: none"> Dissipate energy in front of stormwater outlet by installing energy dissipation blocks, rock apron, or by other method to reduce velocity of outflows from stormwater outlet 	Council	Short term	\$50,000 + maintenance	Council, State Government



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Table 16 – Avoca Lagoon Entrance (Precinct 3) Management Options

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future erosion and inundation risk to properties and infrastructure at Avoca Lake Entrance	A16 Development controls for residences to be above inundation levels on redevelopment of properties	<ul style="list-style-type: none"> As per existing DCP Based on findings of Avoca Storm Wave Inundation Study (2009) and Hazard Assessment (2014) 	Council	Short term	N/A	N/A
	A17 Review entrance management guidelines for mechanical opening of Avoca Lake	<ul style="list-style-type: none"> The entrance management policy and procedure for Avoca Lake is to be reviewed as identified in the Gosford Lagoons planning process 	Council	Short term	\$5,000 for review + \$12,000 p.a. average lagoon opening cost	Council, State Government
	A18 Allow property owners to self-protect in line with NSW Government legislation and provisions for installation of Temporary Coastal Protection Works.	<ul style="list-style-type: none"> Allow property owners to self-protect when erosion escarpment reaches trigger distance from defined building line 	Property owners, Council/Coastal Panel to assess individual DAs	Short term	None allocated in CZMP	Private
	A19 Encourage and assist Dunecare group to improve dune vegetation management using	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune 	Council/OEH	Short term	\$20,000 - \$30,000 p.a. across Avoca/North	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future erosion and inundation risk to properties and infrastructure at Avoca Lake Entrance	appropriate endemic vegetation	Management Manual (DLWC 2001). Remove weeds and install native vegetation. Provide support to local Dunecare groups and local residents to maintain dune as required			Avoca	
	A20 Relocation of sand to improve beach access and amenity	<ul style="list-style-type: none"> Physical relocation of sand along the beach from entrance area to improve beach amenity elsewhere 	Council	Short term/ongoing	Approvals cost included in Action A4, works cost \$5,000 p.a.	Council
Inundation and erosion risk to Ficus Avenue carpark	A21 Repair damage to carpark and other infrastructure should storm erosion occur	<ul style="list-style-type: none"> Restore carpark using damage-resistant pavements should it be damaged in a future storm event 	Council	As required	\$150,000 to \$180,000 following storm event	Council, State Government, Federal Government
	A22 Beach scraping to build dune in front of carpark and properties 165 Avoca Drive to 15 Ficus Avenue	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council	Short term (0 - 5 years)	\$50,000 every two years	Council, State Government, Federal Government



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Table 17 – North Avoca Precincts 4 and 5 – Management Actions

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of erosion to properties at North Avoca Beach	A23 Allowing development landward of a specially defined building line with piled foundations into the 2100 Stable Foundation Zone (i.e. similar to existing DCP, status quo, A4.2)	<ul style="list-style-type: none"> Define a building line and development controls for property within hazard zone 	Council	Short term	Within existing budget allocation	Council
	A24 Development approval conditions for new developments to specify that connection to services are to be maintained by owner in the event of storm erosion	<ul style="list-style-type: none"> Include as a special condition in the DCP 	Council	Short term	Within existing budget allocation	Council
	A25 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> Works may comprise similar design to existing adjacent works Works could be considered to be emergency works if they are in line with the requirements of the Code of 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		Practice under the Coastal Protection Act				
Immediate and future risk of erosion to properties at North Avoca Beach	A26 Monitor storm run-up levels and dune erosion	<ul style="list-style-type: none"> Visual observations during storm events; survey marks of debris line 	Council, SLSC	Short term and following storms as required	Within existing budget allocations	Council
	A27 Terminal seawall protection for all the properties	<ul style="list-style-type: none"> Works may comprise a buried armour seawall protection for all the properties along North Avoca beachfront. Engineered buried terminal protection structure to be implemented in the future once properties subject to immediate erosion hazard risk. Could be funded jointly by State, Federal Government and directly affected landowners or by landowners only. 	Landowners, Council, OEH	Long term	No budget allocated as part of this CZMP, to be reviewed following subsequent review of CZMP	Private, Council, State Government, Federal Government
	A28 Terminal seawall protection for the properties north from the Surf Club only	<ul style="list-style-type: none"> Engineered buried terminal protection structure to be implemented Could be funded jointly by State, Federal Government and directly 	Landowners, SLSC, Council, OEH	Short – medium term (0 – 20 years)	\$40,000 design cost, \$1.2 million approval and construction cost	Private, Council, State Government, Federal Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
		affected landowners or by landowners only			to be allocated after 2020 + maintenance	
Immediate and future risk of erosion to properties at North Avoca Beach	A29 Investigate beach nourishment to increase erosion buffer in this area	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Short term	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Government
	A30 Repair of beach accessways and revegetation of dune following erosion in a large storm event	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Action would be integrated into LGA-wide dune management strategy 	Council	Short term and following storms as required	\$30,000 - \$40,000 + maintenance	Council, State Government, Federal Government
	A31 Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Short term	\$10,000 + maintenance	Council, State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future risk of inundation to properties at North Avoca Beach	A32 Development controls for residences to be above inundation levels on redevelopment of properties	<ul style="list-style-type: none"> As per existing DCP 	Council	Short term	N/A	N/A
Scour erosion due to stormwater outlet	A33 Improve energy dissipation at stormwater outlets	<ul style="list-style-type: none"> Dissipate energy in front of stormwater outlet by installing energy dissipation blocks, rock apron, or by other method to reduce velocity of outflows from stormwater outlet 	Council	Short term	\$50,000 + maintenance	Council, State Government
Immediate and future risk of erosion and inundation risk to the North Avoca SLSC and carpark	A34 Repair damage to surf club carpark should storm erosion occur	<ul style="list-style-type: none"> Restore carpark using damage-resistant pavements should it be damaged in a future storm event 	Council	As required	\$60,000 to \$80,000	Council, State Government, Federal Government
Immediate and future risk of erosion and inundation risk to the North Avoca SLSC and carpark	A35 Beach scraping to build vegetated dune in front of surf club and carpark above the wave runup level with vegetation and/or fencing	<ul style="list-style-type: none"> Scrape sand to build a dune in front of the surf club and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council	Short term (0-5 years)	\$20,000 environmental approvals, \$4,000 - \$7,000 p.a. works costs	Council and State Government
	A36 Confirm whether SLSC is constructed on deep pile	<ul style="list-style-type: none"> On future redevelopment of surf club, reconstruct on deep piled 	Council/SLSC	Medium term (5 – 20 years)	Within existing budget allocations	Council and/or Private



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
	foundations and reconstruct on deep pile foundations on redevelopment of the club if required	foundations. Surf club likely to be underlain by rock – foundations can be piled into the rock				



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Table 18 – Terrigal Beach Management Actions

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Beach erosion/inundation impacting on recreational amenity at The Haven	TW1 Monitor performance of existing seawall in addressing erosion and inundation	<ul style="list-style-type: none"> Monitor performance of existing seawall structure following storm events and inspect for signs of damage 	Council/OEH	Short term, ongoing	N/A	N/A
	TW2 Monitor beach profile following significant storm events	<ul style="list-style-type: none"> Monitor beach profile following storm events and inspect for signs of damage. Implement actions in Council's Beach Management Policy 	Council	Short term, ongoing	Within existing budget allocations	Council
	TW3 Investigate beach nourishment to increase buffer against storm erosion	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Medium term	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council and State Government
	TW4 Repair post-storm damage to existing infrastructure	<ul style="list-style-type: none"> Repair inundation damage should it occur 	Council	Short term, ongoing/as required	Within existing budget allocation	Council
Immediate and future	TW5 Survey floor levels to determine degree of inundation hazard	<ul style="list-style-type: none"> Undertake survey of existing floor levels – raising buildings could be examined as an action 	Council	Short term	\$5,000	Council



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
inundation risk to Terrigal Surf Life Saving Club and Terrigal commercial district	TW6 Monitor performance of existing seawall against erosion and inundation	<ul style="list-style-type: none"> Monitor performance of existing seawall structure following storm events and inspect for signs of damage 	Council	Short term/as required	N/A	N/A
	TW7 Repair post-storm damage to existing infrastructure	<ul style="list-style-type: none"> Repair inundation damage should it occur 	Council	Short term, ongoing/as required	Within existing budget allocation	Council
Beach Amenity	TW8 Investigate sources of sand and feasibility of beach nourishment for Southern Terrigal Beach to increase buffer against storm erosion and improve beach amenity	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to create buffer against storm erosion and improve beach amenity Sand could be scraped along the beach from lagoon entrance area 	Council/OEH	Medium term	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council and State Government
	TW9 Remove old seawall structure at southern end of beach to improve public safety	<ul style="list-style-type: none"> Old buried seawall has become exposed and poses a danger to beach users at southern end of Terrigal Beach – excavate and remove 	Council	Medium term	\$60,000 excavation, demolition and disposal costs	Council and State Government



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Table 19 – Wamberal Beach Management Actions

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future erosion and inundation risk to properties and infrastructures along Wamberal Beach	TW10 Allowing development landward of a specially defined building line with piled foundations into the 2100 Stable Foundation Zone	<ul style="list-style-type: none"> Define a building line and development controls for property within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council
	TW11 Terminal protection - Council to action review, design and funding of terminal protection structure for Wamberal	<ul style="list-style-type: none"> Works may consist of a buried armour seawall. 	Council, OEH, local landowners	Short –medium term	\$200,000 to review and update existing design, \$13 million to \$15 million environmental assessment and construction cost plus 1% p.a. maintenance	Council, State Government, Private, and/or Federal Government.
	TW12 Complete a vegetation profile for Wamberal Beach and support the natural vegetation profile.	<ul style="list-style-type: none"> Profile the natural vegetation for Wamberal Beach and ensure that planting of dune vegetation is consistent with the natural vegetation profile Action would be integrated into LGA-wide dune management strategy 	Council/Dunecare	Short term	\$50,000 to be allocated city-wide for all beaches	Council and State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate and future erosion and inundation risk to properties and infrastructures along Wamberal Beach	TW13 Continue and enhance dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Ongoing	\$15,000 - \$25,000 p.a.	Council and State Government
	TW14 Investigate sources of sand and feasibility of beach nourishment for Wamberal Beach	<ul style="list-style-type: none"> Import of sand into this portion of the beach to increase buffer against beach erosion 	Council/OEH	Short-term	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council and State Government
Immediate and future erosion and inundation risk to properties and infrastructures along Wamberal Beach	TW15 Beach nourishment coupled with a terminal revetment to increase buffer against storm erosion	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Short – medium term	Investigation of feasibility \$50,000. Beach nourishment could be investigated in the review of the revetment design and environmental approvals. Beach nourishment cost estimate approximately \$1 million,	Council and State Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
					implementation in medium term (\$760,000 2004 cost adjusted to 2014 based on ABS annual CPI calculator)	
Immediate and future erosion and inundation risk to properties south of the Wamberal Lagoon entrance	TW16 Review entrance management guidelines for mechanical opening of Wamberal Lagoon	<ul style="list-style-type: none"> The entrance management policy & procedure for Wamberal Lagoon is to be reviewed as identified in the Gosford Lagoons planning process. Consultation with NPWS to be undertaken as the lagoon is under the jurisdiction of NPWS. 	Council, NPWS	Short term	\$5,000 + \$14,500 p.a. lagoon opening cost	Council and State Government
	TW17 Ensure floor levels for new Development Applications are above inundation levels	<ul style="list-style-type: none"> As per existing DCP 	Council	Short term	N/A	N/A
Future erosion and immediate inundation risk to Wamberal Surf	TW18 Repair damage to surf club carpark should storm erosion occur	<ul style="list-style-type: none"> Restore carpark using damage-resistant pavement should it be damaged in a 	Council, SLSC	As required	\$150,000 to \$180,000	Council and/or State Government and/or Federal Government



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Life Saving Club		future storm event				
	TW19 Beach scraping to build vegetated dune in front of carpark	<ul style="list-style-type: none"> Scrape sand to build a dune in front of the carpark and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council, NPWS	Short term (0-5 years)	\$20,000 environmental assessment, \$8,000 - \$10,000 for works	Council and/or State Government
	TW20 Continue and enhance dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Ongoing	Within funding allocation for Action TW13	Council and/or State Government
TW21 Check whether surf club is on deep piled foundations and re-construct on deep piled foundations upon	<ul style="list-style-type: none"> May be done using ground penetrating radar or through a search of construction documentation for existing club 	SLSC/Council	Medium term	\$20,000	Council and/or Private	



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
	redevelopment of club if required					
Immediate and future erosion and inundation risk to properties north of the Terrigal Lagoon entrance	TW22 Review entrance management guidelines for mechanical opening of Terrigal Lagoon	<ul style="list-style-type: none"> The entrance management policy & procedure for Terrigal Lagoon is to be reviewed as identified in the Gosford Lagoons planning process. 	Council	Short term	\$5,000 + \$14,500 p.a. lagoon opening cost	Council
	TW23 Allow lagoon frontage properties at southern end of Pacific Street to self-protect in accordance with existing legislation	<ul style="list-style-type: none"> Allow property owners to self-protect when erosion escarpment reaches trigger distance from defined building line 	Property owners, Council/Coastal Panel to assess individual DAs	Short term	None allocated in CZMP	Private
	TW24 Ensure floor levels for new Development Applications are above inundation levels	<ul style="list-style-type: none"> As per existing DCP 	Council	Short term	N/A	N/A
Immediate and future erosion and	TW25 Investigate purchase of small section of southernmost property (1 Pacific Street) to provide	<ul style="list-style-type: none"> Negotiate with owner to purchase small section of block 	Council	Short Term	To be negotiated with owner	Council



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
inundation risk to properties north of the Terrigal Lagoon entrance	public access along lagoon frontage					
	TW26 Beach scraping from lagoon entrance to reduce erosion and inundation risk to properties at southern end of Pacific Street as well as enhance public access	<ul style="list-style-type: none"> Beach scraping from Terrigal Lagoon entrance channel to beach in front of properties at southern end of Pacific Street as per current Council practice 	Council	Short term	\$15,000 per event works cost, environmental assessment covered in city-wide management action	Council
	TW27 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> Works may comprise similar design to existing adjacent works Works could be considered to be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private



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Table 20 – Forresters Beach Management Actions

Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
Immediate risk of erosion damage to properties and minor structures	F1 Geotechnical investigation to determine the Zone of Reduced Foundation Capacity	<ul style="list-style-type: none"> Investigation to determine the Zone of Reduced Foundation Capacity 	Council/OEH	Short term	\$60,000	Council and/or State Government and/or Private
	F2 Continue dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Ongoing	\$15,000 - \$25,000 p.a.	Council and/or State Government
	F3 Complete a vegetation profile for Forresters Beach and support the natural vegetation profile.	<ul style="list-style-type: none"> Profile the natural vegetation for Forresters Beach and ensure that planting of dune vegetation is consistent with the natural vegetation profile 	Council/Dunecare	Short term	\$50,000 to be allocated city-wide for all beaches	Council and/or State Government
	F4 Collate geotechnical information obtained from DAs		Council	Short term	Within existing budget allocations	Council



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Hazard/Issue Addressed	Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding
	into a central database					
	F5 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> • Works may comprise similar design to existing adjacent works • Works could be considered to be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private
All issues	F6 Monitor beach for erosion and cliff lines for instability	<ul style="list-style-type: none"> • To be undertaken by an experienced engineering geologist 	Council	Short term, ongoing	\$10,000 p.a.	Council



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4 BUDGET ALLOCATIONS

This section describes the budget allocations for the recommended management actions to be implemented under this CZMP. It breaks down the budgets required for each beach and over three timeframes within the ten year life of the CZMP – Year 1, Years 2 – 5 and Years 6 - 10.

Budget allocations required for the actions listed in this Plan are indicated in Table 21, below. The budget allocations refer to the share of funding required for actions to be undertaken wholly or partially by a public authority (Council, OEH or other NSW or Federal Government agency) for implementation within the timeframe covered by the Plan. The allocations do not include actions required under various other Plans which apply to the beach, or actions to be funded under existing funding arrangements.

The funding allocations presented below and in the Implementation schedule tables include the following aspects for each management action:

- Planning, design and approval costs
- Implementation and/or construction costs
- Maintenance and/or recurrent costs that would be incurred up to 2025.

Table 22 provides total budget allocations for all actions, including those to be funded both by private landholders and public authorities.

Table 21 – Estimated budget allocations for public authority actions in the Plan

Beach	2015-6	2017-2020	2021 – 2025	Total to 2025
Patonga	\$542,000	\$168,000	\$680,000	\$1,390,000
Pearl Beach	\$157,000	\$390,000	\$680,000	\$1,227,000
Ocean/Umina	\$1,410,500	\$2,208,800	\$2,647,200	\$6,266,500
Putty/Killcare	\$213,000	\$212,000	\$167,000	\$592,000
McMasters/ Copacabana	\$340,000	\$964,600	\$4,559,000	\$5,863,600
Avoca/North Avoca	\$585,000	\$3,590,800	\$594,000	\$4,769,800
Terrigal/Wamberal	\$560,000	\$3,586,000	\$433,000	\$4,579,000
Forresters	\$95,000	\$140,000	\$175,000	\$410,000
City-wide general allocation	\$40,000	\$440,000	\$100,000	\$580,000
TOTALS	\$3,942,500	\$11,700,200	\$10,035,200	\$25,677,900



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Table 22 – Total estimated budget allocations for all actions in the Plan

Beach	2015-6	2017-2020	2021 – 2025	Total to 2025
Patonga	\$542,000	\$168,000	\$680,000	\$1,390,000
Pearl Beach	\$157,000	\$390,000	\$995,000	\$1,542,000
Ocean/Umina	\$1,410,500	\$2,208,800	\$3,210,000	\$6,829,300
Putty/Killcare	\$213,000	\$212,000	\$167,000	\$592,000
McMasters/ Copacabana	\$340,000	\$964,600	\$4,559,000	\$5,863,600
Avoca/North Avoca	\$585,000	\$3,590,800	\$1,644,000	\$5,819,800
Terrigal/Wamberal	\$560,000	\$16,336,000	\$1,070,500	\$17,966,500
Forresters	\$95,000	\$140,000	\$175,000	\$410,000
City-wide general allocation	\$40,000	\$440,000	\$100,000	\$580,000
TOTALS	\$3,942,500	\$24,450,200	\$12,600,500	\$40,993,200

4.1 Breakdown of Budget allocation by location

The overall budget allocations for the publicly funded components of the CZMP are illustrated in Figure 3. It can be seen that the budget allocations differ for each location, depending on the level of coastal risk and management measures required. Terrigal/Wamberal, Avoca/North Avoca and Copacabana have generally required the highest allocation of funding, due to the quantum of coastal risk in these areas and the nature of the management measures required.

Detailed funding breakdowns in the immediate, short and medium term for each beach in the study area are provided in Appendix 1.



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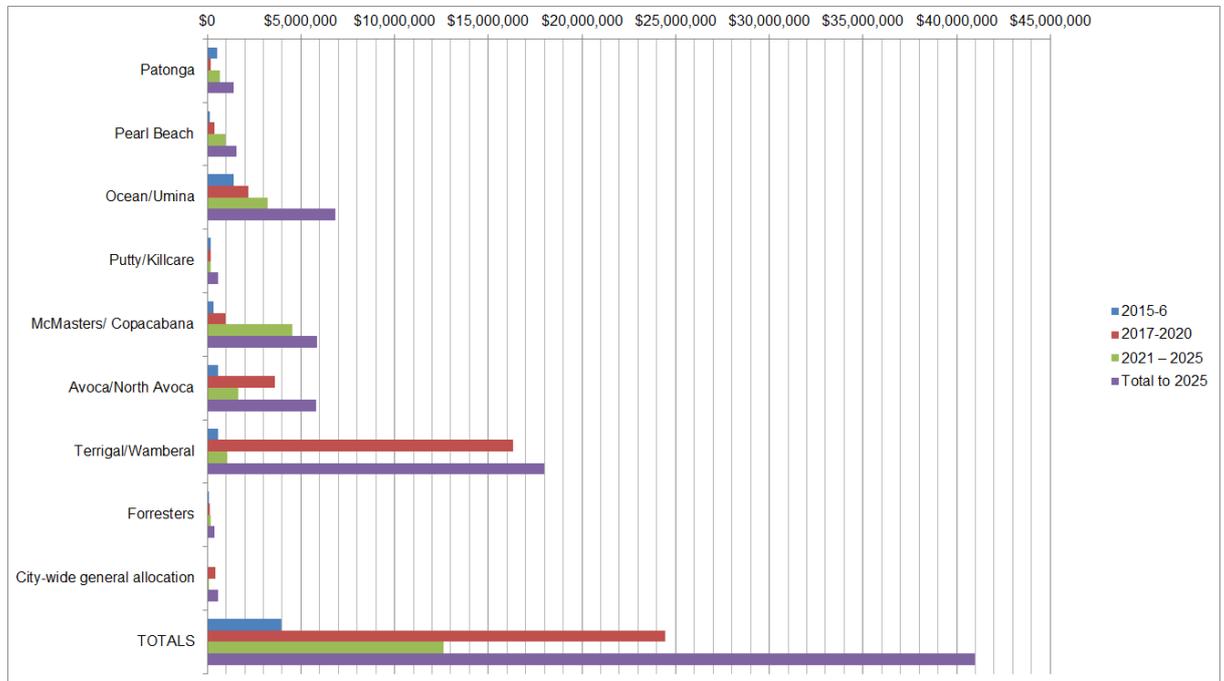


Figure 3 – Relative total budget allocation for each beach. 2015-6; 2017-20; 2021-25; total to 2025.



5 DEVELOPMENT AND LANDUSE ISSUES

This section describes the review of the Gosford DCP Chapter 6.2 Coastal Frontage. It addresses the requirement of the CZMP to address property risk and response categories for all properties in the coastal zone of the open coast and Broken Bay beaches.

5.1 Observations of existing Chapter 6.2 Coastal Frontage Gosford DCP (2013)

The major challenges for coastal management across Gosford's beaches relate to land use and development. The objective of this review is to implement Council's long term strategy through the use of development controls whereby the overall risk to coastal development is reduced over time.

The development of a revised Coastal Zone Management Plan provides the foundation for the development of appropriate planning controls in the coastal zone. The planning process provides the basis upon which a full review of DCP Chapter 6.2 can occur.

In light of the findings of the Coastal Process and Hazard Definition Study (WorleyParsons 2014), the following observations are made about the applicability of the existing DCP:

- A different planning horizon has been adopted for the Open Coast and Broken Bay beaches, as they are each based on the previous and location specific coastal risk assessment information. There is no practical reason why the planning horizon should be different between the Open Coast and Broken Bay beaches. The planning horizon should ideally be adopted based on the level of risk determined at each beach, which is a function of the intensity of existing development in each area, the quantum of development at risk within the coastal hazard zones and community acceptance.
- There is a link between the provisions of the DCP and the way that the hazards are defined. The DCP stipulates deep pile foundations be used as a risk mitigation measure, which would mitigate the risk of structural damage to coastal development. The provision for deep pile foundations is key to mitigating coastal erosion hazard risk to structures in each area. There are also provisions in the DCP to ensure that risk to new development due to coastal inundation hazards is minimised.
- The streamlining of current and future coastal risk assessment processes and identification of management options for all beaches subject to coastal processes will require the planning horizon adopted in the existing DCP to be revised. The timeframe to be adopted should reflect the appropriate planning horizons based upon the economic life and the degree of flexibility associated with a particular coastal management issue. For example, the Australian Tax Office allows the entire construction cost of a residential rental property to be deducted over a period of 40 years. From this, it can be inferred that the economic life of a dwelling is 40 years. Based on this, the 2050 planning horizon may be an appropriate planning horizon to adopt for new residential developments. This would ensure that allowable development in



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each area takes into account factors such as the existing intensity of development in each area (i.e. adopt an adaptive risk management approach at each precinct in accordance with Principle 7 of the Coastal Management Principles, Guidelines for Preparing Coastal Zone Management Plans, OEH 2013). Asset classes and life are also important and require further consideration in development control. The DCP needs to ensure that allowable development in each precinct is dealt with equitably throughout the LGA but at the same time takes into account the social fabric of each precinct.

- The Gosford LEP 2014 identifies that buildings or building structures will not be permitted to be constructed on, over or below the land which has been identified by the Coastal Management Plan for Gosford City Open Coast Beaches as subject to designated coastal hazards (other than as identified in the exceptions). The DCP does not consider the loss of land at present.
- The current DCP differentiates between major and minor development which creates some confusion in development assessment.
- The DCP currently requires property owners execute a positive covenant in favour of Council in order to issue a construction certificate for a minor and often unrelated building development. Requirements in regard to supporting information to be provided for minor development (and requirement for the execution of a covenant) should be reviewed.
- The DCP provisions apply to all land parcels irrespective of whether they lie landward of major road, sewer and water infrastructure (which will be protected). The application of all DCP provisions to all properties identified in 'coastal hazard definition' may need to be reviewed.

Review of the CZMP creates an opportunity to think creatively in determining future DCP provisions to retain development potential. The full review of the DCP will involve Council revisiting concepts and established rules relating to development footprints, engineered design, cantilevering and setbacks from the street-side property boundary to improve development potential and enable ongoing development in the short to medium-term.

The provisions of the existing DCP are strongly linked to the definition of the coastal hazards at each of the beaches as part of the 1995/1998 planning processes. For the sandy beach areas, the latest (2014) hazard definition is based on Nielsen et al (1992), with a number of coastline hazard zones delineated as shown in Figure 4, below.



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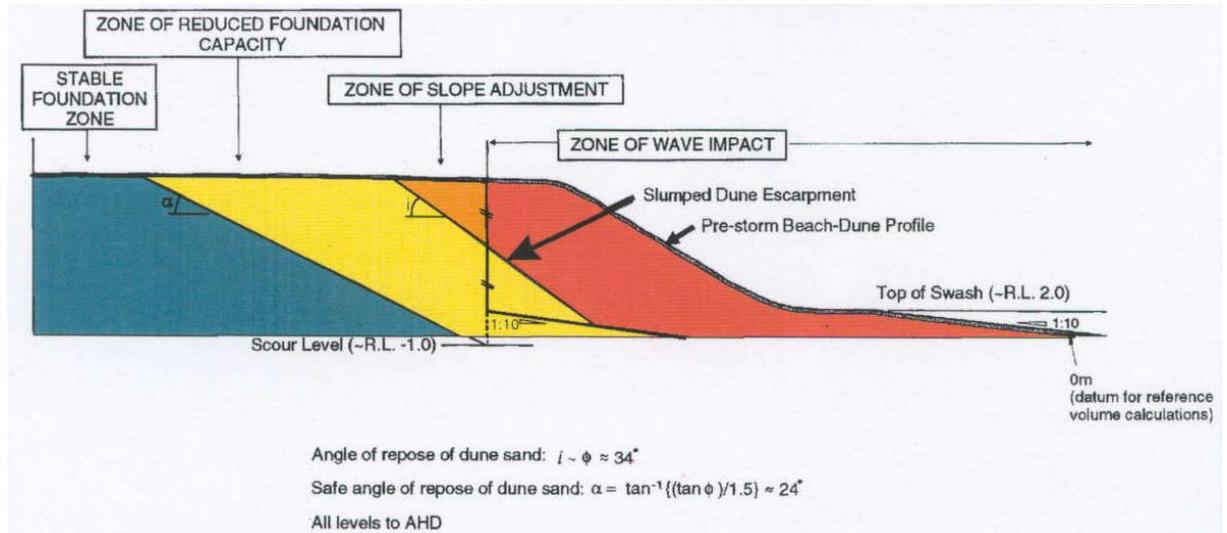


Figure 4: Schematic representation of coastline hazard zones (after Nielsen et al 1992)

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

A *Zone of Slope Adjustment* is delineated to encompass that portion of the seaward face of the beach that would slump to a natural angle of repose following removal by wave erosion of the design storm demand. It represents the steepest stable beach profile under the conditions specified.

A *Zone of Reduced Foundation Capacity* for building foundations is delineated to take account of the reduced bearing capacity of the sand adjacent to the storm erosion escarpment.

Nielsen et al (1992) recommended that structural loads should only be transmitted to soil foundations outside of this zone (i.e. landward or below), as the factor of safety within the zone is less than 1.5 during extreme scour conditions at the face of the escarpment. In general (without the protection of a terminal structure such as a seawall), dwellings/structures not piled and located within the Zone of Reduced Foundation Capacity would be considered to have an inadequate factor of safety.

Within the Zone of Reduced Foundation Capacity, the soil mass has a reduced capacity to support building foundations, unless they constructed on piles deep enough to resist the lateral forces induced on them by movement within the soil mass. Light structures within this zone (e.g. fences, utilities, roads, paths etc.) are not at risk of damage. However, heavy structures (buildings) not supported on piled foundations could be at risk of some structural damage due to an increased risk of slumping in this area if they are located within this zone and the dune in front of them collapses back to the Zone of Slope Adjustment line.

Under this CZMP, it is proposed to uphold the general basis of the existing DCP in stipulating that development in coastal hazard areas, where allowable, should be founded on deep pile foundations. In accordance with this general principle, it is proposed that the requirement for deep piled



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foundations for properties within the Zone of Reduced Foundation Capacity be retained in the updated DCP. However, the required setback for dwelling development from the seaward property boundary (or *building line*) is a matter which has been dealt with independently for each beach in a manner which takes into account the following:

- Level of coastal risk at each location
- Existing intensity of development, asset classes and life at each location
- Social fabric of each district and needs/aspirations of the community
- Maintenance or enhancement of public access, beach amenity and dune ecology along the foreshore
- Established enforceable setbacks for single and multi-dwelling properties; and
- Future coastal management measures to be implemented in the district.

In this Section, the basis under which the various allowable Building Lines have been developed for each beach precinct is described and explained.

5.2 Adjustment to coastline hazard zones due to Council's updated sea level rise benchmarks

For the Coastal Process and Hazard Definition Study undertaken in 2014, coastline hazard zones were estimated at each beach for the:

- immediate planning period;
- 2050 planning period with sea level rise of 0.4m above 1990 levels (0.34 m above present day levels);
- 2100 planning period with sea level rise of 0.9m above 1990 levels (0.84 m above present day levels).

However, it should be noted that there is uncertainty regarding these values, and future sea level rise could be smaller or larger than predicted. On 10 March 2015 Council considered a report in reviewing its sea level rise benchmarks. Council resolved to adopt a Sea Level Rise Planning Level based on RCP8.5 and the medium sea level rise projection as defined in an Independent Report, as a strategic position to inform Council's planning and plan making processes. The rates are provided in Table 23, below.



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Table 23 - Local sea level rise projection (rates projected from current/2015 levels)

**Note: To obtain the absolute projected sea level elevation relative to AHD, a further 0.08m would need to be added to these values*

Year	Medium local sea level rise projection based on RCP8.5 measured in metres (m)
2015	0.00
2030	0.07
2050	0.20
2070	0.39
2100	0.74

Council also resolved that, every Council term or within two years of a new IPCC report, a review of the Sea Level Rise Planning level occurs.

The implications of Council adopting localised sea level rise projections are that the locations of the coastline hazard zones provided in the Coastal Process and Hazard Definition Study (WorleyParsons 2014) will shift seaward at most beaches, by the distances indicated in Table 24, below. These distances will inform the locations of the hazard zones and building lines under which the development requirements have been prescribed for the update of the DCP.

Table 24 – Seaward movement of coastal hazard zones at each beach due to Council’s sea level rise benchmarks adopted on 10 March 2015.

Beach	Inverse Slope	Long Term Recession due to Sea Level Rise (m)		Long term recession due to sea level rise with new Council projections		Difference in spatial location of hazard line on the ground, (m)	
		2050	2100	2050	2100	2050	2100
Patonga	10	3.4	8.4	2.0	7.4	1.4	1.0
Pearl	14	4.8	11.8	2.8	10.4	2.0	1.4
Ocean-Umina	N/A	0	0	0	0	0	0
Putty	25	8.5	21.0	5.0	18.5	3.5	2.5
MacMasters-Copacabana	39	13.3	32.8	7.8	28.9	5.5	3.9
Avoca	50	17.0	42.0	10.0	37.0	7.0	5.0
Terrigal-Wamberal	43	14.6	36.1	8.6	31.8	6.0	4.3
Forresters	4.8	1.6	4.0	1.0	3.6	0.6	0.4



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5.2.1 Establishment of Coastal Building Line

Coastal building lines have been developed and presented in Appendix 3. These lines have been defined based on which of the following are in the most landward position:

- 2050 Zone of Slope Adjustment (adjusted to incorporate Council's latest sea level rise projections);
- General allowable setback from the seaward cadastral boundary for beachfront property being 6 m for single level dwellings and 10 m for multi dwelling structures; and/or
- Existing building lines.

An exception to this approach has been applied to Patonga where an existing/historic building line exists seaward of the general 6/10m setback described above. As these properties are not assessed as being impacted by coastal hazards to 2100, the existing building line will be retained.

The Coastal Building Line attempts to apply an acceptable level of risk. It provides a considered and reasonable balance between a range of factors including:

- Coastal hazards are expected to increase over time due to the projected impacts of climate change. If piling were allowed forward of the coastal building line risk to the development would increase over time within the design life as storms would regularly expose the foundations of the buildings, impacting on beach amenity and potentially beach access during times when the beach is in an eroded state. Thus the piling comes to play only in a storm larger than the design storm rather than being relied upon on a regular basis;
- Potential for piled foundations to increase hazards on neighbouring properties (which may not be piled). Foundations such as piling and especially underground basement structures can have an impact on erosion at neighbouring properties if they are located within the wave impact zone, which would occur if foundations are allowed to be sited within the wave impact zone within the design life of the building;
- Public safety and access issues on all lands;
- Beach amenity, landscape character & view sharing considerations;
- Insurance - coastal risks of storm surge, coastal erosion and gradual sea level rise are excluded by many general insurance policies in Australia. Any impacts on neighbours would not be covered;
- Asset life - New development is not to be directly impacted by wave action and services must be able to be maintained to that development within the development's economic lifespan. For example, the Australian Tax Office allows the entire construction cost of a residential rental property to be deducted over a period of 40 years. From this, it can be inferred that the economic life of a dwelling is 40 years, hence the 2050 planning horizon has been selected;
- Provision of access and services to properties – safe access and services must be maintained to properties during their economic lifespan – for this reason, there must be an



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acceptable risk of development being directly impacted by wave action and services being damaged during the economic lifespan of a property;

- Geotechnical qualities – the properties of the sub-soil will determine the required depth of piling. Where rock is known to occur beneath the dunes at relatively shallow depth, this would reduce the future erodibility of the dune and improve the ability to provide stable building foundations for new developments;
- Challenges in property remediation following an erosion event. Sourcing, screening and placing suitable material to rebuild a dune may be difficult to achieve when it is likely numerous properties on the coast are affected. This creates ongoing safety issues for residents and beach users.

5.3 Recommendations for Revised DCP

Under a revised DCP for coastal development in the Gosford LGA, it is proposed that the following apply:

- Streamlining of coastal hazard planning horizons and coastal building lines occurs for all beaches to provide consistency and simplification.
- New development is to be constructed on deep pile foundations (landward of the coastal building line) for properties in coastal hazard areas where piling is required into 2100 stable foundation zone.
- Piles will be required to be deep enough to resist the lateral forces imposed on them by movement within the soil mass and this would need to be demonstrated by the proponent of a development certifying that this requirement has been met. Updated DCP maps have been produced which identify individual lots within the LGA where this requirement would apply. This is consistent with the existing DCP.
- Cantilevering to be permissible for all properties in designated coastal hazard areas provided certain conditions are satisfied.
- Habitable floor levels for new development identified on the DCP Inundation Maps to be constructed with at least 0.5m freeboard above the 1% AEP maximum wave inundation level, to be demonstrated via a coastal engineering report for that development. The 0.5m freeboard is consistent with the requirements of the NSW Floodplain Development Manual and includes an allowance for sea level rise within the economic lifespan of the development. This is consistent with the existing DCP.
- Removable buildings may be considered within the designated coastal hazard areas provided that it can be shown that they are readily removable and an indemnity is provided.
- The general protocol for defining the setback lines is illustrated in Figure 5.



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- Where new development is to be protected by an existing DA-approved seawall or terminal revetment structure then the general rear-boundary setbacks will apply for areas landward of that seawall.
- Existing buildings which have been identified as being seaward of the coastal building line will be allowed to be renovated only where foundation design is known to have been previously constructed to withstand designated coastal processes and is certified by a coastal and structural engineer as being able to support the proposed structure. Any development application must also provide evidence that the proposed development will not give rise to any increased hazard.
- Geotechnical conditions may influence the ability of properties to be constructed further seaward where it is proven safe to do so.
- For Wamberal Beach, although the recommended management action in the CZMP is for the construction of a Terminal Protection Structure, the coastal building line will apply as an interim measure until construction of the proposed Terminal Protection Structure.
- Council will consider reintroduction of the special building line exemption for Wamberal Beach once an updated and appropriate design for the Terminal Protection Structure is finalised, full funding is guaranteed for construction and ongoing maintenance and relevant approvals have been obtained as required by legislation.
 - It is a recommendation of the CZMP that the design review, environmental approval and development of an appropriate funding mechanism for the Terminal Protection Structure at Wamberal be commenced within one year of CZMP certification.
 - Definitions of 'Major investment' and 'Minor Investment' no longer apply. State Environmental Planning Policy (SEPP) (Exempt and Complying Development Codes) 2008 permits certain development to occur without a Development Application subject to certain criteria.
- Mapping within the DCP amendments will identify lands affected by a coastline hazard, coastal hazard and/or coastal erosion hazard. This delineation will remove the applicability of SEPP (Exempt and Complying Development Codes) from these areas. Subsequently Development Applications will then be required for all proposed developments/activities and merit based assessment will apply.
- 'Maintenance' will continue to be defined as replacing defective, worn-out, rotten and/or damaged materials within the building, that have had development consent, with similar new materials. Maintenance does not include any increase in floor area or the movement of walls, replacement of one type of wall with another (such as replace a timber frame wall with brickwork), building/extending decks, moving kitchens to other areas or changing the roof profile, pitch or height. These definitions are retained within the revised DCP.



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- Wherever present, foredune systems within private property boundaries shall be appropriately rehabilitated and maintained for the life of the development to stabilise an adequate supply of sand.
- The current arrangement under the existing DCP is such that the proponent of a new development would need to execute a positive covenant in favour of Council (pursuant to Section 88E(3) of the Conveyancing Act 1919) requiring the registered proprietor to carry out and maintain works to minimise any threat to the dwelling by the effects of the sea. The positive covenant will be prepared by Council's solicitor at the cost of the registered proprietor. Similarly an indemnity is required to obligate landowners to provide compensation for a particular loss suffered by another person.
- Covenants/indemnities for property behind major infrastructure (i.e. roads, water, sewer etc.) currently apply – the requirement for these is to be reconsidered for minor developments landward of major infrastructure. Clauses will be retained but amended to enable some flexibility in their application.
- It is proposed to retain all other provisions specified in the existing DCP, including the requirement to provide specialist Coastal, Structural and Geotechnical Engineering reports prepared by appropriately qualified, certified practicing engineers supporting proposed development.

5.3.1 Special Considerations

At some of the beachfront lots within the Gosford LGA the projected coastal risk and resultant provisions of the DCP will limit development potential. To improve development potential in those lots severely impacted by coastal hazards, exceptions may be considered.

To improve development potential in the lots severely impacted by coastal hazards, Council could consider the introduction into its DCP of specific location-based exceptions to established rules relating to development footprints, engineered design, cantilevering and setbacks from the street-side property boundary. This would enable ongoing development in the most severely affected lots in the short to medium-term. In doing so, Council must be confident it does not create further legacy implications for future generations. Lots considered to be severely impacted are to be defined in the revised DCP.

5.4 Property Risk and Response Categories

The NSW Government stipulates requirements for Councils to communicate coastal hazard information to purchasers of land subject to coastal hazards via Section 149 certificates – these requirements are outlined below.



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5.4.1 Coastal Hazard notations on Section 149 Certificates

The NSW Planning and Environment Department has outlined guidance for Councils on Section 149 certificate notations relating to coastal hazards. There are two types of information in planning certificates – information under section 149(2) and information under section 149(5).

A planning certificate under section 149(2) includes the mandatory disclosure of matters relating to the land, such as whether a policy (i.e. the DCP) restricts development on land due to a hazard. The notations on the certificates should indicate the type of hazard and whether the hazard is a current or future hazard. In practice for Gosford, all land seaward of the *Present Day Zone of Reduced Foundation Capacity* and for all lots identified as being subject to coastal inundation in the Coastal Process and Hazard Definition Study (WorleyParsons 2014), is subject to a current coastal hazard. All lots that are seaward of the *2100 Zone of Reduced Foundation Capacity* are subject to a future coastal hazard.

A planning certificate may also include information under section 149(5). This allows a council to provide advice on other relevant matters affecting land. This can include past, current or future issues. Inclusion of information under section 149(5) is not a mandatory part of the conveyancing process but any purchaser may request such information be provided, pending payment of a fee to the issuing council. If there is information on coastal hazards that affect a parcel of land, such that it allows the characteristics of the hazard to be described and understood, then the information should be included in a planning certificate under section 149(5). This is the case whether or not relevant provisions of a development control plan apply to the Lot. Section 149(5) provides the means for a council to disclose information about a hazard from the time it comes into knowledge regarding the existence and extent of that hazard (typically evidenced by the adoption by council of a completed investigation or study) until such time that the council has a policy or planning instrument to manage that hazard.



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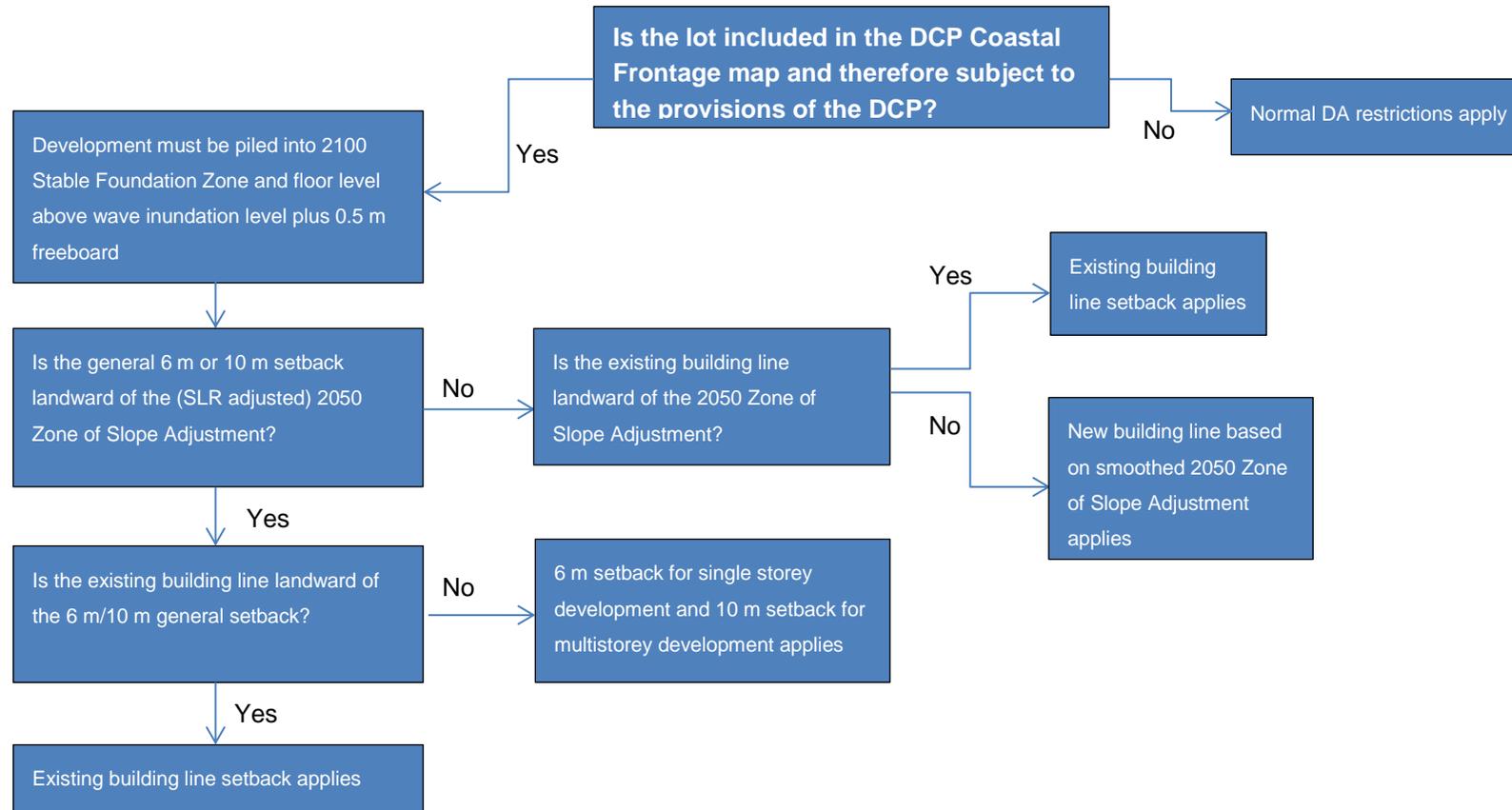


Figure 5 - General protocol used to determine foreshore building lines for revised DCP



6 IMPLEMENTATION, REPORTING AND REVIEW

This section addresses the Minimum Requirement for a description of proposed actions to monitor and report to the community on the Plan's implementation, and a review timetable.

6.1 Plan Implementation and Reporting

Council's Sustainable Corporate & City Planning service unit will be responsible for coordinating the implementation of the actions recommended within this CZMP. This service unit will also be responsible for monitoring implementation and reporting on outcomes in liaison with other sections of Council, key stakeholders and other contributing groups.

The community and key stakeholders will be kept informed of Coastal Zone Management Plan implementation through:

- Media release following Council adoption of the Final CZMP;
- Media release following Ministerial Certification of the Draft CZMP;
- Annual Gosford Coastal Zone Management Reports;
- Public education activities focussing on coastal zone management issues;
- Continuing provision and updating of coastal property hazard maps;
- Updating of Section 149 Property Certificates; and
- Council's annual corporate reporting processes.

Progress on implementation of the CZMP and/or specific achievements will also be reported through an existing dedicated page on Council's website.

6.2 Review of coastal processes and hazard information

The coastal risk assessment undertaken to inform the review of this CZMP involved collation and consideration of coastal data back to 1921. The ongoing monitoring and data collection over that time period that has enabled the development of a thorough understanding of coastal processes and hazards functioning on the NSW Central Coast.

It is understood that the NSW Government currently undertake aerial photography runs on 3-4 year cycles across the entire NSW coast. The imagery gathered is essential in providing for updated photogrammetric analysis of Gosford's beaches. It is not realistic, nor necessarily beneficial, to undertake a full review of the coastal processes and hazards in periods of less than 8-10 years. Periodic coastal risk assessment on this cycle will sufficiently identify trends in beach profiles and enable suitable adjustment to projected recession rates.



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It is important that the review of coastal processes and hazards integrates with any updating of local (or State Government mandated) sea level rise projections.

6.3 Review of development controls

A key mechanism for the implementation of this CZMP is through Chapter 6.2 - Coastal Frontage of the Gosford Development Control Plan 2013 (DCP). A DCP provides detailed planning and design guidelines to support the planning controls in the Gosford Local Environmental Plan 2014 (LEP). It identifies additional development controls and standards for addressing development issues at a local level and can be applied to achieve more flexibly than a LEP.

The Gosford DCP 2013 will be amended to align with this CZMP and will include mapping of properties that require piling and are affected by the Coastal Building Line. This mapping should ideally be reviewed and appropriately adjusted within 12 months of Council reviewing its local Sea Level Benchmarks and/or review of the CZMP.

It is important to retain consistency and minimise uncertainty for property owners who are considering development opportunities. As such it is preferable to avoid coastal planning lines fluctuating over too short a time period.

6.4 Plan review

This Coastal Zone Management Plan should be maintained as required and reviewed in its entirety every 10-15 years from Certification by the relevant Minister. Any review will take account of new data, updated coastline hazards understanding, revised climate change information and changes to legislation.

Earlier CZMP review may be triggered by:

- extraordinary funding becoming available that would permit the implementation of property protection (or other) measures;
- occurrence of a coastal erosion emergency that exceeds the defined hazard extent as outlined in recent coastal risk assessments that redefine the extent of the area covered by the Plan or as a result of unforeseen impacts being experienced by coastal hazards;
- revision of legislation (and associated policy, guides) relevant to the NSW Coastal Zone, to ensure the Plan remains consistent with State objectives;
- unsatisfactory outcomes or concerns following a coastal erosion emergency; or
- Council proposed changes to the adopted Coastal Zone Management Plan.

Likewise, the CZMP may be reviewed in the light of any policy and legislative changes that materially affect its evaluation of alternative management strategies.



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7 CONCLUSION

This Coastal Zone Management Plan has been developed in accordance with the Guidelines for Preparing Coastal Zone Management Plans (OEH 2013). It addresses the minimum requirements to be met in formulation of a CZMP.

The Plan includes proposed management actions over the CZMP's implementation in a prioritised implementation schedule

This Plan has been the result of an extensive development process documented in the following supporting documentation, which together constitutes all the required information to be included in the CZMP:

- A **Coastal Risk Assessment** to identify coastal hazards, management issues and their severity, documented in the Coastal Process and Hazard Definition Study (WorleyParsons 2014). From that study, a series of coastal hazard maps were produced covering each of the beaches in the study area.
- A **Coastal Zone Management Study** to identify and evaluate potential management options to address current and future coastal risk, including climate change (WorleyParsons 2015). That study describes the values of the coastline, as well as the process used to develop the list of management actions included within this CZMP and the public consultation activities undertaken to develop the Plan. The Management Study outlines the geographical and historical setting of the beaches in the study area as well as the study area values, the relevant planning instruments and legislative framework, a summary of the coastal processes in the study area; an overview of the range of available management options, a review of issues and specific options for each precinct.

This Plan provides a list of management actions to be adopted at each beach precinct, with timeframes and budgets for implementation and possible funding sources for those actions.

Landuse and development issues are a major challenge for Gosford LGA. To support the management actions relating to landuse and development, the Plan provides a framework for review of Gosford's DCP Chapter 6.2 Coastal Frontage, together with supporting maps to include in the DCP.

The Plan is intended to be a living document, with a review scheduled in 10 years' time.



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Appendix 1 Detailed Funding Breakdown

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
Pa1 Monitor performance of erosion protection works and monitor beach profile at main carpark (fronting the shops)	<ul style="list-style-type: none"> Undertake inspections and monitoring of performance of works after major storm events Undertake engineering assessment of adequacy of works should future inspections indicate damage. 	Council	Short term/ongoing	Within existing Council budget	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa2 Repair damage to carpark should storm erosion occur	<ul style="list-style-type: none"> Re-instate carpark, pedestrian pathway and beach berm should erosion occur using erosion resistant pavements 	Council	As required	\$150,000 to \$200,000	Council, State Govt., Federal Govt.	\$ 50,000.00	\$ 100,000.00	\$ -	\$ -	\$ -	\$ -
	<ul style="list-style-type: none"> Subject to gazettal of Council as appointed Reserve Trust Manager, complete rehabilitation of the carpark on the foreshore servicing the Patonga boat ramp by: <ul style="list-style-type: none"> Importing road base, spreading and filling potholes Reinstating drainage at the back of the carpark Resurfacing the carpark with a two-coat bitumen seal and Making good the site. (Refer Table 2 Figure 1 in main document for extent of carpark) Note - Council has accepted appointment as Reserve Trust Manager for part of Reserve 66087 – refer Management Action Pa7 	Dol Lands (one-off)	Before end September 2017	\$50,000 to \$100,000	State Government	\$ 50,000.00	\$ 100,000.00	\$ -	\$ -	\$ -	\$ -
Pa3 Investigate feasibility of placement of sand sourced from western beach and shoals at creek entrance to provide buffer against storm erosion	<ul style="list-style-type: none"> Sand to be scraped along beach by over-land equipment from western end of beach adjacent to training wall, sand could also be sourced from maintenance dredging at the creek entrance. 	Council	Investigation/approvals Year 1, works after Year 5, then repeat as required	Initial investigation into dredging, approvals and design \$150,000. Works \$300,000 to \$500,000 (to be allocated after Year 5)	Council, State Govt.	\$ 150,000.00	\$ 150,000.00	\$ -	\$ -	\$ 300,000.00	\$ 500,000.00
Pa4 Beach scraping	<ul style="list-style-type: none"> Sand could be scraped across the beach from the shore line up to the carpark, or along the beach from the large sand supply available at western end of beach adjacent to training wall, which would also help manage shoaling at the entrance to Patonga Creek. 	Council	As required after storms	Cost for initial environmental assessment/approvals \$9,000 - \$12,000 (Year 1) then cost of works as required	Council, State Govt.	\$ 9,000.00	\$ 12,000.00	\$ 20,000.00	\$ 20,000.00	\$ 25,000.00	\$ 25,000.00
Pa5 Future relocation of carpark and associated infrastructure to an area landward of the coastal hazard area	<ul style="list-style-type: none"> Close the existing carpark and replace asphalt with grassed area or dune vegetation. Create a new carpark in a suitable nearby location chosen in conjunction with local stakeholders. 	Council	Long term (> 20 years)	None within next 10 years.	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa6 Stabilisation of dunes in with vegetation and fencing	<ul style="list-style-type: none"> Plant dune vegetation on sandy area at playground to arrest wind erosion Action would be integrated into LGA-wide dune management strategy 	Council	Short term	\$20,000 to \$30,000 initially then \$10,000 p.a. maintenance cost	Council, State Govt	\$ 20,000.00	\$ 30,000.00	\$ 40,000.00	\$ 40,000.00	\$ 50,000.00	\$ 50,000.00

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
Pa7 Monitor and assess existing erosion protection works	<ul style="list-style-type: none"> Undertake inspections and monitoring of performance of works after major storm events Undertake engineering assessment of adequacy of works should future inspections indicate damage. Council has accepted appointment as Reserve Trust Manager for part of Reserve 66087 including the boat ramp and access road.(refer Table 2 Figure 2 in main document for extent of Proposed Reserve area) Refer Management Action Pa2 	Council	Short term/ongoing	Within existing Council budget	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa8 Relocate access road as erosion occurs	<ul style="list-style-type: none"> Remove sections of the existing asphalt access to the boat ramp, reinstate sandy beach in this area, and improve existing access and parking area. 	Council	Long term	None within next 10 years, \$100,000 to \$150,000 once implemented	Council, State Govt., Federal Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa9 Periodic nourishment of area with sand sourced from Patonga Creek entrance	<ul style="list-style-type: none"> Sand could be scraped along the beach by land-based equipment or dredged from the shoals at the creek entrance 	Council, OEH, RMS	Investigation/approvals Year 1, works if required within next 10 years, then repeat as required	Initial investigation into dredging, approvals and design budget included in option Pa3. Works budget to be lumped together with Option Pa3.	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa10 Monitor beach profiles	<ul style="list-style-type: none"> Photogrammetric, LIDAR and land survey 	Council, OEH	Short term/ongoing	Within existing budget allocations.	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa11 Upgrade seawall	<ul style="list-style-type: none"> Replace existing seawall structure with improved design Finalise maintenance repair work that stemmed from the June 2016 storms. 	DoI - Lands	End September 2017	\$200,000 construction + 1% p.a. maintenance	State Govt.	\$ 200,000.00	\$ 200,000.00	\$ 8,000.00	\$ 8,000.00	\$ 10,000.00	\$ 10,000.00
Pa12 Ensure floor levels for new Development Applications are above inundation levels	<ul style="list-style-type: none"> Specify minimum allowable floor levels in the DCP 	Council	Short term/Ongoing	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa13 Upload flood/inundation information onto Council's website for access by property owners	<ul style="list-style-type: none"> Upload flood/inundation information onto Council's website for access by property owners 	Council	Short term	Within existing budget allocations – use existing available information	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa14 Beach scraping and dune management to maintain crest level of dune above wave runup level	<ul style="list-style-type: none"> Sand could be scraped across the beach from the shore line up to the carpark, or along the beach from the large sand supply available at western end of beach adjacent to training wall. Dune vegetation to be maintained and enhanced to assist in stabilising dune. 	Council	As required after storms, linked to action Pa4	Cost for initial environmental assessment/approvals \$9,000 - \$12,000 (Year 1) then cost of works as required. Included in Action Pa4.	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa15 Continue and enhance dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Dune vegetation to be maintained and enhanced to assist in stabilising dune Action would be integrated into LGA-wide dune management strategy 	Council	Ongoing	\$20,000 to \$30,000 initially then maintenance cost	Council, State Govt.	\$ 20,000.00	\$ 30,000.00	\$ 40,000.00	\$ 40,000.00	\$ 50,000.00	\$ 50,000.00

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
Pa16 Undertake survey of floor levels of existing buildings	<ul style="list-style-type: none"> Undertake survey of existing floor levels to inform inundation risk – raising buildings could be examined as an action under a local floodplain management plan. Landowners would be responsible for the raising of the floor levels. 	Council to undertake survey	Medium Term	\$10,000 survey cost. Cost to individual property owners should they choose to raise floor levels.	Private	\$ -	\$ -	\$ -	\$ -	\$ 10,000.00	\$ 10,000.00
Pa17 Monitor and assess existing erosion protection works	<ul style="list-style-type: none"> Undertake inspections and monitoring of performance of works after major storm events Undertake engineering assessment of adequacy of works should future inspections indicate damage. 	Council	Short term/ongoing	Under existing Council budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa18 Implement erosion control works in front of cottages in accordance with Patonga Draft Plan of Management Crown Reserves and Dark Corner Cottages 2013	<ul style="list-style-type: none"> Design and construct new erosion protection works in accordance with recommendations in Patonga Draft Plan of Management Crown Reserves and Dark Corner Cottages 2013. Note that an initial upgrade was undertaken by Dol Lands following the April 2015 storms and minor repair works are currently proposed to repair the works following storms in June 2016. 	Dol Lands	Medium Term	\$30,000 design cost, \$400,000 - \$600,000 construction cost	State Govt.	\$ -	\$ -	\$ -	\$ -	\$ 30,000.00	\$ 30,000.00
Pa19 Investigate periodic maintenance dredging of sand from the creek entrance	<ul style="list-style-type: none"> Investigate the possibility of dredging the entrance to Patonga Creek to improve navigation access 	OEH	Short term	Initial investigation into feasibility included in Action Pa3	State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa20 Investigate lengthening existing entrance breakwater	<ul style="list-style-type: none"> Investigate the design of the existing breakwater at the creek entrance to improve sand trapping efficiency and reduce shoaling of creek entrance 	Council/OEH	Medium-long term	Initial investigation into breakwater can be combined with Action Pa19	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa21 Investigate installation of stormwater energy dissipation to reduce discharge velocities at outlet	<ul style="list-style-type: none"> Dissipate energy in front of stormwater outlet by installing energy dissipation blocks, rock apron, or by other method to reduce velocity of outflows from stormwater outlet 	Council	Short term	Initial investigation into feasibility within existing budget allocations; works cost \$50,000 + maintenance costs	Council	\$ -	\$ -	\$ 50,000.00	\$ 50,000.00	\$ 5,000.00	\$ 5,000.00
Pa22 Post storm beach scraping to assist natural recovery of the dune and repair scour caused by stormwater discharge	<ul style="list-style-type: none"> Undertake beach scraping to repair the scour hole caused by stormwater discharge 	Council	As required	Estimate \$10,000 - \$20,000 annually. Annual maintenance cost may be reduced by implementation of Action Pa21	Council	\$ 10,000.00	\$ 20,000.00	\$ 10,000.00	\$ 10,000.00	\$ -	\$ -
Pa23 Complete a vegetation profile for Patonga Beach and support the natural vegetation profile.	<ul style="list-style-type: none"> Profile the natural vegetation for Patonga Beach and ensure that planting of dune vegetation is consistent with the natural vegetation profile Action would be integrated into LGA-wide dune management strategy 	Council, Dunecare	Short term	\$50,000 to be allocated city-wide	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pa24 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> Works may comprise similar design to existing adjacent works Works could be considered to be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
Pa25 Investigate feasibility of swimming enclosure at Patonga	<ul style="list-style-type: none"> Investigate feasibility of swimming enclosure – this may comprise timber piles with netting 	Council	Short to medium term	Within existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TOTALS						\$ 509,000.00	\$ 642,000.00	\$ 168,000.00	\$ 168,000.00	\$ 480,000.00	\$ 680,000.00

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Public funding		Years 2 - 5		Years 5 - 10		Comments	Private funding		Years 2 - 5		Years 5 - 10	
						Year 1	Year 1	Year 1	Year 1	Year 1	Year 1		Year 1	Year 1				
						Min	Max	Min	Max	Min	Max		Min	Max	Min	Max		
Pe1 Erosion Protection works to be allowed for four properties south of Green Point Creek entrance as well as for sewage pumping station and sewer line at end of Gem Road and south from Gem Road extending to protect infrastructure	<ul style="list-style-type: none"> Works may comprise similar design to existing adjacent works Coordinated buried terminal protection funded jointly by landowners, Council and State Government through Coastal program 	Council, NSW Govt., landowners, works to provide benefit to protect sewer infrastructure and adjacent properties	Short to medium term (0 – 20 years), two of these properties already have protection installed	Design Year 1 \$20,000; works years 5 - 10 \$450,000 to \$600,000	Private, State Govt., Council	\$ 20,000.00	\$ 20,000.00	\$ -	\$ -	\$ 236,250.00	\$ 315,000.00		\$ -	\$ -	\$ -	\$ -	\$ 236,250.00	\$ 315,000.00
Pe2 Monitor performance of existing erosion works at properties south of Green Point Creek entrance	<ul style="list-style-type: none"> Monitor effectiveness of existing works in a future storm event 	Council	Short term/ ongoing	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe3 Relocate sewer infrastructure and pumping station further landward	<ul style="list-style-type: none"> Sewer currently located at the seaward end of the properties – this option would involve investigating the feasibility of moving the sewer landward out of the hazard area along the entire street frontage of Gem Road and Green Point Road 	Council	Short term (0 – 5 years)	Investigation \$20,000 (year 1), works if implemented \$400,000 to \$500,000 (not required if Action Pe1/Pe3 implemented)	Council	\$ 20,000.00	\$ 20,000.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe4 Investigate feasibility/sources of sand for beach nourishment	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Medium term (5 – 20 years)	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	Included in city-wide actions	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe5 Beach scraping to build dune in front of residences, Gem Road and restaurant	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council/OEH	After storm events as required	\$10,000 to \$13,000 plus maintenance cost	Council, State Govt.	\$ 10,000.00	\$ 13,000.00	\$ 10,000.00	\$ 10,000.00	\$ 10,000.00	\$ 10,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe6 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> Works may comprise similar design to existing adjacent works Works could be considered to be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe7 Continue dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm 	Council/OEH	Ongoing	\$100,000 - \$150,000 within next 5 years	Council, State Govt.	\$ 20,000.00	\$ 20,000.00	\$ 80,000.00	\$ 80,000.00	\$ 100,000.00	\$ 100,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe8 Develop entrance management guidelines for mechanical opening of Green Point Creek	<ul style="list-style-type: none"> Formulate an entrance management policy whereby Green Point Creek entrance can be opened at a defined trigger water level and at a defined location on the beach berm to prevent scour in front of the dunes 	Council	Short term	\$3,000	Council, State Govt.	\$ 3,000.00	\$ 3,000.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe9 Development controls as per existing DCP i.e. defined building line with new buildings to be founded into 2100 Stable foundation Zone. Residences and restaurant to be above inundation levels on redevelopment of properties	<ul style="list-style-type: none"> Define a building line and development controls for development within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe10 Investigate "tripper" structure to control opening location of creek	<ul style="list-style-type: none"> Investigate a short buried training wall using reno mattresses to prevent creek from meandering in front of properties at southern end of beach 	Council	Short term	Initial design/investigation \$10,000; works cost \$50,000 – \$100,000	Council, State Govt., Private	\$ 10,000.00	\$ 10,000.00	\$ 50,000.00	\$ 100,000.00	\$ 2,500.00	\$ 5,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe11 Identify floor levels to determine degree of inundation hazard	<ul style="list-style-type: none"> Survey floor levels and compare against wave runoff levels 	Council	Short term	\$10,000	Council	\$ 10,000.00	\$ 10,000.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe12 Complete a vegetation profile for Pearl Beach and support the natural vegetation profile.	<ul style="list-style-type: none"> Profile the natural vegetation for Pearl Beach and ensure that planting of dune vegetation is consistent with the natural vegetation profile. Applies to all precincts of Pearl Beach. Action would be integrated into LGA-wide dune management strategy 	Council/Dunecare	Short term	\$50,000 to be allocated city-wide for all beaches	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe13 Monitor rock pool for storm damage and repair if required	<ul style="list-style-type: none"> Monitor rock pool by regular Council staff inspections, can be done when pool is emptied for cleaning 	Council	Short term/ Ongoing	Monitoring within existing budget allocations; allocate \$5,000 p.a. for repairs	Council, State Govt.	\$ 5,000.00	\$ 5,000.00	\$ 20,000.00	\$ 20,000.00	\$ 25,000.00	\$ 25,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe14 Repair of playground area, toilet block, beach accessways and landscaping works following erosion in a large storm event	<ul style="list-style-type: none"> Restore public reserve and playground area if damaged by future storm erosion 	Council	As required	No capital cost likely to be incurred within the next 10 years; cost \$200,000 - \$250,000 if event occurs	Council, State Govt., Federal Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe15 Beach scraping following storm event to build dune crest level and revegetation	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council	After storm events as required	Included within Action Pe5	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe16 Continue dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm 	Council/OEH	Ongoing	Included in budget for Action Pe7	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Public funding						Comments	Private funding					
						Year 1		Years 2 - 5		Years 5 - 10			Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max		Min	Max	Min	Max	Min	Max
Pe17 Develop entrance management guidelines for mechanical opening of Middle Creek	<ul style="list-style-type: none"> Formulate an entrance management policy whereby Middle Creek entrance can be opened at a defined trigger water level and at a defined location on the beach berm to prevent scour in front of the dunes 	Council	Short term	\$3,000	Council	\$ 3,000.00	\$ 3,000.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe18 Long term removal and relocation of playground should erosion escarpment move landward in future	<ul style="list-style-type: none"> Find an alternative location for the playground at such time as it is damaged by erosion from a future storm event and cannot be reinstated in the same location 	Council	Long term (>20 years)	None by 2025	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe19 Future installation of erosion protection works once erosion escarpment reaches set trigger distance from road edge; or Future closure of road and installation of alternative access (e.g. rear lane access to properties along Pearl Parade)	<ul style="list-style-type: none"> Design erosion protection works to protect Pearl Parade and properties on the landward side from future erosion risk. could be implemented once erosion escarpment reaches set trigger distance from edge of road. Likely not to be required for several years 	Council/OEH	Long term (> 20 years)	None required prior to 2025	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe20 Repair and restoration of Pearl Parade should it be damaged by a future storm	<ul style="list-style-type: none"> Repair and restore Pearl Parade roadway using damage resistant pavements following a large erosion event. Not likely to be required for many years. 	Council/OEH/RMS	Long term (>20 years)	None prior to 2025	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe21 Landward relocation of water supply and electricity should it be damaged by future erosion	<ul style="list-style-type: none"> Landward relocation of services should they be located in the erosion hazard area in the future 	Council/OEH/RMS/services providers	Long term (>20 years)	None prior to 2025	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe22 Development controls as per existing DCP i.e. defined building line for this section of beach with new buildings to be founded into 2100 Stable foundation Zone	<ul style="list-style-type: none"> Define a building line and development controls for development within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe23 Monitor performance, upgrade/repair existing erosion protection works at the restaurant	<ul style="list-style-type: none"> Monitor effectiveness of existing works in a future storm event 	Landholder	Short term and ongoing	N/A	Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe24 Encourage and assist Dunecare group to maintain and revegetate dune after a storm	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm Action would be integrated into LGA-wide dune management strategy 	Council	Ongoing	\$15,000 - \$20,000 p.a.	Council, State Govt.	\$ 15,000.00	\$ 20,000.00	\$ 60,000.00	\$ 80,000.00	\$ 75,000.00	\$ 100,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe25 Post storm beach scraping to assist natural recovery of the dune and repair scour caused by breakout from Pearl Beach Lagoon and Middle Creek	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Repair of scour on the beach berm caused by lagoon breakout 	Council	After storm events as required	Included within Action Pe5	State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe26 Formalise entrance management guidelines for mechanical opening of Middle and Pearl Beach Lagoon entrances	<ul style="list-style-type: none"> Formulate an entrance management policy whereby lagoon entrance can be opened at a defined trigger water level and at a defined location on the beach berm to prevent scour in front of the dunes. Needs to be consistent with requirements in Pearl Beach Lagoon CZMP 	Council	Short term	\$3,000	Council, State Govt.	\$ 3,000.00	\$ 3,000.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe27 Monitor effectiveness of concrete wall on northern bank of outlet	<ul style="list-style-type: none"> Monitor the existing concrete wall following a breakout event to assess any damage or movement 	Council	Short term	Within existing Council budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe28 Continue dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm 	Council/OEH	Ongoing	Included in budget for Action Pe24	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe29 Development controls as per existing DCP i.e. defined building line with new buildings to be founded into 2100 Stable foundation Zone	<ul style="list-style-type: none"> Re-define a building line and development controls for development within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe30 Post storm beach scraping to assist natural recovery of dune	<ul style="list-style-type: none"> Build up sand from the beach berm to provide toe protection to the erosion escarpment and assist natural recovery of the beach 	Council	After storm events as required	Included within Action Pe6	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe31 Investigate feasibility of terminal protection e.g. once erosion escarpment reaches trigger distance from defined building line	<ul style="list-style-type: none"> Design erosion protection works to properties from future erosion risk, could be implemented once erosion escarpment reaches set trigger distance from building line. Likely not to be required for several years 	Council	Long term (> 20 years)	No budget allocated prior to 2025	Council, State Govt., Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe32 Encourage and assist Dunecare group to maintain and revegetate dune after a storm using appropriate endemic vegetation	<ul style="list-style-type: none"> Provide support and education to local Dunecare groups and local residents to maintain dune as required and repair after a storm Action would be integrated into LGA-wide dune management strategy 	Council	Ongoing	\$15,000 - \$25,000 p.a.	Council, State Govt.	\$ 15,000.00	\$ 25,000.00	\$ 60,000.00	\$ 100,000.00	\$ 75,000.00	\$ 125,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe33 Investigate beach nourishment to increase buffer against storm erosion	<ul style="list-style-type: none"> Investigate source of sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion. Not likely to be feasible at this location. 	Council/OEH Council/OEH	Medium term (5-20 years)	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Public funding						Comments	Private funding					
						Year 1		Years 2 - 5		Years 5 - 10			Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max		Min	Max	Min	Max	Min	Max
Pe34 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> Works may comprise similar design to existing adjacent works Works could be considered to be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe35 Post storm beach scraping to assist natural recovery of dune and to maintain crest level of dune above wave runup level	<ul style="list-style-type: none"> Build up sand from the beach berm to provide toe protection to the erosion escarpment and assist natural recovery of the beach. Build this high enough to provide protection against wave inundation. 	Council	As required, once sufficient sand has built up onto the beach	Included within Action Pe5	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe36 Encourage beachfront residents to maintain crest level of dune and vegetate dune on private property in accordance with dune management practice (e.g. community education, provision of free plants)	<ul style="list-style-type: none"> Provide support to local beachfront residents to assist them to maintain the dune in front of their properties 	Council Council	Short term, ongoing	\$5,000 to develop education materials	Council, State Govt.	\$ 5,000.00	\$ 5,000.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Pe37 Development controls as per existing DCP i.e. requirement for floor levels to be above wave runup level and be compatible with inundation hazard	<ul style="list-style-type: none"> Ensure consistency in DCP 	Council	Short term	Existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TOTALS						\$ 139,000.00	\$ 157,000.00	\$ 280,000.00	\$ 390,000.00	\$ 523,750.00	\$ 680,000.00		\$ -	\$ -	\$ -	\$ -	\$ 236,250.00	\$ 315,000.00
Total Public + private						\$ 139,000.00	\$ 157,000.00	\$ 280,000.00	\$ 390,000.00	\$ 760,000.00	\$ 995,000.00							

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Public funding					Comments	Private funding						
						Year 1		Years 2 - 5		Years 5 - 10		Year 1		Years 2 - 5		Years 5 - 10		
						Min	Max	Min	Max	Min		Max	Min	Max	Min	Max	Min	Max
O1 Erosion Protection works to be allowed for four properties and carpark south of Ettalong Creek entrance	<ul style="list-style-type: none"> Coordinated terminal protection constructed along existing embankment funded by landowners Council funded portion to protect carpark Works may comprise engineered revetment placed along existing eroded embankment on seaward side of properties 	Council/OEH/landowners	Short to medium term (0 – 20 years)	\$600,000 - \$800,000	Council, State Govt., Private	\$ -	\$ -	\$ -	\$ -	\$ 207,900.00	\$ 277,200.00		\$ -	\$ -	\$ -	\$ -	\$ 422,100.00	\$ 562,800.00
O2 Monitor performance of existing training wall works along northern side of Ettalong Creek entrance	<ul style="list-style-type: none"> Monitor effectiveness of existing works in a future storm or flood event 	Council/OEH	As required	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O3 Monitor storm run-up levels and dune erosion	<ul style="list-style-type: none"> Survey/observations to be taken post-storm 	Council/OEH	Short term/ongoing	\$5,000 annual budget allocation	Council, State Govt.	\$ 5,000.00	\$ 5,000.00	\$ 20,000.00	\$ 20,000.00	\$ 25,000.00	\$ 25,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O4 Future relocation of residence on No.8 Berrima Crescent landward of immediate hazard area within same lot on redevelopment if revetment wall is not constructed	<ul style="list-style-type: none"> On redevelopment, building to be located landward of hazard zone Property currently has application in place for seawall protection with NSW Coastal Panel which would negate the need for relocation 	Property owner	On redevelopment as per DCP	No budget allocated	Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O5 Investigate feasibility of beach nourishment	<ul style="list-style-type: none"> Import of sand into this portion of the beach to increase buffer against beach erosion 	Council/OEH	Long term (>20 years)	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O6 Beach scraping to build dune in front of residences at Berrima Crescent	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council/OEH	Short term and as required (0-5 years)	Environmental approvals \$20,000, works \$4,000 - \$7,000 p.a.	Council, State Govt.	\$ 20,000.00	\$ 20,000.00	\$ 16,000.00	\$ 28,000.00	\$ 20,000.00	\$ 35,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O7 Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation and consolidation of beach access at southern end of beach	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council	Ongoing	\$15,000 - \$25,000 p.a.	Council, State Govt.	\$ 15,000.00	\$ 25,000.00	\$ 60,000.00	\$ 100,000.00	\$ 75,000.00	\$ 125,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O8 Develop entrance management guidelines for mechanical opening of Ettalong Creek	<ul style="list-style-type: none"> Specify entrance management guidelines for opening of Ettalong Creek to encourage the creek to open in a direction away from the residences at Berrima Crescent 	Council	Short term (0-5 years)	\$3,000	Council, State Govt.	\$ 3,000.00	\$ 3,000.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O9 Voluntary purchase of portion of at risk property	<ul style="list-style-type: none"> Purchase of portion of 8 Berrima Crescent seaward of hazard zone. Resume at-risk portion of land with fair compensation to be negotiated with landowner. Return resumed portion of land to public space e.g. parkland, carparking, beach dune Property currently has application in place for seawall protection with NSW Coastal Panel which would negate the need for purchase 	NSW Govt./Council	Short – medium term	Up to \$1 million but subject to agreement with landholder	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O10 Development controls on redevelopment of properties within hazard area	<ul style="list-style-type: none"> Future development to be located landward of the coastal hazard area and floor levels above inundation level 	Council/landowners	Short term	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O11 Construct “tripper” structure to control opening location of creek	<ul style="list-style-type: none"> Construct a short buried training wall using reno mattresses to prevent creek from meandering in front of properties at southern end of beach 	Council/OEH	Short term	Initial design/ investigation \$10,000; works cost \$50,000 – \$100,000 plus maintenance	Council, State Govt.	\$ 10,000.00	\$ 10,000.00	\$ 50,000.00	\$ 100,000.00	\$ 2,500.00	\$ 5,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O12 Development controls for residences to be above inundation levels on redevelopment of properties	<ul style="list-style-type: none"> Future development to be located landward of the coastal hazard area and floor levels above inundation level 	Council/landowners	Short term	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O13 Monitor existing erosion protection works in front of surf club	<ul style="list-style-type: none"> Monitor effectiveness of existing works in a future storm or flood event 	Council, OEH, SLSC	Short term and following storms as required	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O14 Monitor storm run-up levels and dune erosion	<ul style="list-style-type: none"> Visual observations during storm events; survey marks of debris line 	Council, SLSC	Short term and following storms as required	Within existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O15 Repair of beach accessways and revegetation of dune following erosion in a large storm event	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Consider consolidation of beach accessways along Umina Beach 	Council, OEH	Short term and following storms as required	\$200,000 to \$500,000 to cover entire beach from Ettalong Point to Ettalong Creek	Council, State Govt., Federal Govt.	\$ 20,000.00	\$ 50,000.00	\$ 80,000.00	\$ 200,000.00	\$ 100,000.00	\$ 250,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Public funding		Years 2 - 5		Years 5 - 10		Comments	Private funding		Years 2 - 5		Years 5 - 10	
						Year 1							Year 1					
						Min	Max	Min	Max	Min	Max		Min	Max	Min	Max		
O16 Beach scraping following storm event to build dune crest level and revegetation	<ul style="list-style-type: none"> Push sand from the beach berm to the toe of the dune escarpment 	Council	After storm events as required	Environmental approvals \$20,000, works \$110,000 - \$140,000	Council, State Govt., Federal Govt.	\$ 20,000.00	\$ 20,000.00	\$ 110,000.00	\$ 140,000.00	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O17 Install sand trapping fencing or other appropriate controls in beach access points where sand blowout occurs and in the vicinity of the SLSCs.	<ul style="list-style-type: none"> Installation of sand trapping fencing where required as part of dune management activities 	Council/Dunecare	Short term	\$10,000 plus maintenance	Council, State Govt.	\$ 10,000.00	\$ 10,000.00	\$ 400.00	\$ 400.00	\$ 500.00	\$ 500.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O18 Complete a vegetation profile for Umina and Ocean Beach and support the natural vegetation profile.	<ul style="list-style-type: none"> Profile the natural vegetation for Umina and Ocean Beach and ensure that planting of dune vegetation is consistent with the natural vegetation profile Action would be integrated into LGA-wide dune management strategy 	Council/Dunecare	Short term	\$50,000 to be allocated city-wide for all beaches	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O19 Increase information signage near surf clubs on the ecology and history of Umina/Ocean Beach	<ul style="list-style-type: none"> Provide signage which is not visually obtrusive A separate city-wide coastal zone education program will investigate and implement communication of coastal zone management issues throughout the LGA. 	Council	Short term	\$2,500	Council, State Govt.	\$ 2,500.00	\$ 2,500.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O20 Improve shade areas around the grassed areas and car parks near the SLSCs	<ul style="list-style-type: none"> Tree planting and/or picnic shelters 	Council	Short term	Within existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O21 Maintain current signage and facilities on a regular basis	<ul style="list-style-type: none"> Maintenance of existing facilities and upgrade where required 	Council	As required	\$10,000 - \$20,000 for design and installation	Council	\$ 10,000.00	\$ 20,000.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O22 Encourage and assist Dunecare group to maintain and revegetate dune after a storm using appropriate endemic vegetation	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Short term/ongoing	Part of allocation for Action O7	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O23 Development of local area (Umina/Ocean Beach) online fact sheets and encourage local educational programs in schools regarding the dunes	Action would be incorporated into LGA-wide Coastal Education Strategy	Council/OEH	Short term/ongoing	\$10,000	Council, State Govt.	\$ 10,000.00	\$ 10,000.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O24 Work with the Central Coast Surf Life Saving organisation to look at ways to support Surf Life Savings Australia's EcoSurf policy in the region – including Ocean and Umina Surf Life Saving clubs.		Council	Short term	Within existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O25 Monitor existing erosion protection works in front of surf club	<ul style="list-style-type: none"> Monitor effectiveness of existing works in a future storm or flood event 	Council, OEH, SLSC	Short term and following storms as required	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O26 Monitor storm run-up levels and dune erosion	<ul style="list-style-type: none"> Visual observations during storm events; survey marks of debris line 	Council, SLSC	Short term and following storms as required	Within existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O27 Repair of beach accessways and revegetation of dune following erosion in a large storm event	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Consider consolidation of beach accessways along Umina Beach Action would be integrated into LGA-wide dune management strategy 	Council, OEH	Short term and following storms as required	\$20,000 p.a. for two beach accessway overhauls.	Council, State Govt., Federal Govt.	\$ 20,000.00	\$ 20,000.00	\$ 80,000.00	\$ 80,000.00	\$ 100,000.00	\$ 100,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O28 Beach scraping following storm event to build dune crest level and revegetation	<ul style="list-style-type: none"> Push sand from the beach berm to the toe of the dune escarpment 	Council	After storm events as required	Within budget allocation for action O16	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O29 Install sand trapping fencing or other appropriate controls in beach access points where sand blowout occurs and in the vicinity of the SLSCs.	<ul style="list-style-type: none"> Installation of sand trapping fencing where required as part of dune management activities Action would be integrated into LGA-wide dune management strategy 	Council/Dunecare	Short term	Within budget allocation for action O17	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O30 Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation and consolidation of beach access	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council/OEH	Short term	Within budget allocation for Action O7	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O31 Investigate installation of stormwater energy dissipation to reduce discharge velocities at outlet	<ul style="list-style-type: none"> Dissipate energy in front of stormwater outlet by installing energy dissipation blocks, rock apron, or by other method to reduce velocity of outflows from stormwater outlet 	Council	Short term	\$50,000 plus maintenance	Council, State Govt.	\$ 10,000.00	\$ 10,000.00	\$ 40,000.00	\$ 40,000.00	\$ 2,000.00	\$ 2,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Public funding						Private funding						
						Year 1		Years 2 - 5		Years 5 - 10		Comments	Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max		Min	Max	Min	Max	Min	Max
O32 Post storm beach scraping to assist natural recovery of the dune and repair scour caused by stormwater discharge	<ul style="list-style-type: none"> Undertake beach scraping to repair the scour hole caused by stormwater discharge in the area in front of the surf club 	Council	As required	\$10,000 to \$20,000	Council, State Govt.	\$ 10,000.00	\$ 20,000.00	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
O33 Increase information signage near surf clubs on the ecology and history of Umina/Ocean Beach	<ul style="list-style-type: none"> Provide signage which is not visually obtrusive Action would be incorporated into LGA-wide Coastal Education Strategy 	Council	Short term	\$40,000 to be allocated city-wide for all beaches	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
O34 Improve shade areas around the grassed areas and car parks near the SLSCs	<ul style="list-style-type: none"> Tree planting and/or picnic shelters 	Council	Short term	\$10,000 - \$20,000 for design and installation	Council	\$ 10,000.00	\$ 20,000.00											
O35 Maintain current signage and facilities on a regular basis	<ul style="list-style-type: none"> Maintenance of existing facilities and upgrade where required 	Council	As required	Within existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
O36 Construction of a disabled beach access point outside Ocean Beach SLSC	<ul style="list-style-type: none"> Beach access ramp at required grade and able to be accessed by wheelchairs 	Council	Short term	\$10,000 plus maintenance	Council, State Govt., Private	\$ 10,000.00	\$ 10,000.00	\$ 400.00	\$ 400.00	\$ 500.00	\$ 500.00	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
O37 Encourage and assist Dunecare group to maintain and revegetate dune after a storm using appropriate endemic vegetation	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Short term/ongoing	Part of allocation for Action O7	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
O38 Development of local area (Umina/Ocean Beach) online fact sheets and encourage local educational programs in schools regarding the dunes	Action would be incorporated into LGA-wide Coastal Education Strategy	Council/OEH	Short term/ongoing	Part of allocation for LGA wide Coastal Education Strategy	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
O39 Work with the Central Coast Surf Life Saving organisation to look at ways to support Surf Life Savings Australia's EcoSurf policy in the region – including Ocean and Umina Surf Life Saving clubs.		Council	Short term	Within existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
O40 Monitor storm run-up levels and dune erosion	<ul style="list-style-type: none"> Visual observations during storm events; survey marks of debris line 	Council, SLSC	Short term and following storms as required	Within existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
O41 Repair of beach accessways and revegetation of dune following erosion in a large storm event	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Consider consolidation of beach accessways along Umina Beach Action would be integrated into LGA-wide dune management strategy 	Council, Dunecare	Short term and following storms as required	Within budget allocation for Action O15	Council, State Govt., Federal Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
O42 Beach scraping following storm event to build dune crest level and revegetation	<ul style="list-style-type: none"> Push sand from the beach berm to the toe of the dune escarpment 	Council	After storm events as required	Within budget allocation for action O16	Council, State Govt., Federal Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
O43 Collapse steep eroded escarpment and revegetate following erosion events	<ul style="list-style-type: none"> Temporarily fence off beach section to prevent public access, use excavator to collapse dune escarpment, then revegetate in accordance with the techniques of the Coastal Dune Management Manual (DLWC 2001). 	Council	Short term and as required	\$5,000 for excavator hire per event	Council, State Govt., Federal Govt.	\$ 5,000.00	\$ 5,000.00	\$ 20,000.00	\$ 20,000.00	\$ 25,000.00	\$ 25,000.00	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
O44 Investigate feasibility of beach nourishment to increase erosion buffer at Ettalong Point	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion. Undertake as required Undertake scraping of sand along beach from areas with excess sand as an interim measure. 	Council	Immediate action for scraping of sand along beach from areas with excess sand as an interim measure. Investigation/approvals Year 1, works immediately after in combination with dune management activities	\$50,000 for interim works; \$50,000 for investigation and approvals for nourishment works, \$350,000 p.a. recurrent cost depending on method of nourishment	Council, State Govt., Federal Govt.	\$ 100,000.00	\$ 100,000.00	\$ 1,400,000.00	\$ 1,400,000.00	\$ 1,750,000.00	\$ 1,750,000.00	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
O45 Undertake erosion protection works to protect The Esplanade at Ettalong Point	<ul style="list-style-type: none"> Works may comprise engineered rock revetment works constructed along roadway for a length of around 100 m 	Council/OEH	Short term (0 – 5 years)	\$40,000 design cost, \$1 million at \$10,000/m, \$10,000 p.a. maintenance cost	Council, State Govt., Federal Govt.	\$ 1,040,000.00	\$ 1,040,000.00	\$ 40,000.00	\$ 40,000.00	\$ 50,000.00	\$ 50,000.00	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Public funding						Comments	Private funding					
						Year 1		Years 2 - 5		Years 5 - 10			Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max		Min	Max	Min	Max	Min	Max
O46 Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation and consolidation of beach access	<ul style="list-style-type: none"> Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Action would be integrated into LGA-wide dune management strategy 	Council/OEH	Short term	Within budget allocation for Action O7	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O47 Investigate installation of stormwater energy dissipation to reduce discharge velocities at stormwater outlets	<ul style="list-style-type: none"> Dissipate energy in front of stormwater outlet by installing energy dissipation blocks, rock apron, or by other method to reduce velocity of outflows from stormwater outlet 	Council	Short term	\$50,000 plus maintenance	Council, State Govt.	\$ 10,000.00	\$ 10,000.00	\$ 40,000.00	\$ 40,000.00	\$ 2,000.00	\$ 2,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O48 Post storm beach scraping to assist natural recovery of the dune and repair scour caused by stormwater discharge	<ul style="list-style-type: none"> Undertake beach scraping to repair the scour hole caused by stormwater discharge in the area in front of the surf club 	Council	As required	Within allocation for Action O16	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
O49 Development of local area (Umina/Ocean Beach) online fact sheets and encourage local educational programs in schools regarding the dunes		Council/OEH	Short term/ongoing	Within budget allocation for Action O23	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TOTAL						\$ 1,340,500.00	\$ 1,410,500.00	\$ 1,956,800.00	\$ 2,208,800.00	\$ 2,360,400.00	\$ 2,647,200.00		\$ -	\$ -	\$ -	\$ -	\$ 422,100.00	\$ 562,800.00
Total Public + private						\$ 1,340,500.00	\$ 1,410,500.00	\$ 1,956,800.00	\$ 2,208,800.00	\$ 2,782,500.00	\$ 3,210,000.00							

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
K1 Geotechnical investigation of surf club area	<ul style="list-style-type: none"> Geotechnical drilling to investigate subsurface conditions for surf club. Geotech investigation to confirm condition of surf club footings/piles. 	Council/SLSC	Short term	\$20,000	Council, Private	\$ 20,000.00	\$ 20,000.00	\$ -	\$ -	\$ -	\$ -
K2 Erosion Protection works at surf club if required based on outcome of geotechnical investigation	<ul style="list-style-type: none"> Works may comprise engineered revetment placed along existing embankment on seaward side of surf club 	Council/SLSC	Short to medium term (0 – 20 years)	\$20,000 design cost to be allocated in years 2 – 5, \$700,000 - \$1 million to be allocated after future review of CZMP	Council, State Govt., Private	\$ -	\$ -	\$ 40,000.00	\$ 40,000.00	\$ -	\$ -
K3 Repair damage to surf club carpark should storm erosion occur	<ul style="list-style-type: none"> Restore carpark using damage resistant pavement should it be damaged in a future storm event 	Council/SLSC	As required	\$65,000 to \$130,000	Council, Private	\$ 65,000.00	\$ 130,000.00	\$ -	\$ -	\$ -	\$ -
K4 Investigate feasibility of beach nourishment in front of surf club	<ul style="list-style-type: none"> Import of sand into this portion of the beach to increase buffer against beach erosion 	Council/OEH	Short to medium term	Investigation of feasibility \$10,000. Could be done as part of a city-wide study	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
K5 Beach scraping to build vegetated dune in front of surf club above the wave runup level with vegetation and/or fencing	<ul style="list-style-type: none"> Scrape sand to build a dune in front of the surf club and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). 	Council/OEH	Short term and as required (0-5 years)	Environmental approvals \$20,000, works \$5,000 - \$8,000 p.a.	Council, State Govt.	\$ 25,000.00	\$ 28,000.00	\$ 20,000.00	\$ 32,000.00	\$ 25,000.00	\$ 40,000.00
K6 Future relocation of surf club and associated infrastructure to an area landward of the coastal hazard area if required	<ul style="list-style-type: none"> Relocate surf club to an area outside the erosion hazard zone e.g. adjacent to the main carpark Offer to purchase surf club and provide new site, funded by State Government or jointly with Council at market value 	Council/SLSC	Long term (>20 years)	None required prior to 2025	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
K7 Redevelop surf club on deep piled foundations on future redevelopment	<ul style="list-style-type: none"> On future redevelopment of surf club, reconstruct on deep piled foundations. Existing surf club foundations comprise of piles grout injected socketed into underlying bedrock. 	Council/SLSC	Long term (>20 years)	None required prior to 2025	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
K8 Continue dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Provide support and education to local Dunecare groups and local residents to maintain dune as required and repair after a storm 	Council	Ongoing	\$15,000 - \$25,000 p.a.	Council, State Govt.	\$ 15,000.00	\$ 25,000.00	\$ 60,000.00	\$ 100,000.00	\$ 75,000.00	\$ 125,000.00
K9 Complete a vegetation profile for Putty/Killcare Beach and support the natural vegetation profile.	<ul style="list-style-type: none"> Profile the natural vegetation for Putty/Killcare Beach and ensure that planting of dune vegetation is consistent with the natural vegetation profile 	Council/Dunecare	Short term	\$50,000 to be allocated city-wide for all beaches	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
K10 Move carpark landward in future	<ul style="list-style-type: none"> Move carpark landward as erosion threat increases in future 	Council	Long term (>20 years)	None required prior to 2025	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
K11 Improve stormwater outlet by installing energy dissipation to minimise scour and prevent sand ingress into outlet	<ul style="list-style-type: none"> Install energy dissipation e.g. rocks at outlet to reduce scour caused by stormwater flow 	Council	Short term	\$50,000 + maintenance	Council, State Govt.	\$ 10,000.00	\$ 10,000.00	\$ 40,000.00	\$ 40,000.00	\$ 2,000.00	\$ 2,000.00
K12 Regrade/repair scour caused by stormwater outlet	<ul style="list-style-type: none"> Regrade beach profile to repair scour caused by stormwater outlet 	Council	After storms as required	Within existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
K13 Future relocation of camping area infrastructure to an area landward of the coastal hazard area	<ul style="list-style-type: none"> Undertake pre, during and post storm actions when trigger for action is reached 	OEH (NPWS)	As required	None expected prior to 2025	State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
K14 Monitor beach for erosion in front of surf club and camping area	<ul style="list-style-type: none"> Undertake monitoring of the beach to establish erosion risk to surf club and camping infrastructure 	Council/NPWS/SLSC	Short term/ongoing	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TOTAL						\$ 135,000.00	\$ 213,000.00	\$ 160,000.00	\$ 212,000.00	\$ 102,000.00	\$ 167,000.00

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
M1 Erosion Protection works for Surf Club	<ul style="list-style-type: none"> Works may comprise engineered rock revetment works constructed along face of existing embankment in front of surf club 	SLSC/Council/OEH	Short term (0 – 5 years)	\$40,000 design cost, \$700,000 - \$1 million can be included within budget for Action M4	Council, State Govt., Private	\$ 40,000.00	\$ 40,000.00	\$ -	\$ -	\$ -	\$ -
M2 Monitor performance of existing erosion works around base of Norfolk Island Pine trees and at surf club at southern end of beach and replace/improve as required	<ul style="list-style-type: none"> Monitor effectiveness of existing works in a future storm event 	Council, OEH, SLSC	Short term and following storms as required	Within existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M3 Erosion protection works for Marine Parade	<ul style="list-style-type: none"> Works may comprise engineered rock revetment works constructed along face of existing embankment at Marine Parade and could be a continuation of a revetment provided at the Surf Club. Could be implemented as an emergency or temporary measure. 	Council/OEH/RMS/SLSC	Short term (0 – 5 years)	\$40,000 design cost can be included within allocation for Action M1, \$2.0 - \$3.0 million + maintenance can be shared between all responsible parties	Council, State Govt., Federal Govt., Private	\$ -	\$ -	\$ -	\$ -	\$ 2,100,000.00	\$ 3,150,000.00
M4 Investigate feasibility of beach nourishment in front of surf club and Marine Parade	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Medium term (5 – 20 years)	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M5 Beach scraping to build dune in front of Surf Club, eroded pine tree roots and Marine Parade in the interim until erosion protection works are constructed	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Geotechnical drilling to investigate subsurface conditions on landward side of Marine Parade to inform location of landward limit of Zone of Reduced Foundation Capacity 	Council	After storm events as required	\$20,000 environmental approval, works \$20,000 to \$25,000	Council, State Govt.	\$ 20,000.00	\$ 20,000.00	\$ 20,000.00	\$ 25,000.00	\$ -	\$ -
M6 Undertake geotechnical investigation of area behind Marine Parade	<ul style="list-style-type: none"> Geotechnical drilling to investigate subsurface conditions on landward side of Marine Parade to inform location of landward limit of Zone of Reduced Foundation Capacity 	Council	Short term	\$30,000 but higher if undertaken individually by local landowners	Council, State Govt., Private	\$ 30,000.00	\$ 30,000.00	\$ -	\$ -	\$ -	\$ -
M7 Development controls for residences to be on piled foundations on redevelopment of properties based on defined building line criteria and with new buildings to be founded into 2100 Stable foundation Zone	<ul style="list-style-type: none"> Define a building line and development controls for development within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M8 Landward relocation of sewer infrastructure along Marine Parade if erosion protection works not implemented	<ul style="list-style-type: none"> Reconstruct sewer line on landward side of Immediate Zone of Slope Adjustment line 	Council	Short term (0 – 5 years)	Investigate feasibility \$5,000, works cost \$100,000 to \$200,000 if erosion protection works not implemented	Council, State Govt., Federal Govt.	\$ 5,000.00	\$ 5,000.00	\$ 100,000.00	\$ 200,000.00	\$ -	\$ -
M9 Repair damage to Marine Parade should it be damaged by future erosion if erosion protection works not implemented	<ul style="list-style-type: none"> Repair damage to the road using damage resistant pavements should it be impacted by erosion (i.e. accept existing risk) Undertake repairs to the road as a post-storm emergency measure 	Council/RMS	As required	\$150,000 - \$200,000 to 2020	Council, State Govt., Federal Govt.	\$ -	\$ -	\$ 150,000.00	\$ 200,000.00	\$ -	\$ -
M10 Improve energy dissipation at stormwater outlets	<ul style="list-style-type: none"> Two stormwater outlets – one at Marine Parade Carpark and one draining the reserve near corner of Marine Parade and Gerda Road – provide energy dissipation to reduce impact of scour on beach 	Council	Short term (0 – 5 years)	\$50,000 - \$100,000 + maintenance	Council, State Govt.	\$ 10,000.00	\$ 10,000.00	\$ 40,000.00	\$ 90,000.00	\$ 2,000.00	\$ 4,500.00

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
M11 Periodic beach scraping to repair damage caused by scour from stormwater outlet	<ul style="list-style-type: none"> Scrape sand from beach berm to repair areas scoured by stormwater outflow 	Council	After storm events as required	Environmental approval cost included in Action M6, works cost \$10,000 - \$20,000 p.a.	Council, State Govt.	\$ 10,000.00	\$ 20,000.00	\$ -	\$ -	\$ -	\$ -
M12 Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation	<ul style="list-style-type: none"> Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Action would be integrated into LGA-wide dune management strategy 	Council	Ongoing	\$15,000 - \$25,000 p.a.	Council, State Govt.	\$ 15,000.00	\$ 25,000.00	\$ 60,000.00	\$ 100,000.00	\$ 75,000.00	\$ 125,000.00
M13 Improve pedestrian access onto beach from carpark and minimise scour caused by beach shower	<ul style="list-style-type: none"> Improve pedestrian access onto beach by constructing in accordance with relevant Australian Standard 	Council	Short term (0 – 5 years)	\$20,000	Council, State Govt.	\$ 20,000.00	\$ 20,000.00	\$ -	\$ -	\$ -	\$ -
M14 Monitor rock pool for storm damage and repair if required	<ul style="list-style-type: none"> Monitor rock pool by regular Council staff inspections, can be done when pool is emptied for cleaning 	Council	Ongoing	Monitoring within existing budget allocations; allocate \$5,000 p.a. for repairs	Council, State Govt.	\$ 5,000.00	\$ 5,000.00	\$ 20,000.00	\$ 20,000.00	\$ 25,000.00	\$ 25,000.00
M15 Geotechnical investigation and stability of cliff between 45 and 65 Tudibaring Parade	<ul style="list-style-type: none"> Geotechnical investigation of cliff stability, risk to life assessment 	DPI-Lands Council	Short term	\$30,000	Council, State Govt.	\$ 30,000.00	\$ 30,000.00	\$ -	\$ -	\$ -	\$ -
M16 Development controls for residences on Tudibaring Parade to be on piled foundations on redevelopment of properties based on a defined building line	<ul style="list-style-type: none"> Define a building line and development controls for development within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M17 Not allowing further subdivision of properties on seaward side of Tudibaring Parade	<ul style="list-style-type: none"> Not allow further subdivision of properties on the seaward side of Tudibaring Parade as the seaward side of these lots is subject to unacceptable coastal risk 	Council	Short term	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M18 Investigate feasibility of beach nourishment to increase erosion buffer in this area	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Medium term (5 – 20 years)	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M19 Encourage and assist Dunecare group and local residents to maintain and revegetate dune	<ul style="list-style-type: none"> Provide community education program and material assistance to encourage residents to maintain dune in front of their properties 	Council/OEH	Short term (0 – 5 years)	\$15,000 - \$25,000 p.a	Council, State Govt., Federal Govt.	\$ 15,000.00	\$ 25,000.00	\$ 60,000.00	\$ 100,000.00	\$ 75,000.00	\$ 125,000.00
M20 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> Works may comprise similar design to existing adjacent works Works could be considered to be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
M21 Seaward extension of existing training wall along southern side of entrance	<ul style="list-style-type: none"> Extend existing training wall along southern side of entrance to prevent erosion of toe of dune at southern end of entrance. Links to action M23. 	Council/OEH	Medium term (5 - 20 years)	Investigation cost \$30,000, works and approvals cost \$400,000 - \$500,000	Council, State Govt.	\$ 30,000.00	\$ 30,000.00	\$ -	\$ -	\$ 400,000.00	\$ 500,000.00

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
M22 Undertake review of entrance management procedure as recommended by Gosford Coastal Lagoons CZMP. Implement management actions as required	<ul style="list-style-type: none"> Updated CZMP for Gosford Lagoons includes specific entrance management measures relating to Cockrone Lagoon 	Council	Short term (0 - 5 years)	\$5,000 for review, \$12,000 p.a. ongoing lagoon opening cost	Council, State Govt.	\$ 5,000.00	\$ 5,000.00	\$ 48,000.00	\$ 48,000.00	\$ 60,000.00	\$ 60,000.00
C1 Encourage and assist Dunecare group and local residents to maintain and revegetate dune	<ul style="list-style-type: none"> Provide community education program and material assistance to encourage residents to maintain dune in front of their properties 	Council/OEH	Short term (0 – 5 years)	\$15,000 - \$25,000 p.a.	Council, State Govt., Federal Govt.	\$ 15,000.00	\$ 25,000.00	\$ 60,000.00	\$ 100,000.00	\$ 75,000.00	\$ 125,000.00
C2 Erosion Protection works for Copacabana Beach Surf Club	<ul style="list-style-type: none"> Terminal protection for Copacabana surf club. Surf club is constructed on piles so terminal protection would not improve erosion protection for the building itself but for surrounding land 	Council/SLSC	Medium term (5 - 20 years)	No budget allocated as part of this CZMP, \$600,000 to \$800,000 if required in future	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
C3 Reconstruct SLSC on deep pile foundations on redevelopment of the club	<ul style="list-style-type: none"> Copacabana surf club. Surf club has been recently redeveloped and reconstructed on piles so redevelopment not likely to be required in the short to medium term 	Council/SLSC	Long term	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
C4 Erosion protection works for Del Monte Place to be installed once erosion escarpment reaches set trigger distance from edge of road	<ul style="list-style-type: none"> Not likely to be required for several years as road not within Immediate Zone of Slope Adjustment Engineered buried terminal protection structure to be implemented in the future once roadway subject to immediate erosion hazard risk, or piled seawall on seaward side of road similar to that at Terrigal 	Council/RMS	Long term (>20years)	Medium term design investigation \$40,000. No budget allocated for construction as part of this CZMP	Council, Private	\$ -	\$ -	\$ -	\$ -	\$ 40,000.00	\$ 40,000.00
C5 Landward relocation of sewer and water infrastructure as well as other utilities along Del Monte Place	<ul style="list-style-type: none"> Not likely to be required for several years as services not within Immediate Zone of Slope Adjustment 	Council and relevant services providers	Long term (>20years)	No budget allocated in this CZMP, investigations into feasibility to be done under existing allocated budgets	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
C6 Investigate beach nourishment in front of surf club and Del Monte Place	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Long term (>20 years)	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
C7 Repair damage to Del Monte Place, Surf Club and surrounding land should it be damaged by future erosion	<ul style="list-style-type: none"> Undertake repairs to the road using damage-resistant pavements as a post-storm emergency measure 	Council/RMS	Medium term and as required (> 5 years)	\$300,000 to \$400,000 per event but low probability of occurrence. Budget to be allocated after 2020.	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ 300,000.00	\$ 400,000.00
C8 Long term narrowing, removal and relocation or provision of alternative access for Del Monte Place if erosion protection works are not implemented	<ul style="list-style-type: none"> Long term narrowing of Del Monte Place to a single lane, relocation of services, followed by purchase of an alternative access easement at the rear of the properties for provision of access to properties along Del Monte Place 	Council/RMS	Long term (> 20 years)	No budget allocation within this CZMP	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
C9 Development controls for residences and commercial premises to be on piled foundations on redevelopment of properties based on a defined building line	<ul style="list-style-type: none"> Define a building line and development controls for property within this hazard zone at this portion of beach 	Council	Short term	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
C10 Geotechnical investigation around surf club area and on landward side of Del Monte Place to confirm level of bedrock and reduced foundation capacity hazard	<ul style="list-style-type: none"> Undertake geotechnical drilling to determine the nature of the material under the beach near Surf Club, to determine whether buildings landward of Del Monte Place would be subject to reduced foundation capacity 	Council	Short term (0 – 5 years)	\$30,000	Council, State Govt.	\$ -	\$ -	\$ 30,000.00	\$ 30,000.00	\$ -	\$ -
C11 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> Works could be considered to be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
C12 Improve energy dissipation at stormwater outlet	<ul style="list-style-type: none"> Major stormwater outlet adjacent to surf club 	Council	Short term (0 – 5 years)	\$50,000 + maintenance	Council, State Govt.	\$ 10,000.00	\$ 40,000.00	\$ 1,600.00	\$ 1,600.00	\$ 2,000.00	\$ 2,000.00
C13 Improve existing outlet control structures to prevent scour of the base of the dune	<ul style="list-style-type: none"> Construct a short buried training wall using rock, reno mattresses or geotextile bags to prevent stormwater/creek flows from meandering in front of dune at northern end of beach 	Council	Short term (0 – 5 years)	\$10,000 design/approval \$50,000 construction + maintenance costs 1% p.a.	Council, State Govt.	\$ 10,000.00	\$ 10,000.00	\$ 50,000.00	\$ 50,000.00	\$ 2,500.00	\$ 2,500.00
TOTAL						\$ 270,000.00	\$ 340,000.00	\$ 639,600.00	\$ 964,600.00	\$ 3,156,500.00	\$ 4,559,000.00

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Public funding						Comment	Private funding					
						Year 1		Years 2 - 5		Years 5 - 10			Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max		Min	Max	Min	Max	Min	Max
A1 Construct seawall to protect water and sewer infrastructure and improve beach access/amenity in front of the surf club	Vertical seawall to be implemented to protect water and sewer infrastructure, in accordance with concept presented in Avoca Beach Southern Foreshore Masterplan	Council	Short term	\$3 million including design and environmental approval + maintenance	Council, State Govt.	\$ -	\$ -	\$ 3,000,000.00	\$ 3,000,000.00	\$ 150,000.00	\$ 150,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A2 Survey floor levels to determine degree of inundation hazard	Undertake survey of existing floor levels – raising buildings could be examined as an action	Council	Short term	\$5,000	Council	\$ 5,000.00	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A3 Repair damage to carpark and other infrastructure should storm erosion occur	Restore carpark using damage-resistant pavements should it be damaged in a future storm event	Council	As required, less likely to be required if action A1 implemented	\$150,000 to \$180,000	Council, State Govt., Federal Govt.	\$ 150,000.00	\$ 180,000.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A4 Beach scraping to build vegetated dune in front of carpark	Scrape sand to build a dune in front of the carpark and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001).	Council	Short term (0-5 years)	\$20,000 environmental approval, works \$5,000 p.a.	Council	\$ 25,000.00	\$ 25,000.00	\$ -	\$ -	\$ -	\$ -	Not needed once seawall in place	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A5 Monitor performance of existing rock works in front of surf club and carpark following a large storm	Assess post-storm damage to existing rock protection at Surf Club and carpark to determine level of protection provided and design upgrade if necessary	Council	Short term and as required, in interim until Action A1 implemented	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A6 Development controls based on a defined building line with new buildings to be founded into 2100 Stable Foundation Zone	Define a building line and development controls for property within hazard zone at this portion of the beach	Council	Short term	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A7 Erosion protection works to be allowed for properties for emergency protection	Works may comprise similar design to existing adjacent works	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A8 Investigate beach nourishment to increase erosion buffer in this area	Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion	Council/OEH	Medium term	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A9 Beach scraping to build dune in front of residences	Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001).	Council	Short term (0 - 5 years, ongoing)	Approvals cost included in Action A4, works cost \$50,000	Council, State Govt.	\$ -	\$ -	\$ 50,000.00	\$ 50,000.00	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A10 Repair of beach accessways and revegetation of dune following erosion in a large storm event	Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001).	Council, Dunecare	Short term and following storms as required	\$30,000 - \$40,000 plus maintenance	Council, State Govt., Federal Govt.	\$ -	\$ -	\$ 30,000.00	\$ 40,000.00	\$ 1,500.00	\$ 2,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A11 Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation	Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001).	Council/OEH	Short term	\$10,000 plus maintenance	Council, State Govt.	\$ 10,000.00	\$ 10,000.00	\$ 400.00	\$ 400.00	\$ 500.00	\$ 500.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A12 Monitor Norfolk Island pine stability	Undertake regular inspection of Norfolk Island Pines to ensure root system not unduly damaged by erosion	Council/OEH	Short term and ongoing	Within existing budget allocations	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A13 Development controls for residences to be above inundation levels on redevelopment of properties	As per existing DCP	Council	Short term	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A14 Erosion protection works in front and around the stormwater outlet should storm erosion occur	Work may comprise a suitable apron or rock protection in front of the outlet	Council	Short term	\$100,000 plus maintenance	Council	\$ 100,000.00	\$ 100,000.00	\$ 4,000.00	\$ 4,000.00	\$ 5,000.00	\$ 5,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A15 Improve energy dissipation at stormwater outlets	Dissipate energy in front of stormwater outlet by installing energy dissipation blocks, rock apron, or by other method to reduce velocity of outflows from stormwater outlet	Council	Short term	\$50,000 + maintenance	Council, State Govt.	\$ 10,000.00	\$ 10,000.00	\$ 40,000.00	\$ 40,000.00	\$ 2,000.00	\$ 2,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A16 Development controls for residences to be above inundation levels on redevelopment of properties	Based on findings of Avoca Storm Wave Inundation Study (2009) and Hazard Assessment (2014)	Council	Short term	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A17 Review entrance management guidelines for mechanical opening of Avoca Lake	The entrance management policy and procedure for Avoca Lake is to be reviewed as identified in the Gosford Lagoons planning process	Council	Short term	\$5,000 for review + \$12,000 p.a. average lagoon opening cost	Council, State Govt.	\$ 5,000.00	\$ 5,000.00	\$ 48,000.00	\$ 48,000.00	\$ 60,000.00	\$ 60,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A18 Allow lagoon frontage properties to self-protect	Allow property owners to self-protect when erosion escarpment reaches trigger distance from defined building line	Property owners, Council/Coastal Panel to assess individual DAs	Short term	None allocated in CZMP	Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A19 Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation	Undertake dune management as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001). Remove weeds and install native vegetation. Provide support to local Dunecare groups and local residents to maintain dune as required	Council/OEH	Short term	Within budget allocation for Action A11	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A20 Relocation of sand to improve beach access and amenity	Physical relocation of sand along the beach from entrance area to improve beach amenity elsewhere	Council	Short term/ongoing	Approvals cost included in Action A4, works cost \$5,000 p.a.	Council	\$ 5,000.00	\$ 5,000.00	\$ 20,000.00	\$ 20,000.00	\$ 25,000.00	\$ 25,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A21 Repair damage to carpark and other infrastructure should storm erosion occur	Restore carpark using damage-resistant pavements should it be damaged in a future storm event	Council	As required	\$150,000 to \$180,000 following storm event	Council, State Govt., Federal Govt.	\$ -	\$ -	\$ 150,000.00	\$ 180,000.00	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A22 Beach scraping to build dune in front of carpark and properties 165 Avoca Drive to 15 Ficus Avenue	Build up sand from the beach berm into a dune and vegetate as per standard dune management practice in accordance with the Coastal Dune Management Manual (DLWC 2001).	Council	Short term (0 - 5 years)	\$50,000 every two years	Council, State Govt.	\$ 50,000.00	\$ 50,000.00	\$ 100,000.00	\$ 100,000.00	\$ 100,000.00	\$ 100,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A23 Allowing development landward of a specially defined building line with piled foundations into the 2100 Stable Foundation Zone (i.e. similar to existing DCP, status quo, A4.2)	Define a building line and development controls for property within hazard zone	Council	Short term	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Public funding						Comment	Private funding					
						Year 1		Years 2 - 5		Years 5 - 10			Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max		Min	Max	Min	Max	Min	Max
A24	Development approval conditions for new developments to specify that connection to services are to be maintained by owner in the event of storm erosion	Council	Short term	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A25	Erosion protection works to be allowed for properties	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A26	Monitor storm run-up levels and dune erosion	Council, SLSC	Short term and following storms as required	Within existing budget allocations	Council, Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A27	Terminal seawall protection for all the properties	Landowners, Council, OEH	Long term	No budget allocated as part of this CZMP, to be reviewed following subsequent review of CZMP	Council, State Govt, Federal Govt., Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A28	Terminal seawall protection for the properties north from the Surf Club only	Landowners, SLSC, Council, OEH	Short – medium term (0 – 20 years)	\$40,000 design cost, \$1.2 million approval and construction cost to be allocated after 2020 + maintenance	Council, State Govt, Federal Govt., Private	\$ 40,000.00	\$ 40,000.00	\$ -	\$ -	\$ 210,000.00	\$ 210,000.00	Assumed portion of public funding	\$ -	\$ -	\$ -	\$ -	\$ 1,050,000.00	\$ 1,050,000.00
A29	Investigate beach nourishment to increase erosion buffer in this area	Council/OEH	Short term	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A30	Repair of beach accessways and revegetation of dune following erosion in a large storm event	Council/Dunecare	Short term and following storms as required	\$30,000 - \$40,000 + maintenance	Council, State Govt, Federal Govt.	\$ 30,000.00	\$ 40,000.00	\$ 30,000.00	\$ 40,000.00	\$ 1,500.00	\$ 2,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A31	Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation	Council/OEH	Short term	\$10,000 + maintenance	Council, State Govt.	\$ 10,000.00	\$ 10,000.00	\$ 400.00	\$ 400.00	\$ 500.00	\$ 500.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A32	Development controls for residences to be above inundation levels on redevelopment of properties	Council	Short term	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A33	Improve energy dissipation at stormwater outlets	Council	Short term	\$50,000 + maintenance	Council, State Govt.	\$ 10,000.00	\$ 10,000.00	\$ 40,000.00	\$ 40,000.00	\$ 2,000.00	\$ 2,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A34	Repair damage to surf club carpark should storm erosion occur	Council	As required	\$60,000 to \$80,000	Council, State Govt, Federal Govt.	\$ 60,000.00	\$ 80,000.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A35	Beach scraping to build vegetated dune in front of surf club and carpark above the wave runup level with vegetation and/or fencing	Council	Short term (0-5 years)	\$20,000 environmental approvals, \$4,000 - \$7,000 p.a. works costs	Council, State Govt	\$ 20,000.00	\$ 20,000.00	\$ 16,000.00	\$ 28,000.00	\$ 20,000.00	\$ 35,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
A36	Confirm whether SLSC is constructed on deep pile foundations and reconstruct on deep pile foundations on redevelopment of the club if required	Council/SLSC	Medium term (5 – 20 years)	Within existing budget allocations	Council, Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total						\$ 530,000.00	\$ 585,000.00	\$ 3,528,800.00	\$ 3,590,800.00	\$ 578,000.00	\$ 594,000.00		\$ -	\$ -	\$ -	\$ -	\$ 1,050,000.00	\$ 1,050,000.00
Total public + private						\$ 530,000.00	\$ 585,000.00	\$ 3,528,800.00	\$ 3,590,800.00	\$ 1,628,000.00	\$ 1,644,000.00		\$ -	\$ -	\$ -	\$ -	\$ 1,050,000.00	\$ 1,050,000.00

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Public						Comments	Private					
						Year 1		Years 2 - 5		Years 5 - 10			Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max		Min	Max	Min	Max	Min	Max
TW1 Monitor performance of existing seawall in addressing erosion and inundation	<ul style="list-style-type: none"> Monitor performance of existing seawall structure following storm events and inspect for signs of damage 	Council/OEH	Short term, ongoing	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW2 Monitor beach profile following significant storm events	<ul style="list-style-type: none"> Monitor beach profile following storm events and inspect for signs of damage. Implement actions in Council's Beach Management Policy 	Council	Short term, ongoing	Within existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW3 Investigate beach nourishment to increase buffer against storm erosion	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Medium term	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW4 Repair post-storm damage to existing infrastructure	<ul style="list-style-type: none"> Repair inundation damage should it occur 	Council	Short term, ongoing/as required	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW5 Survey floor levels to determine degree of inundation hazard	<ul style="list-style-type: none"> Undertake survey of existing floor levels – raising buildings could be examined as an action 	Council/SLSC	Short term	\$5,000	Council, Private	\$ 5,000.00	\$ 5,000.00	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW6 Monitor performance of existing seawall against erosion and inundation	<ul style="list-style-type: none"> Monitor performance of existing seawall structure following storm events and inspect for signs of damage 	Council	Short term/as required	N/A	N/A	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW7 Repair post-storm damage to existing infrastructure	<ul style="list-style-type: none"> Repair inundation damage should it occur 	Council	Short term, ongoing/as required	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW8 Investigate sources of sand and feasibility of beach nourishment for Southern Terrigal Beach to increase buffer against storm erosion and improve beach amenity	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to create buffer against storm erosion and improve beach amenity Sand could be scraped along the beach from lagoon entrance area 	Council/OEH	Medium term	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW9 Remove old seawall structure at southern end of beach to improve public safety	<ul style="list-style-type: none"> Old buried seawall has become exposed and poses a danger to beach users at southern end of Terrigal Beach – excavate and remove 	Council	Medium term	\$60,000 excavation, demolition and disposal costs	Council, State Govt.	\$ -	\$ -	\$ 60,000.00	\$ 60,000.00	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW10 Allowing development landward of a specially defined building line with piled foundations into the 2100 Stable Foundation Zone	<ul style="list-style-type: none"> Define a building line and development controls for property within hazard zone at this portion of the beach 	Council	Short term	Within existing budget allocation	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW11 Terminal protection - Council to action review, design and funding of terminal protection structure for Wamberal	<ul style="list-style-type: none"> Works may consist of a buried armour seawall. 	Council, OEH, local landowners	Short –medium term	\$200,000 to review and update existing design, \$13 million to \$15 million environmental assessment and construction cost plus 1% p.a. maintenance	Council, State Govt., Federal Govt., Private	\$ 200,000.00	\$ 200,000.00	\$ 1,950,000.00	\$ 2,250,000.00	\$ 97,500.00	\$ 112,500.00	200 m length of public property protected = 200/1400 m length of frontage = 15% public funding	\$ -	\$ -	\$ 11,050,000.00	\$ 12,750,000.00	\$ 552,500.00	\$ 637,500.00
TW12 Complete a vegetation profile for Wamberal Beach and support the natural vegetation profile.	<ul style="list-style-type: none"> Profile the natural vegetation for Wamberal Beach and ensure that planting of dune vegetation is consistent with the natural vegetation profile 	Council/Dunecare	Short term	\$50,000 to be allocated city-wide for all beaches	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW13 Continue and enhance dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm 	Council/OEH	Ongoing	\$15,000 - \$25,000 p.a.	Council, State Govt.	\$ 15,000.00	\$ 25,000.00	\$ 60,000.00	\$ 100,000.00	\$ 75,000.00	\$ 125,000.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW14 Investigate sources of sand and feasibility of beach nourishment for Wamberal Beach	<ul style="list-style-type: none"> Import of sand into this portion of the beach to increase buffer against beach erosion 	Council/OEH	Short-term	Investigation of feasibility \$50,000. Could be done as part of a city-wide study	Council, State Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW15 Beach nourishment coupled with a terminal revetment to increase buffer against storm erosion	<ul style="list-style-type: none"> Source sand for beach nourishment and place on the beach to build up dune and create buffer against storm erosion 	Council/OEH	Short – medium term	Investigation of feasibility \$50,000. Beach nourishment could be investigated in the review of the revetment design and environmental approvals. Beach nourishment cost estimate approximately \$1 million, implementation in medium term (\$760,000 2004 cost adjusted to 2014 based on ABS annual CPI calculator)	Council, State Govt.	\$ 50,000.00	\$ 50,000.00	\$ 1,000,000.00	\$ 1,000,000.00	\$ -	\$ -	Assume public funding	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TW16 Review entrance management guidelines for mechanical opening of Wamberal Lagoon	<ul style="list-style-type: none"> The entrance management policy & procedure for Wamberal Lagoon is to be reviewed as identified in the Gosford Lagoons planning process. Consultation with NPWS to be undertaken as the lagoon is under the jurisdiction of NPWS. 	Council, NPWS	Short term	\$5,000 + \$14,500 p.a. lagoon opening cost	Council, State Govt.	\$ 5,000.00	\$ 5,000.00	\$ 58,000.00	\$ 58,000.00	\$ 72,500.00	\$ 72,500.00		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

Management Action	Description	Responsibility	Timetable for adoption (short, medium, long term)	Cost	Source of Funding	Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
F1 Geotechnical investigation to determine the Zone of Reduced Foundation Capacity	<ul style="list-style-type: none"> Investigation to determine the Zone of Reduced Foundation Capacity 	Council/OEH	Short term	\$60,000	Council, NSW Govt., Private	\$ 60,000.00	\$ 60,000.00	\$ -	\$ -	\$ -	\$ -
F2 Continue dune vegetation management - Assist/encourage community groups with dune management actions including Dunecare/Bushcare	<ul style="list-style-type: none"> Continue providing support to local Dunecare groups and local residents to maintain dune as required and repair after a storm 	Council/OEH	Ongoing	\$15,000 - \$25,000 p.a.	Council, NSW Govt.	\$ 15,000.00	\$ 25,000.00	\$ 60,000.00	\$ 100,000.00	\$ 75,000.00	\$ 125,000.00
F3 Complete a vegetation profile for Forresters Beach and support the natural vegetation profile.	<ul style="list-style-type: none"> Profile the natural vegetation for Forresters Beach and ensure that planting of dune vegetation is consistent with the natural vegetation profile 	Council/Dunecare	Short term	\$50,000 to be allocated city-wide for all beaches	Council, NSW Govt.	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
F4 Collate geotechnical information obtained from DAs into a central database		Council	Short term	Within existing budget allocations	Council	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
F5 Erosion protection works to be allowed for properties	<ul style="list-style-type: none"> Works may comprise similar design to existing adjacent works Works could be considered to be emergency works if they are in line with the requirements of the Code of Practice under the Coastal Protection Act 	Local landowners, Council/Coastal Panel for DA assessment	Short to medium term, some of these properties already have protection installed	None allocated in CZMP	Private	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
F6 Monitor beach for erosion and cliff lines for instability	<ul style="list-style-type: none"> To be undertaken by an experienced engineering geologist 	Council	Short term, ongoing	\$10,000 p.a.	Council	\$ 10,000.00	\$ 10,000.00	\$ 40,000.00	\$ 40,000.00	\$ 50,000.00	\$ 50,000.00
TOTAL						\$ 85,000.00	\$ 95,000.00	\$ 100,000.00	\$ 140,000.00	\$ 125,000.00	\$ 175,000.00

Management Action	Description	Timing	Cost	Source of Funding		Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
Beaches Water Quality Improvement Plan	This will assist Council in identifying pollutant (stormwater, sewage etc) sources and implementing management response through works, catchment controls, compliance and education activities across the LGA on a priority and integrated approach.	Short (yr. 1)	\$40,000	Council, State and partners		\$ 40,000.00	\$ 40,000.00				
Coastal Zone Education Program	Development and implementation of continuing public education program on coastal management issues and cultural heritage values of the Gosford coastal zone.	Short (yr. 2 - 5)	\$20,000/ year	Council, State and partners				\$ 80,000.00	\$ 80,000.00	\$ 100,000.00	\$ 100,000.00
Coastal Erosion & Inundation Emergency Response Plan	Development of emergency action processes which align with relevant combat agencies, statutory planning and expands approaches present within the Terrigal/Wamberal Emergency Action Plan across all beaches.	Short (yr. 1)	Internal Budget	Council							
Geotechnical database	Establishment of a centralised repository/information system for geotechnical information relevant to coastal frontage development. Individual development proponents will continue to provide geotechnical information in line with DCP requirements. There is an opportunity to collate existing and future information for use in coastal management planning processes to assist in building understanding of geotechnical attributes across coastal hazard areas.	Short (yr. 1)	Internal Budget	Council							
Beach Nourishment Strategy	While beach nourishment studies for parts of Gosford LGA and for other areas along the NSW coastline have been undertaken previously, more detailed work needs to be undertaken to identify LGA wide requirements, sand sourcing and a budget for beach nourishment works.	Short (yr. 2 - 5)	\$50,000	Council/ State				\$ 50,000.00	\$ 50,000.00		
Dune Management and Beach Scraping Strategy	Develop a city wide strategy for Dune Management and Beach to include: <ul style="list-style-type: none"> · Dune vegetation mapping, weed mapping and vegetation profiling; · Developing a works program for individual beaches · Preparation of environmental assessment and obtaining relevant licences. · investigation of reactive scraping following storm events and proactive scraping to build dune while there is sand available on the beach · community engagement and involvement of dunecare/bushcare teams. 	Short (yr. 2 - 5)	\$210,000	Council/ State				\$ 210,000.00	\$ 210,000.00		

Management Action	Description	Timing	Cost	Source of Funding		Year 1		Years 2 - 5		Years 5 - 10	
						Min	Max	Min	Max	Min	Max
Beach & Public Infrastructure Monitoring Program	Develop and implement an ongoing beach and infrastructure monitoring program including: <ul style="list-style-type: none"> · systematic visual inspections and data collation of beach profile and public asset management; · photographic record and survey of wave run up levels following storm events to enable improved comparative analysis 	Short (yr. 1)	Internal Budget	Council							
Rocky shore habitat Inventory & management Strategy	Undertake an inventory and management strategy of rocky shore habitats across the study area. This information will contribute to the sustainable management of key sites in liaison with relevant state government stakeholders.	Short (yr. 2 - 5)	\$25,000/year	Council, State and partners				\$ 100,000.00	\$ 100,000.00		
TOTALS						\$ 40,000.00	\$ 40,000.00	\$ 440,000.00	\$ 440,000.00	\$ 100,000.00	\$ 100,000.00



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**GOSFORD CITY COUNCIL
GOSFORD BEACHES
COASTAL ZONE MANAGEMENT PLAN**

Appendix 2 Wamberal Emergency Action Plan



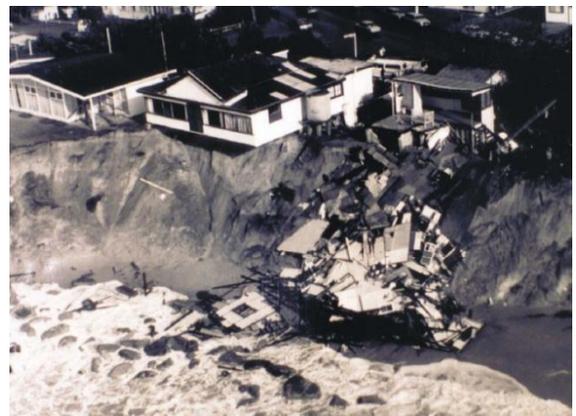
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Coastal Erosion Emergency Action Subplan for Wamberal-Terrigal Beach



15 July 2015

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COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

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COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

1 INTRODUCTION

Coastal communities and local councils are facing difficult issues associated with coastal erosion along the NSW coastline. This issue is not new: records show coastal properties being affected by coastal erosion dating back to the 1940s.

NSW has an established framework for managing coastal erosion risks through the NSW Coastal Policy, the Coastal Protection Act 1979 and the Coastal Protection Regulation 2011. This framework involves local councils, with financial and technical support from the State, undertaking coastal hazard studies and developing coastal zone management plans which then inform land-use planning, development controls and coastal activities. These plans should contain a range of suitable management strategies to inform the community about how coastal erosion will be dealt with in their communities.

Coastal erosion management by local councils

In addition to preparing coastal zone management plans, local councils can carry out activities to reduce the impacts of coastal erosion on property and infrastructure. These activities may include dune restoration, beach nourishment and constructing protection works such as seawalls and groynes.

Under the State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP), councils need to refer coastal protection works proposals to the NSW Coastal Panel.

Councils may also levy a coastal protection service charge on land where the current or past landowners have voluntarily constructed coastal protection works. This charge covers council costs for maintaining the works and restoring the beach if the works cause erosion and must be levied in accordance with adopted guidelines.

Coastal erosion management by private landowners

Landowners in coastal erosion-prone areas can place sand or sandbags on the beach under strict conditions as temporary coastal protection works to reduce the impact of coastal erosion on their property during small storm events. If the bags cause erosion they are to be removed. Coastal erosion-prone areas are defined through a Code of Practice.

Private landowners may also lodge a development application for other coastal protection works. Under the Infrastructure SEPP, the NSW Coastal Panel is the consent authority for long-term coastal protection works where the council does not have a coastal zone management plan in place – where a plan is in place, the council is the consent authority.



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

2 ESTABLISHING THE CONTEXT

An “emergency” is defined in the *State Emergency and Rescue Management Act 1989* and the NSW State Disaster Plan as:

“an emergency due to an actual or imminent occurrence (such as fire, flood, storm, earthquake, explosion, terrorist act, accident, epidemic or warlike action) which:

(a) endangers, or threatens to endanger, the safety or health of persons or animals in the State; or

(b) destroys or damages, or threatens to destroy or damage, any property in the State, being an emergency which requires a significant and co-ordinated response.

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

(a) threats or danger to property includes a reference to threats or danger to the environment, and

(b) the protection of property includes a reference to the protection of the environment.”

A “beach erosion emergency” in the context of this emergency action subplan can therefore be defined as an actual or imminent occurrence of a beach erosion event which “endangers, or threatens to endanger, the safety or health of persons or animals” or “destroys or damages, or threatens to destroy or damage, any property, being an emergency which requires a significant and co-ordinated response.”

The actions contained in this emergency action subplan are triggered by the release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” from the Bureau of Meteorology. This is the same trigger as that used by the State Emergency Service as a primary test of whether or not they should be involved in a potential coastal erosion (and/or inundation) event. In practice, expert engineering judgement would need to be applied at times of storms to assess when to initiate particular actions as required. This approach relies on regular monitoring of environmental conditions and beach behaviour, and seeking appropriate advice when required.

In the *Coastal Protection Act 1979*, an “emergency action subplan” is defined as that part of a coastal zone management plan that deals with the matter referred to in Section 55C(1)(b) of the Act relating to emergency action during periods of beach erosion, namely:

“A coastal zone management plan must make provision for emergency actions carried out during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event.”

On 31 January 2011, the NSW Minister for Climate Change and the Environment (and Minister administering the *Coastal Protection Act 1979*) issued the following directive:



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

“Under the provisions of section 55B of the Coastal Protection Act 1979 (the Act), I direct Gosford City Council to submit a draft emergency action subplan, as defined in the Act, in accordance with the requirements under Part 4A of the Act for the coastline that is a beach from the Wamberal Lagoon entrance south to the Terrigal Lagoon entrance, known as Wamberal/Terrigal Beach¹ to the Minister administering the Act by 31 July 2011”.

Due to ongoing coastal management reforms in NSW this date was extended to 31 May 2014.

¹ The Geographical Names Board of NSW has assigned the name of “Wamberal Beach” to the beach north of Wamberal Lagoon (outside the study area), and the name of “Terrigal Beach” to the beach south of Wamberal Lagoon (covering the study area). However, the name “Wamberal-Terrigal Beach” has been used herein as per the Ministerial Direction and to reflect popular usage of describing the study area as “Wamberal Beach” given that it is located in the suburb of Wamberal (popular usage has “Terrigal Beach” as the name for the beach south of Terrigal Lagoon)



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

3 DEVELOPING THE WAMBERAL-TERRIGAL BEACH EMERGENCY ACTION PLAN FOR COASTAL EROSION

The investigation reported herein is an emergency action subplan for Wamberal Beach as per Section 55C(1)(b) of the *Coastal Protection Act 1979*, intended to meet the requirements of the directive of the then NSW Minister for Climate Change and the Environment (now Minister for the Environment) noted above.

In an emergency action subplan, Council's intended response to a coastal erosion emergency should be outlined, as well as explanation being provided on ways in which beachfront property owners can undertake placement of "emergency coastal protection works" (Office of Environment and Heritage [OEH], 2011).

"Temporary coastal protection works" has a specific meaning in relation to the *Coastal Protection Act 1979*, generally being sand or sandbags (also known as sand-filled geotextile containers) temporarily placed on a beach to reduce beach erosion impacts. To distinguish this specific meaning from the general meaning of emergency coastal protection works in coastal engineering practice (being any works implemented to limit coastal erosion in an emergency), the specific meaning is denoted as "Part 4C sand/sandbags TCPW" of the *Coastal Protection Act 1979*.

OEH (2011) noted that the following are considered to be key elements of an emergency action subplan:

- a clear and concise description of the emergency response actions Council would take when coastal erosion is imminent, occurring or has occurred;
- determination of the criteria or thresholds that would be used to initiate actions under the emergency action subplan;
- identifying actions that would be undertaken before, during and after an erosion emergency; and,
- identifying any site-specific issues that might limit landowners placing "Part 4c sand/sandbags TCPW" at authorised locations.

Note that an emergency action subplan must not include matters dealt with in any plan made under the *State Emergency and Rescue Management Act 1989* (such as a State Emergency Service Local Flood Sub Plan), and no such duplication of material (or change in defined roles and responsibilities) has been included herein.

The investigation herein is set out as follows in relation to the study area of Wamberal-Terrigal Beach:

- the geographical setting is described in Section 4;
- details on historical damage from coastal storms and protective works that have been undertaken are provided in Section 5;
- coastline hazards are defined in Section 6;
- approvals required for implementation of emergency protective works are described in Section 7, both for landowners and Council;



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

- evaluation of potential emergency protection measures is undertaken in Section 8;
- roles and responsibilities of various authorities in coastal emergency management are outlined in Section 9;
- a description of proposed Council actions before, during and after coastal storms is provided in Section 10 (also including discussion on criteria or thresholds to initiate actions);
- details on consultation that has and is proposed to be undertaken are outlined in Section 11;
- key contact details are provided in Section 12; and,
- conclusions and references are provided in Section 13 and Section 14 respectively.

Until longer term coastal erosion risk management measures are implemented as part of a Coastal Zone Management Plan (yet to be prepared) for the study area, the emergency action subplan herein is intended to inform and define Council actions, inform landowners, and meet State Government requirements.

The emergency action subplan herein should be reviewed and amended (if necessary) if any of the following events occur:

- if there is any review of local SES sub plans;
- once a Coastal Zone Management Plan has been completed for the study area; or,
- following a coastal erosion emergency event affecting the study area.



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

4 GEOGRAPHICAL SETTING

An aerial view of the Wamberal-Terrigal Beach study area is provided in **Figure 1**, with a closer view (including house numbers²) in **Figure 2**. There are 69 private lots with beach frontage in the study area (all in the suburb of Wamberal, postcode 2260), namely:

- 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23a, 23, 25, 29, 31 and 33 Pacific Street (17 lots);
- 23a, 23b, 25c, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61³, 63, 65, 67, 73, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99, 101, 101a, 103, 103a and 105 Ocean View Drive (41 lots);
- 2 and 4 Surfers Road (2 lots); and,
- 1, 3, 5, 7, 9, 11, 13, 15 and 17 Calais Road (9 lots).

Public land (Council managed land) with beach frontage in the study area comprises:

- an open space area which has a beach viewing area at its northern end between 25c and 27 Ocean View Drive, which covers the addresses 25b, 25a and 25 Ocean View Drive (Lot 3, Lot 2 and Lot 1 respectively DP 524938 moving south to north) and an undeveloped road reserve, see **Figure 3**;
- an undeveloped road reserve between 65 and 67 Ocean View Drive, on which a beach accessway is located;
- an open space area at 69 and 71 Ocean View Drive (Lot 11 and Lot 10 DP 12022), see **Figure 4**, formerly known as the “Pye” properties (Gosford City Council, 1995);
- beach accessways (undeveloped road reserves) at the seaward ends of Surfers Road and Dover Road; and
- Wamberal Surf Life Saving Club (SLSC), which covers the addresses 1 Remembrance Drive and 20, 18, 16, 14 and 12 Wiles Drive (Lots 6 to 11 DP 14821).

Public and private land with beach frontage in the study area is distinguished in **Figure 5**, with public land further delineated as Council Managed Land, Crown Land or road parcels. It can be noted that a road parcel (undeveloped) extends along the entire length of beach seaward of Wamberal SLSC and the private lots between Wamberal Lagoon and 27 Ocean View Drive. Road parcels are also formed south of 27 Ocean View Drive, between 65 and 67 Ocean View Drive, and at the seaward ends of Surfers Road, Dover Road and Wiles Avenue.

Public beach accessways in the study area are located at the following sites (from south to north):

- south of 27 Ocean View Drive;
- between 65 and 67 Ocean View Drive;
- at the seaward end of Surfers Road
- immediately south of Wamberal SLSC (at the seaward end of Dover Road); and
- at two locations north of Wamberal SLSC, adjacent to its car park.

² Not all numbers are shown for clarity. House numbers not shown can be determined from adjacent depicted numbers, with numbers increasing by two along a particular street moving south to north.

³ Note that there is a single structure at 59-61 Ocean View Drive combined over both lots.



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH



Figure 1: Aerial view of study area at Wamberal-Terrigal Beach



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

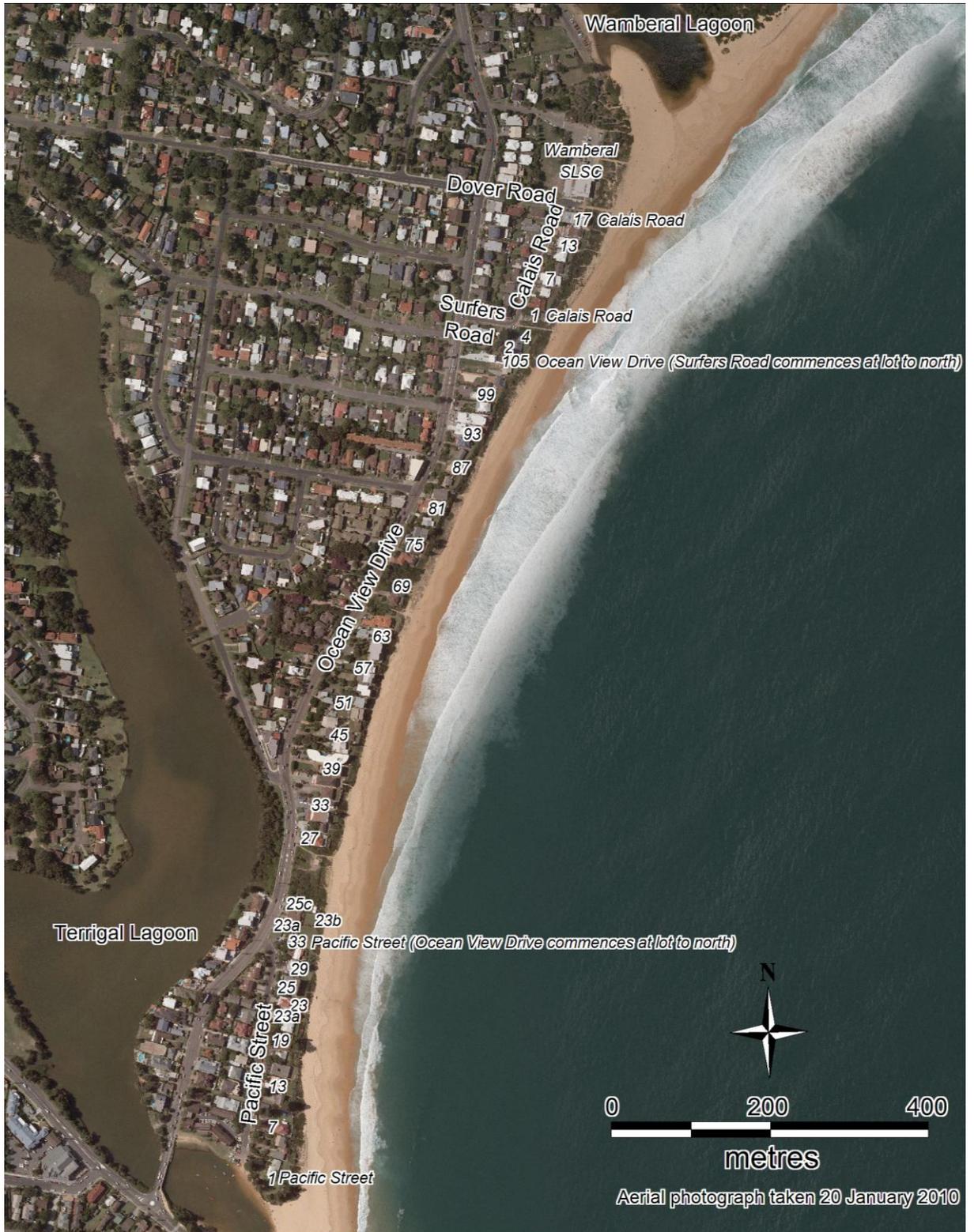


Figure 2: Closer view of Wamberal-Terrigal Beach study area, including house numbers



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH



Figure 3: View of open space between 25c and 27 Ocean View Drive, 22 November 2011



Figure 4: View of open space between 67 and 73 Ocean View Drive, 24 November 2011



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH



Figure 5: Public (Council, Crown and undeveloped roads) and private land in study area



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

The key developed public asset in the study area is thus Wamberal SLSC. A view of this structure is provided in **Figure 6**. Besides relatively minor dune fencing, accessways and bins, the only other public structure of note is the viewing area between 25c and 27 Ocean View Drive as discussed above and shown in Figure 3.



Figure 6: View of Wamberal SLSC from adjacent beach (24 November 2011)

The six public beach accessways in the study area are generally not significant structures, usually comprising sandy pathways with post and wire dune fencing on the sides, with board and chain sections along some accessways (excluding the accessway south of 27 Ocean View Drive adjacent to the viewing area, which has a concrete pathway and concrete steps).

Based on information supplied by Council, the location of minor Council assets in the study area is shown in **Figure 7**. This includes bins, buildings, dune and other fencing, landscaped areas, shelters/tables, signage, and water features such as showers and taps. It is evident that bins, fencing and some signage would be at particular risk of damage from coastal erosion.

No Council stormwater infrastructure discharges on to Wamberal-Terrigal Beach in the study area, with stormwater generally directed landward and located landward of beachfront development⁴ (**Figure 8**). Except at Wamberal SLSC, there is no stormwater infrastructure within 50m of the sand/vegetation interface along the Wamberal-Terrigal Beach study area.

Council also maintains sewer and water assets, with the location of sewer and water mains in the study area shown in **Figure 9**. Again, this infrastructure is located landward of beachfront development (except for a water main north of Wamberal SLSC) and is located at least about 50m landward of the sand/vegetation interface along the Wamberal-Terrigal Beach study area.

Other service providers may also have assets in the study area, such as electricity cables, gas pipes and telecommunications cables.

⁴ Except at the car park north of Wamberal SLSC, where there is a drainage pipe in the vegetated dune.



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH



Figure 7: Location of minor Council assets in study area



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH



Figure 8: Stormwater infrastructure in and adjacent to study area



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

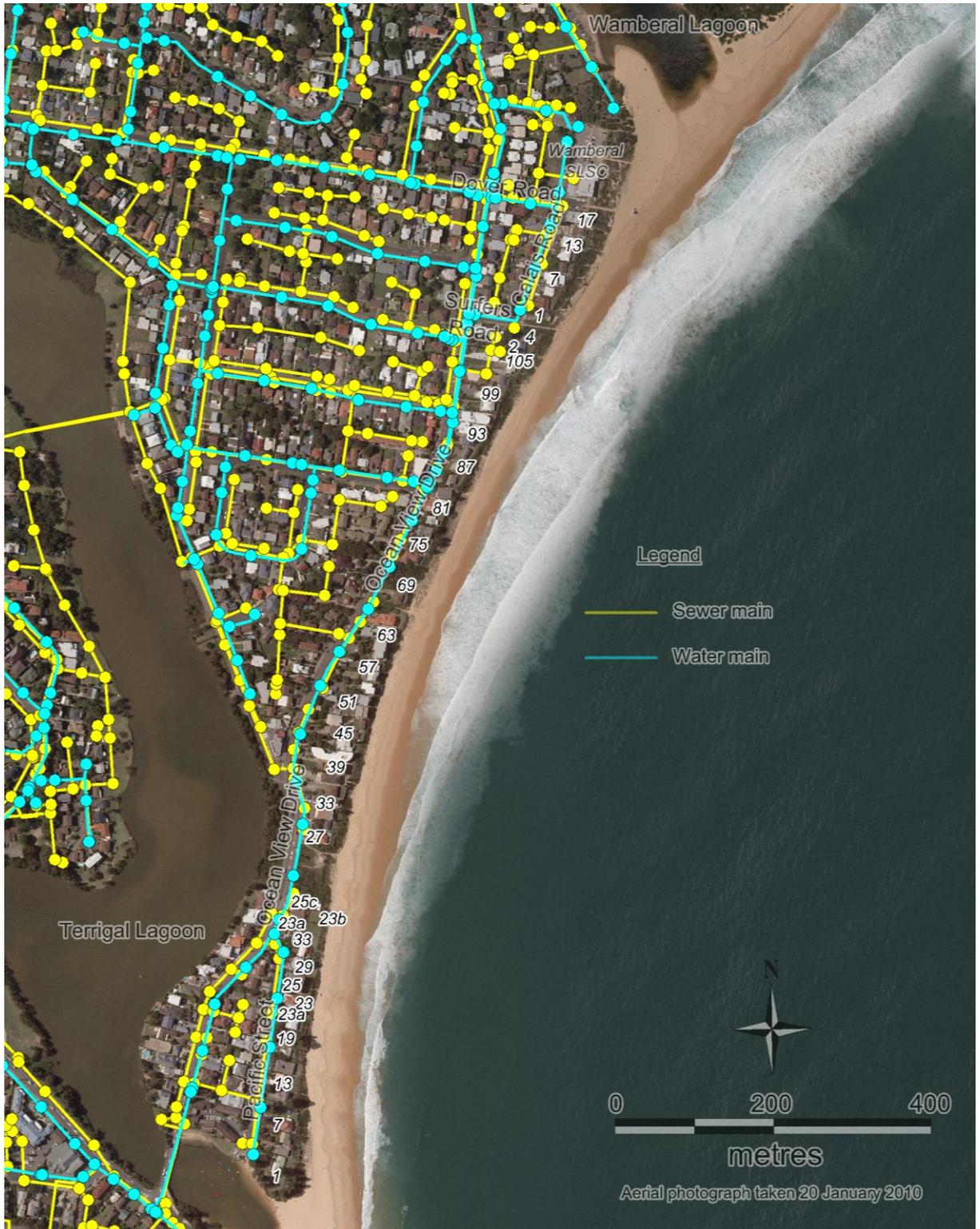


Figure 9: Sewer and water infrastructure in and adjacent to study area



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

5 HISTORICAL DAMAGE AND PROTECTIVE WORKS

Development along Wamberal-Terrigal Beach has been threatened, damaged or destroyed by the action of coastal storms, particularly in the 1960's, 1974 and 1978 (Gosford City Council, 1995). As a result, rock and other material has been placed at some locations in an attempt to prevent property damage. Specifically PWD (1985) noted that:

- major storms of May-June 1974 caused severe erosion of Central Coast beaches, and a house at the northern end of Wamberal-Terrigal Beach was severely damaged as its seaward brick foundation wall was undermined by dune erosion (**Figure 10**); and,
- two houses (at 23a and 23b Ocean View Drive⁵) collapsed due to undermining caused by dune erosion in June 1978, with the first house to collapse shown in **Figure 11**⁶.

PWD (1985) noted that virtually all beachfront development at Wamberal-Terrigal Beach was threatened from severe erosion in the 1974 storms, and that the State Emergency Service and Australian Army were called in and tipped rocks, sand bags and other materials seaward of the eroding dune face. Beachfront property owners also constructed a variety of structures in response, comprising rock rubble, corrugated iron, rubber tyres, besser blocks, concrete walls and gunite (cement, sand, and water applied through a pressure hose).

Newspaper articles at the time of the 1974 storms⁷ indicated that (for example) sand bags were placed at 87 Ocean View Drive, and \$20,000 was spent installing septic tanks to be used as protective works at a home units development (presumably at 25 Pacific Street Wamberal⁵). About 60 homes were at threat in these storms.

Newspaper articles at the time of the 1978 storm⁸ indicated fears that the dune at Wamberal-Terrigal Beach could be cut completely open, causing oceanic inundation to link with Terrigal Lagoon. Five houses were considered to be at particular risk of damage from coastal erosion. A temporary sand and dirt road (washed away and reformed during the storm) was constructed at the base of the eroding dune to allow trucks and bulldozers on to the beach to place rock fill and ballast, including at 23a and 23b Ocean View Drive in an attempt to prevent damage to houses at these properties (at which it was reported that over 10m of lawn on the seaward side of these houses has been eroded). It was also reported that the house at 23a Ocean View Drive had been the oldest surviving house on the beachfront at Wamberal, being 40 years old, and that rocks had been placed there in the 1974 storms.

Couriel et al (1998) noted that other storms since 1974 and 1978 had continued to cause damage to the foreshore and threaten beachfront properties in the study area since that time.

⁵ Based on *Egger v Gosford Shire Council*, Supreme Court of NSW, 67 LGRA, 10 March 1989.

⁶ The second house to collapse (at 23a Ocean View Drive) was immediately to the south of the collapsed house (at 23b Ocean View Drive) in Figure 11 (to the left in the Figure). The next house to the south (far left of Figure 11 at 33 Pacific Street) was relocated about 10m landward to prevent its damage. The Figure was sourced from News Ltd.

⁷ Such as from the *Central Coast Express* (17 June 1974) and *Gosford Star* (“\$20,000 to Hold Back King Tides” on 26 June 1974).

⁸ Such as from the *Central Coast Express* (“Evacuation” on 20 June 1978, “Sea Takes Over” and “Volunteers Jump to Safety; house goes” on 21 June 1978) and *Gosford Star* (“Homes in Danger” on 21 June 1978).



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH



**Figure 10: House severely damaged by dune erosion at Wamberal-Terrigal Beach in 1974
(from PWD, 1985)**



Figure 11: House collapse at Wamberal-Terrigal Beach in June 1978



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

Based on a plan provided by Council, the extent of rock protective works placed in June 1974 was as shown in **Figure 12**. From this, it is evident that private lots with rock protective works near their seaward edge would include:

- 43 (northern half), 45, 51 (northern one-third), 53, 55 (northern 40%), 57, 59, 61, 63, 65, 67, 73 (northern 40%), 75, 81, 83, 87, 89, 91, 93, 95, 97, 99, 101, 103 and 105 Ocean View Drive;
- 2 and 4 Surfers Road; and,
- 1, 3, 5, 7 and 9 (southern one-third) Calais Road.

It is also evident from Figure 12 that public land with rock protective works near their seaward edge would include the road reserve between 65 and 67 Ocean View Drive. Gosford City Council (1995) noted also that, due to protective works undertaken in the 1970's, the public land at 69 and 71 Ocean View Drive was underlain by solid fill (effective protective works) rather than dune sand.

There are also other protective works, rubble placement or retaining walls (that may also act as protective works) that have constructed in the past along Wamberal-Terrigal Beach, as evident in the dune at present, such as (moving south to north):

- some bricks at 9 Pacific Street;
- some rubble at 13, 15 and 17 Pacific Street;
- retaining wall/seawall, rock and some rubble at 19 Pacific Street;
- timber retaining wall structures at 21 (**Figure 13**), 23a and 23 Pacific Street;
- large rock (about 800mm diameter) at 25 Pacific Street (based on *Egger v Gosford Shire Council*⁵, at this site there are also concrete septic tanks filled in sand and gravel, with rock placed landward and in between, and quick-drying concrete placed on top);
- concrete pieces at 29 Pacific Street;
- an upper dune timber retaining wall at 31 Pacific Street;
- large rock (about 700mm diameter) at 33 Pacific Street;
- large rock (about 800mm diameter) on public land between 25c and 27 Ocean View Drive;
- timber retaining walls at 27 (**Figure 14**) and 31 (**Figure 15**) Ocean View Drive;
- a substantial concrete base and concrete besser block seawall at 35 Ocean View Drive (**Figure 16**);
- concrete covered mound at 37 Ocean View Drive;
- timber retaining wall at 41 Ocean View Drive (at upper dune);
- large rock (1m to 2m diameter) at 49 Ocean View Drive (**Figure 17**);
- vertical concrete seawall at 53 Ocean View Drive (**Figure 18**);
- small rock and rubble at 55 Ocean View Drive;
- large rock at 57 Ocean View Drive;
- rock blanket (200mm diameter rock in wire baskets) and vitrified clay hexagonal pipe "seabee" units at 59-61 Ocean View Drive (**Figure 19**);
- some rubble at 65 Ocean View Drive;
- some rock at 67 Ocean View Drive;
- upper dune timber retaining walls at 75, 79, 81 and 83 Ocean View Drive (with some rock exposed at toe of dune at 75 and 81);
- rubble at 85 Ocean View Drive;
- some rock at 91 Ocean View Drive;
- upper dune timber retaining wall and some rock/rubble at 93 and 95 Ocean View Drive;



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

- some rubble at 97 Ocean View Drive;
- upper dune timber retaining wall at 97 Ocean View Drive;
- some rock at 101, 103 and 105 Ocean View Drive (800mm diameter);
- upper dune proprietary concrete retaining wall at 1 Calais Road;
- upper dune timber retaining wall and rubble at 3 Calais Road (**Figure 20**);
- upper-mid dune timber retaining wall at 5 Calais Road; and
- timber retaining walls and rubber tyres at 7 Calais Road.

Note that the above comments are based on what was observable in field inspections. Other protective works would be buried beneath the dune and/or dune vegetation at some locations, and hence not be visible at present.

As full details of historical protective works (1974 and 1978 rock fill and other works and structures listed above) are unknown or uncertain (such as crest and toe levels and rock size where relevant), the future effectiveness of these protective works cannot be determined (and certainly not guaranteed) at this point in time.

There is also an area known to have a high subsurface conductivity (which may relate to a non-sandy subsurface) along the Wamberal-Terrigal Beach study area, in the vicinity of 81 to 97 Ocean View Drive (Coastal & Marine Geosciences, 1997). This includes residual clays (Gosford City Council, 1995; Douglas Partners, 2005) and weathered siltstone/claystone (Jeffery and Katauskas, 2007) located in the dune, which would be expected to have significant resistance to coastal erosion and recession where present. Site-specific geotechnical investigations would be required to assess the nature of the subsurface at particular properties in this area.

It should be noted from Section 55ZA of Coastal Protection Act that a Coastal Authority may order a person who is the owner or occupier of beachfront land to remove a coastal protection structure (including those listed above) if the structure was not lawfully erected and if the structure, in the opinion of the Coastal Authority:

- causes or is likely to cause increased erosion of a beach or land adjacent to a beach, or
- unreasonably limits or is likely to unreasonably limit public access to a beach or headland, or
- poses or is likely to pose a threat to public safety.



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH



Figure 12: Extent of rock protective works placed in June 1974



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH



Figure 13: Timber retaining wall at 21 Pacific Street, 22 November 2011



Figure 14: Timber retaining wall at 27 Ocean View Drive, 22 November 2011



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Figure 15: Timber retaining wall at 31 Ocean View Drive, , 24 November 2011



Figure 16: Concrete seawall at 35 Ocean View Drive, 24 November 2011



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Figure 17: Rock exposed in dune at 49 Ocean View Drive, 24 November 2011



Figure 18: Vertical concrete seawall at 53 Ocean View Drive, 24 November 2011



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH



Figure 19: Rock basket and “seabee” protective works at 59-61 Ocean View Drive, 24 November 2011



Figure 20: Timber retaining wall and rubble at 3 Calais Road, 24 November 2011



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

6 COASTLINE HAZARDS

Ignoring protective works (that is, assuming an entirely sandy subsurface), the approximate predicted landward extent of erosion in a severe (in the order of 100 year average recurrence interval) coastal storm at present is as shown in **Figure 21** and **Figure 22** for the southern and northern halves of the study area respectively. The hazard mapping in Figure 21 and Figure 22 is based on the most recent hazard information. Two Immediate Coastline Hazard Lines are defined, representing the following zones as per Nielsen et al (1992):

- the landward edge of the Zone of Slope Adjustment (ZSA), which is delineated to encompass that portion of the seaward face of the beach that would slump to the natural angle of repose of sand following removal by wave erosion of the design storm erosion volume; and
- the landward edge of the Zone of Reduced Foundation Capacity (ZRFC), which is delineated to take account of the reduced bearing capacity of the sand adjacent to the storm erosion escarpment (the factor of safety within this zone is less than 1.5 during extreme scour conditions at the face of the escarpment).

Based on aerial photography as of 20 January 2010, it is evident that (ignoring protective works) most development in the study area at Wamberal-Terrigal Beach has some portion located seaward of both the Immediate ZSA and Immediate ZRFC. Of the 69 private lots with beach frontage in the study area, 68 are presently developed (have a dwelling constructed on the lot), with 67 private dwellings in the study area³. Of these 67 dwellings (ignoring structures such as beach access stairways):

- 61 dwellings have some portion seaward of the Immediate ZSA, with the 6 dwellings that are located entirely landward of the Immediate ZSA being at 9 Pacific Street⁹, 33 Pacific Street, 47 Ocean View Drive¹⁰, and 11, 15 and 17 Calais Road;
- 65 dwellings have some portion seaward of the Immediate ZRFC, with the 2 dwellings that are located entirely landward of the Immediate ZRFC being at 9 Pacific Street⁹ and 47 Ocean View Drive¹⁰; and
- 24 dwellings have a substantial proportion of their footprint seaward of the Immediate ZSA (that is, would be at particular risk ignoring protective works and piled development), namely at 5, 7, 11, 23a and 31 Pacific Street; 27, 29, 49, 51, 53, 55, 57, 59-61, 67, 75, 77, 79, 81, 83, 85, 89, 101, and 103 Ocean View Drive; and 4 Surfers Road.

Of the structures on public land in the study area:

- the viewing area south of 27 Ocean View Drive is located entirely seaward of the Immediate ZSA (that is, would be at particular risk ignoring protective works and piled foundations); and
- Wamberal SLSC is located entirely landward of the Immediate ZSA and ZRFC, so is at relatively low risk from coastal erosion at present.

⁹ There is a small detached structure located entirely seaward of the Immediate ZSA at this property, separate from the main dwelling.

¹⁰ Ignoring a detached deck structure located well seaward of the Immediate ZSA.



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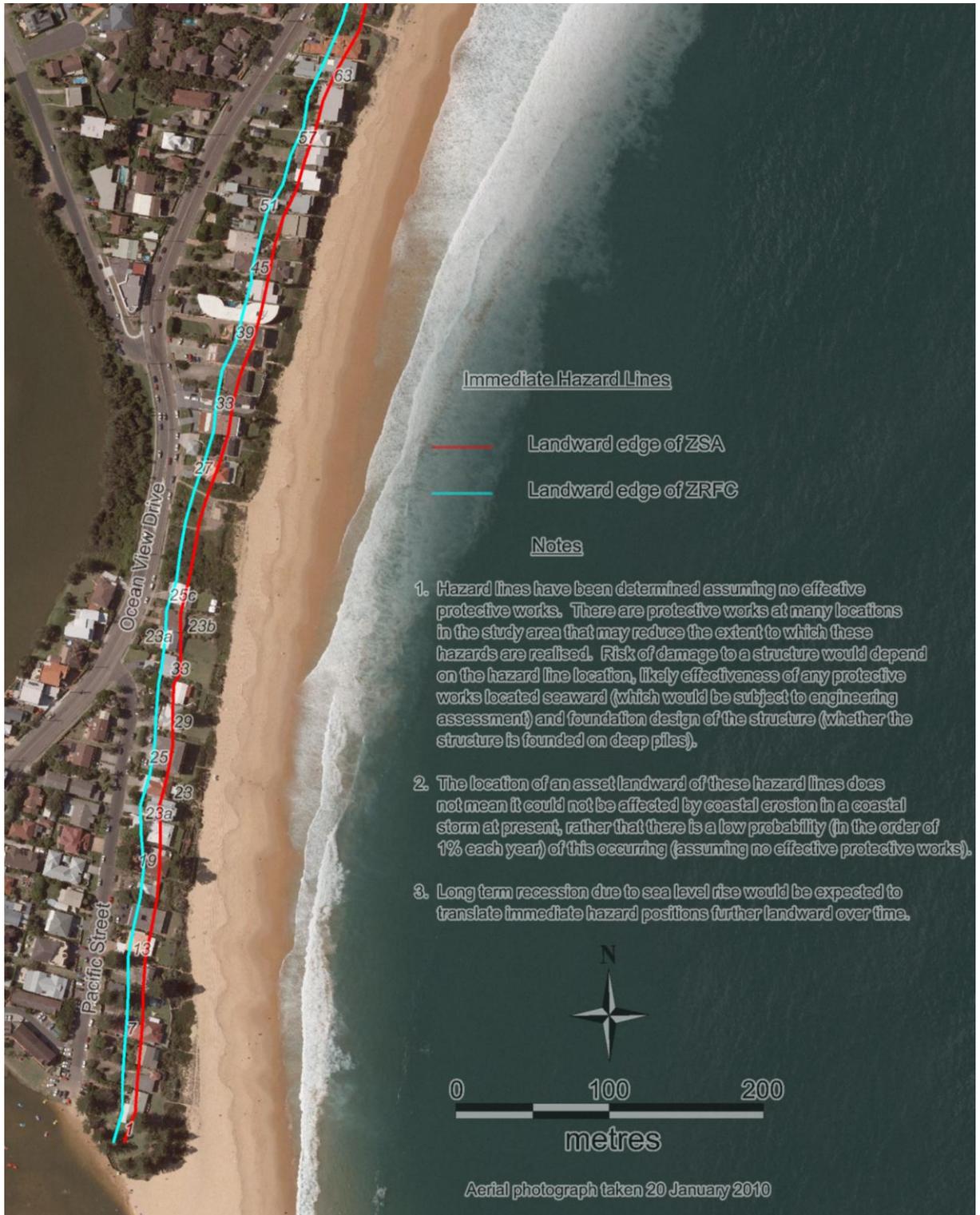


Figure 21: Immediate Coastline Hazard Lines at landward edge of Zone of Slope Adjustment (ZSA) and Zone of Reduced Foundation Capacity (ZRFC) in southern half of study area (ignoring protective works)



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

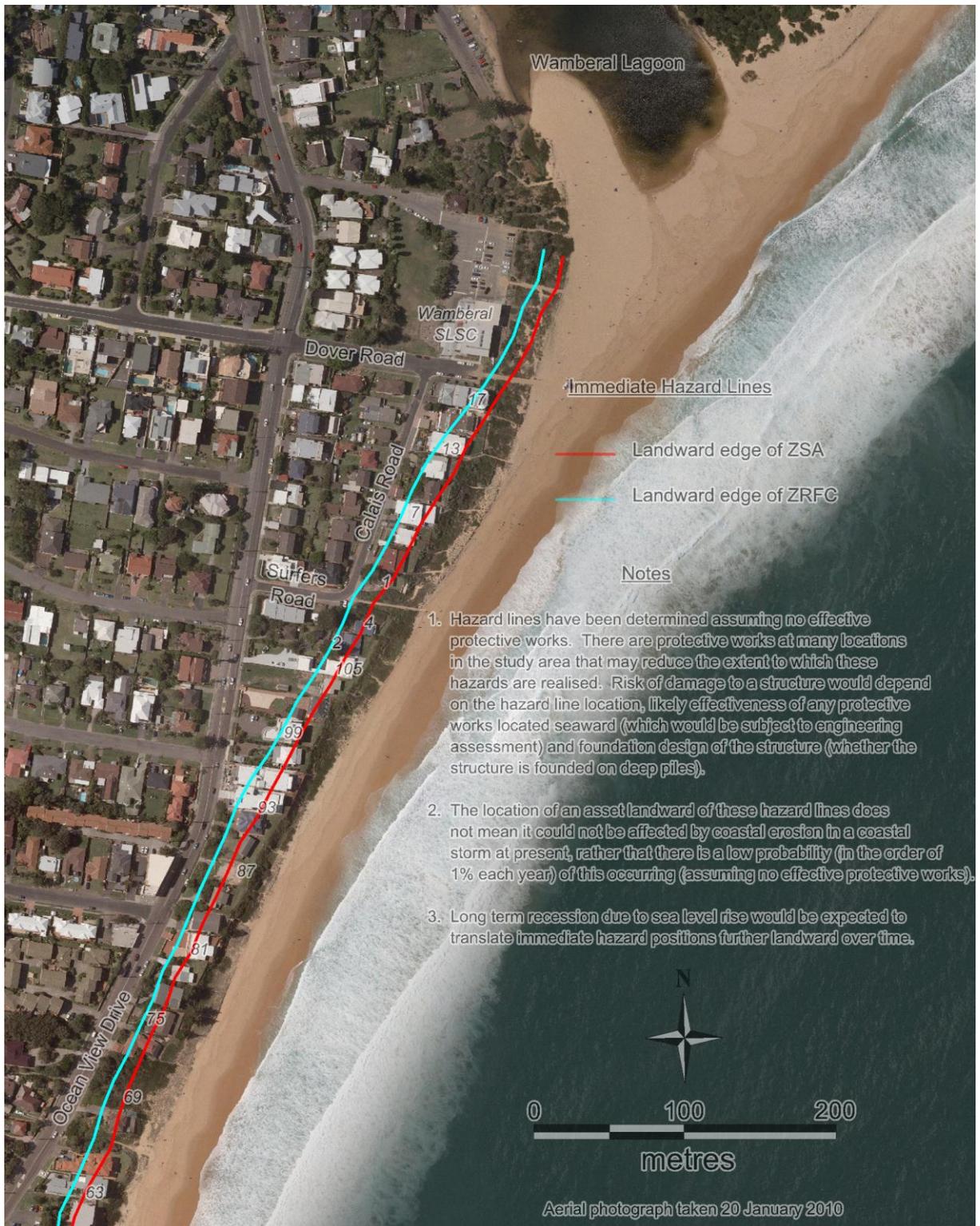


Figure 22: Immediate Coastline Hazard Lines at landward edge of Zone of Slope Adjustment (ZSA) and Zone of Reduced Foundation Capacity (ZRFC) in northern half of study area (ignoring protective works)



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

To assess the risk of damage to structures in the study area, it would be necessary to:

- evaluate the effectiveness of protective works located seaward, which would require knowledge of toe levels, crest levels, and size of the structural elements in the works (such as rock size where applicable);
- have knowledge of the foundation conditions of the structure (in particular whether the development was founded on deep piles); and,
- have undertaken geotechnical investigations in areas known to have a non-sandy subsurface (in particular between 81 and 97 Ocean view Drive).

A methodology to use the above information (along with the position of the Immediate ZSA relative to the position of the structure) to define the risk of damage to development from coastal erosion is described by Horton et al (2011) and Roberts and Horton (2011).

Note that coastline hazard lines are expected to translate landward in the future due to long term recession caused by sea level rise and/or net sediment loss. However, this has not been considered herein given the short-term focus of emergency actions.

Assets in the study area may also be subject to inundation hazards from wave overtopping of the dune or foreshore. Coastal inundation is the flooding of coastal lands by ocean waters, which is generally caused by large waves and elevated water levels associated with severe storms. Wave runup refers to the rush of water up a structure or beach on the breaking of a wave. The amount of run-up is the vertical height above still water level that the rush of water reaches. Assets with floor levels less than 0.5m above surrounding natural ground levels and lower than 6m AHD would be particularly vulnerable to coastal inundation caused by wave runup, but note that maximum wave runup levels in severe storms can exceed 8m AHD where the foreshore extends up to that level.

In the study area, ground levels at the seaward edge of development are approximately as follows (from south to north), reducing moving seaward unless stated otherwise:

- 7m to 7.5m AHD from 1-11 Pacific Street;
- 6m to 6.5m AHD from 13-15 Pacific Street;
- 7.5m to 8m AHD from 17-33 Pacific Street;
- 5.5m to 6m AHD from 23a-25c Ocean View Drive;
- crest of 6.5m AHD along public land between 25c and 27 Ocean View Drive;
- 8.5m from 27-31 Ocean View Drive;
- 7.5 to 8m AHD at 33 Ocean View Drive;
- 9m to 9.5m AHD from 35-49 Ocean View Drive;
- 8.5m to 9m AHD from 51-53 Ocean View Drive;
- 9.5m to 10m AHD from 55-61 Ocean View Drive;
- 8.5m to 9m AHD from 63-67 Ocean View Drive;
- crest of about 8.5m AHD along public land between 67 and 73 Ocean View Drive;
- 8m AHD at 73 Ocean View Drive;
- 9m to 9.5m AHD from 75-81 Ocean View Drive;
- 10m to 10.5m AHD from 83-87 Ocean View Drive;
- 11m AHD at 89-95 Ocean View Drive;
- 9.5m to 10m AHD from 97-105 Ocean View Drive and 2-4 Surfers Road;
- 11m AHD at 1-11 Calais Road;



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- 9m AHD at 13 Calais Road;
- 8m AHD at 15 Calais Road;
- 7m AHD at 17 Calais Road;
- 5.5m AHD at Wamberal SLSC, with a dune crest of about 6.5m AHD located seaward.

Accordingly, the areas at most risk from inundation (particularly where floor levels are less than 0.5m above surrounding natural ground levels) would be at 23a-25c Ocean View Drive and at Wamberal SLSC.

Inundation hazards can be managed through maintaining a difference in height between floor levels and ground levels, and/or by applying risk minimisation measures such as:

- using construction materials that would not be adversely damaged by inundation, such as concrete floors;
- placing electrical equipment, wiring, or any other service pipes and connections that could be damaged by water at a suitably high level;
- storing goods or materials that could potentially be water damaged or water polluting at a suitably high level;
- using impact resistant construction materials in areas that may be subject to direct wave action; and,
- maintaining seawalls seaward of development at a suitably high crest level.



7 APPROVALS REQUIRED FOR IMPLEMENTATION OF TEMPORARY PROTECTIVE WORKS

7.1 Approvals Required by Landowners

7.1.1 Preamble

There are two options available for landowners considering construction of temporary coastal protective works at their property, namely either:

- undertaking temporary sand/sandbags “temporary coastal protection works” (as defined under Part 4c of the *Coastal Protection Act 1979*) at limited authorised locations, denoted herein as “Part 4c sand/sandbags TCPW”; or,
- installation of emergency or long term coastal protective works of any form based on *State Environmental Planning Policy (Infrastructure) 2007* (denoted as *SEPP Infrastructure* herein).

The approvals required for installing these works are described in Section 7.1.2 and Section 7.1.3 respectively.

It is emphasised that landowners must act well (generally months) in advance of a storm to consider implementing either of these works. It should also be noted that landowners are not permitted to install coastal protective works without following these procedures, and severe penalties may apply if they are not followed.

7.1.2 “Part 4c Sand/Sandbags TCPW”

“Part 4c sand/sandbags TCPW” comprise either:

- sand-filled geotextile containers each of maximum 0.75m³ filled volume stacked in a single layer up to 1.5m high (at a slope flatter than 34° from the horizontal, that is flatter than 1:1.5 vertical:horizontal); or,
- clean sand placed up to the crest on the seaward side of an eroding escarpment.

“Part 4c sand/sandbags TCPW” are only permitted at authorised locations, namely only at Wamberal-Terrigal Beach, North and South Avoca Beach, Forresters Beach, Copacabana-MacMasters Beach, Pearl Beach and Patonga Beach in the Gosford Local Government Area (LGA). On the basis of information presented in Section 5, locations at Wamberal-Terrigal Beach that may not have existing effective¹² protective works or inerodible subsurfaces (and hence where “Part 4c sand/sandbags TCPW” may be feasible) are at (see **Figure 23**):

- 1, 3, 5, 7, 9, 11, 13, 15, 17, 29 and 33 Pacific Street;

¹² Non-inclusion of a property in the list of locations where “Part 4c sand/sandbags TCPW” can be undertaken should not be considered as a guarantee that protective works at that location would be effective against future coastal storms. Rather, non-inclusion was on the basis that existing protective works were considered to be likely to be more effective than “Part 4c sand/sandbags TCPW”. That stated, many of these existing works would be expected to fail in a severe coastal storm.



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- 23a, 23b, 25c, 29, 33, 39, 41, 43 (southern half), 47, 51 (southern two-thirds), 55 (southern 60%), 73 (southern 60%), 77, and 79 Ocean View Drive;
- 2 and 4 Surfers Road (2 lots); and,
- 1, 9, 11, 13, 15 and 17 Calais Road.

Note that many of these locations have evidence of protective works, but have still been listed above as the extent of these works is unknown. Given the uncertainty relating to the extent of historical protective works and inerodible subsurfaces, it may be feasible for other properties not listed above to undertake “Part 4c sand/sandbags TCPW”, if desired.

“Part 4c sand/sandbags TCPW” are meant to reduce the erosion threats to houses while landowners identify more permanent solutions and consider seeking approval for permanent works. That stated, “Part 4c sand/sandbags TCPW” are not recommended by Council for use as long term coastal protection works by authorised landowners at Wamberal-Terrigal Beach and are subject to various limitations, such as:

- the designated bag (sand-filled geotextile container) size of 0.75m³ is not stable under severe open coast wave action, with design wave heights to cause damage of bag structures at a slope of 1:1.5 (vertical:horizontal) of only about 1m to 1.5m (Coghlan et al, 2009);
- only limited beach excavation can be undertaken, meaning that the structure toe level would most likely be inadequate;
- the maximum allowable structure height of 1.5m would not be expected to provide adequate protection of eroded escarpments up to about 10m high, as may occur at Wamberal-Terrigal Beach in severe storms; and,
- the bags would be difficult to install in an emergency as they require adequate foundation and careful placement (it is also not allowable to install the works during storm conditions unless a professional engineer advises that such placement would not present a significant safety risk).

“Part 4c sand/sandbags TCPW” must be placed in accordance with the requirements of:

- Part 4c of the *Coastal Protection Act 1979*;
- a *Code of Practice under the Coastal Protection Act 1979* (OEH, 2013)¹³; and,
- any Council Coastal Erosion Emergency Action Subplan as per the document herein (other than the limited allowable locations for placement as listed above, no specific requirements for “Part 4c sand/sandbags TCPW” have been listed herein).

These requirements include that:

- only sand or sandbags are used (that is, use of rocks, concrete, construction waste or other debris is not permitted);
- a certificate is obtained (which remains valid for 2 years) from OEH prior to placing the works on public land or if public land is to be occupied or used for access (this is not required for placement of works on private land)¹⁵;

¹³ Note that this Code of Practice supersedes the previously released Code of Practice *under the Coastal Protection Act 1979* published in March 2011.



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

- sand used in the works must not be taken from a beach or a sand dune adjacent to a beach; and,
- sandbags must be placed and removed (with restoration of land) within two years (or longer if a development application under the *Environmental Planning and Assessment Act 1979* is lodged for longer term or alternate temporary coastal protection works).

Other requirements which may affect the placement of temporary coastal protection works include (from OEH 2013):

- A police officer may direct a person to leave or not enter a specified danger area in an emergency, and may also direct the taking of safety measures in an emergency, including the removal of material presenting a public safety risk or interfering with the operations of emergency services. Such a direction may include the removal or modification of temporary coastal protection works;
- For the installation of longer-term emergency coastal protection works, the landowner will need to satisfy the consent authority that suitable arrangements will be in place to maintain the works and manage any off-site erosion impacts;
- Temporary coastal protection works cannot be installed during storm conditions unless the landowner has obtained a written opinion from a professional engineer that states that the placement of the works under these conditions do not pose a significant safety risk.

Based on OEH (2013), the only authorised beach access location for placing “Part 4c sand/sandbags TCPW” works at Wamberal-Terrigal Beach is adjacent to Wamberal SLSC at Dover Road (see **Figure 23**). It should be noted that during storm conditions Wamberal beach is generally very narrow with wave run up to the base of the fore-dune, making placement of temporary coastal protection works likely to be impossible. For this reason, temporary coastal protection works should be installed prior to a storm, while conditions are safe enough to do so.

According to the Code of Practice under the Coastal Protection Act 1979 (OEH 2013), when site constraints prevent access for relevant machinery to install works on private land, vehicular access to a beach at an authorised location must be by the authorised access point shown in Figure 23. Note that the property owner does not have permission to access public land with a vehicle directly from their property for placement of the works, and access must be via the authorised access point. As Council does not have any “authorised officers” under the *Coastal Protection Act 1979*, regulating the placement of temporary coastal protection works is the role of OEH.

¹⁵ To obtain a certificate, an application form needs to be completed along with payment of a \$110 fee. No other regulatory approvals are required as per Section 55O of the *Coastal Protection Act 1979* (therefore, for example, there is no requirement to submit a Development Application for the works). Note that Gosford Council does not have any “authorised officers”, so the certificate application must be submitted to OEH.



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Figure 23: Locations where “Part 4c sand/sandbags TCPW” may be feasible at Wamberal-Terrigal Beach, and authorised beach access location



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7.1.3 Other Works (of any Form)

Based on *State Environmental Planning Policy (Infrastructure) 2007* (denoted as *SEPP Infrastructure* herein), landowners can consider the installation of temporary or long term coastal protective works of any form. As consent is required under *SEPP Infrastructure* for such works, Part 4 of the *Environmental Planning and Assessment Act 1979* applies. Therefore, before installing these general protective works it would be necessary for landowners to:

- undertake an environmental assessment, that is either a Statement of Environmental Effects or an Environmental Impact Statement (the latter if significant impacts were expected); and,
- lodge a Development Application (DA) with a consent authority.

Until a Coastal Zone Management Plan (CZMP) is in force on the land, the NSW Coastal Panel is the consent authority. A CZMP is not in force at present at Wamberal-Terrigal Beach.

7.2 Approvals Required by Gosford Council

Based on *SEPP Infrastructure*, coastal protection works (of any form) can be carried out by Council without consent on any land. Given this, Part 5 of the *Environmental Planning and Assessment Act 1979* applies to coastal protection works (emergency or long term) undertaken by Council, unless the works can be considered to be exempt development.

If the works are not exempt development, before installing protective works it would be necessary for Council to:

- undertake an environmental assessment, that is either a Review of Environmental Factors or an Environmental Impact Statement (the latter if significant impacts were expected); and,
- (until a CZMP is in force on the land) notify the NSW Coastal Panel before carrying out the works and take into consideration any response received from the Coastal Panel within 21 days of the notification (unless the proposed works only comprise the placement of sand or sandbags, or only replacement, repair or maintenance of works is proposed).

Council would generally be the determining authority for these works.

A number of emergency works may be considered to be exempt development under *SEPP Infrastructure*, including emergency works undertaken by Council to protect roads and stormwater management systems, as long as the works are of minimal environmental impact and structurally adequate.



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8 EVALUATION OF EMERGENCY PROTECTION MEASURES

Various potential temporary or long-term measures (protective works) can be considered for implementation at Wamberal-Terrigal Beach, assuming that environmental impacts have been assessed to be acceptable and appropriate approvals are in place. These works could include:

- sand-filled geotextile containers (0.75m³ and 2.5m³ bags have been evaluated herein);
- rock (basalt or sandstone); and,
- concrete blocks (either “standard” concrete or high-density concrete).

While rock and concrete as temporary protection works are not permissible under the *Coastal Protection Act 1979*, these types of works may be permissible based on *State Environmental Planning Policy (Infrastructure) 2007*. As consent is required under SEPP Infrastructure for such works, Part 4 of the *Environmental Planning and Assessment Act 1979* applies.

Densities of these materials vary from 1.7 tonnes/m³ for the bags, 2.2 tonnes/m³ for sandstone, 2.4 tonnes/m³ for standard concrete, 2.6 tonnes/m³ for basalt and 3.0 tonnes/m³ for high density concrete.

Both 0.75m³ and 2.5m³ sand-filled geotextile containers (bags) are unlikely to be stable as protective works in severe storms, and thus cannot be expected to provide adequate protection. There is also a risk in using bags along Wamberal-Terrigal Beach that the bottom layer of bags could be damaged if placed on existing rock or rubble works. Accordingly, use of these bags as emergency protective works in the study area is not recommended.

Rock and concrete blocks can be dropped in place (random placement), achieved by specification of a minimum rock strength and other requirements such as maximum rock aspect ratio for rock, and by specifying a minimum concrete strength for concrete.

The cheapest protection option out of the works evaluated is sandstone rock, costing about \$1,000/m for toe protection and \$1,800/m for escarpment protection, with basalt rock costing about 20% to 30% more.

Concrete blocks are significantly more expensive, costing about \$2,500/m (standard mix) and \$3,700/m (high-density mix) for toe protection.

Using a commercial sand source, 0.75m³ sand-filled geotextile containers would cost about \$1,200/m for toe protection and \$3,900/m for escarpment protection.

Using a commercial sand source, 2.5m³ sand-filled geotextile containers are more expensive still, and would cost about \$2,700/m for toe protection and \$5,900/m for escarpment protection (if a “free” local source of sand was used, these costs would reduce by about 25%). Vandal deterrent fabric sand-filled geotextile containers would cost more still.

Rock and concrete blocks have well established and accepted design guidelines, and can be sized to provide adequate protection. Rock and concrete blocks also have much faster placement rates



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than sand-filled geotextile containers, and can generally be placed at times of storms. For more severe events than the design event, rock and concrete blocks would be more likely to interlock (since these materials are randomly placed) after any movement and suffer damage more progressively than bags.

However, exposed rock and concrete blocks remaining in the long term after a storm may be unacceptable, and may require removal except when they would be covered with sand during natural beach recovery.

In summary, to achieve effective protection during an emergency only rock or concrete blocks can be considered to be appropriate, with rock also being the cheapest option. That stated, such works could only be implemented if environmental impacts were acceptable. Installation of such temporary or long term coastal protective works may only be permissible based on *State Environmental Planning Policy (Infrastructure) 2007* and if approval were granted under Part 4 of the *Environmental Planning and Assessment Act 1979*, as described in Section 7.1.3.



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9 ROLES AND RESPONSIBILITIES IN COASTAL EMERGENCY MANAGEMENT

9.1 Preamble

The roles and responsibilities of the State Emergency Service, Gosford Council, Office of Environment and Heritage, Bureau of Meteorology and NSW Police in coastal emergency management are described below in turn. Further discussion on these matters is provided in the *NSW State Storm Sub Plan* (currently dated June 2007).

Landowners also have responsibilities if they want to install protective works (refer to Section 7.1 for a description of the approvals process).

9.2 State Emergency Service

The role of the State Emergency Service (SES) in coastal erosion and inundation emergencies is essentially warning and evacuation of residents at risk, and lifting and/or relocating readily moveable household goods and commercial stock and equipment. These activities would be carried out in accordance with a Coastal Erosion Annex to the SES Local Flood Sub Plan.

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

SES use the release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” from the Bureau of Meteorology as a primary test of whether or not they should be involved in a potential coastal erosion (and/or inundation) event. If required (that is if an emergency developed) when neither of these warnings had been issued, it is expected that Council would call on SES for assistance in matters that SES deal with.

9.3 Gosford Council

Under the *Coastal Protection Act 1979*, Council is the designated coastal authority with responsibility for care of public land within its care, control and management. The carrying out (or authorising and coordinating) of coastal emergency protective works to protect public assets from coastal erosion and inundation is Gosford Council’s role, if it chooses to undertake such measures.

Council could choose to undertake physical erosion protection measures to protect public assets from coastal erosion and inundation if considered to be appropriate (assuming adequate environmental assessment had been carried out and the NSW Coastal Panel had been notified where appropriate).

However, private landholders are responsible for private land. Council does not have a positive obligation to take particular action to protect private property from erosion events. There is, however, a statutory obligation upon Council to consider any valid development application for erosion protection works which may be lodged by property owners.



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If a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” had been released or SES was mobilised in some other manner, Council would assist SES as required and where resources permit.

If SES was not mobilised (eg if neither of the above warnings had been released by the Bureau of Meteorology), Council may undertake some of the activities that would otherwise be conducted by SES (where resources allow, although not obligated to), but note that Council cannot order evacuation. If required, Council could request SES taking on a Combat Agency role if an actual emergency was occurring.

In practice, typical tasks that Council may undertake (where required) before, during and after a coastal erosion/inundation event (besides considering the need for and potentially implementing protective works on public land) would be as discussed in Section 10.

9.4 Office of Environment and Heritage

The Office of Environment and Heritage (OEH) is the NSW government authority responsible for advising on coastal zone management. OEH staff would also be responsible for assessing any landowner applications for “Part 4c sand/sandbags TCPW”, as Gosford Council has elected not to have any staff trained as an “authorised officer” (as per Section 7 of the *Coastal Protection Act 1979*) in this regard.

9.5 Bureau of Meteorology

The release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” by the Bureau of Meteorology is the trigger adopted by SES for involvement in a coastal erosion/inundation episode.

A “Severe Weather Warning for Damaging Surf” is issued if waves in the nearshore zone are forecast to exceed a significant wave height of 5m (irrespective of wave period) in the next 24 hours. A “Severe Weather Warning for Storm Tides” is included if storm surge, wave setup or and/or outflow from river flooding are expected to raise ocean water levels significantly above Highest Astronomical Tide.

9.6 NSW Police

The NSW Police Force is the agency responsible for:

- law enforcement and search and rescue;
- controlling and coordinating the evacuation of victims from the area affected by the emergency in conjunction with the combat agency; and,
- being the combat agency for terrorist acts.

Some members of the NSW Police may also be appointed as Emergency Operations Controllers.

Police would typically become involved in a coastal erosion event as follows:



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- assisting SES where required (for example controlling and coordinating evacuation) when SES was acting in its Combat Agency role; or,
- if SES was not mobilised, police may undertake or coordinate activities such as evacuation, barricading, removal of the contents of buildings and the like.

In either case (if SES was or was not the Combat Agency), some argue that it is possible that Police may act according to their statutory powers to protect life and property, and therefore authorise emergency protective works. However, it is expected that in making such a decision, police would need to recognise the Combat Agency's authority (if applicable), ensure appropriate approvals are in place for any proposed works, and seek proper advice before acting (such as from a qualified engineer and Council)¹⁶.

9.7 Fire and Rescue NSW

Fire and Rescue NSW has a Mutual Aid Agreement with the SES and would have a support role assisting the SES during a coastal emergency. In particular, Fire and Rescue NSW would become involved during a coastal emergency in the following ways:

- Assist the SES in monitoring / reconnaissance of areas potentially damaged by storms;
- Provide storm damage response teams to assist the SES, including strike teams when requested, to assist the SES;
- Assist with the evacuation of at-risk communities; and
- Provide staff to support a spatial information group established by the SES.

¹⁶ Mr Phil Watson (Office of Environment and Heritage) considers that although a requirement for protection of life and property may exist within Police powers, a memorandum of understanding was reached between the combat agencies relating to coastal erosion emergency event roles and responsibilities in the update of the *NSW State Storm Plan 2007*, leaving the responsibility for protection works on beaches only with local government authorities (personal communication, 1 December 2011).



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10 COUNCIL ACTIONS

10.1 Preamble

An Environmental Impact Statement has been prepared (Manly Hydraulics Laboratory, 2003) for the construction of protective works along the entire Wamberal-Terrigal Beach study area. However, these works have not been able to be implemented at this point in time, mainly due to lack of funding and lack of an accessible suitable sand source for ongoing periodic maintenance beach nourishment.

The following sections provide a brief discussion on the triggers for implementation of the Emergency Action Subplan (Section 10.2) along with the identification of potential actions that Council should undertake before, during and after a coastal erosion emergency (Sections 10.3, 10.4 and 10.5 respectively).

The key Council actions and trigger points prior to, during and following a coastal erosion event are outlined in **Table 10.1**.

The key public asset at risk in the study area is Wamberal SLSC. However, this risk is relatively low at present, and until further investigations are completed, Council's intended protection strategy for public assets such as Wamberal SLSC is not to undertake protective works. This framework governs the actions that have been listed.

Another public asset is a viewing area south of 27 Ocean View Drive. This area is not considered by Council to be worthy of protection due to the relatively minor nature of the works, which can be reconstructed if damaged following a storm event. However, this area is a vulnerable location due to proximity of the lagoon and where breakthrough of the dune into the lagoon has threatened to occur in the past. Ocean View Drive is landward of the Immediate Zone of Reduced Foundation Capacity at this location. However, as the dune is at around 6m AHD at this location, overtopping of the dune due to wave runup could occur during a coastal emergency, cutting off access along the coastline. Again, until further investigations are completed, Council does not intend to undertake protective works at this site (there may be existing rock protective works at the site).

It is not considered to be appropriate or practical to attempt to protect minor assets such as dune fencing, bins and signage in any emergency. These would be removed to prevent damage, repaired or replaced as required (where appropriate).

Council intend to undertake actions to warn the public of and/or reduce the risks associated with storm damage and severe beach erosion hazards. All Council units have a responsibility to document records of decisions made and the reasoning in making those decisions (before, during and after coastal erosion emergencies).

As stated previously, Council does not have a responsibility to protect private property from coastal erosion and inundation hazards before or during an emergency event, and does not intend to do so other than by undertaking the actions identified in the Section 10 of this Subplan.



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10.2 Criteria/Thresholds for Action

The actions contained in this emergency action subplan are triggered by the release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” from the Bureau of Meteorology. This is the same trigger as that used by the State Emergency Service as a primary test of whether or not they should be involved in a potential coastal erosion (and/or inundation) event. This trigger activates the during-storm actions of the sub-plan, particularly the monitoring of environmental conditions and beach behaviour.

Pre-storm actions are to be undertaken as soon as practicable and are independent of the occurrence of a coastal emergency.

During a storm, it is considered that a prescriptive set of trigger conditions that would be used to initiate individual Council actions in relation to coastal erosion emergencies are impractical to stipulate. This is because such conditions would be exceedingly complex to devise, and would still be unlikely to cover every situation¹⁷. Examples of complexities include variability in storm conditions (wave height and period, wave direction, water level, location of rips), state of the tide, antecedent conditions, forecasts, existing protective works, and existing structure types (in particular foundations). In the case of protective works and foundations, there may also be unknowns regarding the nature of the works. In practice, expert engineering judgement would need to be applied at times of storms to assess when to initiate particular (during-storm) actions as required. This approach relies on regular monitoring of environmental conditions and beach behaviour, and seeking appropriate advice when required.

10.3 Before a Storm

The following actions that should be undertaken before a storm are listed in OEH (2011), with discussion relevant to the responses of Gosford Council provided in footnotes:

- informing the community of the council's intended erosion emergency responses under its emergency action subplan¹⁸;
- preparing a communication strategy to advise the community of the likelihood of an impending beach erosion emergency that would initiate actions under the subplan¹⁹;
- identifying areas where landowners may install “Part 4c sand/sandbags TCPW” and any applicable site-specific requirements for those works²⁰;
- preparing for planned emergency actions²¹;
- undertaking necessary environmental assessments and any development approval processes, where necessary, to facilitate emergency works outlined in the subplan²¹; and,

¹⁷ There is also no single quantitative parameter, such as an offshore significant wave height of a certain magnitude, minimum beach width of a certain value, or distance from an erosion escarpment which can be adopted as the trigger for imminent damage to an asset since there are a combination of many factors involved.

¹⁸ As per the document herein.

¹⁹ See Section 11 for discussion on consultation activities that have and are proposed to be undertaken.

²⁰ See Figure 23 for the locations where “Part 4c sand/sandbags TCPW” may be undertaken at Wamberal-Terrigal Beach. Council has not resolved to apply any additional site-specific requirements to these works.

²¹ As no protection works are proposed by Gosford Council, this is not relevant to Council at this point in time.



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- preparing up-to-date personal contact details for key council staff involved in coordinating actions under the subplan (include responsibilities of staff who prepare for, manage and coordinate recovery from an erosion emergency event) and individuals the council may need advice from, such as OEH staff, or to integrate with from other emergency sectors)²².

Given that Council is not proposing to undertake any protective works, potential actions listed in OEH (2011) relating to this matter are not listed herein.

Other relevant actions for Council before a storm are listed below:

- monitoring beach erosion and weather/wave conditions and forecasts;
- ensuring sufficient warning signage and barricades are available for use if required (eg to close off damaged and potentially dangerous beach access points);
- provision of information and advice to affected beachfront landowners and the wider community; and,
- consulting with SES and other relevant agencies such as OEH as required.

Monitoring is the key to maximising warning time, preparedness and predictive capability in regard to emergency coastal erosion events.

Monitoring of physical environmental conditions would include weather conditions (measurements, warnings and forecasts), wave forecasts (height and direction), water level (tidal) predictions, real time wave data (height, period and direction), real time water level data (including consideration of elevated water levels due to storm surge), and beach behaviour (extent of erosion, beach width, understanding of historical beach behaviour at times of storms, location of rips).

In a potential emergency event, it would be expected that beach areas would be inspected at least daily, particularly at high tide, where resources permit.

Council is considering the appropriateness of undertaking a cost:benefit analysis of implementing emergency protective works to reduce the risk of damage to Wamberal SLSC and the viewing area south of 27 Ocean View Drive, including assessment of insurance implications. In conjunction with this, it would be beneficial to undertake investigations to determine the extent of protective works seaward of the viewing area (e.g. by excavating a test pit), which would assist in predicting the risk of damage to this area in a severe coastal storm. While this area is not considered by Council to be worthy of protection due to the relatively minor nature of the viewing area, this area is a vulnerable location due to proximity of the lagoon and where breakthrough of the dune into the lagoon has threatened to occur in the past. While Ocean View Drive is landward of the Immediate Zone of Reduced Foundation Capacity, as the dune is at around 6m AHD in this location, overtopping of the dune due to wave runup could occur during a coastal emergency cutting off access to the coastline.

If it is found that it is appropriate to protect either of these areas, it would then be necessary for an environmental assessment of the works to be undertaken. If environmental impacts were found to be acceptable, it would then be necessary to develop specific designs and methods of works for

²² See Section 12.



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protective actions that it is intended to undertake, obtain and stockpile required materials, and identify appropriate plant and equipment and personnel to carry out the works if required.

Council is also intending to consider the need to develop a communications strategy to keep affected communities informed during an erosion emergency, and developing the strategy if required.

10.4 During a Storm

In OEH (2011) it is stated that actions undertaken during an erosion emergency should be managed by Council officers who clearly understand the subplan and know the roles and responsibilities of key personnel. It is also stated in OEH (2011) that:

- no actions undertaken should impede, conflict or overlap with those of response agencies under the *State Emergency and Rescue Management Act 1989* unless there is prior agreement between the relevant parties;
- actions should focus on the safety of personnel who might be working under the extreme adverse weather conditions that gave rise to the emergency;
- a communication strategy needs to be in place during an erosion emergency, keeping affected communities informed of the Council's intended responses (this should include giving regular warnings where erosion is likely to sever public access and result in relatively high, unstable, near-vertical erosion escarpments along beaches; in this case, it is vital to advise the public of the dangers these conditions may present); and,
- the communications strategy may need to be complemented by erection of temporary safety fencing and associated warning signage.

Council actions during a storm shall include:

- regular monitoring of environmental conditions and beach behaviour;
- assessing the need for barriers and safety signage to be erected at damaged and potentially dangerous beach access points, to minimise risk to public safety;
- erecting barricades and safety signage if required;
- assessing the need to remove existing beach signage, bins and dune fencing where threatened by coastal erosion (and removing these assets where safe to do so to prevent damage or being washed away);
- seeking coastal and geotechnical engineering advice where required;
- seeking advice from OEH staff as required;
- supporting SES as required and where resources allow;
- releasing information to the media; and,
- provision of information and advice to beachfront landowners and wider community.

10.5 After a Storm

Actions after an erosion emergency listed in OEH (2011) comprise the following, with discussion relevant to the responses of Gosford Council provided in footnotes:

- restore services and public access, and remove any threats to public safety (such as debris deposited or exposed on beaches);



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- continue temporary safety fencing and associated warning signage (as necessary);
- monitor the performance and impact of any coastal protection works including any temporary coastal protection works (“Part 4c sand/sandbags TCPW”) installed and take remedial action where necessary²³;
- assess the structural integrity of unprotected infrastructure, buildings and other assets exposed during the erosion event and take appropriate action where necessary;
- continue to maintain a communication strategy warning of the dangers of any persisting high, unstable or near-vertical erosion escarpments drying out and collapsing without notice (in high-use public areas, the Council may consider collapsing these escarpments with machinery);
- replenish any emergency materials and supplies for use in any future erosion events; and,
- critically review the subplan to ensure it achieved its performance objectives and revise it to address any identified shortcomings.

Council actions after a storm are likely to include:

- cleansing the beach of debris and other inappropriate materials;
- remedial works to restore safe beach access;
- repairing or replacing damaged infrastructure, such as dune fencing and beach accessways once the dune has sufficiently recovered;
- rehabilitation of damaged dune vegetation;
- beach scraping and/or sand nourishment to restore beach amenity;
- maintaining photographic and written records of events and decision making processes; and,
- monitoring unauthorised coastal protection works and enforcement of penalties under the *Coastal Protection Act 1979* (this may also be undertaken before and during a storm).

Dune fencing along access ways running perpendicular to the beach, bins and signage (s632 notices, dog area signs, dune restoration signs) will be repaired and/or replaced as soon as practicable after an event. Beach accessways will be closed if necessary until the beach has recovered sufficiently to allow them to be re-graded.

²³ As Council does not have any authorised officers, this would be the role of OEH.



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Table 8.1 – Specific actions and triggers under this Emergency Action Subplan

Pre storm action	During Storm Action	Post Storm Action	
Action	When	By whom	Trigger for action
Inform the community of the council’s intended erosion emergency responses under its emergency action subplan	Prior to storm	Integrated Planning Customer Services & Communication	No specific trigger, to be done upon release of subplan
Prepare a communication strategy to advise the community of the likelihood of an impending beach erosion emergency that would initiate actions under the subplan	Prior to storm	Integrated Planning Customer Services & Communication	No specific trigger, as soon as possible
Identify areas where landowners may install “Part 4c sand/sandbags TCPW” and any applicable site-specific requirements for those works	Prior to storm	Integrated Planning	No specific trigger, to be done upon release of subplan
Prepare needed resources for planned emergency actions;	Prior to storm	Maintenance Operations	No specific trigger
Undertake necessary environmental assessments and any development approval processes, where necessary, to facilitate emergency works outlined in the subplan	Prior to storm	Development Open Space and Leisure Services Infrastructure Planning	No specific trigger, to be done as soon as possible following release of subplan
Prepare up-to-date personal contact details for key council staff involved in coordinating actions under the subplan (including responsibilities) and agency	Prior to storm	Integrated Planning	No specific trigger, to be done upon release of subplan



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Action	When	By whom	Trigger for action
representatives Council may need advice from (i.e. OEH and emergency services)			
Monitor beach erosion and weather/wave conditions and forecasts	Prior to storm	Integrated Planning	Ongoing monitoring underway. Release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” triggers hourly monitoring.
Ensure sufficient warning signage and barricades are available for use if required (e.g. to close off damaged and potentially dangerous beach access points)	Prior to storm	Maintenance Services Open Space and Leisure Services	Ongoing
Provide information and advice to affected beachfront landowners and the wider community	Prior to storm	Integrated Planning Open Space and Leisure Services Education & Compliance	Ongoing
Consult with SES and other relevant agencies such as OEH as required, including preparation of a communication strategy	Prior to storm	Integrated Planning Open Space and Leisure Services Education & Compliance	Ongoing as required, with communication strategy actions triggered by the release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” from the Bureau of Meteorology.
Regular monitoring of environmental conditions and beach behaviour;	During storm	Integrated Planning Open Space and Leisure Services	Triggered by the release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” from the Bureau of



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Action	When	By whom	Trigger for action
			Meteorology.
Assessing the need for barriers and safety signage to be erected at damaged and potentially dangerous beach access points, to minimise risk to public safety;	During storm	Open Space and Leisure Services	Triggered by the release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” from the Bureau of Meteorology.
Erecting barricades and safety signage if required;	During Storm	Open Space and Leisure Services	Triggered by a determination by Council officers that these are required at specific locations based on ongoing monitoring and assessment as per the previous action
Assessing the need to remove existing beach signage, bins and dune fencing where threatened by coastal erosion (and removing these assets where safe to do so to prevent damage or being washed away);	During Storm	Open Space and Leisure Services	Triggered by a determination by Council officers that this is required based on ongoing monitoring and assessment
Seeking coastal and geotechnical engineering advice where required;	During Storm	Integrated Planning Open Space and Leisure Services	Triggered by the release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” from the Bureau of Meteorology.
Seeking advice from OEH staff as required	During Storm	Integrated Planning Open Space and Leisure Services Education & Compliance	Triggered by the release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” from the Bureau of



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Action	When	By whom	Trigger for action
			Meteorology.
Supporting SES as required and where resources allow	During Storm	Open Space and Leisure Services	Triggered by the release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” from the Bureau of Meteorology.
Releasing information to the media	During Storm	Education & Compliance Integrated Planning Customer Services & Communication Open Space and Leisure Services	Triggered by the release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” from the Bureau of Meteorology, with regular updates as needed.
Provision of information and advice to beachfront landowners and wider community	During Storm	Education & Compliance Integrated Planning Customer Services & Communication Open Space and Leisure Services	Triggered by the release of a “Severe Weather Warning for Damaging Surf” or “Severe Weather Warning for Storm Tides” from the Bureau of Meteorology.
Restore services and public access, and remove any threats to public safety (such as debris deposited or exposed on beaches);	Following storm	Open Space and Leisure Services	Triggered by the cancellation of Bureau of Meteorology warnings and a determination by authorised staff that the danger has passed
Continue temporary safety fencing and associated warning signage (as necessary);	Following storm	Open Space and Leisure Services	Triggered by the cancellation of Bureau of Meteorology warnings and



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Action	When	By whom	Trigger for action
			a determination through ongoing monitoring that the use of these safety measures is necessary
Monitor the performance and impact of any coastal protection works including any temporary coastal protection works ("Part 4c sand/sandbags TCPW") installed and take remedial action where necessary ;	Following storm	OEH authorised officers	Triggered by the cancellation of Bureau of Meteorology warnings and a determination by the authorised officer that the danger has passed
Assess the structural integrity of unprotected infrastructure, buildings and other assets exposed during the erosion event and take appropriate action where necessary;	Following storm	Open Space and Leisure Services Maintenance Services	Triggered by the cancellation of Bureau of Meteorology warnings and a determination through ongoing monitoring that the danger has passed
Continue to maintain a communication strategy warning of the dangers of any persisting high, unstable or near vertical erosion escarpments drying out and collapsing without notice (in high use public areas, the Council may consider collapsing these escarpments with machinery);	Following storm	Integrated Planning Customer Services & Communication Open Space and Leisure Services	Triggered by the cancellation of Bureau of Meteorology warnings and a determination by authorised staff through ongoing monitoring that the danger has passed
Replenish any emergency materials and supplies for use in any future erosion events	Following storm	Maintenance Services	Triggered by the cancellation of Bureau of Meteorology warnings and completion of post-storm restoration works
Critically review the subplan to ensure it achieved its performance objectives and revise it to address any	Following storm	Integrated Planning	Triggered by the cancellation of Bureau of Meteorology warnings and



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Action	When	By whom	Trigger for action
identified shortcomings.			completion of post-storm restoration works
Cleansing the beach of debris and other inappropriate materials.	Following storm	Open Space and Leisure Services	Triggered by the cancellation of Bureau of Meteorology warnings and a determination by authorised staff through ongoing monitoring that the danger has passed
Remedial works to restore safe beach access.	Following storm	Open Space and Leisure Services	Triggered by the cancellation of Bureau of Meteorology warnings and a determination through ongoing monitoring that the danger has passed
Repairing or replacing damaged infrastructure, such as dune fencing and beach accessways once the dune has sufficiently recovered.	Following storm	Open Space and Leisure Services	Triggered by a determination by authorised staff through ongoing monitoring that the dune has sufficiently recovered
Rehabilitation of damaged dune vegetation.	Following storm	Open Space and Leisure Services	Triggered by a determination through ongoing monitoring that the dune has sufficiently recovered
Beach scraping and/or sand nourishment to restore beach amenity.	Following storm	Open Space and Leisure Services	Triggered by the cancellation of Bureau of Meteorology warnings and a determination by authorised staff through ongoing monitoring that the danger has passed
Maintaining photographic and written records of events	Following storm	All identified business units	Triggered by the cancellation of



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Action	When	By whom	Trigger for action
and decision making processes;		OEH authorised officers	Bureau of Meteorology warnings and a determination by authorised staff through ongoing monitoring that the danger has passed
Monitoring unauthorised coastal protection works and enforcement of penalties under the Coastal Protection Act 1979 (this may also be undertaken before and during a storm).	Following storm	Education & Compliance OEH authorised officers	Ongoing.



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11 CONSULTATION

The *Coastal Protection Act 1979* does not specifically stipulate the requirement for public consultation in the development of a subplan. The NSW *Guidelines for Preparing Coastal Zone Management Plans (2013)* state that:

“these (Emergency Action) subplans are to be prepared with direct consultation with landowners affected by the subplan”.

This suggests no requirement exists to consult more broadly than those affected.

Council, at its meeting of 5 June 2012, resolved to place the draft Coastal Erosion Emergency Action Subplan (EAS) for Wamberal-Terrigal Beach on public exhibition in accordance with the process stipulated in the NSW Government’s guidelines.

The draft EAS was exhibited in line with Council’s resolution for a period of 42 days between 25 June and 6 August 2012.

Individual property owners were contacted directly during the consultation and comments sought from them as well as the wider community.

A total of seven property owners contacted Council via telephone and/or email to discuss the Draft EAS and provide comment.

Face to face meetings were held with two property owners along with representatives of Coastal Residents Inc. and the Community Environment Network. A total of seven written submissions were received.

Written submissions and feedback received during meetings and discussion with stakeholders resulted in a number of amendments to the Draft Plan following the exhibition process.

Council is preparing a Coastal Zone Management Plan for the Open Coast & Broken Bay Beaches (the Coastal Plan) and this will be developed with the community (the subplan will form an appendix to this plan).

This overarching Coastal Plan addresses risk posed by a series of coastal hazards over an immediate and future planning period. It applies to all property (both public and private) on Gosford’s Open Coast and Broken Bay Beaches which may be impacted by current and/or future coastal hazards. It establishes strategic responses to the management of those risks.

The Coastal Plan is to be developed through a series of stages, during which the community will be consulted (prior to the exhibition of the draft Coastal Plan). Section 55E of the *Coastal Protection Act 1979* identifies the requirement for Council to publicly exhibit the Coastal Plan for a period of not less than 21 days.



12 KEY CONTACT DETAILS

- State Emergency Service (SES), telephone 132 500
- Local Emergency Operations Controller (LEOCON)
 - Police Service Local Area Commander, telephone 4323 5599 (Brisbane Water Local Area Command, Level 3, 9-11 Mann Street Gosford)
 - local police are at 13 Church Street Terrigal, telephone 4384 4822
- Gosford Council general switch telephone 4325 8222, and website <http://www.gosford.nsw.gov.au>
- Office of Environment and Heritage local representative: Mr Neil Kelleher, telephone 4320 4206

If SES was mobilised, Council has a Local Emergency Management Officer (LEMO). A LEMO is appointed under Section 32 of the *State Emergency and Rescue Management Act 1989*, in which it is stated that “A council is to provide executive support facilities for the Local Emergency Management Committee and the Local Emergency Operations Controller in its area. The principal executive officer is to be known as the Local Emergency Management Officer”.



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

13 CONCLUSIONS

A coastal erosion emergency action subplan for Wamberal-Terrigal Beach (covering the beachfront area between Wamberal Lagoon and Terrigal Lagoon) has been completed as set out herein.

The study area comprises 69 private lots, as well as some public land. Public land is located south of 27 Ocean View Drive (including a viewing area), a beach accessway between 65 and 67 Ocean View Drive exclusive, an open space area between 67 and 73 Ocean View Drive exclusive, beach accessways at the seaward ends of Surfers Road and Dover Road, and at Wamberal SLSC. The key public assets in the study area are the Wamberal SLSC building and a viewing area south of 27 Ocean View Drive.

Development along Wamberal-Terrigal Beach has been threatened, damaged or destroyed by the action of coastal storms, particularly in 1974 and 1978. As a result, rock and other material has been placed at some locations in an attempt to prevent property damage. However, as full details of these protective works are unknown or uncertain, the future effectiveness of these works cannot be determined (and certainly not guaranteed) at this point in time. There is also an area which may have a non-sandy (relatively inerodible) subsurface in the vicinity of 81 to 97 Ocean View Drive.

Ignoring protective works, of the 67 dwellings in the study area, 61 and 65 have some portion seaward of the Immediate Zone of Slope Adjustment (ZSA) and Zone of Reduced Foundation Capacity (ZRFC) respectively. The viewing area south of 27 Ocean View Drive is located entirely seaward of the Immediate ZSA, while Wamberal SLSC is located entirely landward of the Immediate ZSA and ZRFC.

There are two options available for landowners considering construction of emergency coastal protective works at their property, namely either:

- undertaking temporary sand/sandbags “temporary coastal protection works” (as defined under Part 4c of the *Coastal Protection Act 1979*) at limited authorised locations, denoted herein as “Part 4c sand/sandbags TCPW”; or,
- installation of temporary or long term coastal protective works of any form based on *SEPP Infrastructure*.

It is emphasised that landowners must act well (generally months) in advance of a storm to consider implementing either of these works. However, “Part 4c sand/sandbags TCPW” are not recommended by Council for use by these landowners due to various limitations.

Before installing general *SEPP Infrastructure* protective works it would be necessary for landowners to:

- undertake an environmental assessment, that is either a Statement of Environmental Effects or an Environmental Impact Statement (the latter if significant impacts were expected); and,



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

- lodge a Development Application (DA) with a consent authority (the NSW Coastal Panel at present).

Based on *SEPP Infrastructure*, coastal protection works (of any form) can be carried out by Council without consent. Given this, Part 5 of the *Environmental Planning and Assessment Act 1979* applies to coastal protection works (emergency or long term) undertaken by Council, unless the works can be considered to be exempt development.

If the works are not exempt development, before installing protective works it would be necessary for Council to:

- undertake an environmental assessment, that is either a Review of Environmental Factors or an Environmental Impact Statement (the latter if significant impacts were expected); and,
- (until a CZMP is in force on the land) notify the NSW Coastal Panel before carrying out the works and take into consideration any response received from the Coastal Panel within 21 days of the notification (unless the proposed works only comprise the placement of sand or sandbags, or only replacement, repair or maintenance of works is proposed).

A number of emergency works may be considered to be exempt development under *SEPP Infrastructure*, including emergency works undertaken by Council to protect roads and stormwater management systems, as long as the works are of minimal environmental impact and structurally adequate.

To achieve effective protection during an emergency only rock or concrete blocks can be considered to be appropriate, with rock also being the cheapest option. That stated, such works could only be implemented if environmental impacts were acceptable.

The key public assets at potential risk from coastal erosion in the study area are Wamberal SLSC (relatively low risk at present) and the viewing area south of 27 Ocean View Drive. Until further investigations are completed, note that Council's intended protection strategy for these assets is not to undertake protective works.

Under the *Coastal Protection Act 1979*, Council is the designated coastal authority with responsibility for care of public land within its care, control and management. The carrying out (or authorising and coordinating) of coastal emergency protective works to protect public assets from coastal erosion and inundation is Gosford Council's role, if it chooses to undertake such measures.

Council could choose to undertake physical erosion protection measures to protect public assets from coastal erosion and inundation if considered to be appropriate (assuming adequate environmental assessment had been carried out and the NSW Coastal Panel had been notified where appropriate).

However, private landholders are responsible for private land. Council does not have a positive obligation to take particular action to protect private property from erosion events. There is, however, a statutory obligation upon Council to consider any valid development application for erosion protection works which may be lodged by property owners.



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

Council's intended actions before, during and after coastal erosion emergencies have been described in Section 10.3, 10.4 and 10.5 respectively and summarised in Table 10.1.



COASTAL EROSION EMERGENCY ACTION SUBPLAN FOR WAMBERAL-TERRIGAL BEACH

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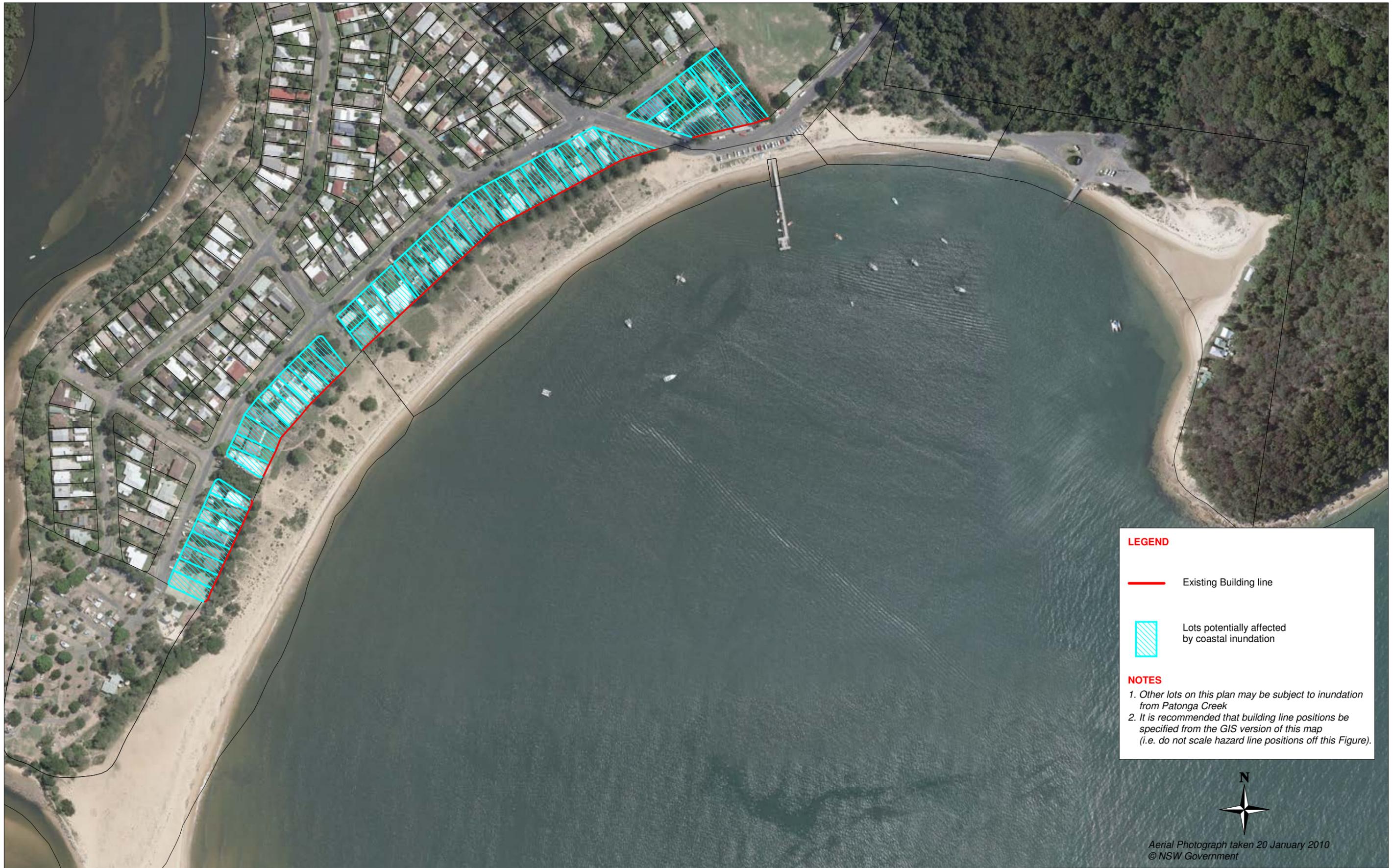
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GOSFORD BEACHES
COASTAL ZONE MANAGEMENT PLAN**

Appendix 3 Proposed DCP Chapter 6.2 maps



LEGEND

— Existing Building line

▨ Lots potentially affected by coastal inundation

NOTES

1. Other lots on this plan may be subject to inundation from Patonga Creek
2. It is recommended that building line positions be specified from the GIS version of this map (i.e. do not scale hazard line positions off this Figure).



Aerial Photograph taken 20 January 2010
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DATE 15 July 2015

0 50 100
metres

COORDINATE SYSTEM MGA Zone 56

FIG NO. A3.1

FIGURE TITLE Patonga Beach Coastal Planning Map

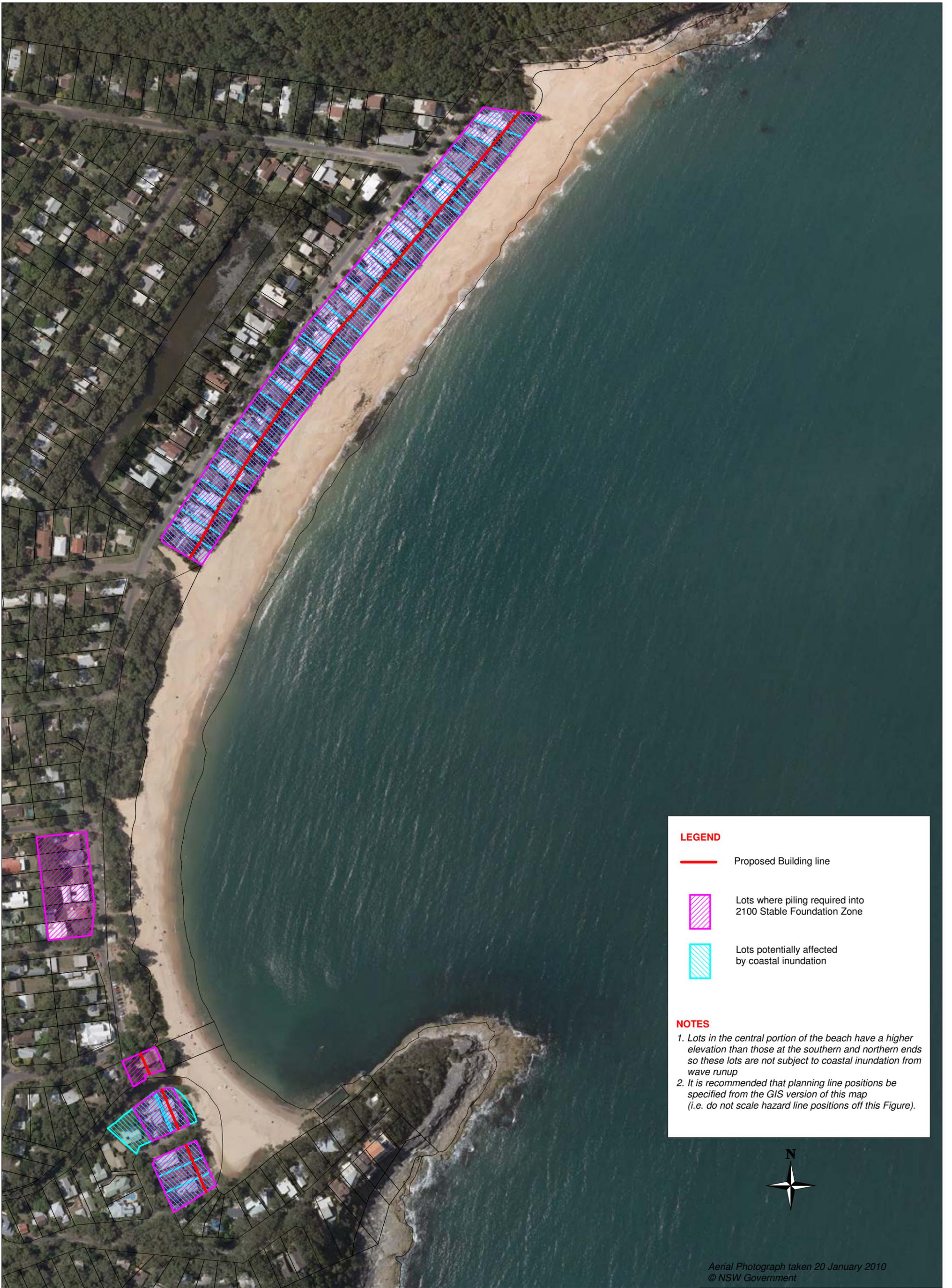
PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

CREATED BY C. Adamantidis

FILE REFERENCE C:\Users\chris.adamantidis\Documents\projects\Gosford\GIS\Workspaces\Planning Maps





LEGEND

-  Proposed Building line
-  Lots where piling required into 2100 Stable Foundation Zone
-  Lots potentially affected by coastal inundation

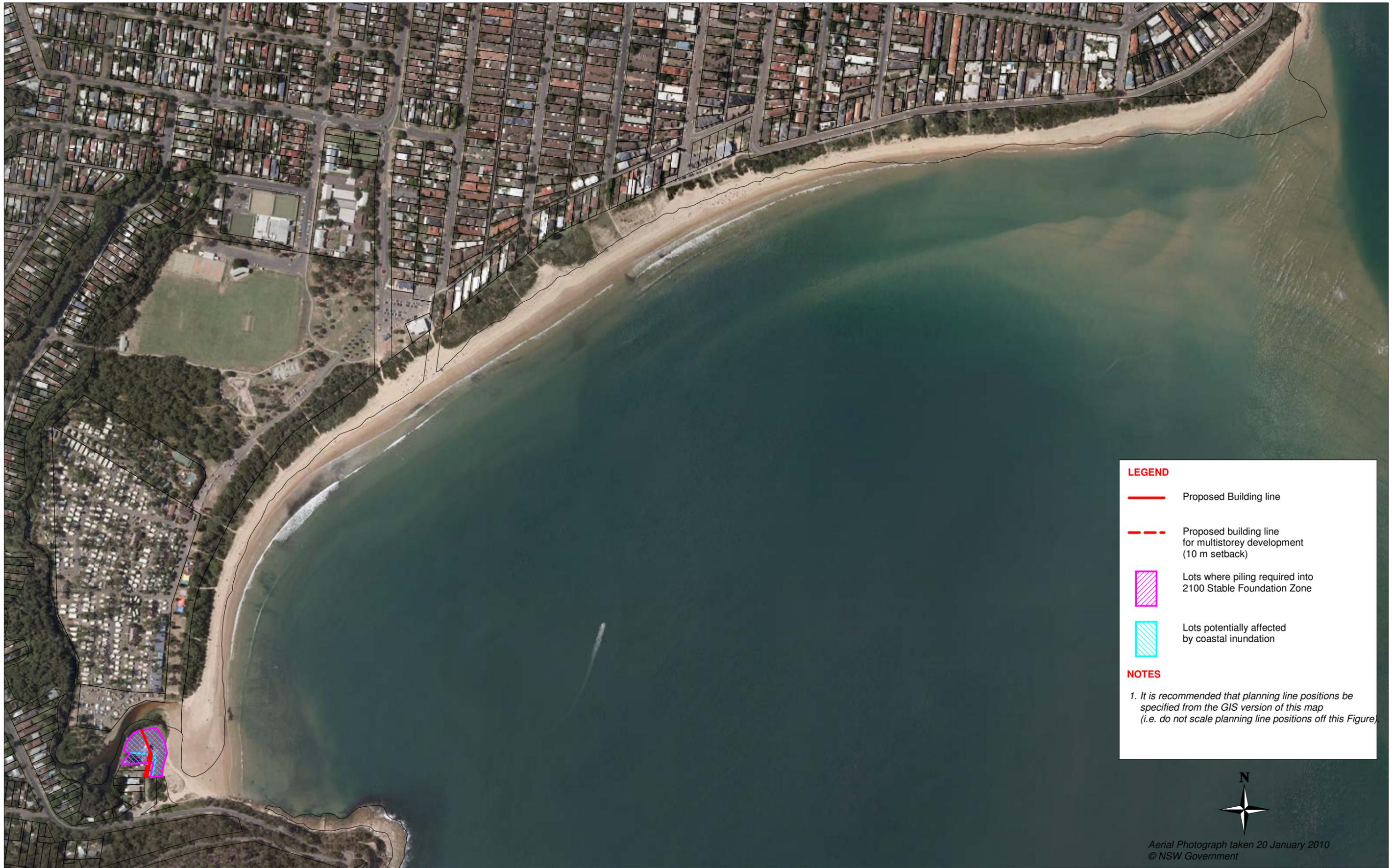
NOTES

1. Lots in the central portion of the beach have a higher elevation than those at the southern and northern ends so these lots are not subject to coastal inundation from wave runup
2. It is recommended that planning line positions be specified from the GIS version of this map (i.e. do not scale hazard line positions off this Figure).



Aerial Photograph taken 20 January 2010
© NSW Government

DATE 15/7/15		COORDINATE SYSTEM MGA Zone 56	FIG NO. A3.2	FIGURE TITLE Pearl Beach Coastal Planning Map	 
PROJECT NO. 301015-03417	PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan		CREATED BY C. Adamantidis	FILE REFERENCE C:\Users\chris.adamantidis\Documents\projects\Gosford\GIS\Workspaces\Planning Maps	



LEGEND

-  Proposed Building line
-  Proposed building line for multistorey development (10 m setback)
-  Lots where piling required into 2100 Stable Foundation Zone
-  Lots potentially affected by coastal inundation

NOTES

1. It is recommended that planning line positions be specified from the GIS version of this map (i.e. do not scale planning line positions off this Figure).



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DATE 15/7/15



COORDINATE SYSTEM MGA Zone 56

FIG NO. A3.3

FIGURE TITLE Ocean-Umina Beach Coastal Planning Map

PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

CREATED BY C. Adamantidis

FILE REFERENCE C:\Users\chris.adamantidis\Documents\projects\Gosford\GIS\Workspaces\Planning Maps





LEGEND

 Lots where piling required into 2100 Stable Foundation Zone

 Lots potentially affected by coastal inundation

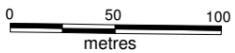
NOTES

1. It is recommended that planning line positions be specified from the GIS version of this map (i.e. do not scale planning line positions off this Figure).



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DATE 15/7/15



COORDINATE SYSTEM MGA Zone 56

FIG NO. A3.4

FIGURE TITLE Putty Beach Coastal Planning Map

PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

CREATED BY C. Adamantidis

FILE REFERENCE C:\Users\chris.adamantidis\Documents\projects\Gosford\GIS\Workspaces\Planning Maps





LEGEND

-  Proposed Building line
-  Proposed building line for multistorey development (10 m setback)
-  Lots where piling required into 2100 Stable Foundation Zone
-  Lots potentially affected by coastal inundation

NOTES

1. It is recommended that planning line positions be specified from the GIS version of this map (i.e. do not scale planning line positions off this Figure).



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LEGEND

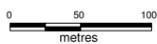
-  Proposed Building line
-  Proposed building line for multistorey development (10 m setback)
-  Lots where piling required into 2100 Stable Foundation Zone
-  Lots potentially affected by coastal inundation

NOTES

1. It is recommended that planning line positions be specified from the GIS version of this map (i.e. do not scale planning line positions off this Figure).

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DATE 15/7/15



COORDINATE SYSTEM
MGA Zone 56

FIG NO. A3.6 **FIGURE TITLE** Avoca Beach Coastal Planning Map

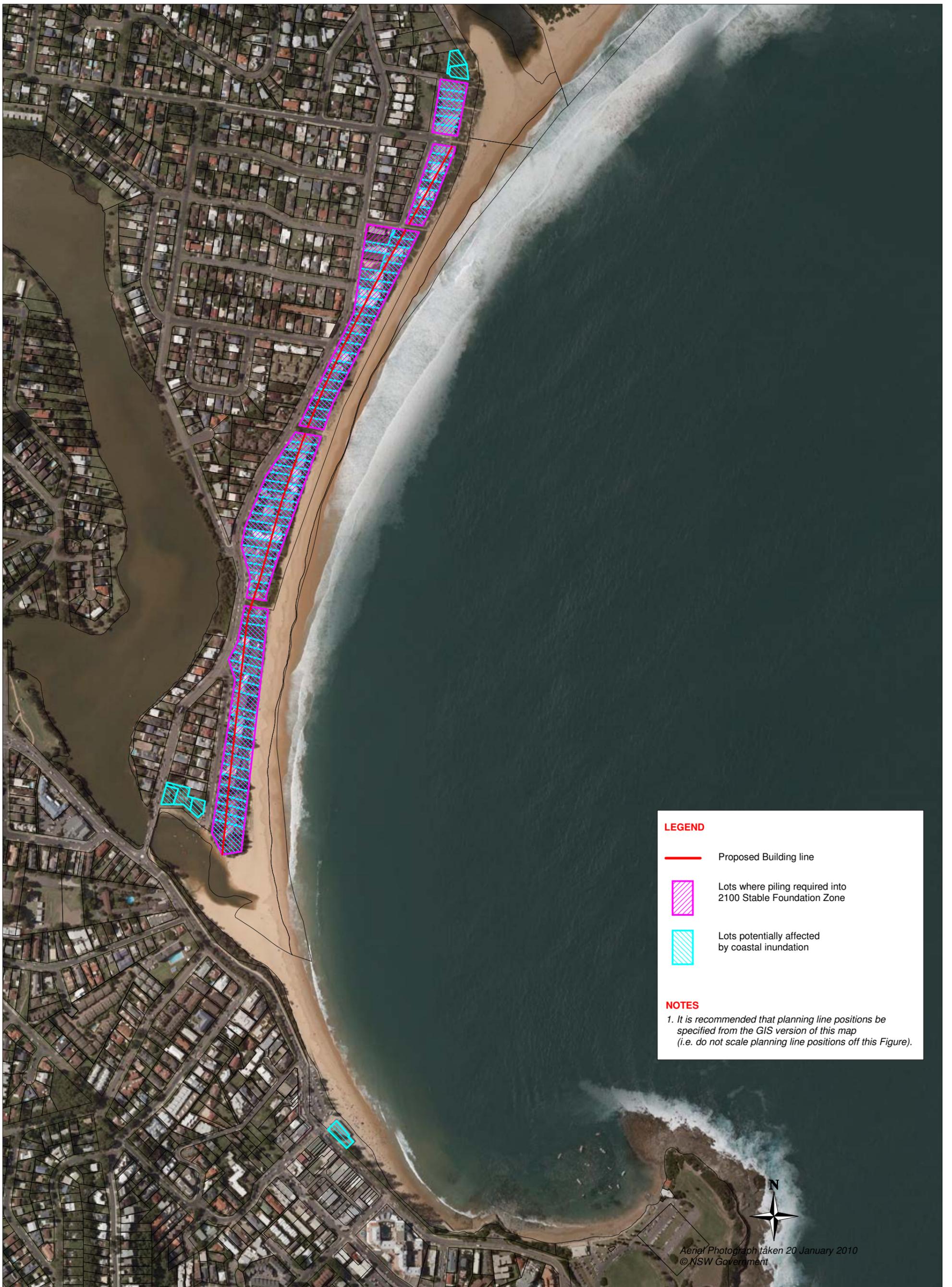
PROJECT NO.
301015-03417

PROJECT TITLE
Open Coast and Broken Bay Beaches
Coastal Zone Management Plan

CREATED BY
C. Adamantidis

FILE REFERENCE
C:\Users\chris.adamantidis\Documents\projects\Gosford\GIS\Workspaces\Planning Maps





LEGEND

-  Proposed Building line
-  Lots where piling required into 2100 Stable Foundation Zone
-  Lots potentially affected by coastal inundation

NOTES

1. It is recommended that planning line positions be specified from the GIS version of this map (i.e. do not scale planning line positions off this Figure).



LEGEND

 Lots where geotechnical advice required



Aerial Photograph taken 20 January 2010
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<p>DATE 15/7/15</p>		<p>COORDINATE SYSTEM MGA Zone 56</p>	<p>FIG NO. A3.8 FIGURE TITLE Forresters Beach Coastal Planning Map</p>	 
<p>PROJECT NO. 301015-03417</p>	<p>PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan</p>	<p>CREATED BY C. Adamantidis</p>	<p>FILE REFERENCE C:\Users\chris.adamantidis\Documents\projects\Gosford\GIS \Workspaces\Planning Maps</p>	



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Appendix 4 Community presentation and consultation materials



Coastal processes

affecting our coastline

Our coastline is dynamic and exposed to never ending change by the sea, atmosphere and coastal rivers.

Extreme events, such as storms, are usually well remembered, and slow gradual changes often go unseen. An avid beach observer will notice the constant changing and reshaping of the beach. In order to better manage coastline hazards, it is necessary to understand the various processes that cause them. The waves, water levels and winds, together with coastal currents and estuaries flowing into coastal waters, reshape beaches and shift beach sediments offshore, onshore and alongshore. At best, a restless balance is achieved with sandy beaches waxing and waning in response to these forces.

It is essential to appreciate that these processes do not operate in isolation, but interact with each other, often in quite complex ways.

Waves

Most deepwater waves approach the NSW coastline from the South-East. As these waves move into shallower water their final direction of approach to the coast is altered. Within the surf-zone, waves are the major mechanism for sand movement. The rates of erosion, transport and deposition, depend on wave energy, wave angle, and rips.



Coastal processes do not operate in isolation, but interact with each other, often in quite complex ways.



Human activities can significantly affect coastal processes. These effects can be both beneficial and detrimental.

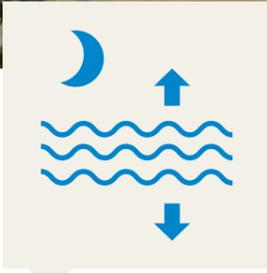
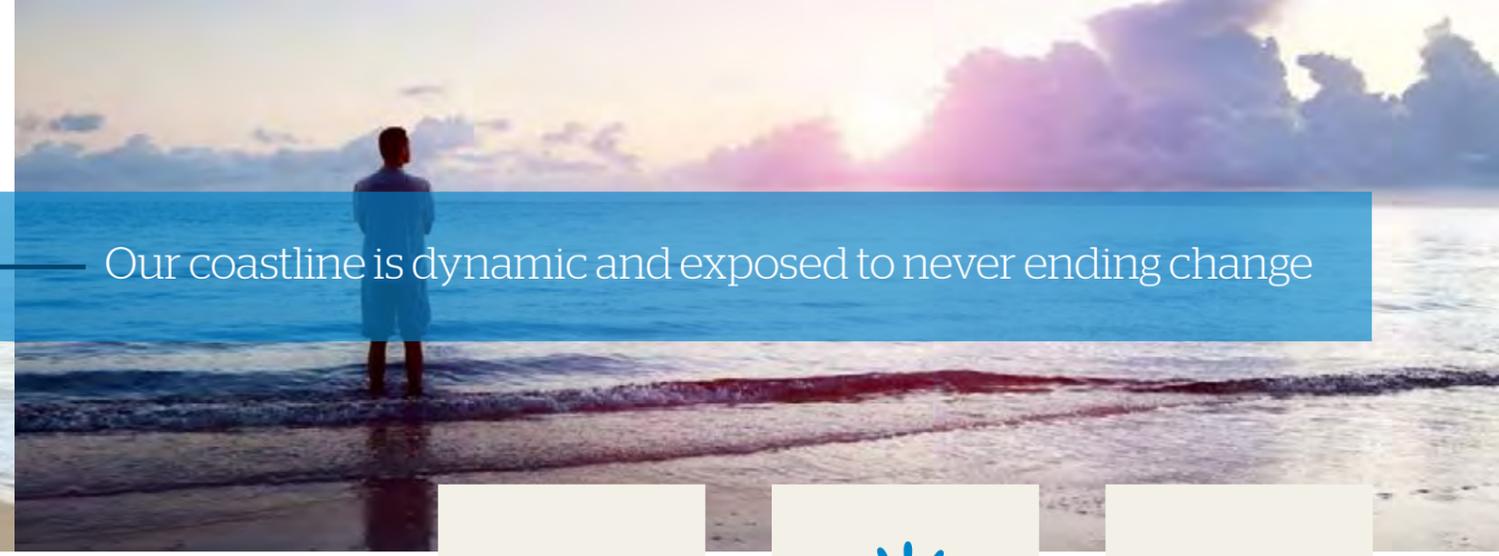


Severe storms are often accompanied by extended periods of heavy rainfall which can have significant effects on coastal processes.





Our coastline is dynamic and exposed to never ending change

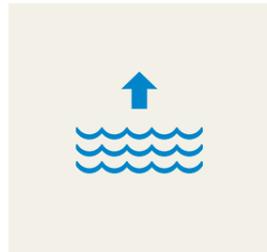


Tides

The tides are caused by the gravitational effect of the moon, and to a lesser extent, the sun and other planets on the oceans. Along the NSW coast, tides are semi-diurnal, i.e. two high tides and two low tides per day.

Tidal ranges vary significantly throughout each lunar month and from month to month. Very high and very low tides occur more frequently around Christmas and in the mid-winter months (King Tides). The tidal range is relatively constant along the open coast of New South Wales.

periods of calm between major storms can give a false sense of security. Under calm conditions the sand may shift just a millimetre or so however during an extreme storm event beaches can change rapidly as sand is moved distances offshore.



Elevated water levels

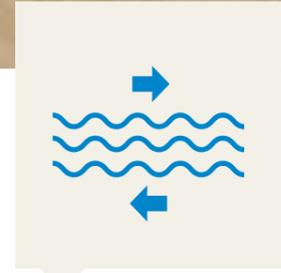
Storms develop with low atmospheric pressure, strong onshore winds and large waves. These factors lead to the development of elevated water levels which allow larger waves to break closer to the beach and cause greater damage to the coast.



Storms

Storms generate large waves and currents that can cause significant damage along the coastline.

A severe storm such as a 1 in 100 year storm may occur at any time. The long



Currents

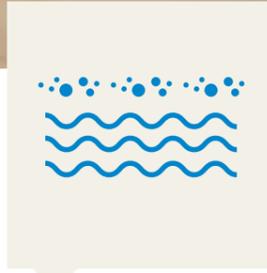
There are four main types of currents.

Ocean currents are driven by global scale interactions between the atmosphere and the sea. (i.e East Australia Current (EAC) which consists of a series of warm water eddies that originate in the Coral Sea and slowly move southward).

Shelf currents are a complex mix of the EAC, the counter currents associated with its eddies, internal waves, coastal trapped waves, tides and local wind induced currents.

Nearshore currents help to move sand in the nearshore zone, they also transport water shoreward as waves break and help to rebuild beaches after storm erosion. Nearshore rip currents help water pushed onshore escape seawards and if enlarged by storms can transport large volumes of sand offshore.

Finally, Longshore currents generated by waves breaking at an angle to the beach, by rip currents, and from changes in water levels along the shoreline transport sand in, out and along a beach.



Waterborne sediment transport

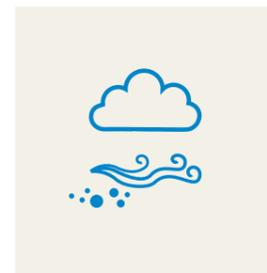
Sediment is transported onshore, offshore and alongshore through the action of waves and currents. The beach undergoes a series of erosion and accretion cycles of short-term (weeks) medium-term (years) and long-term (decades) with vast quantities of seabed sediment mobilised under wave action.



Dune vegetation

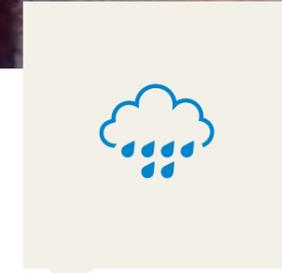
Vegetation is the key factor in controlling wind borne sand movement. Dune stability is important as dunes provide a reservoir of sand during erosive periods. Dune vegetation is very vulnerable to damage from human and natural causes. The understanding of coastal dune vegetation, including plant species and their distribution is critical to

the effective management of dunes and their role in coastal processes and coastline hazard management.



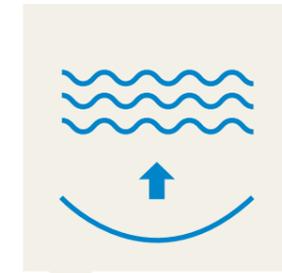
Windborne sediment transport

Wind promotes coastal erosion by transporting sand by either suspension, where fine grains enter into the atmosphere itself, saltation, where larger sand grains are briefly brought into suspension before falling back to the surface, and traction where larger particles roll, slide and push along the surface. "Blowouts" on coastal dunes can result in vegetation loss, potential dune migration, reduced amenity and the loss of sand from the beach system.



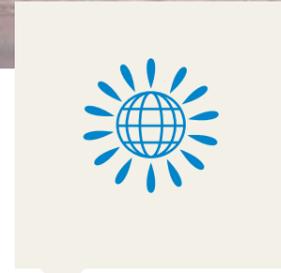
Rainfall and runoff

Severe storms are often accompanied by extended periods of heavy rainfall which can have significant effects on coastal processes. These can include creek and stormwater outlets eroding the beach, rising groundwater levels which can exacerbate erosion of dunes and increased inundation of low lying areas.



Coastal entrances

Coastal entrances affect the currents and amenity of our beaches. Entrances are influenced by tides, waves, currents, sediment movement and floods. These interactions and the ever changing nature of these factors can cause entrances to migrate along the coastline, to close up and to re-open.



Climate change

Recent experiences internationally have shown that in a changing climate, coastal recession is a real and growing threat to the present-day sustainability of our coasts. Climate change is predicted to have significant impacts upon coastal areas with some of the predicted future impacts of climate change on the NSW coast including, sea level rise, increase in the intensity of flood events and ocean storm events, changes in the average annual rainfall, increases to atmospheric and sea surface temperatures, increased wind speeds and an increase in evapotranspiration. These impacts may change coastal groundwater levels and salinity, accelerated recession and erosion events and intensify coastal inundation events.



Human activities

Human activities in the coastal zone are many and varied and include the construction of coastal protection works, passive and active recreational pursuits and the use of certain areas for residential, commercial or ecological purposes.

Human activities can significantly affect coastal processes. These effects can be both beneficial and detrimental. For example, the construction of a seawall has the benefit of protecting properties at risk of erosion or recession hazard however the construction may also have detrimental effects including the loss of beach sand through interference with the amount of sediment on a beach, more limited access to the beach and reduced recreational amenity.





How do coastal processes interact?

The interactions between processes are complex. For instance, coastal water levels are influenced by storms (storm surge), rainfall (flood levels in estuaries), the gravitational effects of the planets and moon (tides), climate change and waves (wave setup). In addition to this, wave behaviour is impacted by storms, currents, water levels, offshore sediment movement and potentially coastal protection works.

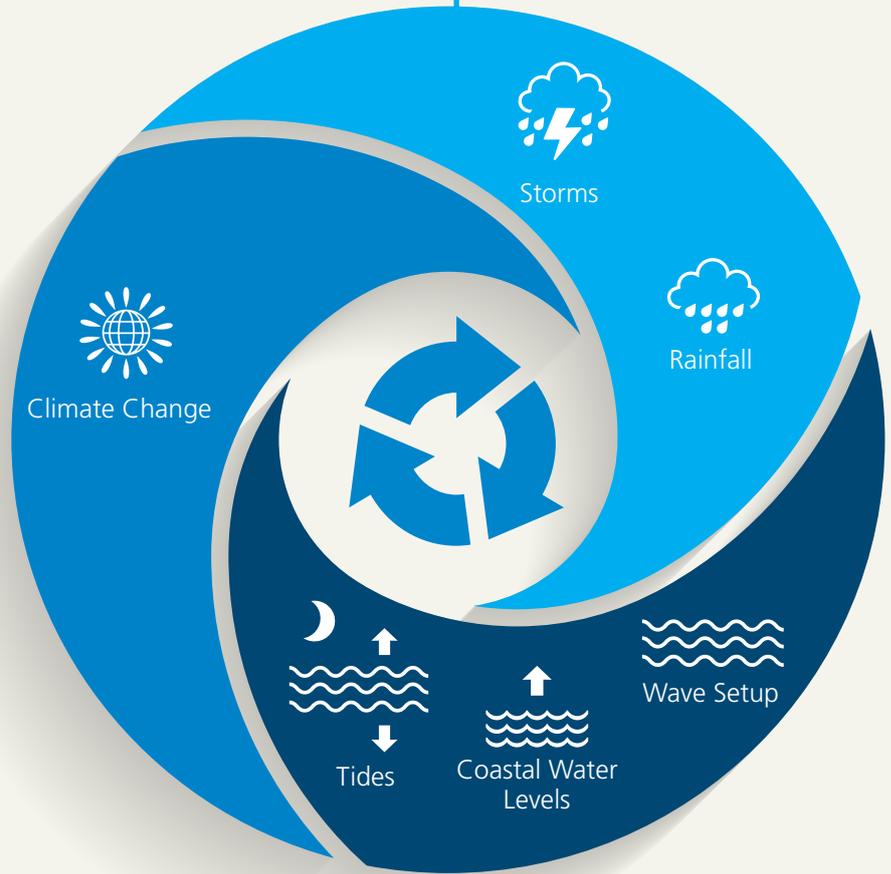
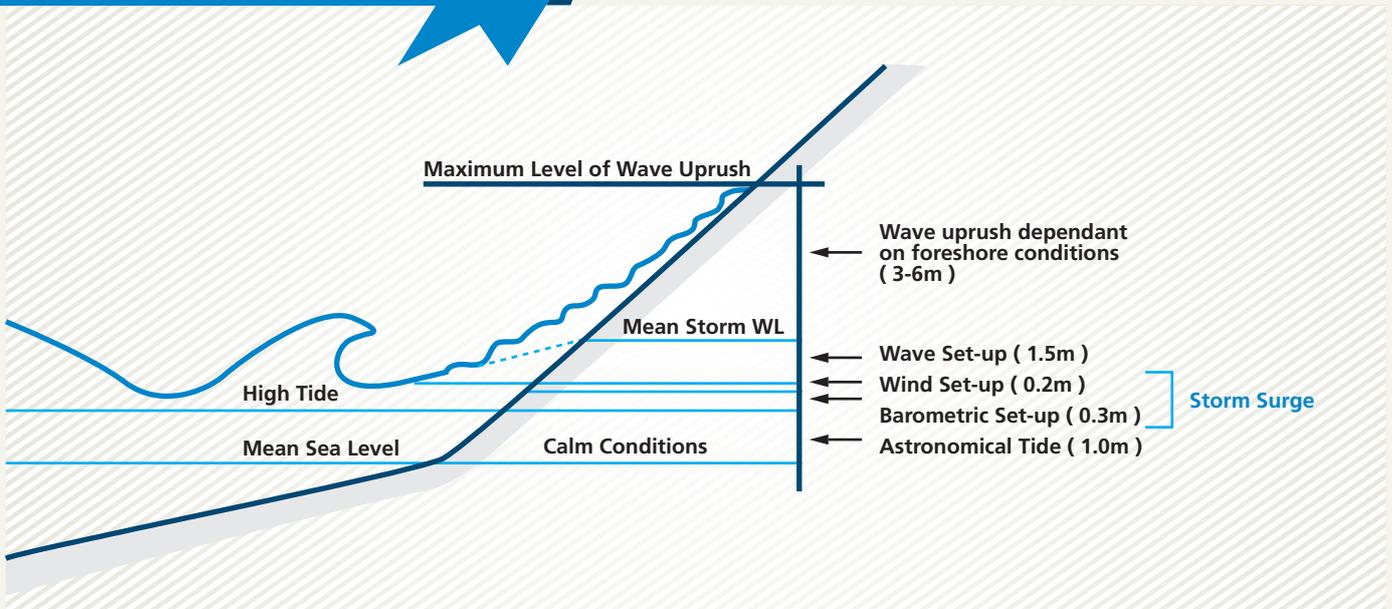


Figure: Elevated water levels during a storm



Find out more about Gosford City Council's coastal management planning from our website

www.gosford.nsw.gov.au

Prepared in consultation with Councils Catchments and Coast Committee.





Beach erosion scarp creates issues for access and safety on our beaches

Coastal hazards

affecting our coastline

Seven hazards have been identified as influencing the NSW coastline and the processes within them.

If not properly managed, such hazards can reduce amenity, place coastal developments at risk and lead to major financial loss. While the pressure to develop additional areas of the coastline is intensifying, potential problems can be avoided if recognised at an appropriate point in the decision making process. An understanding of coastline hazards and their effects on developments, coastal ecology and amenity is essential if the coastline is to be better managed. The solution lies first in the recognition of hazards and their impacts, and second, in the adoption of a balanced management approach.

1

Beach erosion

Erosion is part of the natural response of a beach to changing wave and water level conditions. Generally, the eroded sand is returned to shore and the beach is rebuilt during calmer periods. However, the large waves, elevated water levels and strong winds generated by a storm can cause severe erosion to sandy beaches. Storm wave attack can move significant quantities of sand offshore with waves undercutting the beach berm and frontal dune to form a pronounced erosion escarpment. The foredune may be cut back by up to 20m during a major storm event.

Buildings and infrastructure located within the "active" beach system, or area subject to erosion, will be undermined, and if not designed for this hazard, may collapse.



The two causes of shoreline recession are sediment loss and an increase in sea levels.

Foredunes may be cut back by up to

20m

during a major storm event.



Sand Drift can cause the abrasion of motor vehicles, buildings, vegetation; the burial of roadways and coastal ecosystems; the blockage of street gutters and stormwater drains; and structural damage to buildings.



2 Shoreline recession

Shoreline recession refers to the progressive landward shift of the average long term position of the coastline. Recession is different to beach erosion, although they both may be caused by the same processes. The two causes of shoreline recession are sediment loss and an increase in sea levels.

3 Coastal entrance instability

Both natural and trained coastal entrances can create a variety of hazards. Natural entrances tend to move along the beach in response to freshwater flooding and coastal storm effects, and may threaten any adjacent developments and the amenity of affected beaches. Stabilisation works can help to protect the location of an entrance, but may create significant changes to the estuary and nearby beaches.

4 Sand drift

Sand drift is caused when sand is moved by wind and is a seemingly unrelenting coastal phenomenon with all sandy beaches experiencing sand drift to some extent. Moreover, it is a seemingly slow moving and gradual process, but short episodes of strong wind can move surprisingly large volumes of sand. At best drifting sand is a nuisance; at worst it represents a permanent loss of sand from the beach system and may completely overwhelm coastal developments. Detrimental effects include the abrasion of motor vehicles, buildings, vegetation and park and garden fittings; the burial of roadways and coastal ecosystems; the blockage of street gutters and stormwater drains; and structural damage to buildings caused by forces imposed by the sand. Vegetation of the beach dunes can significantly reduce sand drift.

5 Coastal inundation

Coastal inundation is the flooding of low lying coastal lands by ocean waters. These include wetland and other fringe areas of coastal lagoons and rivers, and the areas behind beach and dune systems. The inundation of these areas can be caused by large waves and elevated water levels associated with severe storms.

Severe coastal inundation is an infrequent event and normally lasts for only a short period of time (i.e. several hours). Nevertheless, it can cause significant damage to public and private property: buildings can be damaged; the contents of flooded buildings can be damaged; saltwater can intrude into freshwater systems and groundwater can cause problems through the breakdown of transport and communications.

6 Slope and cliff instability

Slope and cliff instability hazards refer to the possible structural weaknesses in dunes and rocky headlands and associated potential problems with the foundations of buildings, seawalls and other coastal works. Coastal bluffs and the erosion escarpments of sand dunes can slump, sea cliffs can collapse, and foundations of developments and structures can fail. Slope and cliff instability is different to coastal erosion and recession as the collapse of a foreshore slope or the failure of a foundation primarily depends upon the geological properties of a location.

7 Stormwater erosion

Many back beach areas are drained by small creeks and stormwater outlets that cross the beach to discharge stormwater into coastal waters. During major runoff events, such creeks can cause significant erosion of the beach and the nearshore area around their entrance. This in turn allows larger waves to attack the creek entrance, which if unstable, may migrate along the beach.

Climate change may exacerbate all the above hazards.



Find out more about Gosford City Council's coastal management planning from our website

www.gosford.nsw.gov.au

Prepared in consultation with Councils Catchments and Coast Committee.





Risk assessment outcomes

What were the outcomes of the assessment and what will it mean to me?

The purpose of the Coastal Hazard Risk Assessment is to define the level of threat of erosion and flooding along the open coast and Broken Bay Beaches within the Gosford Local Government area. The coastal hazards defined in the risk assessment are those relating to:

- inundation of land from waves running up the beach in a severe storm (wave runup) and coastal inundation due to storm surge
- coastal erosion as a result of waves in a severe storm event, in the present day
- coastal erosion projected into the future in 2050 and 2100, as a result of observed long term changes in shoreline position
- coastal erosion projected into the future in 2050 and 2100, as a result of projected changes in shoreline position as a result of sea level rise due to climate change

- capacity of the beach dunes to support building foundations, both in the present day and projected into the future.

The risk along the various beaches has been represented in terms of mapped Coastal Hazard Lines along each beach.

Coastal Hazard Lines (representing the assessed extent of erosion under a severe coastal storm) for the study area were last defined in 1994 for open coast beaches and in 1998 for Broken Bay beaches, and adopted as planning controls for development. However, these lines did not take into account the sea level rise planning benchmarks adopted by Council in August 2013, nor did they make any allowance for reduced foundation capacity as required now by the NSW State Guidelines for Preparing Coastal Zone Management Plans.

In recognition of these limitations, the adequacy of the hazard lines has been reviewed and revised hazard lines for the present day, 2050 and 2100 future planning periods have been developed.



The risk along the various beaches has been represented in terms of mapped Coastline Hazard Lines along each beach.

Hazard lines for the present day,

2050

and 2100 future planning periods have been developed.



For most landowners, no action would be required other than being aware of the coastal hazards, as the level of risk to life and property would be low.





Any structures seaward of this line are therefore at risk of being damaged in a severe storm (with approximately a

1% probability of occurrence in any one year).



Coastal erosion

Coastal inundation

Reduced foundation capacity

Future hazards

Physically, the potential present day dune erosion extent is represented in the maps (see maps on Council's website) by the dashed Zone of Slope Adjustment line. The level of risk assigned to this line is equivalent to the consequence of erosion that could happen under a storm event that has approximately a 1% chance of occurring in any one year. Typically during a storm event, the eroded dune face forms a vertical face known as a scarp. Once it dries out, this dune face will collapse to the natural angle of the sand, and the top of the dune face will move landward in response to this collapse. The extent of the top of the dune once the sand face has collapsed is known as the Zone of Slope Adjustment.

The line represents the possible extent of erosion in any one location, including an allowance for slumping of the dune face. However, the line does not mean that the dune would erode back this far along the entire length of beach in the next large storm event. The line represents the possible extent of erosion, given that large rips can form in a storm and increase the volume of sand taken from the beach in the location directly landward of where the rip forms.

The magnitude of a storm event that could lead to erosion as depicted by the "Zone of Slope Adjustment" line is approximately equivalent to the storm event that occurred in May-June 1974. While other storms have occurred since that time, generally, (but not in all areas), they have been of lesser magnitude and caused less erosion damage than the 1974 storm.

Any structures seaward of this line are therefore at risk of being damaged in a severe storm (with approximately a 1% probability of occurrence in any one year).

Elevated water levels at times of storms comprise storm surge, including wind setup (the piling up of water against the coastline caused by onshore wind), barometric setup (elevated water levels caused by low atmospheric pressure) and wave setup (elevated water levels caused by breaking waves). This increased water level may persist for several hours to days and, when combined with high tides, can inundate low lying beach areas and coastal creeks.

On a beach dune, waves can typically run up the dune and reach a maximum level which is much higher than the water level due to storm surge and tide alone. The wave runup is a function of the height of the waves and the slope of the beach face. The maximum extent of the wave runup on each beach was assessed for a storm having approximately a 1% probability of occurrence in any one year. Future sea level rise would be expected to increase the risk of inundation due to wave runup.

At lagoon entrances, the inundation hazard can occur as a result of ocean storm wave inundation and/or flooding from rainfall in the catchment.

Individual lots which have been identified as being affected by maximum wave runup have been marked on the maps in blue. Marking of an individual lot does not necessarily mean that there would be overfloor flooding of dwellings within the lot, but only that part of the land within the lot could be affected by wave runup or coastal inundation.

Immediately landward of the Zone of Slope Adjustment is a zone known as the Zone of Reduced Foundation Capacity. Within this zone, the soil mass has a reduced capacity to support building foundations, unless they are constructed on piles deep enough to resist damage by movement within the soil mass.

The NSW Government Office of Environment and Heritage defines the landward extent of this zone as being the Coastal Hazard area.

Light structures within this zone (e.g. fences, utilities, roads, paths etc.) are not considered to be at serious risk although they may suffer damage.

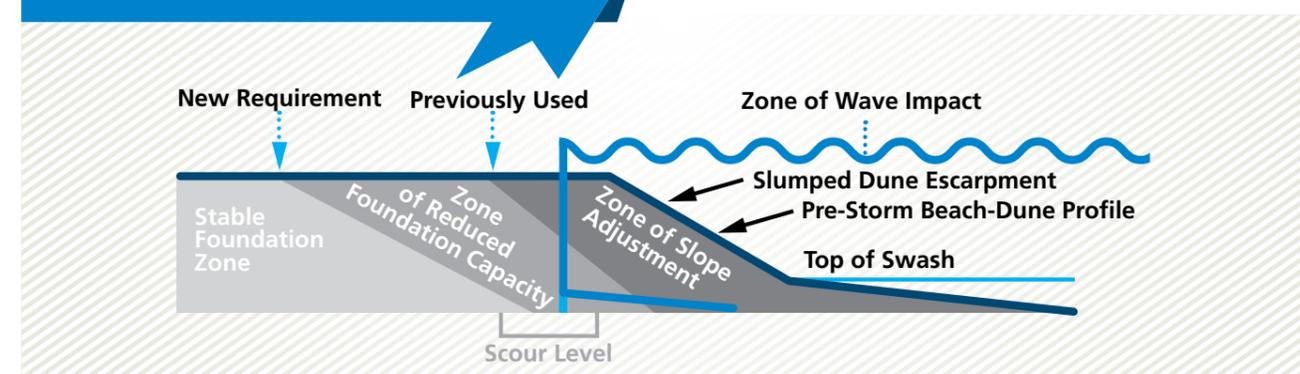
However, heavy structures (buildings) not supported on piled foundations could be at risk of some structural damage due to an increased risk of slumping in this area when the dune in front of them collapses back to the Zone of Slope Adjustment line.

The hazards of erosion and reduced foundation capacity have been projected forward into the future, based on the observed trends in shoreline movement over time and projected shoreline movement as a result of sea level rise.

The observed trends in shoreline movement at each beach may be a result of natural coastal processes affecting a particular area. At some beaches, the shoreline has been observed to be receding over time as sand from the beach is being lost gradually over time, due to movement of the sand to another area from which it is unable to return to the beach. At other areas, there has been a gradual build-up of sand on the beach, or no significant trend. These trends have been defined at each beach in the study area and projected into the future to 2050 and 2100.

In addition to the observed trends, projected changes in future shoreline position have been developed by applying Gosford City Councils adopted sea level rise planning benchmarks for future sea level rise.

Figure 1: Coastal hazard zones



Assessing beach slope instability

For sandy beach and dune areas within the active coastal zone, a number of coastal hazard zones can be delineated as shown in Figure 1.



Typically during a storm event, the eroded dune face forms a vertical face known as a scarp.





What does this all mean for me?

In most areas, the projected hazard lines have not changed substantially from the last assessments carried out in 1994 and 1998. In some areas, updated data analysis has shown that the risk has been projected to have decreased while in others the risk has increased. The risk is based on the best information available at the time of the assessment and is subject to continual refinement as more information becomes available.

Council uses the risk assessment information to assess which of its assets are at risk from damage due to coastal erosion and inundation. For example, utilities may need to be relocated if they are within the hazard area, and the risk to Council and public infrastructure such as carparks, roads, dune fencing and surf club facilities is able to be assessed. This enables Council to make informed decisions about how to best manage these assets into the future, and how best to allocate funding for their management.

In some areas, the coastal hazard lines affect private properties. Council has a duty of care to inform residents should their property be affected by coastal hazards. Landowners with existing developments within the hazard zones should ensure that they are aware of the risk to their property.



For most landowners, no action would be required other than being aware of the coastal hazards, as the level of risk to life and property would be low

Council also uses the risk information to regulate what types of structures are allowable within each hazard area, and this is done through development controls defined in the Local Environment Plan and Development Control Plan. Should a landowner wish to undertake alterations to their property through a Development Application, Council can provide the landowner with the exact location of the hazard zones on their property, to enable developments to be designed to Council's requirements and to ensure property is not placed at risk from future coastal hazards.

For most landowners, no action would be required other than being aware of the coastal hazards, as the level of risk to life and property would be low, even if their property is designated to be within a coastal hazard zone. However, at Wamberal which is considered to be the highest risk area within the Gosford LGA, an Emergency Action Sub-plan has been developed which defines specific actions that Council and landowners should take in a coastal erosion emergency, as well as the roles and responsibilities of various authorities in management of a coastal emergency.

Knowing the degree of risk which applies to each area will enable the most appropriate management strategy to be adopted, with the aim of the strategy being to reduce the risk to a particular area.



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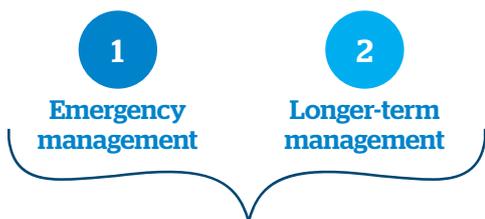


Coastal management options

The Gosford coastline is an attractive area in which to live, work and play.

However, improperly sited, poorly designed or inadequately protected coastal developments are exposed to a variety of coastline hazards. Beach erosion, coastal inundation and windblown sand can damage or destroy coastal developments and reduce beach amenity.

Hazard management generally draws on a mix of emergency and long-term management options, which are incorporated into a Coastal Zone Management Plan. Several organisations are responsible for the management options including the private landowner, local and state government, the Bureau of Meteorology, NSW State Emergency Service, NSW Police and Fire and Rescue NSW.



Coastal zone management plan



Council, the NSW State Emergency Service and NSW Police can barricade dangerous areas, such as eroded beach paths, to maintain public safety and prevent further damage to the affected areas.

Environmental planning and policies are developed to **protect coastal land** and ensure development is carefully designed in hazardous sites.



Successful dune management includes, planning, reconstruction, revegetation, protection and maintenance





Emergency management



Longer-term management

Coastal erosion is a natural and dynamic process with sand and other materials moving on and off beaches over time. During storms however, erosion and inundation events can occur rapidly causing damage and potential danger to buildings, infrastructure and people. There are a range of emergency options that can help reduce the danger including:

Emergency warnings:

The Bureau of Meteorology monitors weather systems and can release severe weather warnings for damaging surf or storm tides.

Evacuation:

The NSW emergency services can assist with warning affected residents and coordinating evacuation and removal of contents from impacted properties. Search and rescue can also be undertaken by the emergency services if required.

Emergency protection works:

Council, and private landowners can undertake temporary coastal protection works, such as sandbagging, with the consent of State Government. This can help to protect properties until a more permanent solution can be found.

Barricading dangerous areas:

Council, the NSW State Emergency Service and NSW Police can barricade dangerous areas, such as eroded beach paths, to maintain public safety and prevent further damage to the affected coastal areas.

Options for managing coastline hazards can be grouped into four categories of environmental planning, development controls, dune management and protective works. Together, these options provide a suite of methods for protecting our coastal areas over the longer term.

Environmental planning

Environmental planning and policies are developed to protect coastal land and ensure development is carefully designed in or withdrawn from hazardous sites. Environmental planning comprises four key areas including:

- Buffers to allow the natural fluctuations of the coastal areas to be accommodated within an area protected from development.
- Restrictive zones to help protect existing developments within the coastal zone by providing development controls on any further incompatible site development to reduce any exacerbation of the existing hazard.
- Planned retreat which permits development for a limited life and allows use and occupation of the coastal site until coastal hazards threaten or damage property. Once an identified trigger deems the building to be at threat it must be demolished (or relocated landward if possible) and it is the owners responsibility to do so.
- Voluntary purchase schemes which bring certain coastal properties threatened by hazards, into public ownership. Following purchase, structures are usually removed and dune vegetation regenerated.

Development control conditions

There are a whole range of development controls that alone or in combination, can help to limit damage of new developments and redevelopments from coastal hazards. These include:

- Building setbacks which position buildings to the landward boundary of properties in order to maintain their distance from potentially eroding dunes and bluffs;
- Dune protection that can ensure the integrity of the foredune system;
- Flood mitigation measures, including minimum floor levels, especially for buildings on land subject to coastal inundation;
- Foundation design that can assist a building to remain standing if the sand beneath it is eroded away;
- Relocatable buildings that can facilitate a temporary occupation of a beachfront site and allow for hazards to be avoided by movement of the structure further landward when appropriate;



During storms, erosion and inundation events can occur rapidly causing damage and potential danger to buildings, infrastructure and people.

Emergency options can help reduce the danger.





Dune management

Dune management is the combination of activities to maintain vegetative cover on the foredune to prevent sand blowing inland where it is lost from the coastal system. Key elements of successful dune management include, planning, reconstruction (inc. beach scraping), revegetation, protection and maintenance. To be most successful, dune management programs require the community to be aware of, and actively or passively support, dune management works. Dune management initiated in the 1980's has been very effective in addressing potential sand loss from Gosford's beaches.

Beach nourishment

Beach nourishment is the process of artificially bringing in sand from external sources to increase the volume of sand on a beach impacted by erosion. Beach nourishment programs have few if any detrimental effects provided that suitable sand supply is available and that it can be obtained without undue consequences. One potential drawback of beach nourishment is that further nourishments may be needed in the future. This can be an ongoing and costly exercise and is usually combined with one or more additional management option.

Construction of protective works

In general, protective works often provide the most publicly acceptable means of reducing hazards to existing properties at risk. When properly designed, constructed and maintained protective works can provide a significant return on investment. However, they are typically expensive and unless carefully designed and constructed, structural works, by reason of their location within the active beach zone, may have a number of unforeseen detrimental effects on amenity. The main types of protective works include: seawalls, groynes, offshore breakwaters, configuration dredging and artificial headlands. Each management option has varying degrees of positive and negative impact on coastal areas.

Beach nourishment is the process of artificially bringing in sand from external sources to increase the volume of sand on a beach impacted by erosion.



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Coastal zone management planning

Gosford City Council has a strong tradition of planning for hazards such as coastal erosion and flooding.

Gosford City Council takes its responsibilities for planning seriously and has sought to bring together experts, planners and the community to deal with the complex issues. Those issues are neither certain nor does planning ensure perfect outcomes.

Our coastal management plans, estuary management plans and floodplain risk management plans have provided our community with information and guidance regarding local flooding and coastal erosion risks.

The primary purpose of coastal management planning is to describe what can be done, and by whom, to address management issues in the coastal zone including managing risks to public safety and built assets, pressures on coastal ecosystems, and community uses of the

coastal zone. A quality Coastal Zone Management Plan will depend largely on the knowledge, involvement and support of the local community. Accordingly, community consultation and participation is an integral element of the process.

Council is updating the existing Open Coast Beaches (1995) and Broken Bay Beaches (1999) Coastal Management Plans to improve management of our coastal risks whilst providing opportunities for development. Community engagement will be undertaken through the entire coastal zone management planning process to enable alignment with community objectives and concerns. A revised Coastal Zone Management Plan will combine both the Open Coast and Broken Bay beaches plans and is being prepared in the following series of steps:



Council's assessment, which was completed in 2014, examines the coastal processes and hazards that impact the coastline between Patonga and Forresters Beach.



The committee comprises of Council staff, NSW Government officers and community representatives who oversee and advise the coastal zone management planning process



The planning process comprehensively assesses the social, economic, aesthetic, recreational and ecological issues associated with land use along the coastline.





This stage involves identifying coastal management issues and setting goals and objectives to address the issues.



1

Form management committee (June 2013)

The Catchments and Coasts Committee has been established to enable stakeholder input and provides advice to Council during plan preparation. This committee comprises of Council staff, NSW Government officers and community representatives who oversee and advise the entire coastal zone management planning process



2

Identify issues and set goals

Frame the vision, goals and objectives for planning and review existing data. This stage also involves identifying coastal management issues and setting goals and objectives to address the issues. Many of the goals and objectives are already established through State Government guidelines and policies, however there is still an opportunity to incorporate local objectives into the planning process.

3

Undertake Coastal Risk Assessment (February 2014)

A Coastal Risk Assessment describes the coastal hazards that impact our beaches and makes an assessment of the risks to life and property posed by these hazards.

The risk assessment forms the initial phase of the planning process and applies the latest information (including Council's adopted sea level rise scenarios), modelling and engineering methodologies, to provide an understanding of the coastal processes that operate within the study area. The NSW Government requires that risks need to be assessed with consideration of current and future conditions (2050 and 2100) to include the natural processes that occur on our beaches and the impacts of projected climate changes. Council's assessment, which was completed in 2014, examines the coastal processes and hazards that impact the coastline between Patonga and Forresters Beach. These include:

Coastal processes

- Waves
- Storms
- Elevated Water Levels
- Currents
- Sediment Transport
- Dunes
- Coastal Entrances
- Climate Change

Coastal hazards

- Beach erosion
- Shoreline recession
- Coastal entrance instability
- Sand drift
- Coastal inundation
- Coastal cliff or slope instability
- Stormwater erosion
- Climate Change

3

Undertake Coastal Zone Management Study (current focus)

Having defined the type, nature and significance of coastline hazards, a Coastline Zone Management Study is the next step to be undertaken to identify options relevant to the environmental planning and management of the area. The management study will consider all feasible management options.

Council is currently undertaking a Coastal Zone Management Study which is expected to be completed by mid-2014. The study comprehensively assesses the social, economic, aesthetic, recreational and ecological issues associated with land use along the coastline, in addition to coastline hazards, including climate change. Assessment of management options will consider, the complexities of:

- implications of existing land ownership, future development and planning controls,
- the local economy, including the local employment market,
- the preservation of areas of aesthetic or ecological significance,
- the protection or enhancement of recreational amenity,
- the opportunity for and management of tourism.



A range of management options are identified including, emergency responses such as emergency warnings, evacuation, emergency protection works and barricading dangerous areas to more longer term management options including, environmental planning, development control conditions, dune management, beach nourishment and the construction of protective works.

As part of the assessment of management options, the likely advantages, disadvantages, potential environmental, social and economic impacts and indicative costs are considered. Estimates of capital and maintenance costs for protection works are also prepared.

The 'do nothing' option is also considered to assist in undertaking a damages assessment. This will be based on the value of coastal property and indicative costs for public infrastructure that would be lost or damaged if management strategies were not adopted. The final Coastal Zone Management Study will assist Council in developing appropriate planning provisions and in applying the criteria for proposed development.





5

Prepare Coastal Zone Management Plan (mid-2014)

The next stage in the process is to develop a Coastal Zone Management Plan. The primary purpose of coastal management planning is to describe proposed actions to be implemented by council, other public authorities and potentially by the private sector to address priority management issues in the coastal zone over a defined implementation period. These issues include:

- equitably managing risks to public safety and built assets
- pressures on coastal ecosystems, and
- community uses of the coastal zone.

The planning process aims to ensure an appropriate long term balance in the utilisation and conservation of the coastline. This will facilitate a compatibility of uses with hazards by reducing private and public losses from hazard damage and protect the recreational amenity of beaches. Plans may include:

- a description of the objectives of the plan;
- a discussion of issues, problems, special features and values specific to the area of the plan;
- a schedule of specific management measures aimed at achieving the objectives; and
- a description of the means and timing of implementation of these measures.
- The development of the Coastal Zone Management Plan requires that a number of considerations be taken into account, including:
 - implications of coastal planning policy and guidelines;
 - the type and nature of coastline hazards, including risk and potential damage to coastal developments and amenity;
 - aesthetic, recreational and ecological values of Gosford's coastline;
 - social factors, including the needs and desires of the community, the social disruption and other intangible costs of potential damage, and the physical and psychological effects of damage;
 - long term considerations of climate change; and
 - an economic analysis of proposed or existing development, including expected costs and benefits to both the public and private sectors, based on options to develop, redevelop or leave undeveloped an area of the coast.

Council expects this plan to be completed by mid-2014.

6

Implement Coastal Zone Management Plan (over a 10-15 yr period)

Once a Coastal Zone Management Plan has been adopted, the next step is to implement the management measures listed within the plan. Certain measures can be implemented quickly, such as development and building controls, hazard education, public awareness and dune management programs. However, it is unlikely that any management plan could be implemented immediately in its entirety. For example, availability of funding will determine when certain options can be implemented (e.g. structural measures, voluntary purchase of property). Consequently, a strategy needs to be developed to implement the plan over time. The strategy should include the staging of measures that are dependent on availability of funds, the adoption of interim measures, protection priorities, etc.

Relevant time periods will include the long-term planning horizon (e.g. 50 to 100 years to set strategic directions for coastal hazard areas), the period for implementing proposed management actions (e.g. 5 to 10 years) and the period for reviewing the CZMP (e.g. towards the end of the implementation period).



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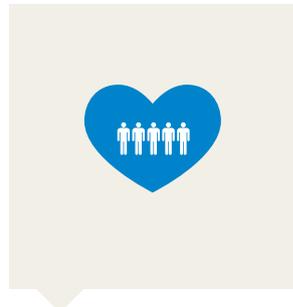


What is the value of our coastline?

Gosford's beaches and the developments along them are of major social, environmental and economic importance to the Gosford local government area.

Both natural and built coastal assets are under increasing pressure from a growing population. The NSW Central Coast already experiences severe storms caused by low pressure systems such as East Coast Lows which can adversely impact our coastal areas. The impacts of these storm events will be exacerbated by climate-induced sea level rise and the projected changes to coastal processes.

There is a need to better understand how much these assets are worth to society and how they might be at risk from current and future pressures. In considering the costs associated with implementing coastal management options it is important to consider what the partial or total loss of beaches would mean for tourism and recreation, the local property market, beach users and the environment. By better understanding the social, economic and environmental values of our coastline, we can more easily determine whether the cost of protecting our coastline outweighs the value or more particularly what management options are appropriate.



Social values

The Gosford beaches provide many social values to our community and visitors to the area. Our beaches provide more than just a high quality of visual amenity as they often link closely with our lifestyle choices as well as indigenous, spiritual and cultural value. Our coastline provides a range of social and recreational opportunities including, walking or jogging on the beach, meeting with family and friends, relaxing, swimming, bonding with nature, sightseeing and



The economic value of our coastline includes the value of private dwellings, public infrastructure and the income provided through tourism.



The beaches of Gosford are highly valued by residents and a key asset in attracting visitors to the area.



Sand dunes exhibit high biodiversity value and protect our developments during storms.





people watching, surf lifesaving and nippers, sunbathing and beach games. The high visitation rates we have to our beaches demonstrates the importance that both local residents and tourists put on the social value of our coastline.



Economic values

The economic value of our coastline includes the value of private dwellings, public infrastructure and the income provided through tourism and recreation.

There is widespread residential development along our coastline with beachfront properties generally highly valued within the property market. The built coastal environment is strongly linked to the risks proposed

by climate change projections as infrastructure is often in close proximity to the coastline and coastal waterways. In a 1 in 100 year storm event, there are over 360 properties identified as being at risk of either erosion or inundation along our coastline. The extent to which the buildings on these properties are at risk is a function of their design and location.

Our coastline provides a sense of liveability to the community. Given the popularity of our coastline, there are a vast number of coastal assets managed by local government, including beach pathways and fencing, existing protective works and drainage infrastructure, amenities, car parks and surf clubs. They also require a financial commitment for both construction and maintenance. The impacts of climate change are likely to exacerbate these maintenance costs. This is likely to place immense pressure financially on Council to continue to provide such assets.



Environmental values

The value of the natural environment is also a paramount consideration in the sustainable management of the coastline.

While beaches may appear barren and largely devoid of life, they support a great diversity of flora and fauna and provide habitat and nursery ground for many coastal and estuarine species. Moreover, sandy beaches are an important ecosystem that links the ecology of sand dunes, the surf zone, intertidal zones, and nearby rocky reefs. Sand dunes also exhibit high biodiversity value and protect our developments during storms.

Several natural coastal and marine ecosystems are at risk from human use and coastal hazards now and into the future. They are impacted through landward migration and erosion, recreational activities (i.e. fishing, harvesting), coastal development, beach cleaning and nourishment.

Depending on the location, there may be opportunity to retreat or relocate such infrastructure, however in many cases the infrastructure hinges on the location of private property and there may be no room to move.

Central Coast Tourism reported that the beaches of Gosford are highly valued by residents and a key asset in attracting visitors to the area. In 2011/12, the total tourism and hospitality sales in Gosford City was \$504.1m, with visitors spending an additional \$216.8m in the local economy. Tourism supports more than 11,000 jobs on the Central Coast.

How do we measure the value of coastal zone management options?



A cost benefit analysis will be undertaken for all management options at individual beaches across Gosford as part of the Coastal Zone Management Plan development and will include consideration of the "no action" assumption. The "no action" assumption is different from the "business as usual" in such a way that the latter takes into consideration current adaptation measures already being undertaken.

Using cost benefit analysis allows Council to determine if a management option will cost more than the value of the asset it protects. This will help us to decide if it is an option worth pursuing.



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Coastal zone terminology

Accreted profile - The profile (cross-section) of a sandy beach that develops in the "calm" periods between major storm events. During such periods, swell waves move sediment from the offshore bar back onto the beach to rebuild the beach berm.

Barometric setup - The increase in mean sea level caused by a drop in barometric pressure.

Bathymetry - The measurement of depths of water; also information from such measurements.

Beach berm - That area of shoreline lying between the swash zone and the dune system.

Beach erosion - The offshore movement of sand from the beach during storms.

Beach nourishment - The mechanical supply of sediment to increase sand on a beach.

Blowout - removal of sand from a dune by wind drift after protective dune vegetation has been lost.

Breaker zone - That area of coastal waters where shoaling effects cause swell waves to break. This typically occurs in the shallower waters over an offshore bar.

Breaking waves - As waves increase in height through the shoaling process, the crest of the wave tends to speed up relative to the rest of the wave. Waves break when the speed of the crest exceeds the speed of advance of wave as a whole. Waves can break in three modes: spilling, surging and plunging.

Breakwater - Structure protecting a shoreline, harbour, anchorage or basin from ocean waves.

Buffer zone - A zone of land between beach and development, within which coastline fluctuations and

hazards can be accommodated in order to minimise damage to the development.

Coastal structures - Those structures on the coastline designed to protect and rebuild the coastline and/or enhance coastal amenity and use.

Coastline hazards - Detrimental impacts of coastal processes on the use, capability and amenity of the coastline. Coastline hazards include beach erosion, shoreline recession, entrance instability, sand drift, coastal inundation, slope and cliff instability and stormwater erosion.

Damage potential - The susceptibility of coastline development to damage by coastline hazards.

Design wave height - The wave height adopted for the purposes of designing coastal structures such as breakwaters and seawalls. It is chosen to ensure that the structures are not at undue risk of wave damage.

Diffraction - The "spreading" of waves into the lee of obstacles such as breakwaters by the transfer of wave energy along wave crests. Diffracted waves are lower in height than the incident waves.

Dune field - The system of incipient dunes, foredunes and hinddunes that is formed on sandy beaches to the rear of the beach berm.

Dune maintenance - The management technique by which dunes, dune vegetation and dune protective structures are kept in good "working order"; activities may include weed/pest/fire control, replanting, fertilising, repair of fences and accessways, and publicity.

Dune management - The general term describing all activities associated with the restoration and/or maintenance of the role and values of beach dune systems; dune

management activities and techniques include planning, dune reconstruction, revegetation, dune protection, dune maintenance, and community involvement.

Dune protection - The management technique by which the dune system is protected from damage by recreational and development activities; dune protection activities generally include the use of fences, accessways and signposts to restrict and control access to dune systems.

Entrance instability - Refers to the tendency of lagoon entrances to migrate along the shore, close up, reopen, form new entrances, etc. in response to wave and current action and freshwater flows.

Foredune - The larger and more mature dune lying between the incipient dune and the hinddune area. Foredune vegetation is characterised by grasses and shrubs. Foredunes provide an essential reserve of sand to meet erosion demand during storm conditions.

Groynes - Low walls built perpendicular to a shoreline to trap longshore sediment. Typically, sediment buildup on the updrift side of a groyne is offset by erosion on the downdrift side.

Hinddune - Sand dunes located to the rear of the foredune characterised by mature vegetation including trees and shrubs.

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

Littoral zone - Area of the coastline in which sediment movement by wave, current and wind action is prevalent. The littoral zone extends from the onshore dune system to the seaward limit of the offshore zone and possibly beyond.

Longshore currents - Currents flowing parallel to the shore within the inshore and nearshore zones. Longshore currents are typically caused by waves approaching the beach at an angle. The "feeder" currents to rip cells are another example of longshore currents.

Mass transport - The net shoreward currents associated with the movement of waves through the nearshore and inshore zones. Sediment transport from the offshore bar by this current is responsible for the rebuilding of storm eroded beaches during inter-storm periods.

Nearshore zone - Coastal waters between the offshore bar and the 60m depth contour. Swell waves in the nearshore zone are unbroken, but their behaviour is influenced by the presence of the seabed.

Offshore bar - Submerged sandbar formed offshore by the processes of beach erosion and accretion. Typically, swell waves break on the offshore bar.

Offshore breakwater - Offshore structure built parallel to the beach to protect the beach and/or reduce wave action in inshore waters.

Offshore zone - Coastal waters to the seaward of the nearshore zone. Swell waves in the offshore zone are unbroken and their behaviour is not influenced by the presence of the seabed.

Onshore/offshore transport - The process whereby sediment is moved onshore and offshore by wave, current and wind action.

Pocket beaches - Small beach systems typically bounded by rocky headlands. Because of the presence of the headlands and the small size of these beaches, longshore currents are relatively insignificant in the overall sediment budget.

Reflected wave - That part of an incident wave that is returned seaward when a wave impinges on a steep beach, barrier, or other reflecting surface.

Refraction - The tendency of wave crests to become parallel to bottom contours as waves move into shallower waters. This effect is caused by the shoaling process which slows down waves in shallower waters.

Rip currents - Concentrated currents flowing back to sea perpendicular to the shoreline. Rip currents are caused by wave action piling up water on the beach. Feeder currents running parallel to the shore (longshore currents) deliver water to the rip current.

Coastal zone terminology

Sand drift - The movement of sand by wind. In the context of coastlines, "sand drift" describes sand movement resulting from degradation of dune vegetation, resulting in either nuisance or major drift. Sand drift can damage buildings, roads, and adjoining natural features such as littoral rainforest or wetlands; sand drift can be a major coastline hazard.

Sand dunes - Mounds or hills of sand lying to landward of the beach berm. Sand dunes are usually classified as an incipient dune, a foredune or hinddunes. During storm conditions, incipient and foredunes may be severely eroded by waves. During the intervals between storms, dunes are rebuilt by wave and wind effects. Dune vegetation is essential to prevent sand drift and associated problems.

Scarp - Also known as the Dune Scarp and Backbeach Erosion Escarpment. The landward limit of erosion in the dune system caused by storm waves. At the end of a storm the scarp may be nearly vertical; as it dries out, the scarp slumps to a typical slope of 1V:1.5H.

Seawalls - Walls built parallel to the shoreline to limit shoreline recession.

Sea waves - Waves in coastal waters resulting from the interaction of different wave trains and locally generated wind waves. Typically, sea waves are of short wavelength and of disordered appearance.

Sediment budget - An accounting of the rate of sediment supply from all sources (credits) and the rate of sediment loss to all sinks (debits) from an area of coastline to obtain the net sediment supply/loss.

Sediment sink - A mode of sediment loss from the coastline, including longshore transport out of area, dredging, deposition in estuaries, windblown sand, etc.

Sediment source - A mode of sediment supply to the coastline, including longshore transport into the area, beach nourishment, fluvial sediments from rivers, etc.

Semi-diurnal tides - Tides with a period, or time interval between two successive high or low waters, of about 12.5 hours. Tides along the New South Wales coast are semi-diurnal.

Shoaling - The influence of the seabed on wave behaviour. Such effects only become significant in water depths of 60m or less. Manifested as a reduction in wave speed, a shortening in wave length and an increase in wave height.

Shelf wave - Long period waves of low height that travel along the continental shelf and may modify coastal water levels off New South Wales by up to 0.2m. Shelf waves are generated by the pressure gradients associated with atmospheric disturbances in Bass Strait.

Shoreline recession - A net long term landward movement of the shoreline caused by a net loss in the sediment budget.

Significant wave height - The average height of the highest one third of waves recorded in a given monitoring period.

Slope readjustment - The slumping of a backbeach erosion escarpment from its near vertical post-storm profile to a slope of about 1V:3H.

Storm profile - The profile (cross-section) of a sandy beach that develops in response to

storm wave attack. Considerable volumes of sediment from the beach berm, the incipient dune and the foredune can be eroded and deposited offshore. The landward limit of the storm profile is typically defined by a backbeach erosion escarpment (dune scarp).

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

Storm bar - An offshore bar formed by sediments eroded from the beach during storm conditions.

Surf zone - Coastal waters between the breaker zone and the swash zone characterised by broken swell waves moving shorewards in the form of bores.

Swash zone - That area of the shoreline characterised by wave uprush and retreat.

Swell waves - Wind waves remote from the area of generation (fetch) having a uniform and orderly appearance characterised by regularly spaced wave crests.

Tides - The regular rise and fall of sea level in response to the gravitational attraction of the sun, moon and planets. Tides along the New South Wales coastline are semi-diurnal in nature, i.e. they have a period of about 12.5 hours.

Tsunami - Long period ocean waves generated by geological and tectonic disturbances below the sea.

Wave height - The vertical distance between a wave trough and a wave crest.

Wave hindcasting - The estimation of wave climate from meteorological data (barometric pressure, wind) as opposed to wave measurement.

Wave length - The distance between consecutive wave crests or wave troughs.

Wave period - The time taken for consecutive wave crests or troughs to pass a given point.

Wave rider buoy - A floating device, moored to the seabed, used to measure water level variations caused by waves

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

Wave setup - The increase in water level within the surf zone above mean still water level caused by the breaking action of waves.

Wind setup - The increase in mean sea level caused by the "piling up" of water on the coastline by the wind.

Wind waves - The waves initially formed by the action of wind blowing over the sea surface. Wind waves are characterised by a range of heights, periods and wavelengths. As they leave the area of generation (fetch), wind waves develop a more ordered and uniform appearance and are referred to as swell or swell waves.

Windborne sediment transport - Sand transported by the wind. Sand can be moved by the processes of suspension (fine grains incorporated in the atmosphere), saltation (medium grains "hopping" along the surface) and traction (large grains rolled along the surface).



Find out more about Gosford City Council's coastal management planning from our website

www.gosford.nsw.gov.au

Prepared in consultation with Councils Catchments and Coast Committee.





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Open Coast and Broken Bay Beaches

Coastal Zone Management Study – Pearl Beach

Chris Adamantidis

Pearl Beach 2 February 2015



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Open Coast and Broken Bay Beaches

**Coastal Zone Management Study – Broken Bay Beaches
Patonga, Ocean/Umina, Killcare/Putty**

Chris Adamantidis

3 February 2015



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Coastal Zone Management Study MacMasters-Copacabana Beach

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Coastal Zone Management Study Avoca and North Avoca

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Coastal Zone Management Study Terrigal, Wamberal and Forresters Beach

Chris Adamantidis

9 February 2015

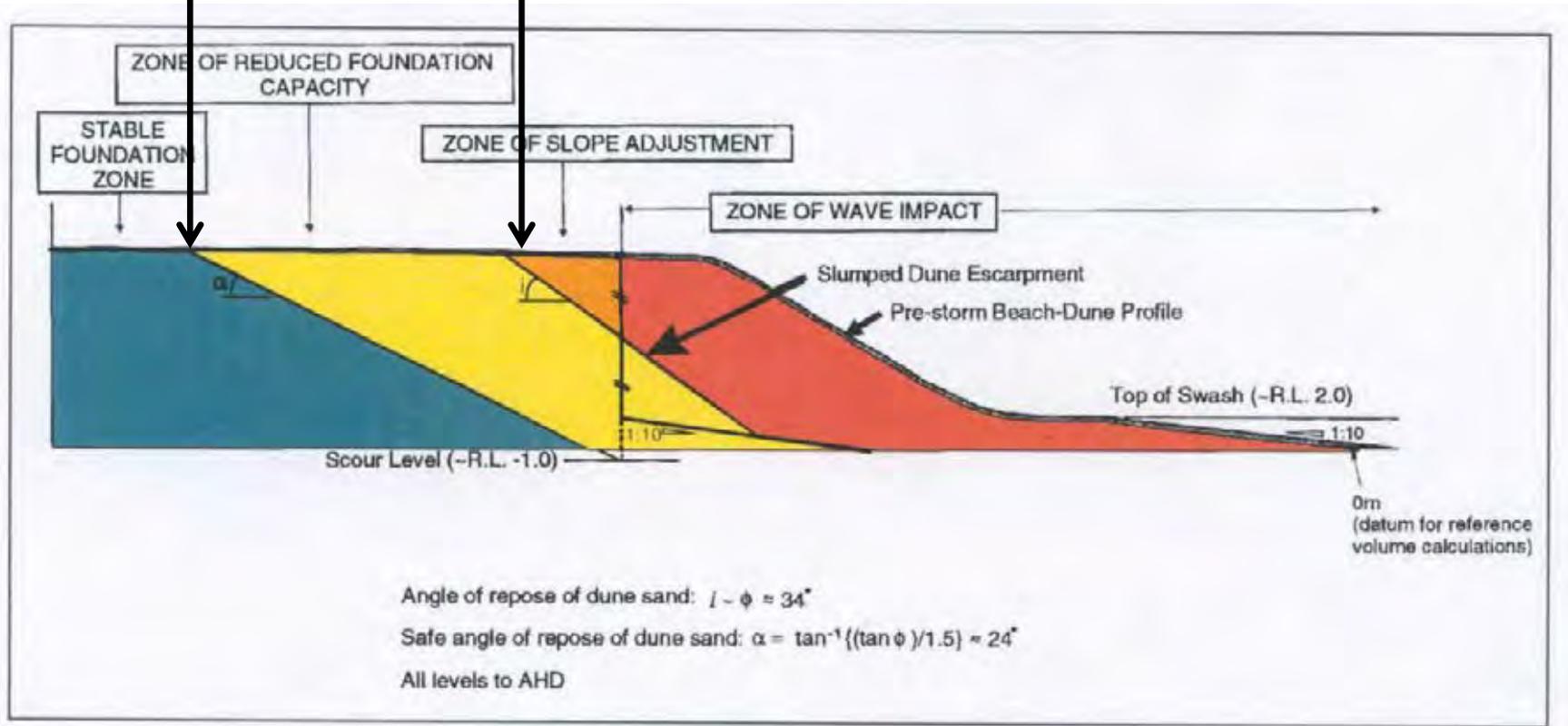
Outline of Presentation

- ▶ Coastal Processes and Hazards at Pearl Beach
- ▶ Coastal management issues and measures at each precinct
- ▶ Overview of Preferred Management Options

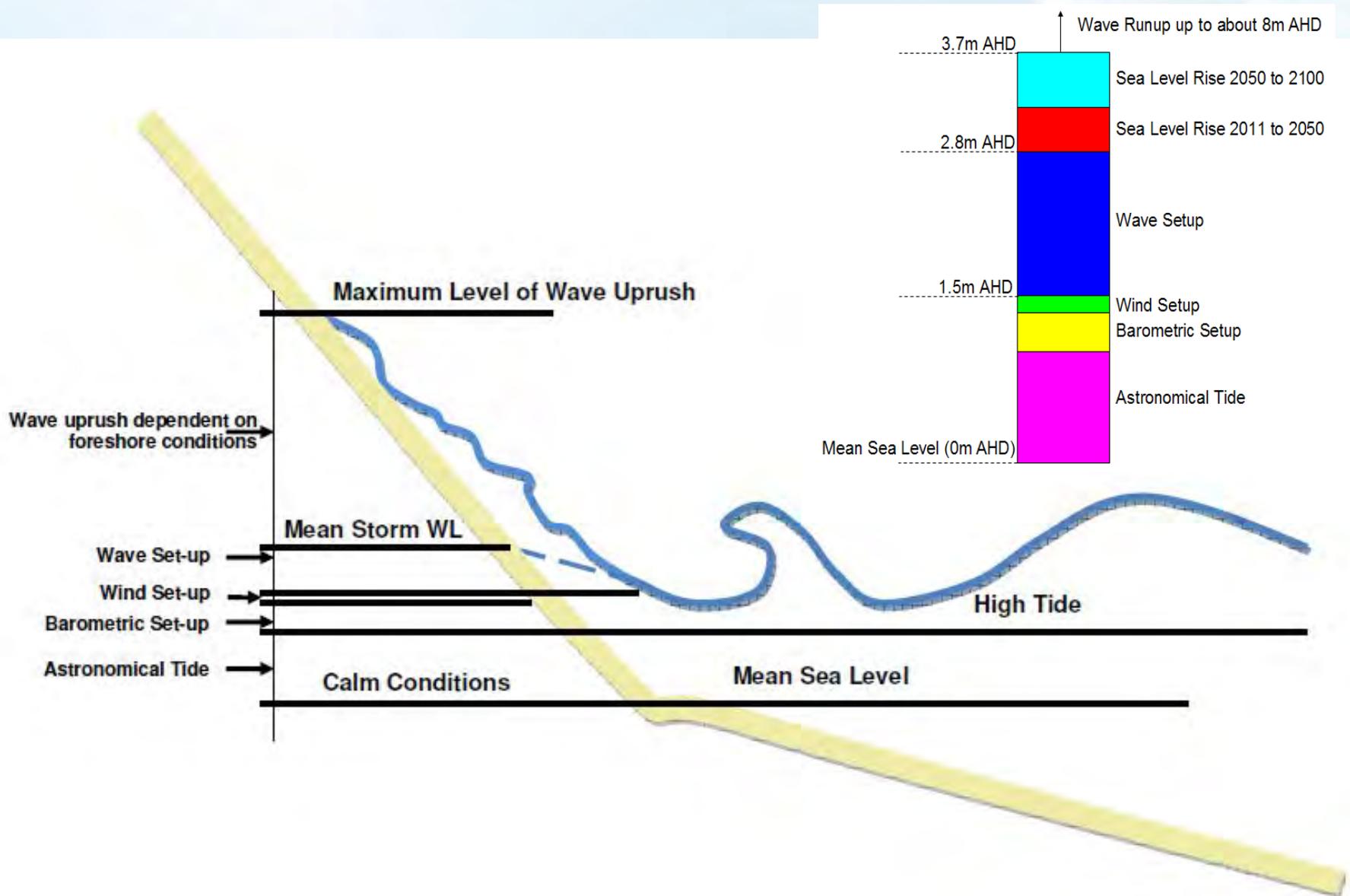
Coastal Risk Assessment

New Hazard Line Definition

Existing (1995) Planning Line



Coastal Inundation – Wave Runup



Coastal Processes and Hazards

- ▶ beach erosion;
- ▶ shoreline recession;
- ▶ sand drift;
- ▶ coastal inundation;
- ▶ stormwater erosion;
- ▶ slope instability; and
- ▶ climate change.

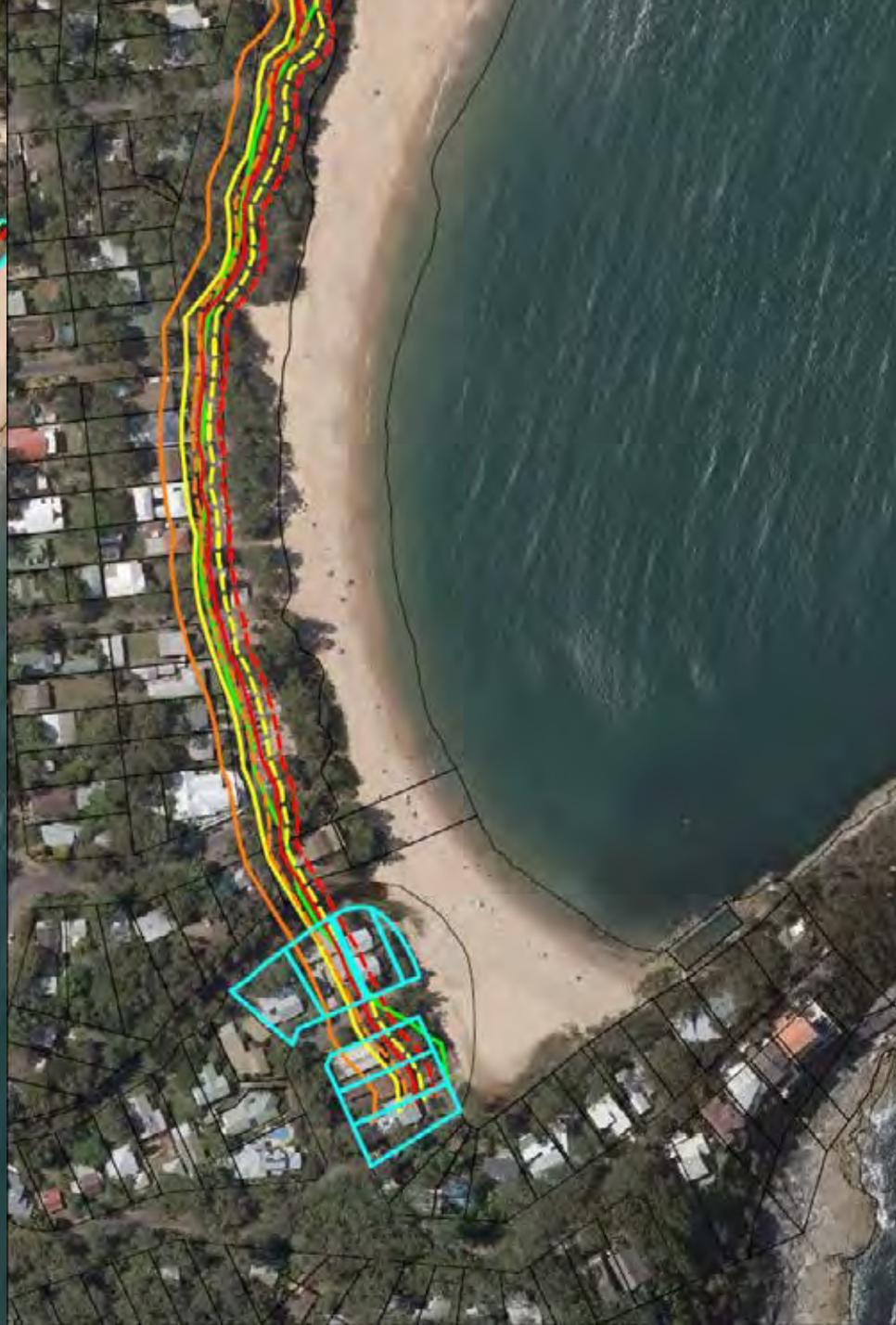
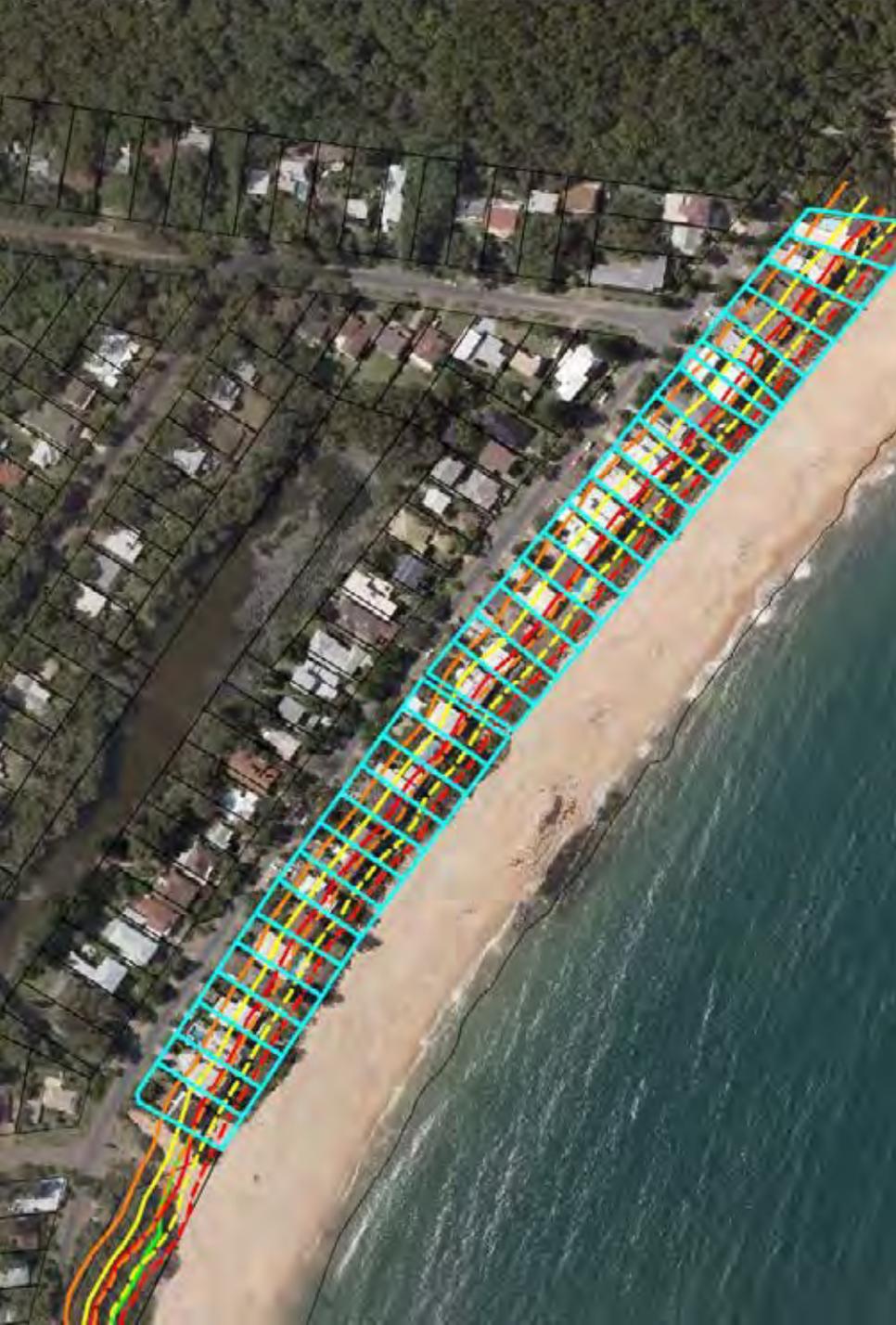
Pearl Beach



A bulldozer working last week at Pearl Beach, pushing sand in front of homes in Coral Crescent. Work is still proceeding this week.

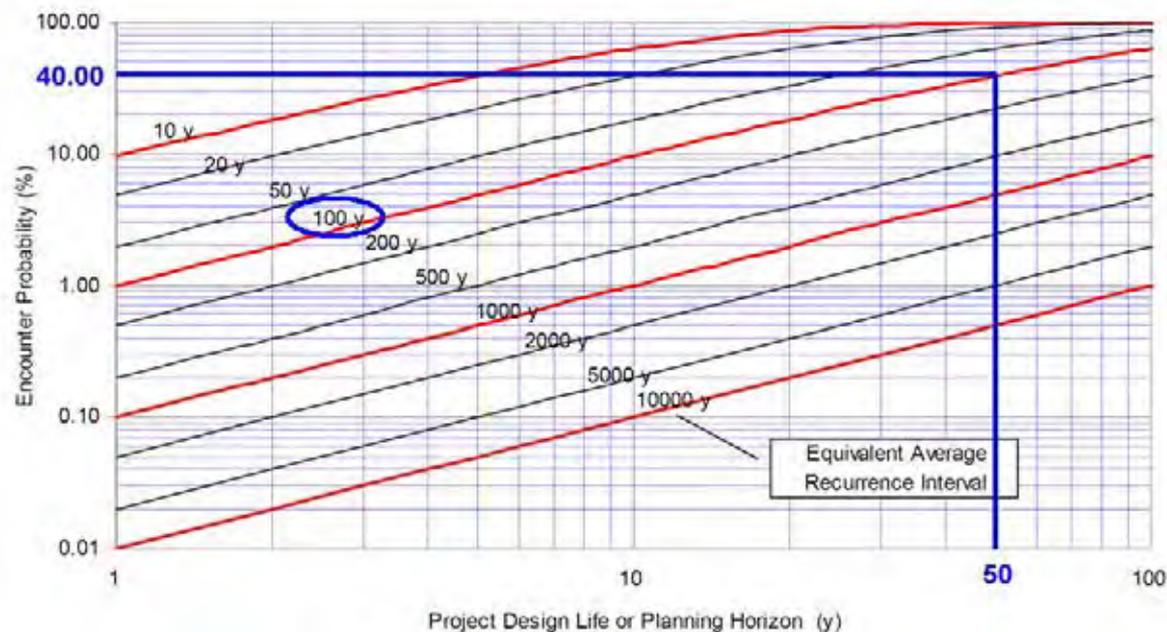
—Prestige Photographics.





Risk Assessment

- ▶ Quantum of assets at risk has been identified
- ▶ Three planning periods considered – present, 2050 and 2100
- ▶ Risk is equivalent to approximately a 1% annual exceedance probability



Pearl Beach

- ▶ Hazard not dissimilar to previous assessment
- ▶ Partly protected from heavy ocean swell
- ▶ Storm erosion demand increases from south – north
- ▶ Very low measured long term recession (0.05 m/year)
- ▶ Sea level rise recession 4.8 m by 2050, 11.8 m by 2100
- ▶ Present Day Wave Run-up 3.8 m AHD (south), 6.4 m AHD (north)
- ▶ 38 beachfront lots at Pearl Beach may be at threat to coastal inundation due to wave runup.
- ▶ Two dwellings and parts of 32 beachfront lots lie within the Immediate Zone of Slope Adjustment, with an additional 21 lots affected by reduced foundation capacity by 2100.
- ▶ Parts of the beachfront access road may be at risk from coastal erosion by 2050

Pearl Beach – Coastal Hazards

- ▶ **Coastal inundation** due to wave runup affecting the beachfront residences at Coral Crescent and near Green Point Creek;
- ▶ **Coastal erosion** having the potential to impact on the beachfront residences at Coral Crescent and near Green Point Creek, as well as the public reserve, playground and amenities block along the southern end of the beach;
- ▶ **Slope Instability;**
- ▶ **Future coastal erosion** and recession affecting up to 135 m length of Pearl Parade by 2100, as well as dwellings, services including stormwater, sewer, water and power along Pearl Parade and Gem Road;
- ▶ **Erosion associated with estuary entrance instability** at Green Point Creek and Middle Creek.

Existing Coastal Management Issues at each beach – Pearl Beach



Management Options

- ▶ Review of available Management Options
- ▶ “No-regrets” options
- ▶ Major challenges/ “big ticket” items
- ▶ Funding options
- ▶ Assessment of key Management Options –
Environmental, Social, Economic
- ▶ Economic and Cost Benefit Assessment

Pearl Beach Precincts

- ▶ **Precinct 1** – Southern end of the beach south from the restaurant;
- ▶ **Precinct 2** – Between Green Point Creek and Middle Creek entrances;
- ▶ **Precinct 3** – Middle Creek to Pearl Beach Lagoon Outlet;
- ▶ **Precinct 4** – Coral Crescent beachfront residences.

Review of Available Management Options

- ▶ Risk Management Approach
- ▶ Product of *likelihood* and *consequence*
- ▶ **Likelihood** = 1% Annual Exceedance Probability
- ▶ **Consequence** = Value of assets exposed to the hazards, what management measures are already in place
- ▶ Beach erosion, shoreline recession, slope stability, coastal inundation.

Risk Matrix

Likelihood

Consequence

	Unlikely	Almost Certain	Certain
Low	Low Risk	Low Risk	Low Risk
Moderate	Low Risk	Low Risk	Moderate Risk
High	Low Risk	Moderate Risk	High Risk
Very High	Low Risk	High Risk	Extreme Risk
Extreme	Low Risk	High Risk	Extreme Risk



Low Risk



Moderate Risk



High Risk



Extreme Risk

Risk Management

- ▶ **Avoid** the risk (setbacks, planning controls, building design criteria)
- ▶ Change the **likelihood** (coastal protection works, beach nourishment, compliance action on illegal works)
- ▶ Change the **consequence** (building infrastructure modification, relocation)
- ▶ **Share** the risk (i.e. insurance)
- ▶ **Retain** the risk (emergency management)
- ▶ Guidelines stipulate management of high public safety risk to take priority over built assets
- ▶ If risks are low, maintain the level of risk
- ▶ If risks are high, avoid further development or ensure development can accommodate the risks; consider works to reduce risk levels

Spatial and Temporal Scale

- ▶ Define management options on a precinct-by-precinct spatial scale
- ▶ Some will be city-wide actions while others will be localised
- ▶ Precincts defined based on natural boundaries, physical attributes and risk levels
- ▶ Temporal scale depends on how risk is changing over time and how quickly option can be implemented
 - Short term (0 – 5 years)
 - Medium term (5 – 20 years)
 - Long term (20 + years)

Avoiding Risk

- ▶ Planning and Development controls DCP/LEP – refinement of these where required
 - Updated erosion hazard predictions;
 - Consistency of application of the policy between various beaches;
 - Inclusion of additional requirements to address the hazard of reduced foundation capacity.
 - Planning horizon
 - Setbacks/planning line – hazard is only one “piece of the puzzle”
 - Inclusion of building and infrastructure criteria

Gosford DCP 2013

- ▶ Minimise the risk to life and property associated with development and building on land which has a coastal beach and/or cliff frontage; and
- ▶ Provide guidelines for the development of land within the coastal frontage area.
- ▶ Broken Bay Beaches - designated coastal hazard areas are seaward of the 2098 erosion line
- ▶ Open Coast Beaches - designated coastal hazard areas are seaward of the 2045 erosion line
- ▶ New coastal hazard assessment – updated erosion zones
- ▶ no technical basis for adopting a different planning horizon (i.e. 2045 or 2098) for the Broken Bay and Open Coast beaches

Options to change risk likelihood

- ▶ Coastal protection works
 - Seawalls/revetments
 - Groynes
 - Artificial reefs
- ▶ Beach nourishment
- ▶ Dune revegetation

Protection Options

- ▶ Impacts on natural character, local economy, scenic character, public access, cultural heritage and coastal processes on adjoining lands
- ▶ Advantages and disadvantages of “hard” vs. “soft” options
- ▶ Who pays and who maintains?
- ▶ Maintenance cost vs value of assets being protected
- ▶ Funding under the NSW Coastal Management Program is limited, and funding priorities are for works that improve public safety and protecting valuable publicly-owned assets, and then to private land.

Seawalls and revetments



Advantages

- ▶ Can be effective in protecting infrastructure from erosion;
- ▶ Can be covered with beach nourishment sand and planted over with native vegetation to reduce visual impact and may only become visible after a major storm;
- ▶ Can be designed to absorb wave energy e.g. rock revetment
- ▶ Can be designed to enhance public access e.g. by incorporating a promenade or walkway
- ▶ Would allow development to continue to occur in its current location as can be designed to effectively reduce the coastline risk to properties.

Disadvantages

- ▶ Cost
- ▶ A revetment may not mitigate inundation
- ▶ False sense of security
- ▶ Impact on visual and recreational amenity of the beach if not combined with beach nourishment;
- ▶ Large footprint area;
- ▶ Can result in higher rates of beach erosion at the ends of the revetment due to edge effects
- ▶ Require on-going maintenance.

Impact of seawalls – Byron Bay



Groynes



- ▶ Only effective where longshore drift is dominant mechanism i.e. not Pearl Beach
- ▶ Can cause erosion downdrift of the structures
- ▶ Can create a usable beach on the updrift side
- ▶ Can detract from visual and recreational amenity
- ▶ Can create a hazard to swimmers
- ▶ Require careful design

Beach nourishment



- ▶ Requires suitable source of sand
- ▶ Ongoing commitment
- ▶ Improvement in beach amenity
- ▶ Can be effective in reducing erosion risk
- ▶ Requires careful study and assessment of environmental impact
- ▶ Most viable source of sand not legally accessible
- ▶ Entire profile must be nourished
- ▶ Smother benthic ecosystems

Artificial Reefs

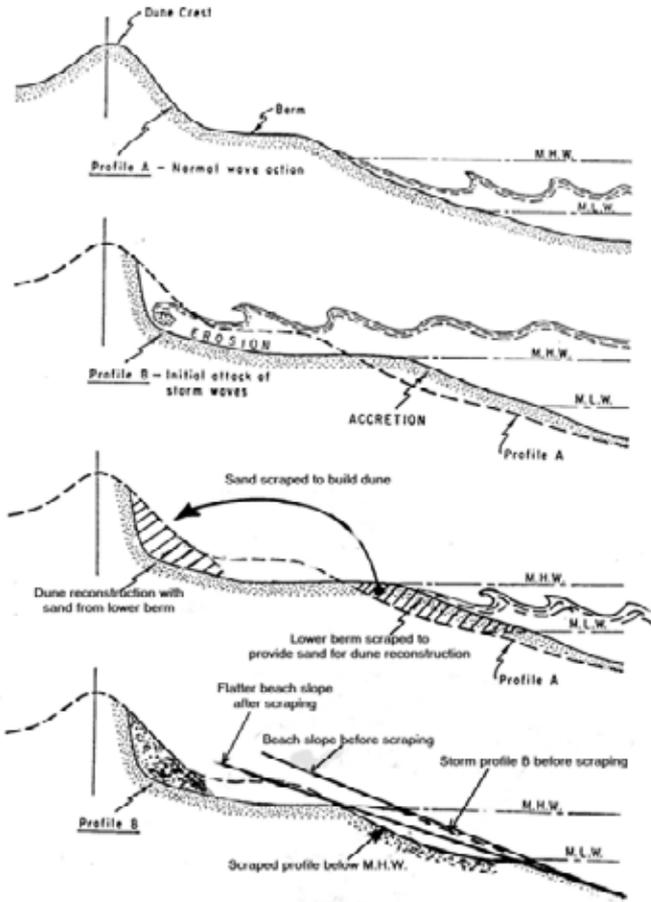


- ▶ Can trap sand in lee of the structure
- ▶ Can enhance surfing amenity
- ▶ Visually unobtrusive
- ▶ Cost
- ▶ Erosion on either side of the structure
- ▶ Smother benthic ecosystems
- ▶ Difficult to predict effectiveness



Beach scraping

- ▶ Speeding up the natural dune rebuilding process



Options to change risk consequence

- ▶ Retreat of public and private infrastructure
 - Relocation to another site
 - Relocation within a property boundary
 - Large scale relocation of settlements and infrastructure
- ▶ Could be implemented through development controls – trigger for development to be moved landward
- ▶ Acquisition of properties at greatest risk – very costly and high social impact on the community
- ▶ Relocation of services landward e.g. Sewer, power, water, roads

Emergency Management

- ▶ Communication of impending beach erosion events
- ▶ Identification of areas where temporary protection works can be installed
- ▶ Monitoring beach erosion
- ▶ Removal of minor infrastructure
- ▶ Police, SES, Fire and Rescue, OEH
- ▶ Installation of temporary fencing, closure of roads, barricades, repairing or replacing damaged infrastructure

No-regrets options

- ▶ Dune Management/vegetation management
- ▶ Stormwater management
- ▶ Monitoring, research and data collection
- ▶ Community education
- ▶ Repair of damaged public infrastructure



Major challenges/big ticket items

- ▶ Landuse and Development Issues
- ▶ Where risk is highest – Wamberal, North Avoca – i.e. both likelihood and consequence is high
- ▶ Do we Defend, accommodate, retreat or maintain status quo?
- ▶ Who pays?
- ▶ Over what timeframe do we want to plan?
- ▶ What is the impact on community?
- ▶ How do we want our beaches to be managed into the future?
- ▶ What legacy will we leave for our children?

Specific Options for Pearl Beach

- ▶ **Development controls** - Council's DCP 2013 Chapter 6.2 Coastal Frontage
- ▶ **Relocation** of existing buildings landward following re-development (e.g. the restaurant, and residences);
- ▶ Undertake or allow residents to undertake **erosion protection works** to protect the residences and sewage pumping station at the southern end of the beach and/or the seaward boundaries of residences along Coral Crescent;
- ▶ **Beach scraping**
- ▶ **Beach nourishment** to provide a buffer against erosion;
- ▶ **Estuary entrance management**
- ▶ **Monitor** existing erosion protection works;
- ▶ **Maintenance of dune vegetation**
- ▶ **Stormwater management**
- ▶ **Relocation of infrastructure** subject to potential damage;
- ▶ **Maintenance of the dune crest** above the level of wave runup;
- ▶ **Maintain the status quo** – do nothing apart from maintain existing planning controls and existing coastal management regime.

Economic Criteria

- ▶ Undertaken a basic costing of all options
- ▶ Construction/Design Cost estimates – rough estimate only
- ▶ Costs/benefits include indirect costs and benefits where known
- ▶ Maintenance Cost/Recurring Costs
- ▶ Net Present Value – discounting of future costs i.e. would you rather get \$100 now or \$200 in 5 years time?
- ▶ What is the value of the benefit vs. the total cost?
- ▶ Total cost could be borne by Council, State Government, community or individual
- ▶ Options can be assessed against total cost and benefit-cost ratios.

Pearl Beach Precincts

- ▶ **Precinct 1** – Southern end of the beach south from the restaurant;
- ▶ **Precinct 2** – Between Green Point Creek and Middle Creek entrances;
- ▶ **Precinct 3** – Middle Creek to Pearl Beach Lagoon Outlet;
- ▶ **Precinct 4** – Coral Crescent beachfront residences.

Precinct 1 - Southern end of the beach

Issues	Option	Timeframe
Immediate and future risk of erosion and reduced foundation capacity to four properties and sewage pumping station	Erosion Protection works to be allowed for four properties south of Green Point Creek entrance (funded jointly by residents, Council and State Government through Coastal program) (Pe1.1)	Short to medium term (0 – 20 years), two of these properties already have protection installed
	Monitor performance of existing erosion works at properties south of Green Point Creek entrance (Pe1.2)	Immediate and ongoing
	Erosion protection works for sewage pumping station and sewer line at end of Gem Road and south from Gem Road (Pe1.3)	Short term (0 – 5 years)
	Relocate sewer infrastructure and pumping station further landward (Pe1.4)	Short term (0 – 5 years)
	Beach nourishment (Pe1.5)	Medium term (5 – 20 years)
Coastal inundation of lots south of Green Point Creek entrance	Beach scraping to build dune in front of residences, Gem Road and restaurant (Pe1.6)	After storm events as required
	Continue dune vegetation management at southern end of beach (Pe1.7)	Ongoing
	Develop entrance management guidelines for mechanical opening of Green Point Creek (Pe1.8)	Short term
	Development controls as per existing DCP i.e. defined building line (e.g. existing building line or 2050 Zone of Slope Adjustment) with new buildings to be founded into 2100 Stable foundation Zone. Residences and restaurant to be above inundation levels on redevelopment of properties (Pe1.10)	Short term
	Construct “tripper” structure to control opening location of creek (Pe1.11)	Short term
	Survey floor levels to determine degree of inundation hazard (Pe1.14)	Short term

Precinct 1

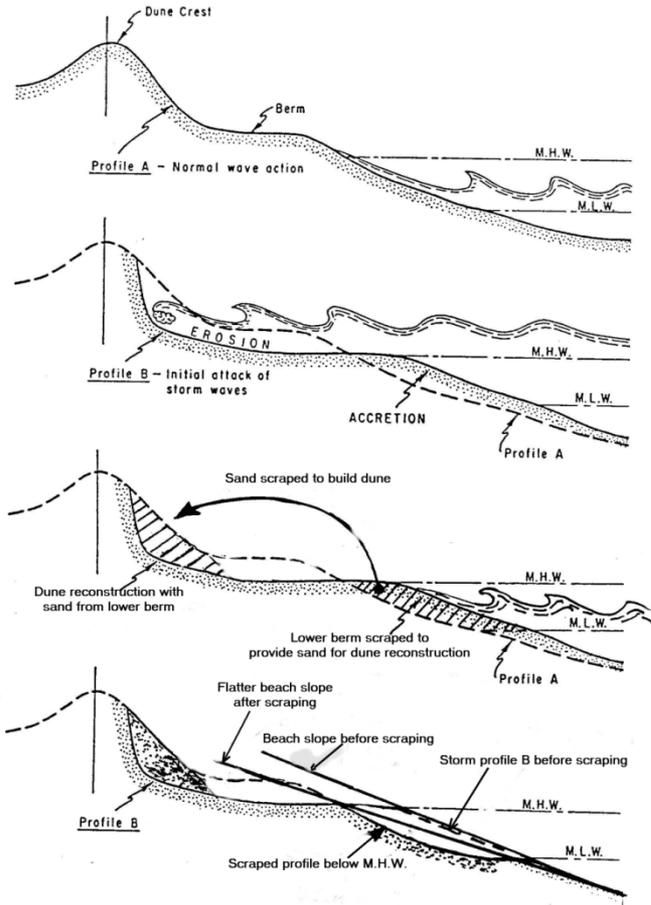


Estuary entrance “tripper” wall to prevent erosion due to meandering of entrance



Beach scraping

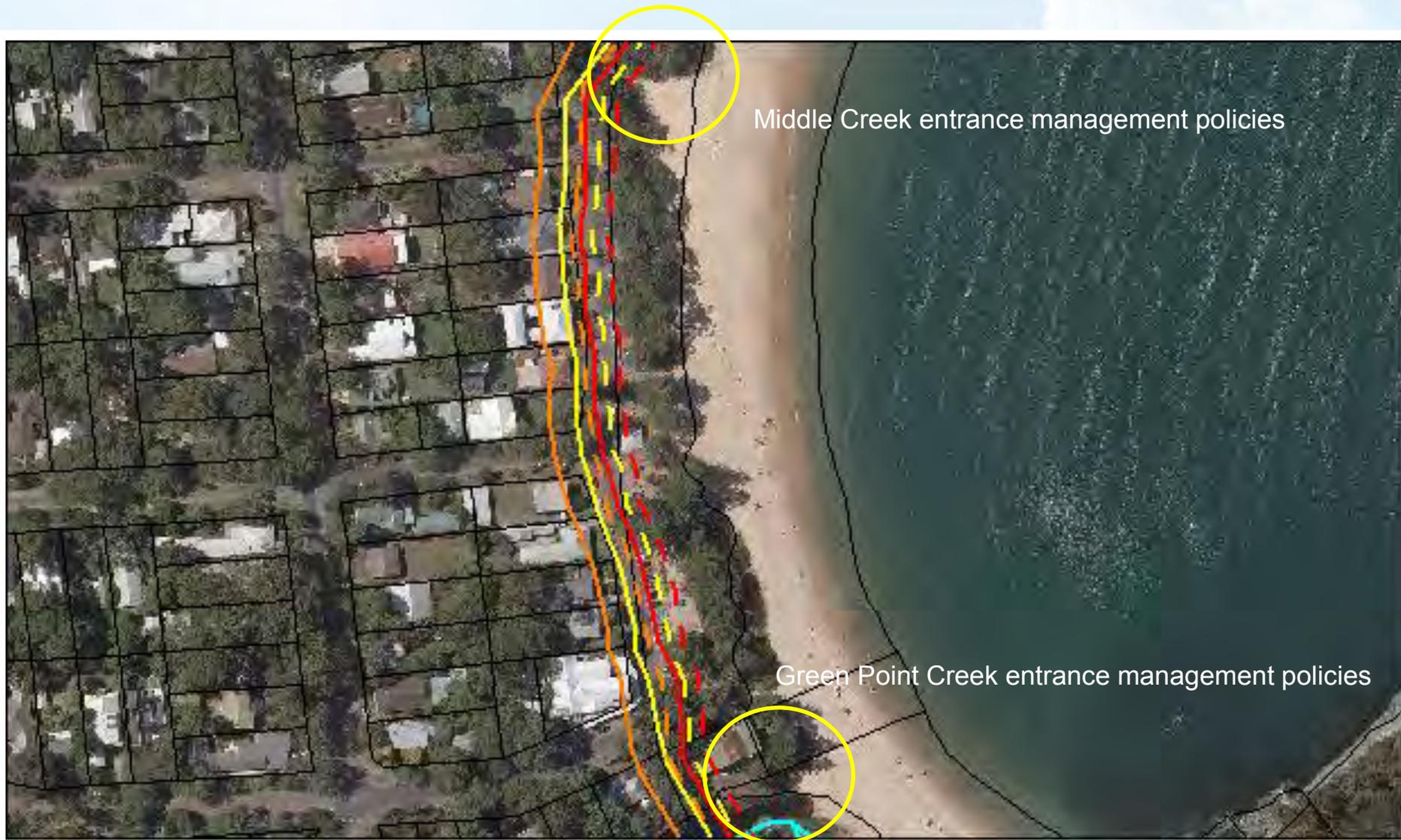
- ▶ Speeding up the natural dune rebuilding process



Precinct 2 - Between Green Point Creek and Middle Creek entrances

Issue	Option	Timeframe
Immediate and future risk of erosion to playground area	Repair of playground area, toilet block, beach accessways and landscaping works following erosion in a large storm event (Pe2.2)	As required
	Beach scraping following storm event to build dune crest level and revegetation (Pe2.3)	After storm events as required
	Develop entrance management guidelines for mechanical opening of Middle Creek (Pe2.5)	Short term
	Long term removal and relocation of playground should erosion escarpment move landward in future (Pe2.6)	Long term (>20 years)
Future risk of erosion to Pearl Parade and associated services	Future installation of erosion protection works once erosion escarpment reaches set trigger distance from road edge (Pe2.7)	Long term (> 20 years)
	Future closure of road and installation of alternative access (e.g. rear lane access to properties along Pearl Parade) (Pe2.8)	Long term (>20 years)
	Repair and restoration of Pearl Parade should it be damaged by a future storm (Pe2.9)	Long term (>20 years)
	Landward relocation of water supply and electricity should it be damaged by future erosion (Pe2.10)	Long term (>20 years)
	Development controls as per existing DCP i.e. defined building line (e.g. existing building line or 2050 Zone of Slope Adjustment) with new buildings to be founded into 2100 Stable foundation Zone (Pe2.11)	Short term

Precinct 2



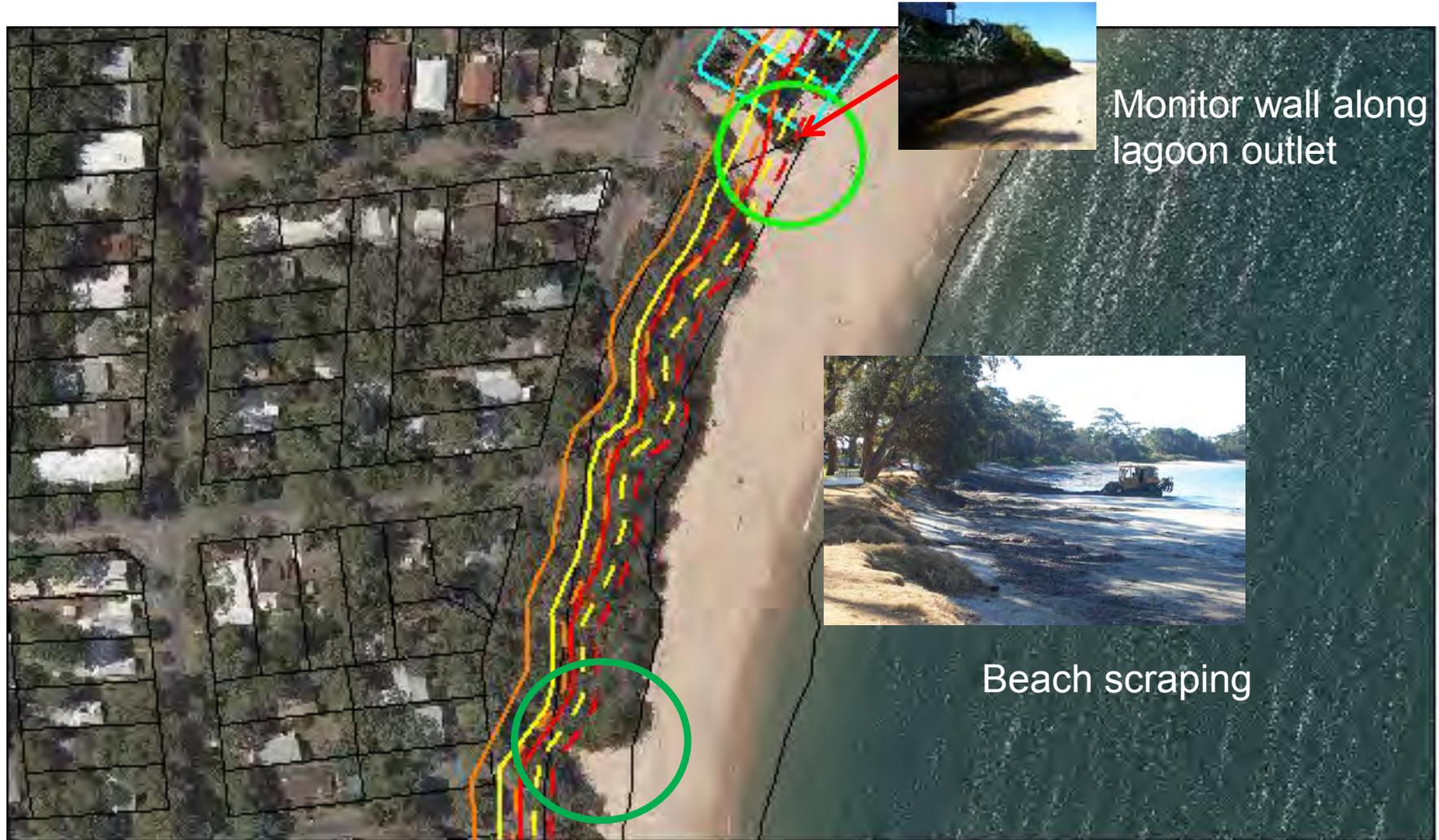
Precinct 2



Precinct 3 – Middle Creek to Pearl Beach Lagoon outlet

Issue	Option	Timeframe
Immediate erosion risk to dune	Encourage and assist Dunecare group to maintain and revegetate dune after a storm (Pe3.1)	Ongoing
	Post storm beach scraping to assist natural recovery of the dune and repair scour caused by breakout from Pearl Beach Lagoon and Middle Creek (Pe3.2)	After storm events as required
	Formalise entrance management guidelines for mechanical opening of Middle and Pearl Beach Lagoon entrances (Pe3.3)	Short term
	Monitor effectiveness of concrete wall on northern bank of outlet (Pe3.4)	Short term

Precinct 3



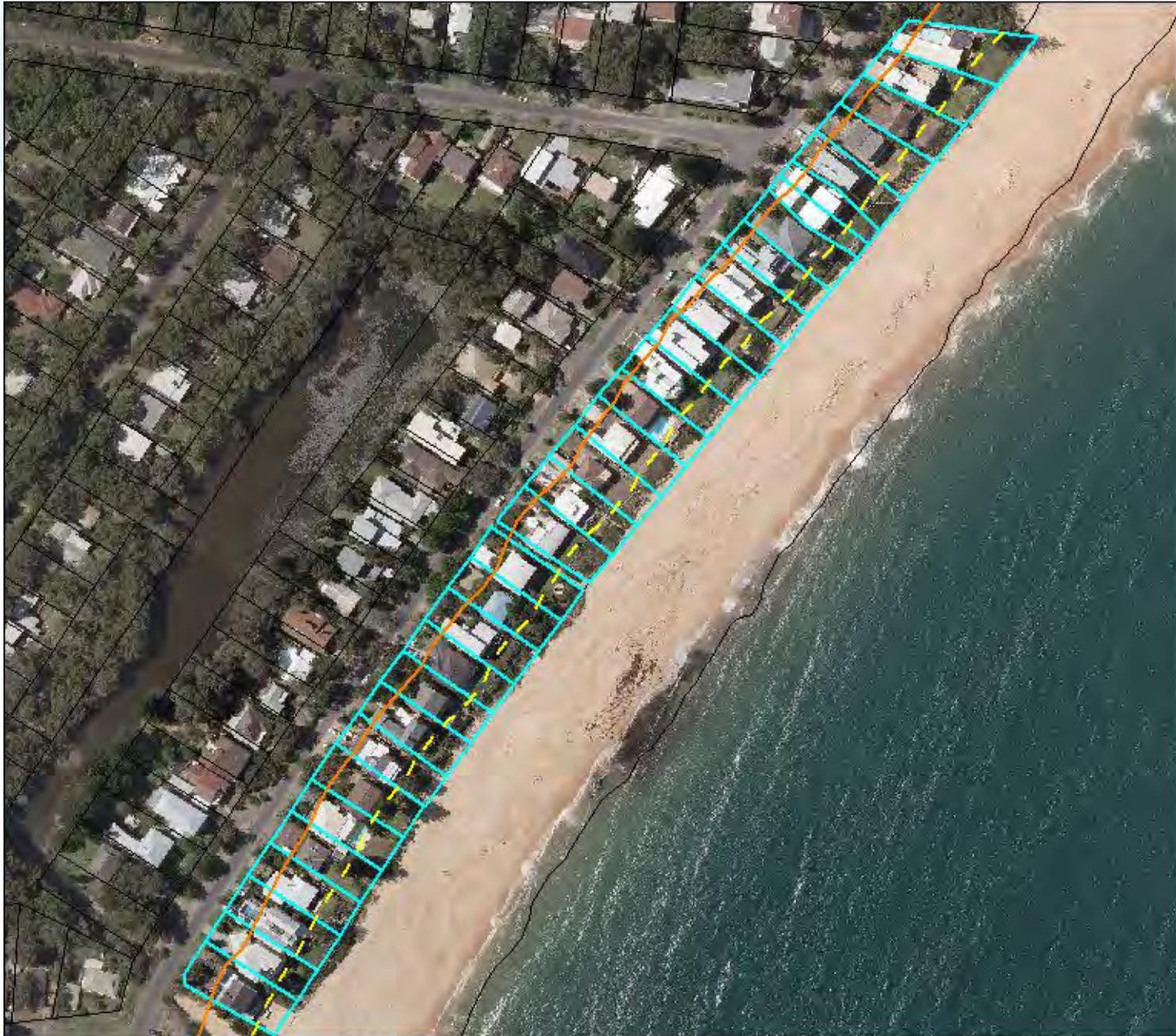
Precinct 4 – Coral Crescent beachfront properties

Issue	Option	Timeframe
Immediate and future erosion risk to Coral Crescent properties	Development controls as per existing DCP i.e. defined building line (e.g. existing building line or 2050 Zone of Slope Adjustment) with new buildings to be founded into 2100 Stable foundation Zone (Pe4.1)	Short term
	Allowing development landward of the 2100 Zone of Slope Adjustment with piled foundations into the 2100 Stable Foundation Zone (Pe4.2).	Short term
	Post storm beach scraping to assist natural recovery of dune (Pe4.3)	After storm events as required
	Terminal protection once erosion escarpment reaches trigger distance from defined building line (Pe4.4)	Long term (> 20 years)
	Encourage and assist Dunecare group to maintain and revegetate dune after a storm (Pe4.7)	Ongoing
	Beach nourishment to increase buffer against storm erosion (Pe4.8)	Medium term (5 – 20 years)
Immediate and future inundation risk to Coral Crescent properties	Beach scraping to maintain crest level of dune above wave runup level (Pe4.9)	After storm events as required
	Encourage beachfront residents to maintain crest level of dune and vegetate dune on private property in accordance with dune management practice (e.g. community education, provision of free plants) (Pe4.10)	Short term, ongoing
	Development controls as per existing DCP i.e. requirement for floor levels to be above wave runup level and be compatible with inundation hazard (Pe4.11)	Short term



**DCP/foreshore
building line**

**2050 erosion hazard
2050 ZRFC**



**2050 erosion hazard
2100 ZRFC**



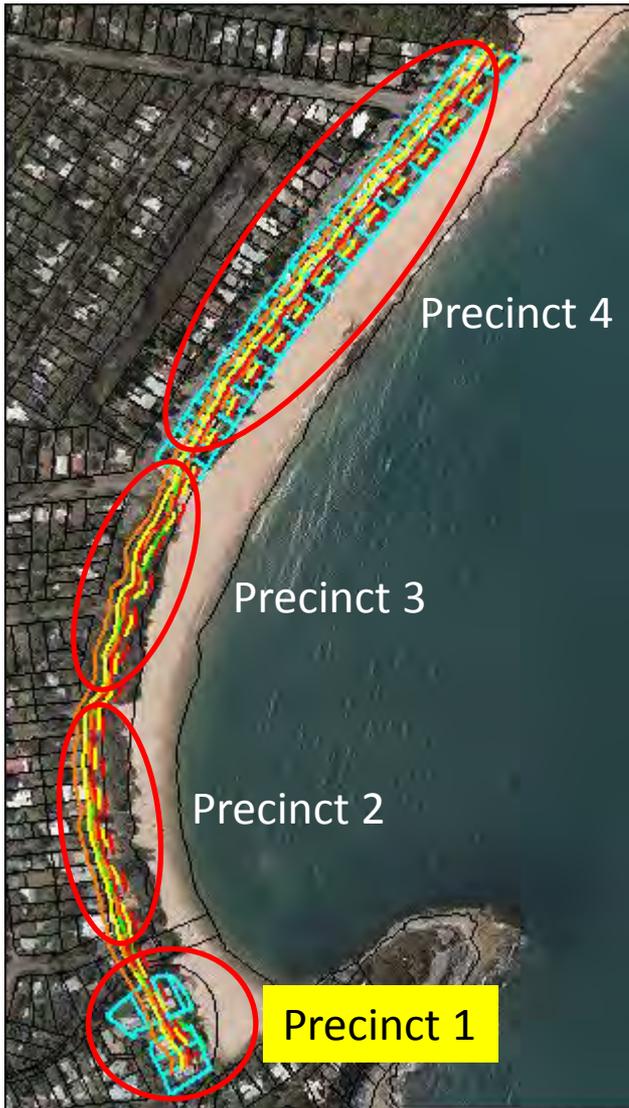
2100 erosion hazard
2100 ZRFC

Beach scraping

Dune vegetation management
Maintain dune crest levels

Options which have been ruled out

Option	Reasons for exclusion
Future relocation of restaurant landward on redevelopment (Pe1.9)	<ul style="list-style-type: none">• Low BCR, high social impact
Voluntary Purchase (Planned retreat) for two unprotected properties including restaurant (Pe1.12)	<ul style="list-style-type: none">• Low BCR, high social impact
Erosion Protection works in front of playground area (Pe2.1)	<ul style="list-style-type: none">• Low BCR, potential for adverse environmental impact
Beach nourishment to increase erosion buffer in this area (Pe2.4)	<ul style="list-style-type: none">• Low BCR, potential for adverse environmental impact
Voluntary purchase of individual properties once erosion escarpment reaches set trigger distance from defined building line (Pe4.5)	<ul style="list-style-type: none">• Low BCR, potential for adverse social impact
Trigger limited consents (Pe4.6)	<ul style="list-style-type: none">• Low BCR, potential for adverse social impact



Example of estuary entrance “tripper” wall to prevent meandering of entrance

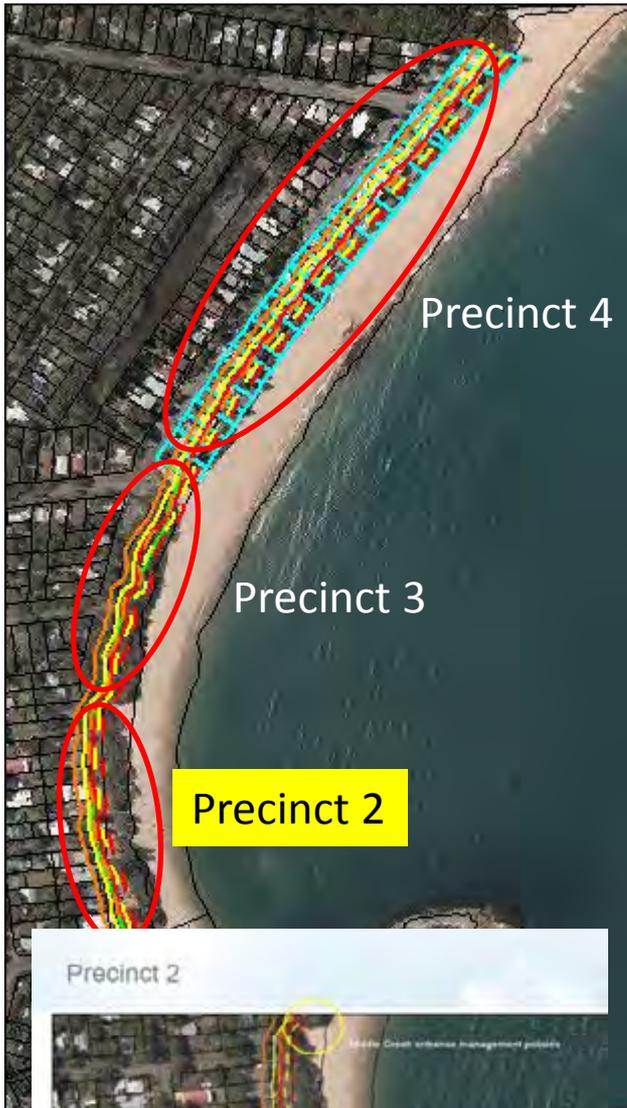


Coastal hazards at Precinct 1 – inundation and erosion



Meandering of creek entrance influencing erosion in this area

Issues	Option	Timeframe
Immediate and future risk of erosion and reduced foundation capacity to four properties and sewage pumping station	Erosion Protection works to be allowed for four properties south of Green Point Creek entrance (funded jointly by residents, Council and State Government through Coastal program) (Pe1.1)	Short to medium term (0 – 20 years), two of these properties already have protection installed
	Monitor performance of existing erosion works at properties south of Green Point Creek entrance (Pe1.2)	Immediate and ongoing
	Erosion protection works for sewage pumping station and sewer line at end of Gem Road and south from Gem Road (Pe1.3)	Short term (0 – 5 years)
	Relocate sewer infrastructure and pumping station further landward (Pe1.4)	Short term (0 – 5 years)
	Beach nourishment (Pe1.5)	Medium term (5 – 20 years)
	Beach scraping to build dune in front of residences, Gem Road and restaurant (Pe1.6)	After storm events as required
Coastal inundation of lots south of Green Point Creek entrance	Continue dune vegetation management at southern end of beach (Pe1.7)	Ongoing
	Develop entrance management guidelines for mechanical opening of Green Point Creek (Pe1.8)	Short term
	Development controls as per existing DCP i.e. defined building line (e.g. existing building line or 2050 Zone of Slope Adjustment) with new buildings to be founded into 2100 Stable foundation Zone. Residences and restaurant to be above inundation levels on redevelopment of properties (Pe1.10)	Short term
	Construct “tripper” structure to control opening location of creek (Pe1.11)	Short term
	Survey floor levels to determine degree of inundation hazard (Pe1.14)	Short term



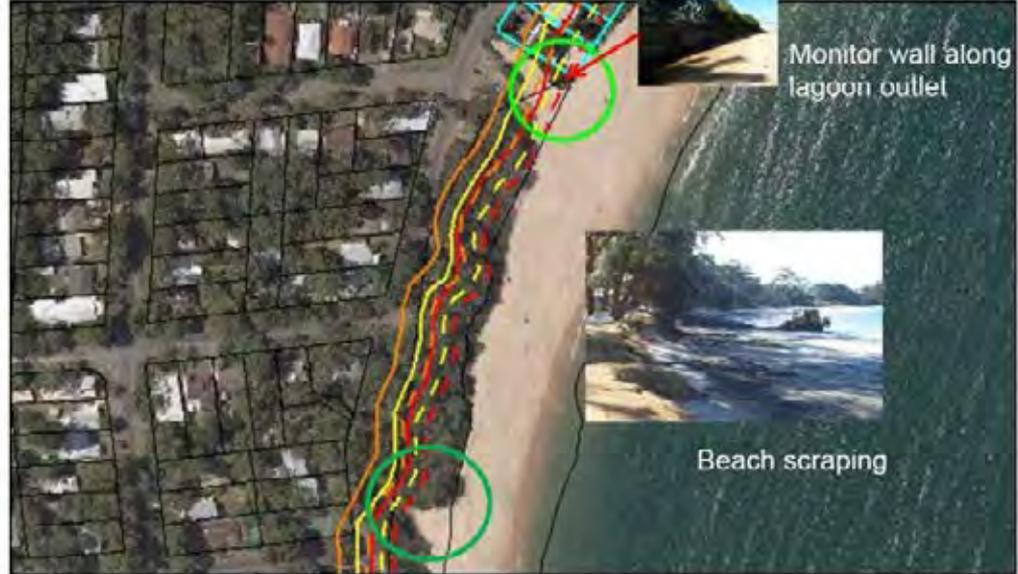
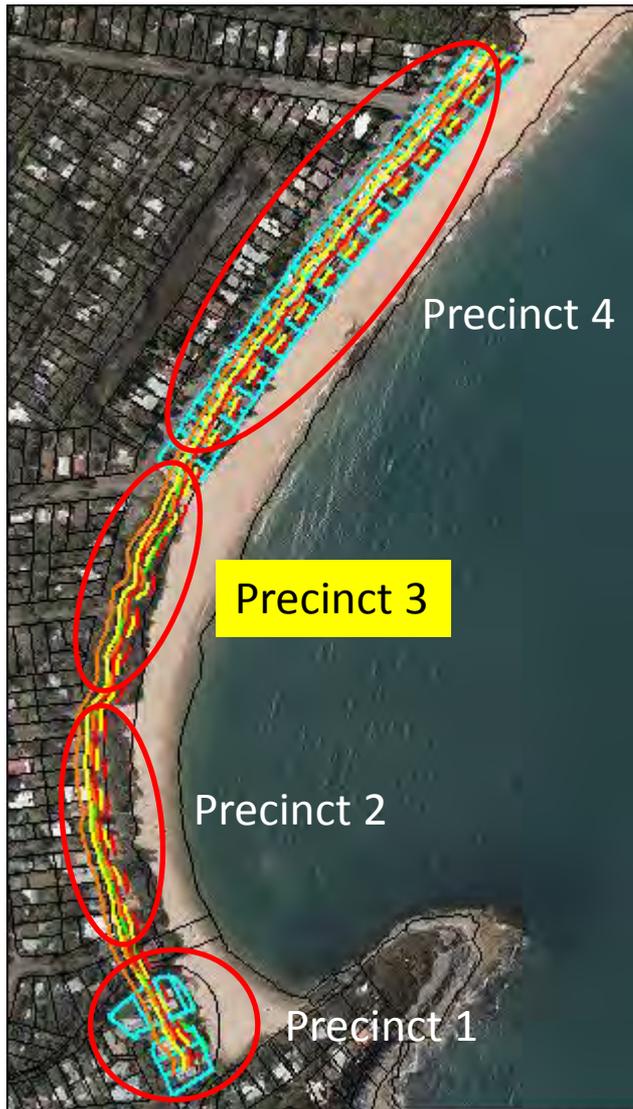
Precinct 2

Precinct 2



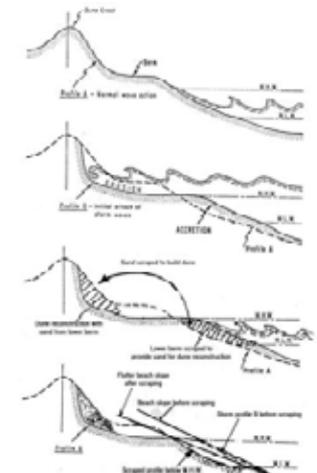
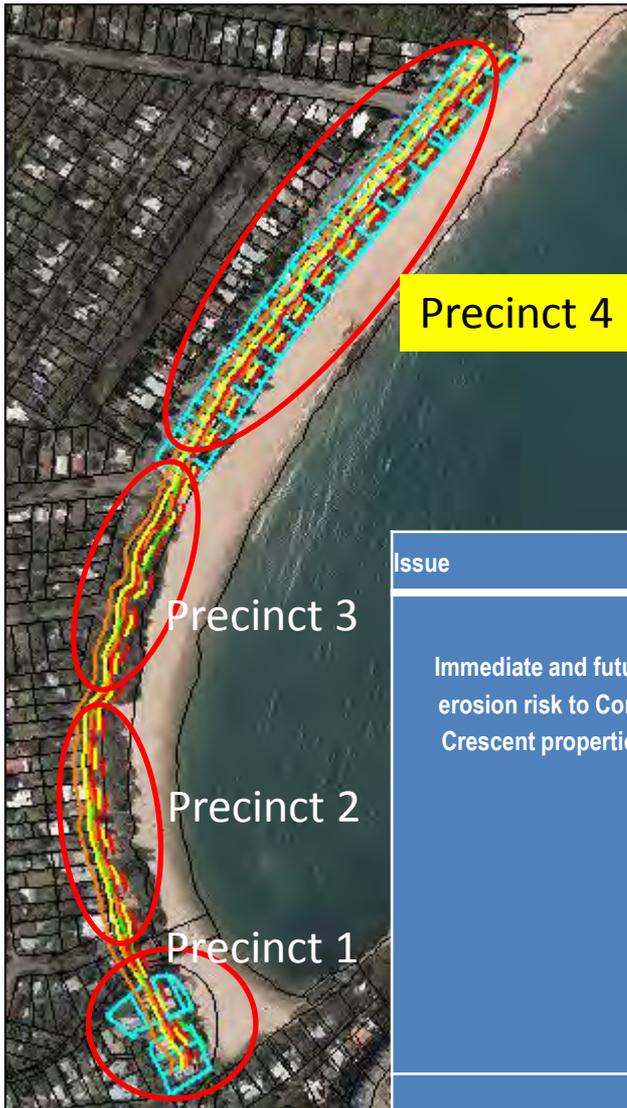
Coastal hazards at Precinct 2

Issue	Option	Timeframe
Immediate and future risk of erosion to playground area	Repair of playground area, toilet block, beach accessways and landscaping works following erosion in a large storm event (Pe2.2)	As required
	Beach scraping following storm event to build dune crest level and revegetation (Pe2.3)	After storm events as required
	Develop entrance management guidelines for mechanical opening of Middle Creek (Pe2.5)	Short term
	Long term removal and relocation of playground should erosion escarpment move landward in future (Pe2.6)	Long term (>20 years)
Future risk of erosion to Pearl Parade and associated services	Future installation of erosion protection works once erosion escarpment reaches set trigger distance from road edge (Pe2.7)	Long term (> 20 years)
	Future closure of road and installation of alternative access (e.g. rear lane access to properties along Pearl Parade) (Pe2.8)	Long term (>20 years)
	Repair and restoration of Pearl Parade should it be damaged by a future storm (Pe2.9)	Long term (>20 years)
	Landward relocation of water supply and electricity should it be damaged by future erosion (Pe2.10)	Long term (>20 years)
	Development controls as per existing DCP i.e. defined building line (e.g. existing building line or 2050 Zone of Slope Adjustment) with new buildings to be founded into 2100 Stable foundation Zone (Pe2.11)	Short term



Coastal hazards at Precinct 3

Issue	Option for Precinct 3	Timeframe
<p>Immediate erosion risk to dune</p>	<p>Encourage and assist Dunecare group to maintain and revegetate dune after a storm (Pe3.1)</p>	<p>Ongoing</p>
	<p>Post storm beach scraping to assist natural recovery of the dune and repair scour caused by breakout from Pearl Beach Lagoon and Middle Creek (Pe3.2)</p>	<p>After storm events as required</p>
	<p>Formalise entrance management guidelines for mechanical opening of Middle and Pearl Beach Lagoon entrances (Pe3.3)</p>	<p>Short term</p>
	<p>Monitor effectiveness of concrete wall on northern bank of outlet (Pe3.4)</p>	<p>Short term</p>



Beach scraping – speeding up the natural dune rebuilding process

Issue	Option for Precinct 4	Timeframe
Immediate and future erosion risk to Coral Crescent properties	Development controls as per existing DCP i.e. defined building line (e.g. existing building line or 2050 Zone of Slope Adjustment) with new buildings to be founded into 2100 Stable foundation Zone (Pe4.1)	Short term
	Allowing development landward of the 2100 Zone of Slope Adjustment with piled foundations into the 2100 Stable Foundation Zone (Pe4.2).	Short term
	Post storm beach scraping to assist natural recovery of dune (Pe4.3)	After storm events as required
	Terminal protection once erosion escarpment reaches trigger distance from defined building line (Pe4.4)	Long term (> 20 years)
	Encourage and assist Dunecare group to maintain and revegetate dune after a storm (Pe4.7)	Ongoing
Immediate and future inundation risk to Coral Crescent properties	Beach nourishment to increase buffer against storm erosion (Pe4.8)	Medium term (5 – 20 years)
	Beach scraping to maintain crest level of dune above wave runup level (Pe4.9)	After storm events as required
	Encourage beachfront residents to maintain crest level of dune and vegetate dune on private property in accordance with dune management practice (e.g. community education, provision of free plants) (Pe4.10)	Short term, ongoing
	Development controls as per existing DCP i.e. requirement for floor levels to be above wave runup level and be compatible with inundation hazard (Pe4.11)	Short term



WorleyParsons

resources & energy

Open Coast and Broken Bay Beaches

**Coastal Zone Management Study – Broken Bay Beaches
Patonga, Ocean/Umina, Killcare/Putty**

Chris Adamantidis

3 February 2015

Outline of Presentation

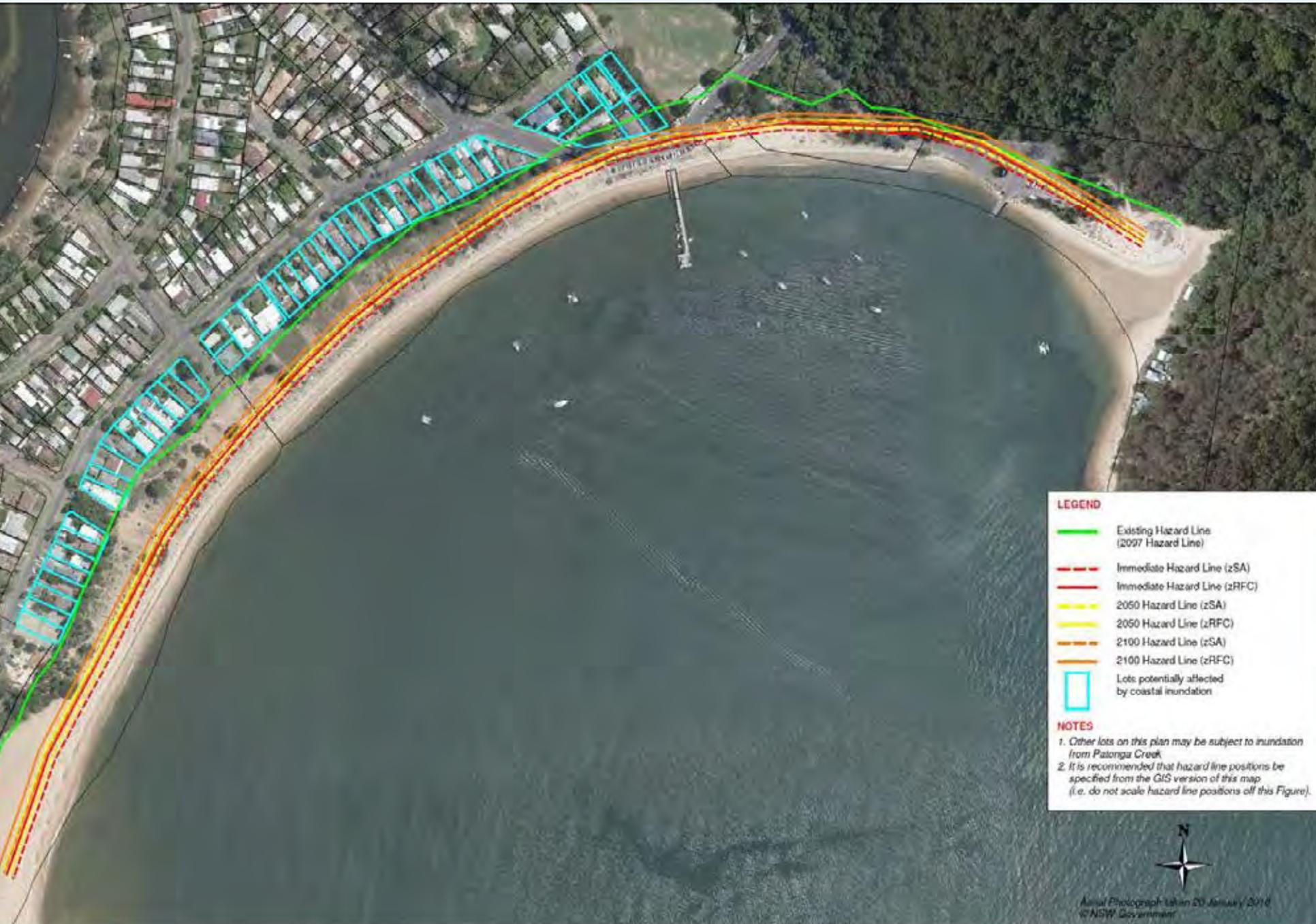
- ▶ Coastal Processes and Hazards at Patonga, Ocean-Umina and Killcare-Putty Beaches
- ▶ Coastal management issues and measures at each precinct
- ▶ Overview of Preferred Management Options

Patonga Beach

- ▶ No measured long term recession
- ▶ Protected beach well inside Broken Bay
- ▶ Sea level rise recession 3.4 m (2050), 8.4 m (2100)
- ▶ Wave Run-up 2.5 m AHD
- ▶ 49 lots in Patonga may be subject to coastal inundation due to wave runup
- ▶ The main jetty and boat ramp carparks may be at immediate coastal hazard risk.
- ▶ Parts of the coastal access road could be at longer term coastal erosion risk
- ▶ Risk has projected to have decreased compared with previous assessment

Patonga – Coastal Hazards

- ▶ **Coastal inundation** due to wave runup affecting the beachfront residences;
- ▶ **Coastal erosion** having the potential to impact on the carpark near the centre of the village, parts of Patonga Drive and associated stormwater and power services;
- ▶ **Coastal erosion** affecting the access road to the boat ramp and associated services.
- ▶ **Future coastal erosion** and recession affecting parts of Patonga Drive and impacting on access to the village.



LEGEND

- Existing Hazard Line (2097 Hazard Line)
- - - Immediate Hazard Line (zSA)
- Immediate Hazard Line (zRFC)
- 2050 Hazard Line (zSA)
- 2050 Hazard Line (zRFC)
- - - 2100 Hazard Line (zSA)
- 2100 Hazard Line (zRFC)
- Lots potentially affected by coastal inundation

NOTES

1. Other lots on this plan may be subject to inundation from Palonga Creek
2. It is recommended that hazard line positions be specified from the GIS version of this map (i.e. do not scale hazard line positions off this Figure).



Ocean/Umina Beach

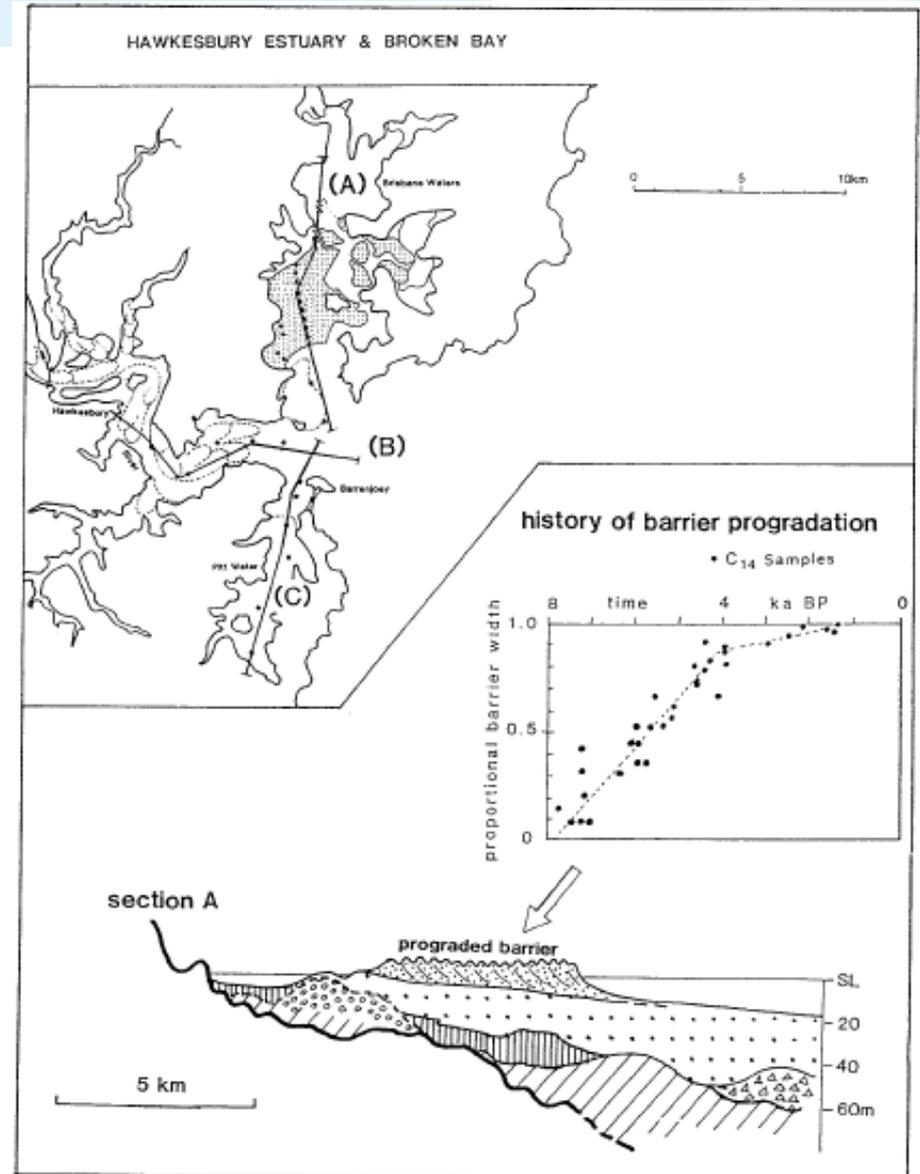
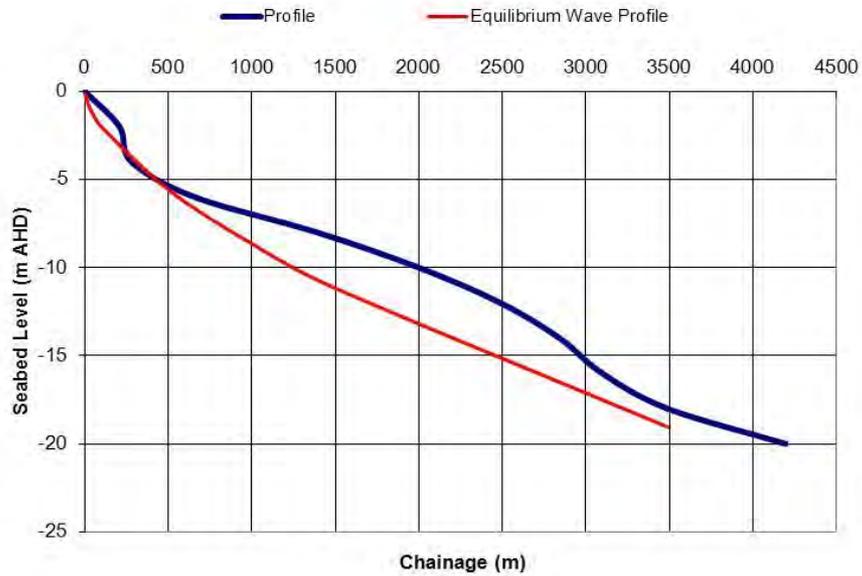


Ocean/Umina Beach

- ▶ Not fully exposed to open ocean wave climate
- ▶ Storm erosion demand increasing from south to north
- ▶ No measured long term recession
- ▶ No forecast sea level rise recession
- ▶ Two lots at Ocean-Umina Beach may be subject to coastal inundation due to wave runup
- ▶ Two lots within the Zone of Slope Adjustment and three within Zone of Reduced Foundation Capacity (Berrima Crescent)
- ▶ Hazard not dissimilar to previous assessment

Ocean/Umina

Ocean Beach Umina



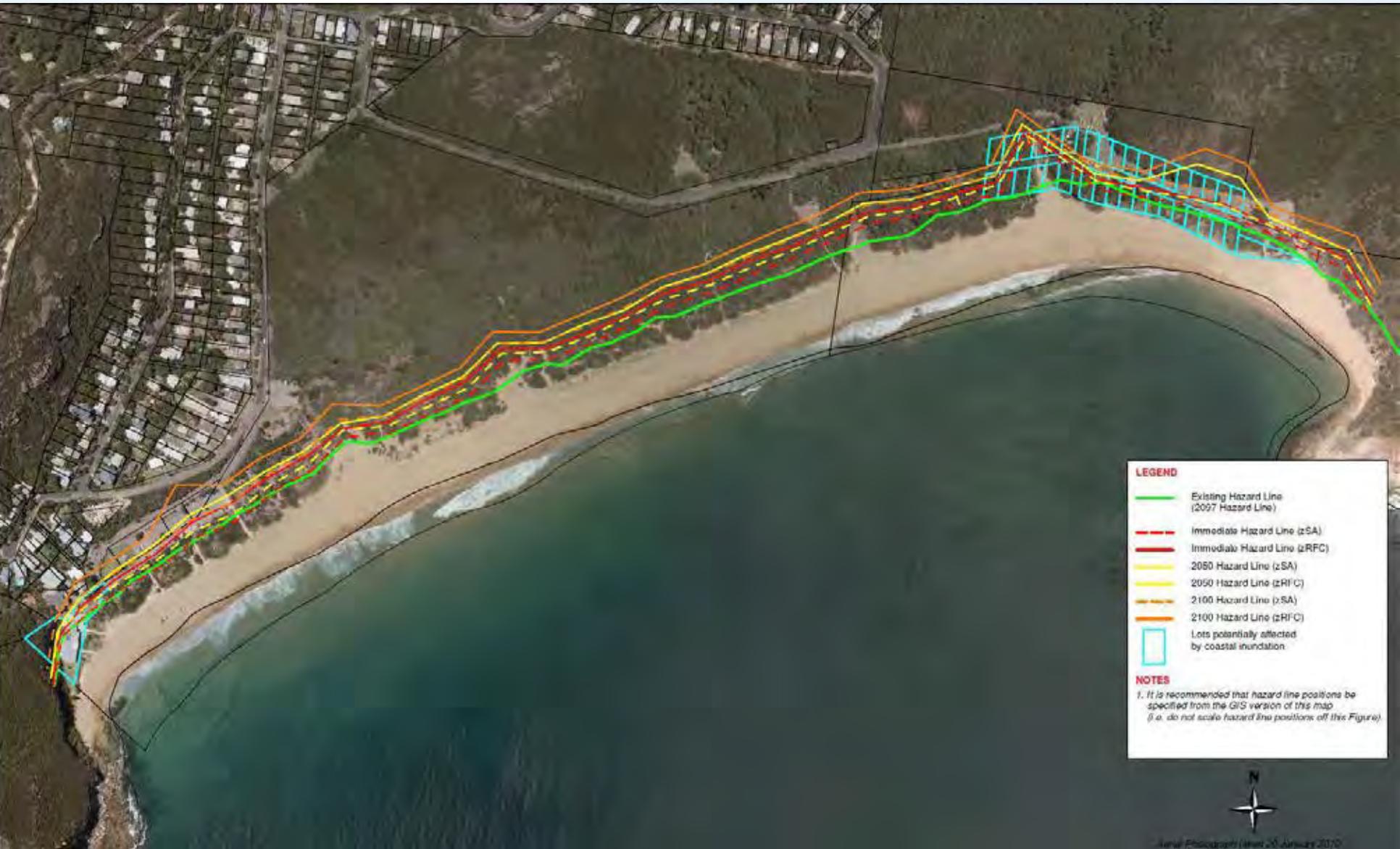


Putty Beach



Putty Beach

- ▶ Fully exposed to ocean wave climate
- ▶ 8.5 m sea level rise recession (2050), 21 m (2100)
- ▶ Zero measured long term recession
- ▶ Surf club building may be at immediate risk from coastal erosion and inundation
- ▶ Carparks at the western and eastern ends becoming at risk from coastal erosion by 2100.
- ▶ One lot is partially within the 2100 Zone of Reduced Foundation Capacity



LEGEND

-  Existing Hazard Line (2097 Hazard Line)
-  Immediate Hazard Line (2SA)
-  Immediate Hazard Line (2RFC)
-  2050 Hazard Line (2SA)
-  2050 Hazard Line (2RFC)
-  2100 Hazard Line (2SA)
-  2100 Hazard Line (2RFC)
-  Lots potentially affected by coastal inundation.

NOTES

1. It is recommended that hazard line positions be specified from the GIS version of this map (i.e. do not scale hazard line positions off this Figure).



Existing Coastal Management Issues at each beach – Patonga Beach



1. Shoaling at the entrance channel at Patonga, making navigation hazardous



2. Sand bypassing of the entrance training wall at Patonga Creek;



3. Ad-hoc protection works at Dark Corner cottages



4. Sink-hole below boatramp cottages



5. Build up of sand against training wall at southern end of beach



6. Potential for sand from beach to be lost onto the road by wind erosion



7. Existing erosion protection works at boat ramp and minor erosion adjacent to works



8. Scour on beach berm due to creek flows onto beach

Existing coastal management issues at Ocean-Umina



1. Ettalong Creek meandering along beach berm in front of properties at southern end of beach, 3 April 2014



2. Ad-hoc erosion protection and embankment erosion along Berrima Crescent properties, south end of beach, 3 April 2014



3. Informal/overgrown beach access at south end of Umina Beach, 3 April 2014



4. Erosion escarpment north end of Ocean Beach, 16 September 2010



5. Training wall at Ettalong Creek entrance, 3 April 2014



6. Scour at stormwater outlet, Umina SLSC 3 April 2014



7. Dunes with scant vegetation cover, Umina Beach 3 April 2014



8. Umina Beach Surf Club seawall, 3 April 2014

Existing coastal management issues at Putty-Killcare



1. Embankment in front of surf club, 3 April 2014



2. Stormwater outlet at surf club, 3 April 2014



3. Rock boulders within embankment in front of surf club, 3 April 2014



4. Stormwater outlet at surf club, 30 April 2011



5. Windblown dunes and small creek entrance, Putty Beach, 30 April 2011

Specific Options for Patonga

- ▶ **Erosion protection works** to protect the main village carpark and/or parts of Patonga Drive under erosion threat;
- ▶ **Monitor** existing erosion protection works on the western side of the boat ramp and upgrade if needed;
- ▶ **Development controls** - Council's DCP 2013 Chapter 6.2 Coastal Frontage
- ▶ **Relocation of infrastructure** subject to damage due to coastal erosion e.g. services, carparking.
- ▶ **Maintenance of the dune crest** above the level of wave runup;
- ▶ **Placement of sand** on the beach in front of the main carpark and near the boat ramp to increase the buffer of sand available and provide some protection against storm erosion. This sand could be sourced from the sand shoals at the western end of the beach;
- ▶ **Maintenance of dune vegetation**
- ▶ **Stormwater management**
- ▶ **Maintaining the status quo** – do nothing apart from maintain existing planning controls and existing coastal management regime.

Patonga

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate risk of erosion damage to main carpark	Erosion Protection works at main carpark (P1)	Short term (0 – 5 years), as carpark already under erosion threat
	Repair damage to carpark should storm erosion occur (P2)	As required
	Placement of sand sourced from western shoals at creek entrance to provide buffer against storm erosion (P3)	Short term, then repeat as required
	Beach scraping (P4)	As required after storms
	Future relocation of carpark and associated infrastructure to an area landward of the coastal hazard area (P5)	Medium term (5 – 20 years)
	Stabilisation of dunes in front of carpark with vegetation and fencing (P6)	Short term
Future risk of erosion damage to Patonga Drive	Erosion Protection works at site of main carpark (P7)	Long term (>20 years), as road not yet under erosion threat
	Future relocation of main access into village (P8)	Long term (>20 years), as road not yet under erosion threat
Immediate erosion risk to boat ramp and access road	Monitor and assess existing erosion protection works (P9)	Short term
	Relocate access road as erosion occurs (P10)	Medium term
	Reinstate access road and erosion works following erosion event (P11)	As required
	Periodic nourishment of area with sand sourced from Patonga Creek entrance (P12)	Short term, then repeat as required

Patonga

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Inundation due to wave runup	Development controls (P13)	Short term
	Beach scraping to maintain crest level of dune above wave runup level (P14)	Short term
	Investigate raising floor levels of existing buildings (P15)	Medium Term
Erosion in front of cottages at Dark Corner	Monitor and assess existing erosion protection works (P16)	Short term
	Implement erosion control works in front of cottages in accordance with Patonga Draft Plan of Management Crown Reserves and Dark Corner Cottages 2013 (P17)	Medium Term
Shoaling at entrance channel of Patonga Creek	Investigate periodic maintenance dredging of sand from the creek entrance (P18)	Short term
	Investigate lengthening existing entrance breakwater (P19)	Medium-long term
	Beach scraping of built-up sand adjacent to creek entrance (P20)	Short term
Scour from stormwater and creek flows at eastern end of beach	Investigate installation of stormwater energy dissipation to reduce discharge velocities at outlet (P21)	Short term
	Post storm beach scraping to assist natural recovery of the dune and repair scour caused by stormwater discharge (P22)	As required
All issues	Emergency Management (P23)	As required
	Maintain Status Quo (P24)	Short term

Patonga





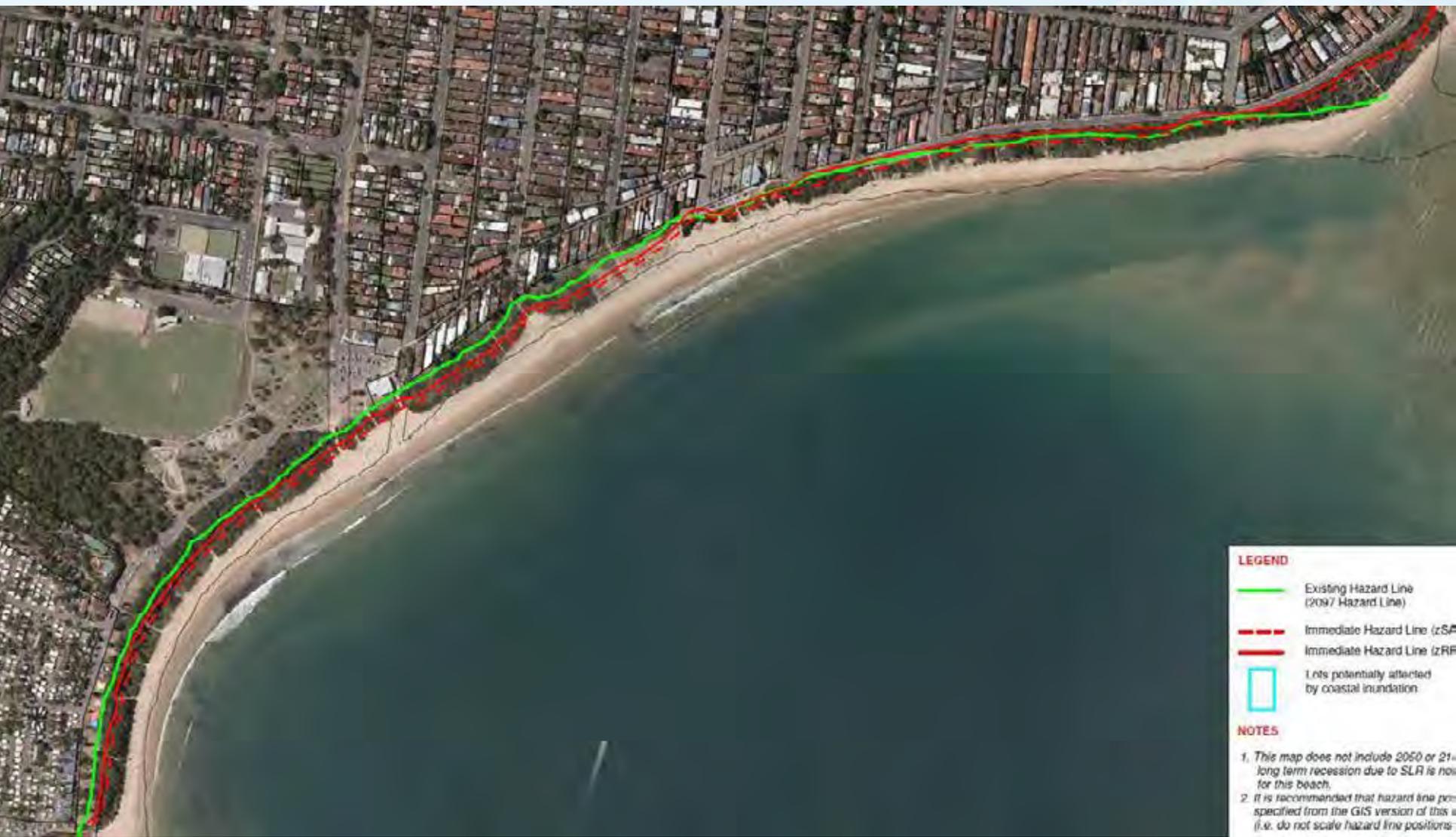
Options with low BCR - Patonga

Option	Reasons for exclusion
Erosion Protection works at main carpark (P1), (P7)	<ul style="list-style-type: none"> • Low BCR 0.05 – 0.1 • Potential for adverse environmental impact • Erosion risk not high enough to justify works at present time.
Placement of sand sourced from western shoals at creek entrance to provide buffer against storm erosion (P3)	<ul style="list-style-type: none"> • Low BCR 0.2 • Potential for adverse environmental impact
Future relocation of carpark and associated infrastructure to an area landward of the coastal hazard area (P5)	<ul style="list-style-type: none"> • Low BCR – 0.08 – 0.19 • Option may be reconsidered in future if erosion risk increases
Periodic nourishment of area with sand sourced from Patonga Creek entrance (P12)	<ul style="list-style-type: none"> • Low BCR • Potential for adverse environmental impact • Erosion risk not high enough to justify works at present time.
Investigate raising floor levels of existing buildings (P15)	<ul style="list-style-type: none"> • Cost of raising existing buildings higher than cost of potential inundation damage
Implement erosion control works in front of cottages in accordance with Patonga Draft Plan of Management Crown Reserves and Dark Corner Cottages 2013 (P17)	<ul style="list-style-type: none"> • Low BCR • May be considered in future due to heritage value of cottages
Investigate periodic maintenance dredging of sand from the creek entrance (P18)	<ul style="list-style-type: none"> • Low BCR and potential for adverse environmental impact
Investigate lengthening existing entrance breakwater (P19)	<ul style="list-style-type: none"> • Low BCR

Ocean-Umina Precincts

- ▶ **Precinct 1** – Southern end of the beach south from the entrance to Ettalong Creek (Berrima Crescent);
- ▶ **Precinct 2** – Between Ettalong Creek (at the Caravan Park) and Ettalong Point.





LEGEND

-  Existing Hazard Line (2017 Hazard Line)
-  Immediate Hazard Line (zSA)
-  Immediate Hazard Line (zRF)
-  Lots potentially affected by coastal inundation

NOTES

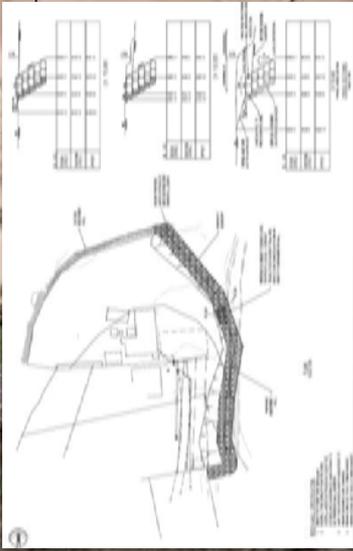
1. This map does not include 2050 or 2100 long term recession due to SLR is not specified for this beach.
2. It is recommended that hazard line positions be specified from the GIS version of this map (i.e. do not scale hazard line positions).

Ocean Umina - Precinct 1

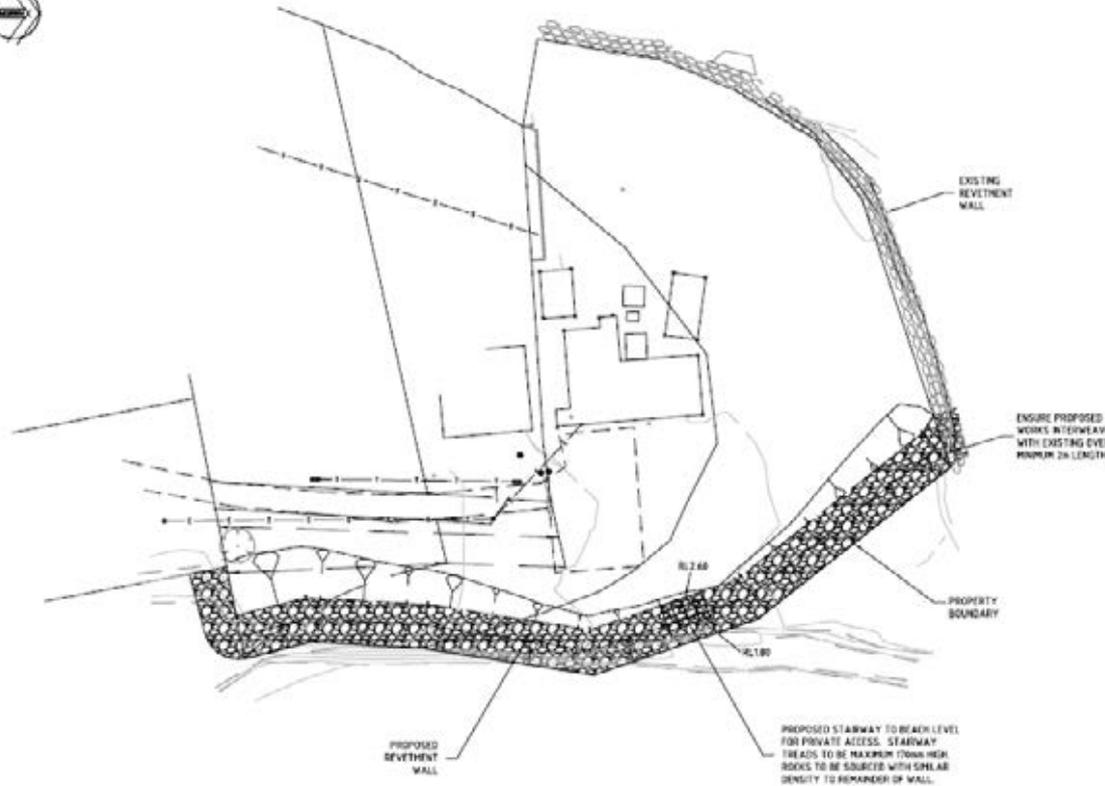
Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future risk of erosion and reduced foundation capacity to four properties and estuary entrance instability	Erosion Protection works to be allowed for four properties and carpark south of Ettalong Creek entrance (funded by Council and/or residents) (O1.1)	Short to medium term (0 – 20 years)
	Monitor performance of existing training wall works along northern side of Ettalong Creek entrance (O1.2)	As required
	Future relocation of residence on No.8 Berrima Crescent landward of immediate hazard area within same lot on redevelopment (O1.3)	On redevelopment as per DCP
	Beach nourishment (O1.4)	Long term (>20 years)
	Beach scraping to build dune in front of residences at Berrima Crescent (O1.5)	Short term and as required (0-5 years)
	Encourage and assist Dunecare group to improve dune vegetation management and consolidation of beach access at southern end of beach (O1.6)	Short term (0-5 years)
	Develop entrance management guidelines for mechanical opening of Ettalong Creek (O1.7)	Short term (0-5 years)
	Voluntary purchase of portion of at risk property (O1.9)	Short – medium term
	Development controls on redevelopment of properties within hazard area (O1.10)	Short term
	Construct “tripper” structure to control opening location of creek (O1.11)	Short term
Coastal inundation of lots south of Ettalong Creek entrance	Development controls for residences to be above inundation levels on redevelopment of properties (O1.12)	Short term
All issues	Emergency Management (O2.6)	As required



New rock revetment



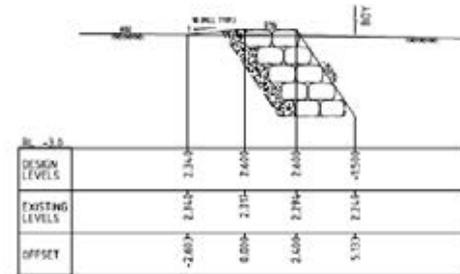
Specific options Ocean-Umina – Precinct 1 – Approved by Coastal Panel



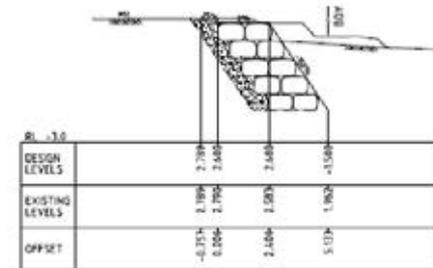
PLAN
SCALE 1:500

ROCK WALL SPECIFICATION

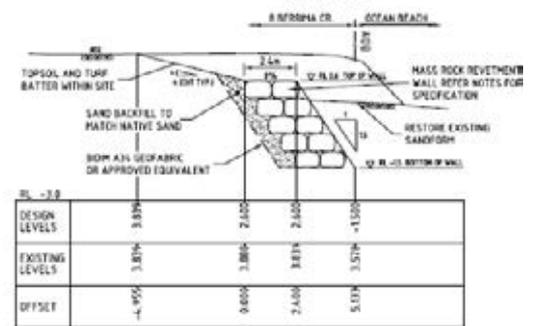
1. DENSITY OF STONE TO BE 2600 kg/m³
2. BACKFILL TO BE SIMILAR TO NATIVE SAND OVERTILL WHERE EXISTING BEACH SCOUR FACE EXTENDS ONTO 8 BERIRMA CR. AND CUTBACK TO SUIT PROPOSED WALL GEOMETRY
3. CARE TO BE EXERCISED WHEN PLACING ROCKS TO ENSURE GEOGRABIC IS NOT DAMAGED.
4. MEDIUM STONE SIZE TO BE 5 TONNE IN WEIGHT. MINIMUM STONE SIZE TO BE 2.5 TONNE IN WEIGHT.



CH 75.000



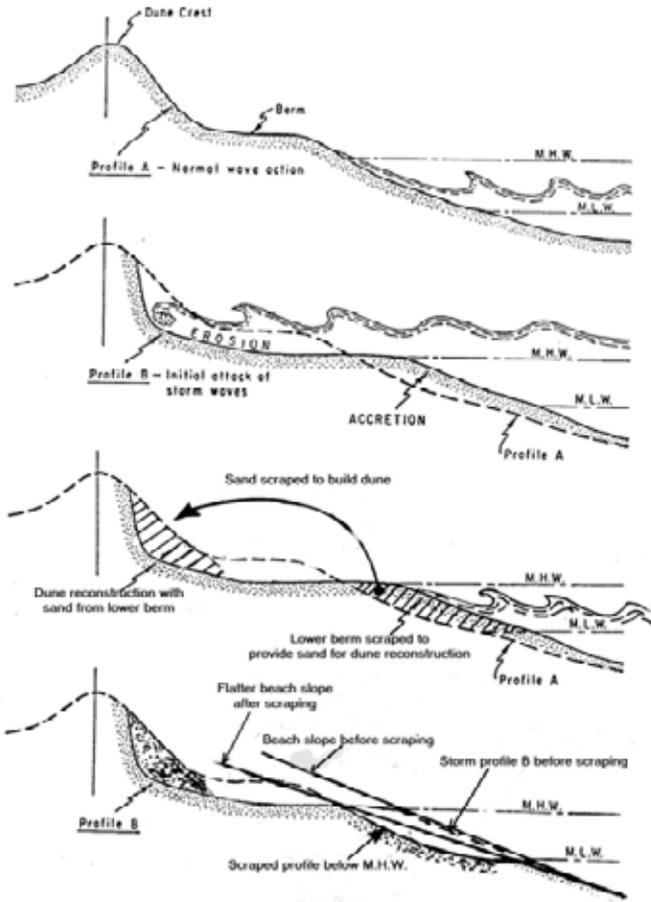
CH 50.000



CH 15.000
TYPICAL CROSS SECTION
CROSS SECTIONS
SCALE 1:100

Beach scraping

- ▶ Speeding up the natural dune rebuilding process



Estuary entrance “tripper” wall to prevent erosion due to meandering of entrance



Ocean-Umina Precinct 2

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future risk of erosion to dunes, Ettalong Point and surf club carpark; Windblown dune erosion	Monitor existing erosion protection works in front of Ocean Beach surf club (O2.1)	Short term and following storms as required
	Repair of beach accessways and revegetation of dune following erosion in a large storm event (O2.2)	Short term and following storms as required
	Beach scraping following storm event to build dune crest level and revegetation (O2.3)	After storm events as required
Scour due to stormwater outlet at Ocean Beach Surf Club	Investigate installation of stormwater energy dissipation to reduce discharge velocities at outlet (O2.4)	Short term (0 – 5 years)
	Post storm beach scraping to assist natural recovery of the dune and repair scour caused by stormwater discharge (O2.5)	As required
All issues	Emergency Management (O2.6)	As required

Precinct 2 – Ocean-Umina



Putty-Killcare Beach

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate risk of erosion and inundation damage to surf club and carpark	Erosion Protection works at surf club (K1)	Short to medium term (0 – 20 years)
	Repair damage to surf club carpark should storm erosion occur (K2)	As required
	Beach nourishment in front of surf club (K3)	Short to medium term (0 – 20 years)
	Beach scraping to build vegetated dune in front of surf club (K4)	Short term (0-5 years)
	Future relocation of surf club and associated infrastructure to an area landward of the coastal hazard area (K5)	Short to medium term (0 – 20 years)
	Build a dune in front of surf club above the wave runup level with vegetation and/or fencing (K6)	Short term (0-5 years)
	Redevelop surf club on deep piled foundations and undertake geotechnical investigation of surf club area (K7)	Long term (>20 years)
	Maintain status quo (K8)	Ongoing
Future risk of erosion damage to main carpark	Move carpark landward in future (K9)	Long term (>20 years)
Stormwater erosion hazard	Improve stormwater outlet by installing energy dissipation to minimise scour and prevent sand ingress into outlet (K10)	Short term
Future erosion damage to Putty Beach camping area	Future relocation of camping area infrastructure to an area landward of the coastal hazard area (K11)	Long term >20 years
All issues	Emergency Management (K12)	As required
	Monitor beach for erosion in front of surf club and camping area (K13)	Short term, ongoing

Killcare-Putty Beach - Options





Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate risk of erosion damage to main carpark	Erosion Protection works at main carpark (P1)	Short term (0 – 5 years), as carpark already under erosion threat
	Repair damage to carpark should storm erosion occur (P2)	As required
	Placement of sand sourced from western shoals at creek entrance to provide buffer against storm erosion (P3)	Short term, then repeat as required
	Beach scraping (P4)	As required after storms
	Future relocation of carpark and associated infrastructure to an area landward of the coastal hazard area (P5)	Medium term (5 – 20 years)
	Stabilisation of dunes in front of carpark with vegetation and fencing (P6)	Short term
Future risk of erosion damage to Patonga Drive	Erosion Protection works at site of main carpark (P7)	Long term (>20 years), as road not yet under erosion threat
	Future relocation of main access into village (P8)	Long term (>20 years), as road not yet under erosion threat
Immediate erosion risk to boat ramp and access road	Monitor and assess existing erosion protection works (P9)	Short term
	Relocate access road as erosion occurs (P10)	Medium term
	Reinstate access road and erosion works following erosion event (P11)	As required
	Periodic nourishment of area with sand sourced from Patonga Creek entrance (P12)	Short term, then repeat as required

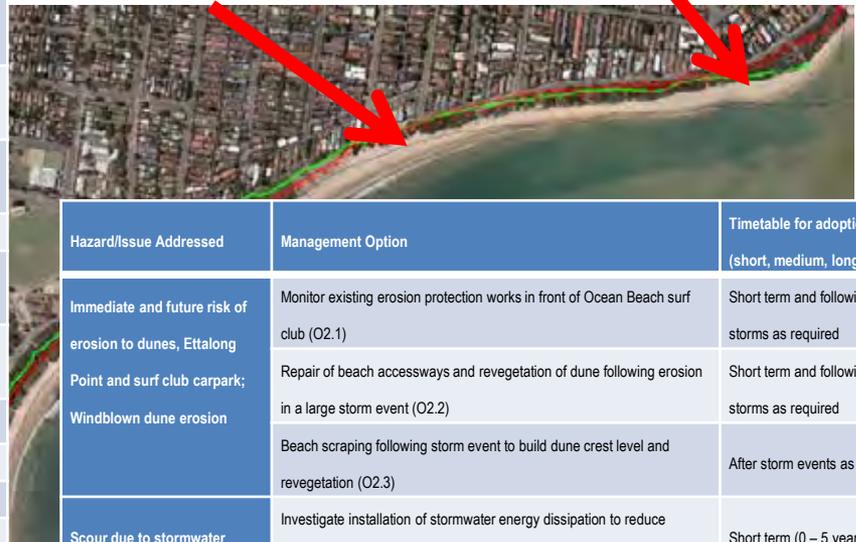
Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Inundation due to wave runup	Development controls (P13)	Short term
	Beach scraping to maintain crest level of dune above wave runup level (P14)	Short term
	Investigate raising floor levels of existing buildings (P15)	Medium Term
Erosion in front of cottages at Dark Corner	Monitor and assess existing erosion protection works (P16)	Short term
	Implement erosion control works in front of cottages in accordance with Patonga Draft Plan of Management Crown Reserves and Dark Corner Cottages 2013 (P17)	Medium Term
Shoaling at entrance channel of Patonga Creek	Investigate periodic maintenance dredging of sand from the creek entrance (P18)	Short term
	Investigate lengthening existing entrance breakwater (P19)	Medium-long term
	Beach scraping of built-up sand adjacent to creek entrance (P20)	Short term
Scour from stormwater and creek flows at eastern end of beach	Investigate installation of stormwater energy dissipation to reduce discharge velocities at outlet (P21)	Short term
	Post storm beach scraping to assist natural recovery of the dune and repair scour caused by stormwater discharge (P22)	As required
All issues	Emergency Management (P23)	As required
	Maintain Status Quo (P24)	Short term

Ocean-Umina



Beach scraping to repair eroded beach escarpment and repair of beach accessways

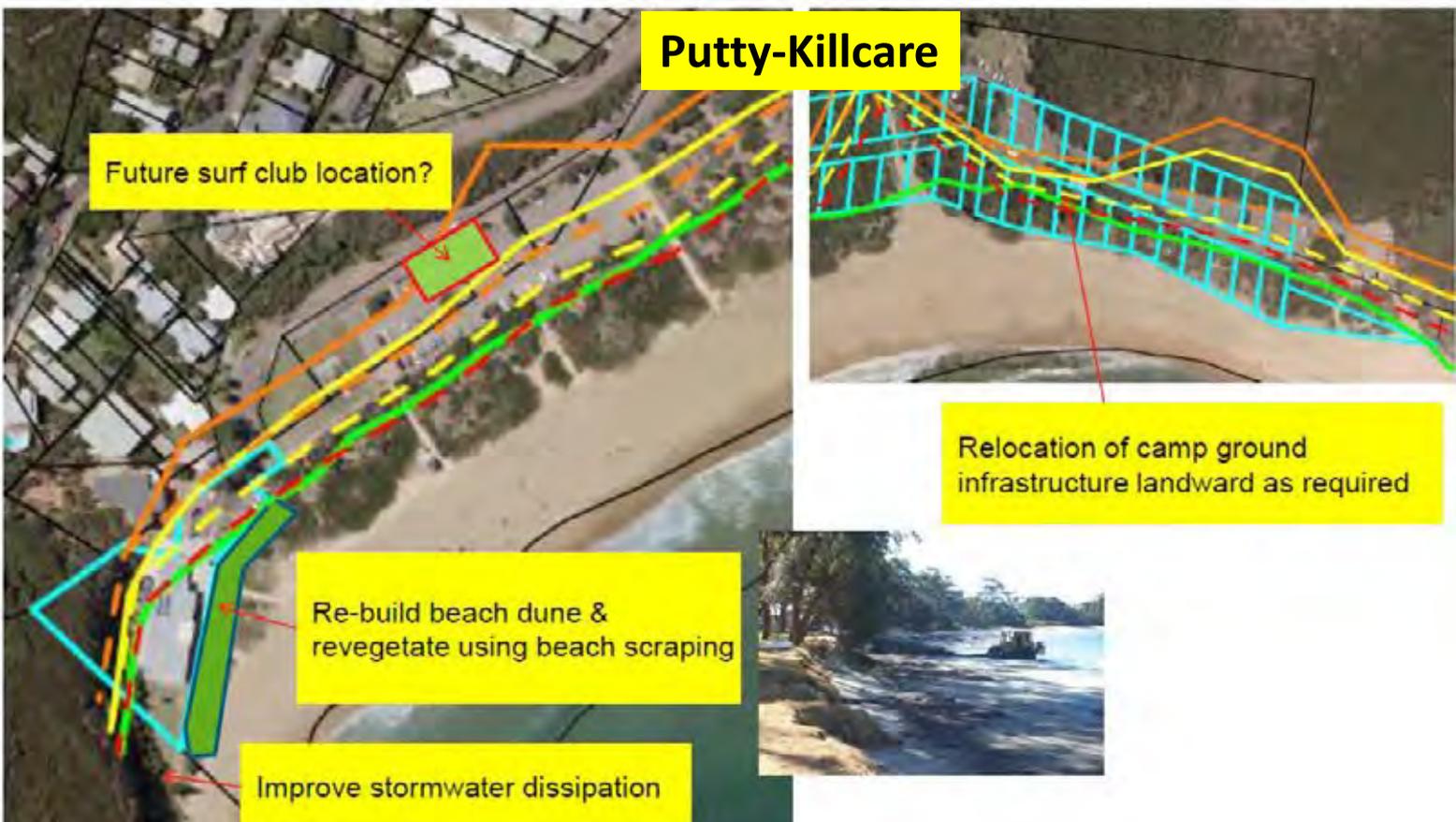
Stormwater management; monitor existing seawall



Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future risk of erosion to dunes, Ettalong Point and surf club carpark;	Monitor existing erosion protection works in front of Ocean Beach surf club (O2.1)	Short term and following storms as required
Windblown dune erosion	Repair of beach accessways and revegetation of dune following erosion in a large storm event (O2.2)	Short term and following storms as required
	Beach scraping following storm event to build dune crest level and revegetation (O2.3)	After storm events as required
Scour due to stormwater outlet at Ocean Beach Surf Club	Investigate installation of stormwater energy dissipation to reduce discharge velocities at outlet (O2.4)	Short term (0 – 5 years)
	Post storm beach scraping to assist natural recovery of the dune and repair scour caused by stormwater discharge (O2.5)	As required
All issues	Emergency Management (O2.6)	As required

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future risk of erosion and reduced foundation capacity to four properties and estuary entrance instability	Erosion Protection works to be allowed for four properties and carpark south of Ettalong Creek entrance (funded by Council and/or residents) (O1.1)	Short to medium term (0 – 20 years)
	Monitor performance of existing training wall works along northern side of Ettalong Creek entrance (O1.2)	As required
	Future relocation of residence on No.8 Berrima Crescent landward of immediate hazard area within same lot on redevelopment (O1.3)	On redevelopment as per DCP
	Beach nourishment (O1.4)	Long term (>20 years)
	Beach scraping to build dune in front of residences at Berrima Crescent (O1.5)	Short term and as required (0-5 years)
	Encourage and assist Dunecare group to improve dune vegetation management and consolidation of beach access at southern end of beach (O1.6)	Short term (0-5 years)
	Develop entrance management guidelines for mechanical opening of Ettalong Creek (O1.7)	Short term (0-5 years)
	Voluntary purchase of portion of at risk property (O1.9)	Short – medium term
	Development controls on redevelopment of properties within hazard area (O1.10)	Short term
	Construct "tripper" structure to control opening location of creek (O1.11)	Short term
Coastal inundation of lots south of Ettalong Creek entrance	Development controls for residences to be above inundation levels on redevelopment of properties (O1.12)	Short term
All issues	Emergency Management (O2.6)	As required

Putty-Killcare



Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate risk of erosion and inundation damage to surf club and carpark	Erosion Protection works at surf club (K1)	Short to medium term (0 – 20 years)
	Repair damage to surf club carpark should storm erosion occur (K2)	As required
	Beach nourishment in front of surf club (K3)	Short to medium term (0 – 20 years)
	Beach scraping to build vegetated dune in front of surf club (K4)	Short term (0-5 years)
	Future relocation of surf club and associated infrastructure to an area landward of the coastal hazard area (K5)	Short to medium term (0 – 20 years)
	Build a dune in front of surf club above the wave runup level with vegetation and/or fencing (K6)	Short term (0-5 years)
	Redevelop surf club on deep piled foundations and undertake geotechnical investigation of surf club area (K7)	Long term (>20 years)
Future risk of erosion damage to main carpark	Maintain status quo (K8)	Ongoing
Stormwater erosion hazard	Move carpark landward in future (K9)	Long term (>20 years)
Future erosion damage to Putty Beach camping area	Improve stormwater outlet by installing energy dissipation to minimise scour and prevent sand ingress into outlet (K10)	Short term
All issues	Future relocation of camping area infrastructure to an area landward of the coastal hazard area (K11)	Long term >20 years
	Emergency Management (K12)	As required
	Monitor beach for erosion in front of surf club and camping area (K13)	Short term, ongoing



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Open Coast and Broken Bay Beaches

Coastal Zone Management Study MacMasters-Copacabana Beach

Chris Adamantidis

4 February 2015

Outline of Presentation

- ▶ Coastal Processes and Hazards at MacMasters-Copacabana
- ▶ Coastal management issues and measures at each precinct
- ▶ Overview of Preferred Management Options

MacMasters/Copacabana



1974



MacMasters/Copacabana

- ▶ Fully exposed to open ocean wave climate
- ▶ 200 – 280 m³/m storm erosion demand
- ▶ Up to 0.1 m/year measured long term beach recession
- ▶ Slope of profile for sea level rise assessment 1V:39H
- ▶ 13.3 m sea level rise recession by 2050
- ▶ 32.8 m sea level rise recession by 2100
- ▶ Wave runup level 6.0 – 7.0 m AHD



Tudibaring Headland
Cliff line Hazard Definition Study
Shirley Consulting 1996



LEGEND

- Existing Hazard Line (2045 Hazard Line)
- - - Immediate Hazard Line (zSA)
- Immediate Hazard Line (zRFC)
- 2050 Hazard Line (zSA)
- 2050 Hazard Line (zRFC)
- - - 2100 Hazard Line (zSA)
- 2100 Hazard Line (zRFC)
- Lots potentially affected by coastal inundation

NOTES

1. It is recommended that hazard line positions be specified from the GIS version of this map (i.e. do not scale hazard line positions off this Figure).

MacMasters/Copacabana

- ▶ One lot was found to be subject to coastal inundation from wave runup.
- ▶ The access road and carpark at the southern end of the beach may be at immediate risk from coastal erosion.
- ▶ Thirteen lots have a portion partially within the Immediate Zone of Slope Adjustment.
- ▶ The coastal road at the northern end of the beach may be at risk from coastal erosion by 2050.
- ▶ A further 42 lots have a portion partially seaward of the 2100 Zone of Reduced Foundation Capacity limit.

MacMasters/Copacabana Hazards

- ▶ **Coastal inundation** due to wave runup affecting the MacMasters Beach Surf Club at the southern end of the beach and properties fronting the lagoon entrance;
- ▶ **Coastal erosion** having the potential to impact on the Surf Club at the southern end of the beach, as well as the carpark along Marine Parade, seaward portion of properties along Tudibaring Parade and future erosion affecting Copacabana Surf Club, Del Monte Place and properties along Del Monte Place;
- ▶ **Slope Instability** having the potential to result in future reduced foundation capacity for several lots along Marine Parade, Tudibaring Parade and Del Monte Place;
- ▶ **Estuary Entrance Instability** associated with the entrance to Cockrone Lagoon;
- ▶ **Scour associated with stormwater drainage** at Copacabana and MacMasters Beach Surf Club.

Existing Coastal Management Issues at MacMasters/Copacabana



1. Rock protection installed at base of Norfolk Pine tree, south end of beach, 5 October 2010



2. Ad-hoc erosion protection and embankment erosion along beachfront at MacMasters Beach Surf Club, 5 October 2010



3. Scour at stormwater drain and weed growth over embankment, Marine Parade MacMasters Beach, 3 April 2014



4. Dune and development on seaward side of Tudibaring Parade, 5 October 2010



5. Erosion along northern bank of Cockrone Lagoon entrance, 5 October 2010



6. Windblown dune near northern end of Cockrone Lagoon entrance, 5 October 2010



7. Scour at stormwater drain and creek entrance, near Copacabana surf club, 5 October 2010



8. Scour at stormwater drain and creek entrance, near Copacabana surf club, 3 April 2014

Beach Precincts

- ▶ **Precinct 1** – Southern end of the beach between MacMasters Surf Club and the bluff;
- ▶ **Precinct 2** – Between the bluff and entrance to Cockrone Lagoon;
- ▶ **Precinct 3** – North from Cockrone Lagoon outlet (Copacabana).



Specific Options for MacMasters/Copacabana

- ▶ **Development controls** Council DCP 2013 6.2 Coastal Frontage;
- ▶ **Relocation** of existing buildings landward following re-development (e.g. the surf clubs, residences);
- ▶ Undertake or allow residents to undertake **erosion protection works** to protect the residences on the seaward side of Tudibaring Parade, carpark at Marine Parade, surf clubs, Del Monte Place and water and sewage infrastructure;
- ▶ Post-storm **beach scraping** adjacent to the stormwater outlets;
- ▶ **Beach nourishment** to provide a buffer against erosion and improve beach amenity in the long term;
- ▶ Update the **entrance management** guidelines for Cockrone Lagoon Entrance;
- ▶ **Maintenance of dune vegetation;**
- ▶ **Stormwater management;**
- ▶ **Geotechnical Investigations;**
- ▶ **Relocation of infrastructure;**
- ▶ **Emergency Management.**

MacMasters Beach – Precinct 1

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future risk of erosion and reduced foundation capacity to surf club and Marine Parade	Erosion Protection works for MacMasters Beach Surf Club (M1.1)	Short term (0 – 5 years)
	Monitor performance of existing erosion works around base of Norfolk Island Pine trees and at surf club at southern end of beach (M1.2)	Ongoing
	Erosion protection works for Marine Parade (M1.3)	Short term (0 – 5 years)
	Improve stormwater outlet (M1.4)	Short term (0 – 5 years)
	Beach nourishment in front of surf club and Marine Parade (M1.5)	Medium term (5 – 20 years)
	Beach scraping to build dune in front of Surf Club, eroded pine tree roots and Marine Parade (M1.6)	After storm events as required
	Dune vegetation management at southern end of beach (M1.7)	Ongoing
	Undertake geotechnical investigation of area behind Marine Parade (M1.8)	Short term (0 – 5 years)
	Future relocation of surf club landward on redevelopment (M1.9)	Medium term (5 – 20 years)
	Development controls for residences to be on piled foundations on redevelopment of properties within 2050 or 2100 hazard area (i.e. maintain status quo) (M1.10)	Short term (0 – 5 years)
	Landward relocation of sewer infrastructure along Marine Parade (M1.11)	Short term (0 – 5 years)
	Repair damage to Marine Parade should it be damaged by future erosion (M1.12)	As required
	Long term narrowing, removal and relocation or provision of alternative access for Marine Parade (M1.13)	Medium to long term (> 5 years)
	Planned retreat from this area, including the voluntary purchase/relocation of the surf club, properties that would lose their access should Marine Parade be damaged by future erosion and closure of Marine Parade. (M1.14)	Long term (> 20 years)
	Do nothing (M1.15)	Short term
Scour due to stormwater outflow	Improve stormwater outlet to reduce scour (M1.16)	Short term (0 – 5 years)
	Periodic beach scraping to repair damage caused by scour from stormwater outlet (M1.17)	After storm events as required
Dune vegetation management/ beach amenity	Beach scraping to create dune in front of Marine Parade and Surf Club; remove weeds and encourage maintenance by Dunecare groups (M1.18)	Short term
	Improve pedestrian access onto beach from carpark (M1.19)	Short term (0 – 5 years)



Precinct 1

- ▶ Erosion protection works
- ▶ Dune vegetation management
- ▶ Stormwater management
- ▶ Relocation of services/infrastructure
- ▶ Geotechnical investigations
- ▶ Repair road to maintain access
- ▶ Beach scraping

Alternative access



MacMasters Beach – Precinct 2

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future risk of erosion and reduced foundation capacity to properties along seaward side of Tudibaring Parade	Development controls for residences on Tudibaring Parade to be on piled foundations on redevelopment of properties within 2050 or 2100 hazard area (M2.1)	Short term (0 – 5 years)
	Not allowing further subdivision of properties on seaward side of Tudibaring Parade (M2.2)	Short term
	Future voluntary purchase of properties offered when erosion scarp reaches set trigger distance from buildings (M2.3)	Medium – long term (> 5 years)
	Terminal protection structure for properties along seaward side of Tudibaring Parade (M2.4)	Medium term (5 – 20 years)
	Beach nourishment to increase erosion buffer in this area (M2.5)	Medium term (5 – 20 years)
	Encourage and assist Dunecare group and local residents to maintain and revegetate dune after a storm through provision of free plants and public education material (M2.6)	Short term (0 – 5 years)
Risk of erosion due to lagoon entrance instability	Seaward extension of existing training wall along southern side of entrance (M2.7)	Medium term (5 - 20 years)
	Undertake review of entrance management procedure as recommended by Gosford Coastal Lagoons CZMP. Implement management actions as required (M2.8)	Short term (0 - 5 years)



Precinct 2

- ▶ Development controls DCP 2013 – which planning horizon do we adopt?
- ▶ Subdivision of lots intensifies development in the coastal hazard zones
- ▶ Future hazard expected to increase – subdivided lots have reduced development potential
- ▶ Future erosion protection works – longer term
- ▶ Future extension of training wall at lagoon mouth to reduce erosion impact
- ▶ Dune vegetation



Copacabana Beach – Precinct 3

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Windblown erosion of dune	Encourage and assist Dunecare group and local residents to maintain and revegetate dune after a storm through provision of free plants and public education material (M3.1)	Short term (0 – 5 years)
Risk of future erosion damage to Del Monte Place, services/ utilities and Copacabana surf club	Erosion Protection works for Copacabana Beach Surf Club (M3.2)	Medium term (5 - 20 years)
	Erosion protection works for Del Monte Place to be installed once erosion escarpment reaches set trigger distance from edge of road (M3.3)	Long term (> 20years)
	Landward relocation of sewer and water infrastructure along Del Monte Place (M3.4)	Long term (> 20years)
	Beach nourishment in front of surf club and Del Monte Place (M3.5)	Long term (> 20 years)
	Repair damage to Del Monte Place should it be damaged by future erosion (M3.6)	Medium term and as required (> 5 years)
	Long term narrowing, removal and relocation or provision of alternative access for Del Monte Place (M3.7)	Long term (> 20 years)
	Future relocation of surf club landward on redevelopment (M3.8)	Long term (>20 years)
	Voluntary purchase of properties affected by coastal hazards (M3.9)	Long term (>20 years)
	Development controls for residences and commercial premises to be on piled foundations on redevelopment of properties within 2050 or 2100 hazard area; i.e. status quo (M3.10)	Short term (0 – 5 years)
	Geotechnical investigation around surf club area to confirm level of bedrock and reduced foundation capacity hazard (M3.11)	Short term (0 – 5 years)
	Scour and water quality issues due to stormwater management near Copacabana surf club	Improve energy dissipation at stormwater outlet (M3.12)
Construct “training” or “tripper” control structure to prevent stormwater outlet from scouring base of dune along Del Monte Place (M3.13)		Short term (0 – 5 years)
Dune vegetation management	Dune vegetation management to remove weeds and encourage dune growth (M3.14)	Ongoing
All issues	Emergency Management (M3.15)	As required

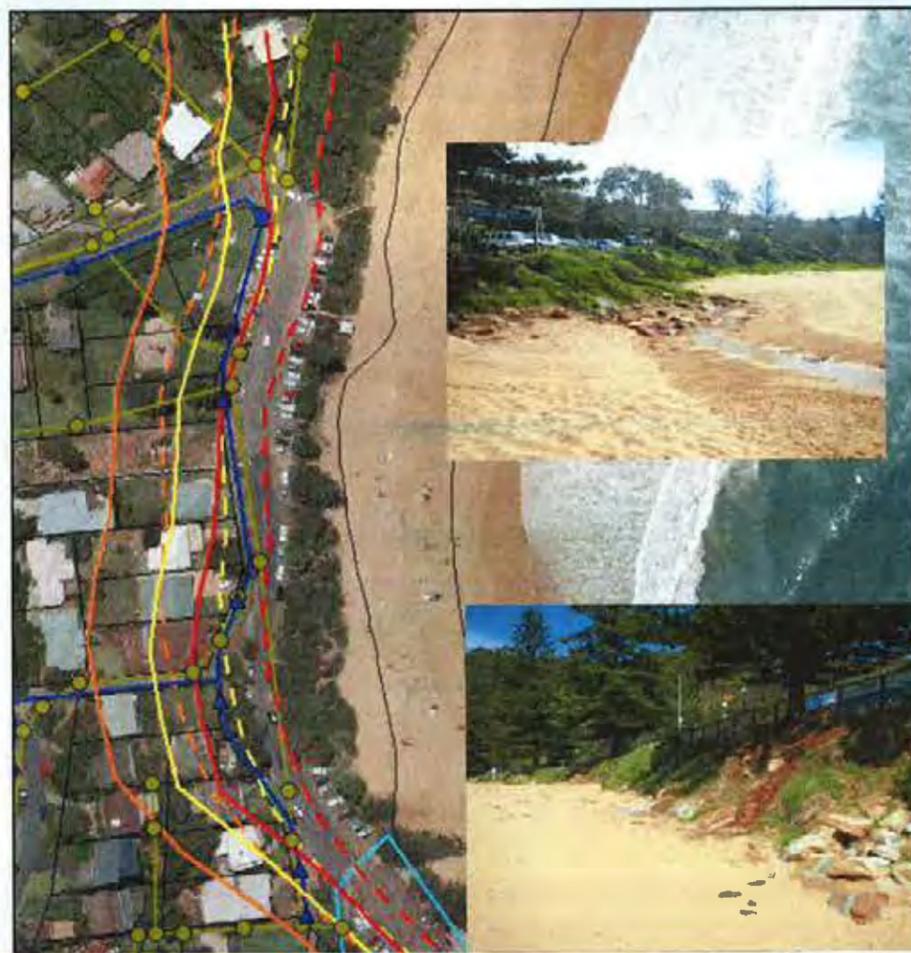


Precinct 3

- ▶ Dune vegetation
- ▶ Future protection for Del Monte Place once erosion reaches set trigger distance
- ▶ Repair damage to road in erosion event
- ▶ Provide future rear access to properties – long term after 2050
- ▶ Development controls as per existing DCP
- ▶ Management of creek entrance

Options with low BCR

Option	Reasons for exclusion
Erosion protection works for Marine Parade (M1.3)	<ul style="list-style-type: none"> • Low BCR 0.18 – cost is greater than repair cost for road.
Beach nourishment in front of surf club and Marine Parade (M1.5)	<ul style="list-style-type: none"> • Low BCR 0.15 – 0.2
Future relocation of surf club landward on redevelopment (M1.9)	<ul style="list-style-type: none"> • Low BCR, social impact.
Planned retreat from this area, including the voluntary purchase/relocation of the surf club, properties that would lose their access should Marine Parade be damaged by future erosion and closure of Marine Parade. (M1.14)	<ul style="list-style-type: none"> • Low BCR, social impact
Do nothing (M1.15)	<ul style="list-style-type: none"> • High social impact
Future voluntary purchase of properties offered when erosion scarp reaches set trigger distance from buildings (M2.3)	<ul style="list-style-type: none"> • Low BCR, high social impact.
Terminal protection structure for properties along seaward side of Tudibaring Parade (M2.4)	<ul style="list-style-type: none"> • Low BCR, erosion risk currently not high enough to justify option at this time
Beach nourishment to increase erosion buffer in this area (M2.5)	<ul style="list-style-type: none"> • Low BCR, erosion risk currently not high enough to justify option at this time
Erosion Protection works for Copacabana Beach Surf Club (M3.2)	<ul style="list-style-type: none"> • Low BCR, erosion risk currently not high enough to justify option at this time
Erosion protection works for Del Monte Place to be installed once erosion escarpment reaches set trigger distance from edge of road (M3.3)	<ul style="list-style-type: none"> • Low BCR, erosion risk currently not high enough to justify option at this time
Landward relocation of sewer and water infrastructure along Del Monte Place (M3.4)	<ul style="list-style-type: none"> • Low BCR, erosion risk currently not high enough to justify option at this time, may be reconsidered in future
Beach nourishment in front of surf club and Del Monte Place (M3.5)	<ul style="list-style-type: none"> • Low BCR, erosion risk currently not high enough to justify option at this time, may be reconsidered in future
Future relocation of surf club landward on redevelopment (M3.8)	<ul style="list-style-type: none"> • Low BCR, erosion risk currently not high enough to justify option at this time, social impact
Voluntary purchase of properties affected by coastal hazards (M3.9)	<ul style="list-style-type: none"> • Low BCR, adverse social impact

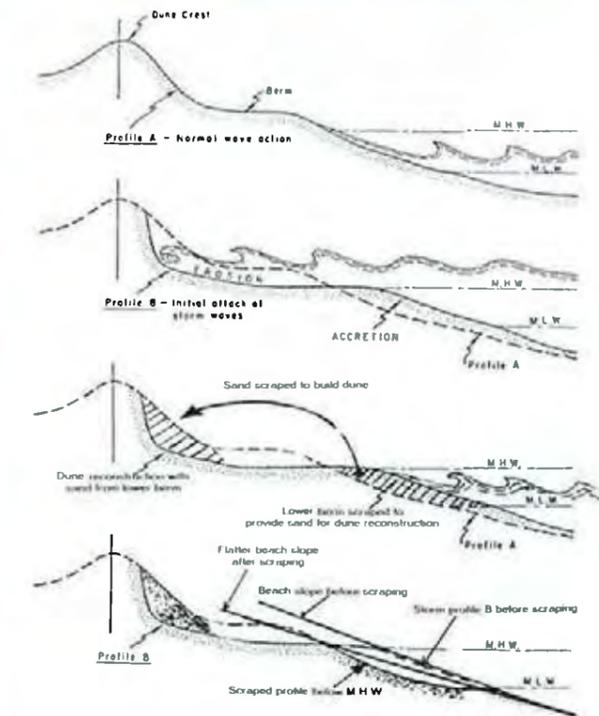


Precinct 1

- ▶ Erosion protection works
- ▶ Dune vegetation management
- ▶ Stormwater management
- ▶ Relocation of services/infrastructure
- ▶ Geotechnical investigations
- ▶ Repair road to maintain access
- ▶ Beach scraping



Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future risk of erosion and reduced foundation capacity to surf club and Marine Parade	Erosion Protection works for MacMasters Beach Surf Club (M1.1)	Short term (0 – 5 years)
	Monitor performance of existing erosion works around base of Norfolk Island Pine trees and at surf club at southern end of beach (M1.2)	Ongoing
	Erosion protection works for Marine Parade (M1.3)	Short term (0 – 5 years)
	Improve stormwater outlet (M1.4)	Short term (0 – 5 years)
	Beach nourishment in front of surf club and Marine Parade (M1.5)	Medium term (5 – 20 years)
	Beach scraping to build dune in front of Surf Club, eroded pine tree roots and Marine Parade (M1.6)	After storm events as required
	Dune vegetation management at southern end of beach (M1.7)	Ongoing
	Undertake geotechnical investigation of area behind Marine Parade (M1.8)	Short term (0 – 5 years)
	Future relocation of surf club landward on redevelopment (M1.9)	Medium term (5 – 20 years)
	Development controls for residences to be on piled foundations on redevelopment of properties within 2050 or 2100 hazard area (i.e. maintain status quo) (M1.10)	Short term (0 – 5 years)
	Landward relocation of sewer infrastructure along Marine Parade (M1.11)	Short term (0 – 5 years)
	Repair damage to Marine Parade should it be damaged by future erosion (M1.12)	As required
	Long term narrowing, removal and relocation or provision of alternative access for Marine Parade (M1.13)	Medium to long term (> 5 years)
Scour due to stormwater outflow	Do nothing (M1.15)	Short term
	Improve stormwater outlet to reduce scour (M1.16)	Short term (0 – 5 years)
Dune vegetation management/ beach amenity	Periodic beach scraping to repair damage caused by scour from stormwater outlet (M1.17)	After storm events as required
	Beach scraping to create dune in front of Marine Parade and Surf Club; remove weeds and encourage maintenance by Dunecare groups (M1.18)	Short term
	Improve pedestrian access onto beach from carpark (M1.19)	Short term (0 – 5 years)



Beach scraping – speeding up the natural dune rebuilding process



Precinct 2

- ▶ Development controls DCP 2013 – which planning horizon do we adopt?
- ▶ Subdivision of lots intensifies development in the coastal hazard zones
- ▶ Future hazard expected to increase – subdivided lots have reduced development potential
- ▶ Future erosion protection works – longer term
- ▶ Future extension of training wall at lagoon mouth to reduce erosion impact
- ▶ Dune vegetation

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future risk of erosion and reduced foundation capacity to properties along seaward side of Tudibaring Parade	Development controls for residences on Tudibaring Parade to be on piled foundations on redevelopment of properties within 2050 or 2100 hazard area (M2.1)	Short term (0 – 5 years)
	Not allowing further subdivision of properties on seaward side of Tudibaring Parade (M2.2)	Short term
	Future voluntary purchase of properties offered when erosion scarp reaches set trigger distance from buildings (M2.3)	Medium – long term (> 5 years)
	Terminal protection structure for properties along seaward side of Tudibaring Parade (M2.4)	Medium term (5 – 20 years)
	Beach nourishment to increase erosion buffer in this area (M2.5)	Medium term (5 – 20 years)
	Encourage and assist Dunecare group and local residents to maintain and revegetate dune after a storm through provision of free plants and public education material (M2.6)	Short term (0 – 5 years)
Risk of erosion due to lagoon entrance instability	Seaward extension of existing training wall along southern side of entrance (M2.7)	Medium term (5 - 20 years)
	Undertake review of entrance management procedure as recommended by Gosford Coastal Lagoons CZMP. Implement management actions as required (M2.8)	Short term (0 - 5 years)

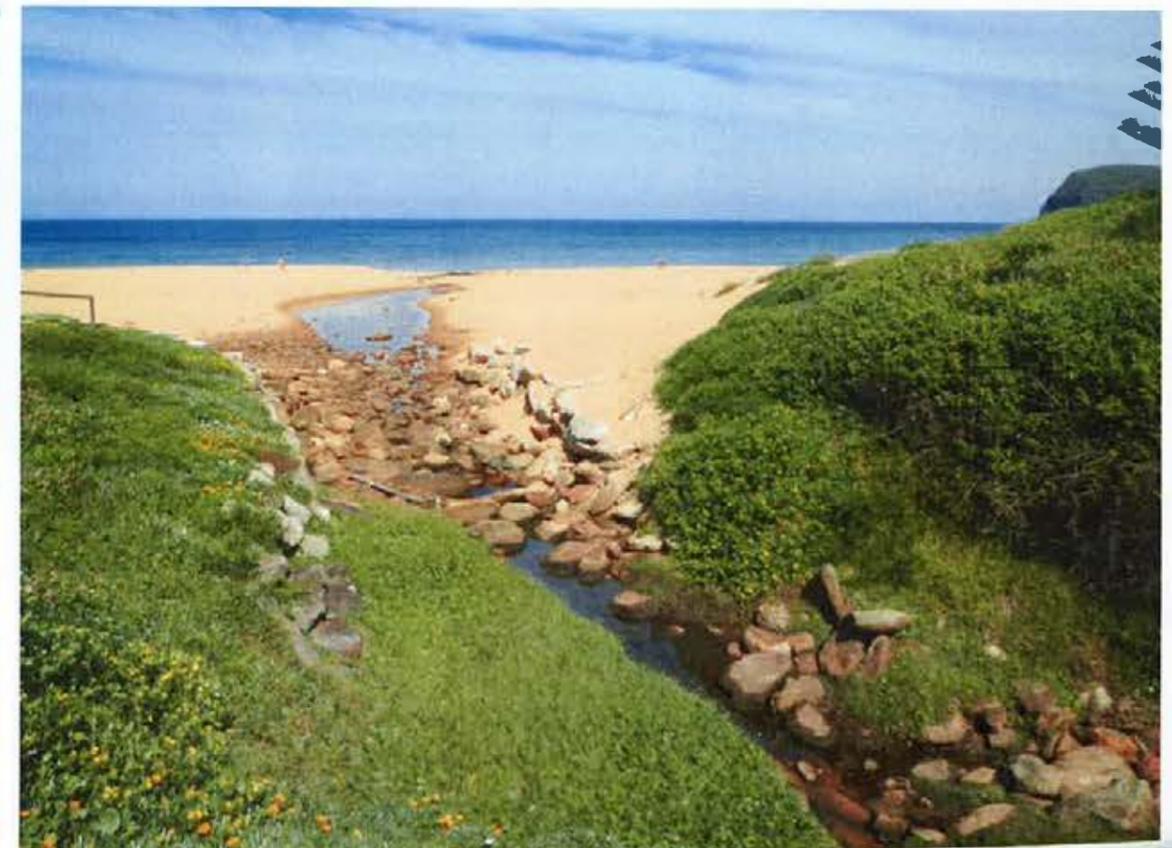




Precinct 3

- ▶ Dune vegetation
- ▶ Future protection for Del Monte Place once erosion reaches set trigger distance
- ▶ Repair damage to road in erosion event
- ▶ Provide future rear access to properties – long term after 2050
- ▶ Development controls as per existing DCP
- ▶ Management of creek entrance

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Windblown erosion of dune	Encourage and assist Dunecare group and local residents to maintain and revegetate dune after a storm through provision of free plants and public education material (M3.1)	Short term (0 – 5 years)
Risk of future erosion damage to Del Monte Place, services/ utilities and Copacabana surf club	Erosion Protection works for Copacabana Beach Surf Club (M3.2)	Medium term (5 - 20 years)
	Erosion protection works for Del Monte Place to be installed once erosion escarpment reaches set trigger distance from edge of road (M3.3)	Long term (> 20years)
	Landward relocation of sewer and water infrastructure along Del Monte Place (M3.4)	Long term (> 20years)
	Beach nourishment in front of surf club and Del Monte Place (M3.5)	Long term (> 20 years)
	Repair damage to Del Monte Place should it be damaged by future erosion (M3.6)	Medium term and as required (> 5 years)
	Long term narrowing, removal and relocation or provision of alternative access for Del Monte Place (M3.7)	Long term (> 20 years)
	Future relocation of surf club landward on redevelopment (M3.8)	Long term (>20 years)
	Voluntary purchase of properties affected by coastal hazards (M3.9)	Long term (>20 years)
	Development controls for residences and commercial premises to be on piled foundations on redevelopment of properties within 2050 or 2100 hazard area; i.e. status quo (M3.10)	Short term (0 – 5 years)
	Geotechnical investigation around surf club area to confirm level of bedrock and reduced foundation capacity hazard (M3.11)	Short term (0 – 5 years)
	Scour and water quality issues due to stormwater management near Copacabana surf club	Improve energy dissipation at stormwater outlet (M3.12)
Construct "training" or "tripper" control structure to prevent stormwater outlet from scouring base of dune along Del Monte Place (M3.13)		Short term (0 – 5 years)
Dune vegetation management	Dune vegetation management to remove weeds and encourage dune growth (M3.14)	Ongoing
All issues	Emergency Management (M3.15)	As required





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Open Coast and Broken Bay Beaches

Coastal Zone Management Study Avoca and North Avoca

Chris Adamantidis
5 February 2015

Outline of Presentation

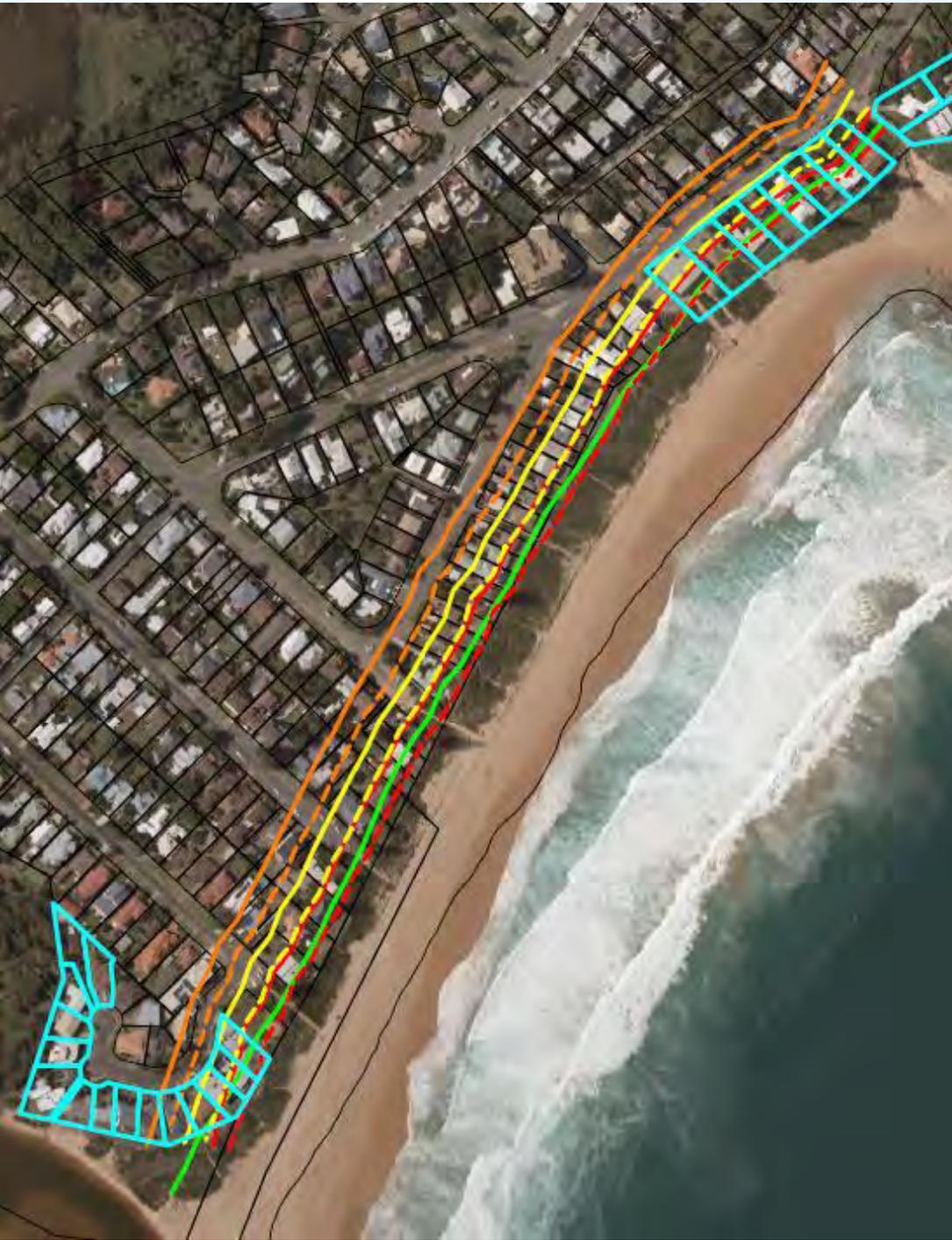
- ▶ Coastal Processes and Hazards at Avoca and North Avoca
- ▶ Coastal management issues and measures at each precinct
- ▶ Overview of Preferred Management Options

Avoca and North Avoca



Avoca and North Avoca Beach

- ▶ Fully exposed to open ocean wave climate
- ▶ Storm erosion demand increases from south to north
- ▶ Wave runup levels increase from south to north
- ▶ Measured long term recession rate – zero
- ▶ Sea level rise recession 17 m (2050), 42 m (2100)
- ▶ All oceanfront and lagoon-front lots on the southern side of the lagoon are subject to coastal inundation due to wave runup.
- ▶ A further 15 lots on the northern side of the lagoon entrance and 11 lots at the northern end of the beach are subject to coastal inundation hazard.
- ▶ Approximately 10 lots have a portion within the Immediate Zone of Slope Adjustment,
- ▶ All oceanfront lots at Avoca subject to coastal erosion by 2100



Notes about hazard mapping

- ▶ Hazard lines represent potential maximum extent of erosion in a design storm event – does not mean that erosion would be uniform back to that line along the whole beach
- ▶ Hazard lines do not take into account presence of rock and protection works under the dunes

Avoca and North Avoca Hazards

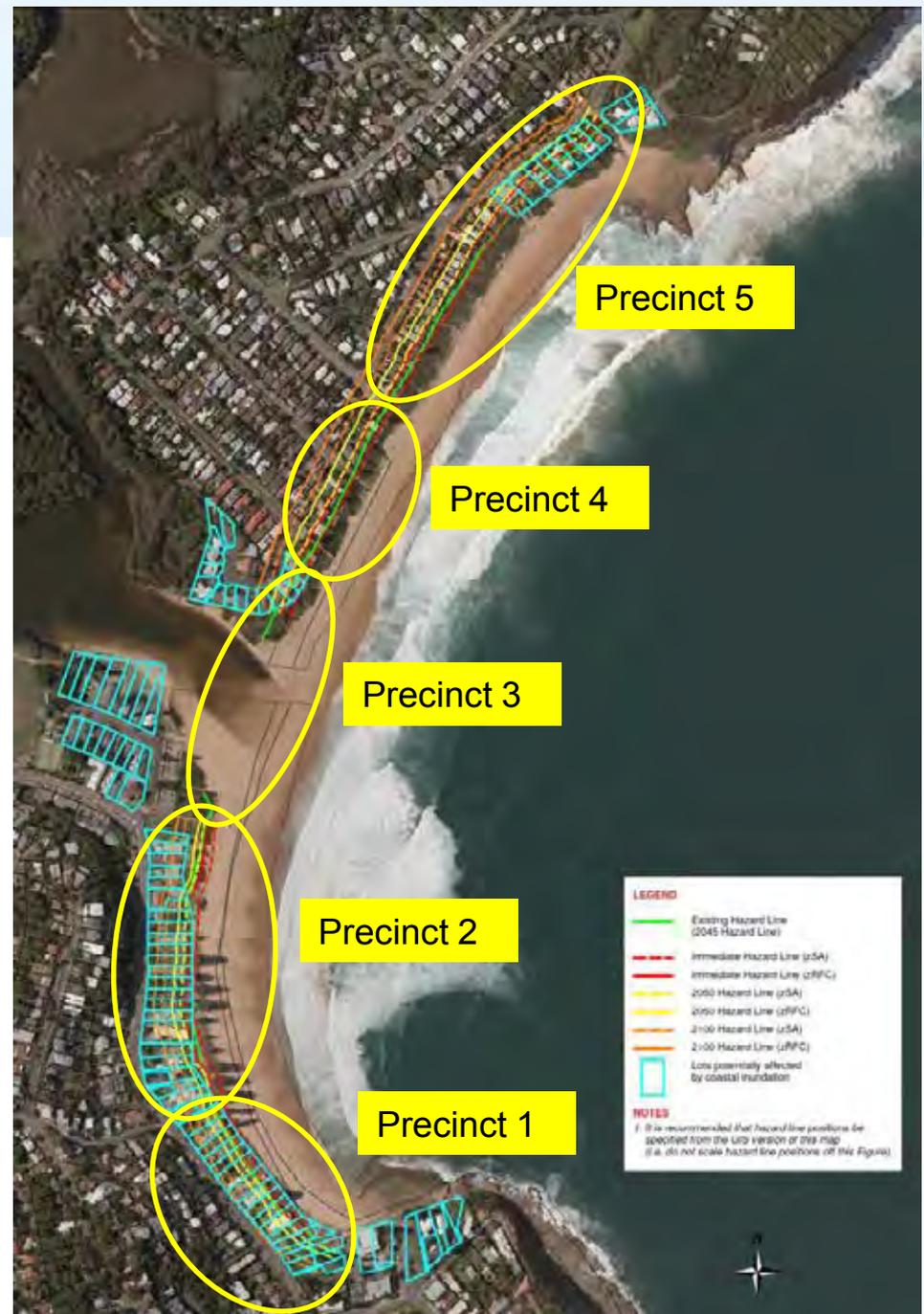
- ▶ **Coastal inundation** of houses and carpark by wave runup and at the lagoon entrance;
- ▶ **Coastal erosion** having the potential to impact on public and private infrastructure;
- ▶ **Slope Instability** - reduced foundation capacity for up to 71 lots, with this number increasing to 114 lots by 2100;
- ▶ **Future coastal erosion** and recession affecting up to 90 m length of Bareena Avenue, 220 m length of North Avoca Drive and ends of View Street, Ocean Street and Lake Street
- ▶ **Erosion associated with estuary entrance instability** at Avoca Lake.

Coastal Management Issues at Avoca



Beach Precincts

- ▶ **Precinct 1** – Avoca Beach, South of Austral Avenue
- ▶ **Precinct 2** – Avoca Beach, Austral Avenue to Ficus Avenue;
- ▶ **Precinct 3** – Avoca Lake Entrance;
- ▶ **Precinct 4 & 5** – Avoca Beach, North of Avoca Lake Entrance.



Specific Options for Avoca Beach (south)

- ▶ **Development controls** Council DCP 2013 6.2 Coastal Frontage;
- ▶ Investigate effectiveness of **existing rock protection works** for Surf Club and at southern end of Avoca Lake entrance
- ▶ Investigate which properties have existing protection works and establish their effectiveness
- ▶ **Beach scraping** to help build up dune and provide cover for roots of Norfolk Pine trees – improve inundation protection
- ▶ Investigate relocation of sewer infrastructure

Avoca Beach – Precinct 1 and 2

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate risk of inundation to Avoca Beach SLSC	Survey floor levels to determine degree of inundation hazard (A1.1)	Short term
Immediate and future risk of erosion and inundation damage to the surf club carpark	Repair damage to carpark and other infrastructure should storm erosion occur (A1.2)	As required
	Beach scraping to build vegetated dune in front of carpark (A1.4)	Short term (0-5 years)
	Future relocation of carpark to an area landward of the coastal hazard area (A1.5)	Short to medium term (0 – 20 years)
	Monitor performance of existing rock works in front of surf club and carpark following a large storm (A1.6)	Short term and as required
Immediate and future risk of erosion to properties on Avoca Drive	Development controls as per existing DCP i.e. defined building line (e.g. defined building line, or 2050 Zone of Slope Adjustment) with new buildings to be founded into 2100 Stable foundation Zone (A1.7)	Short term
	Development controls based on 2100 Zone of Slope Adjustment with new buildings to be founded into 2100 Stable foundation Zone (A1.8)	Short term
	Erosion protection works to be allowed for properties for emergency protection (funded by residents) (A1.9)	Short to medium term, some of these properties already have protection installed
	Terminal seawall protection for the properties (A1.10)	Short to medium term
	Relocate sewer infrastructure further landwards (A1.12)	Short term (0 – 5 years)
	Beach nourishment to increase erosion buffer in this area (A1.13)	Short term
	Beach scraping to build dune in front of residences (A1.14)	Short term (0 - 5 years, ongoing)
	Repair of beach accessways and revegetation of dune following erosion in a large storm event (A1.15)	Short term and following storms as required
Immediate and future risk of inundation risk to properties (south of Austral Avenue)	Development controls for residences to be above inundation levels on redevelopment of properties (A1.16)	Short term
Erosion risk to stormwater outlets	Erosion protection works in front and around the stormwater outlet should storm erosion occur (A1.17)	Short term
	Relocate stormwater outlets (A1.18)	Short term
Inundation and erosion risk to Ficus Avenue carpark	Repair damage to carpark and other infrastructure should storm erosion occur (A1.19)	As required
	Beach scraping to build dune in front of carpark and properties 165 Avoca Drive to 1 Ficus Avenue (A1.20)	Short term (0 - 5 years)



Precinct 1



- **Development controls** Council DCP 2013 6.2 Coastal Frontage;
- Investigate effectiveness of **existing rock protection works** for Surf Club and at southern end of Avoca Lake entrance
- Investigate which properties have existing protection works and establish their effectiveness
- **Beach scraping** to help build up dune and provide cover for roots of Norfolk Pine trees – improve inundation protection
- Investigate relocation of sewer infrastructure

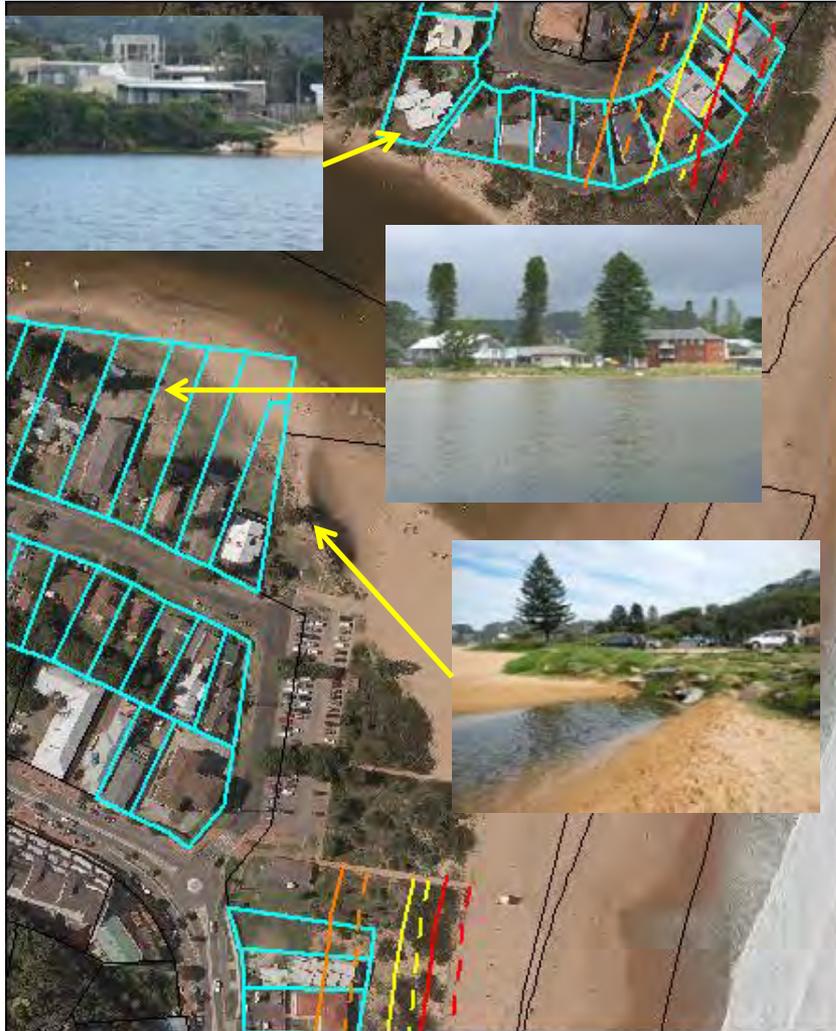


Precinct 2



- **Development controls**
Council DCP 2013 6.2
Coastal Frontage;
- Investigate which properties have existing protection works and establish their effectiveness
- **Beach scraping** to help build up dune and provide cover for roots of Norfolk Pine trees – improve inundation protection
- Dune re-vegetation

Precinct 3 – Lagoon entrance



Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future erosion and inundation risk to properties and infrastructures at Avoca Lake Entrance	Development controls for residences to be above inundation levels on redevelopment of properties (A3.1)	Short term
	Review entrance management guidelines for mechanical opening of Avoca Lake (A3.2)	Short term
	Allow lagoon frontage properties to self-protect (A3.3)	Short term

North Avoca Precincts 4 and 5

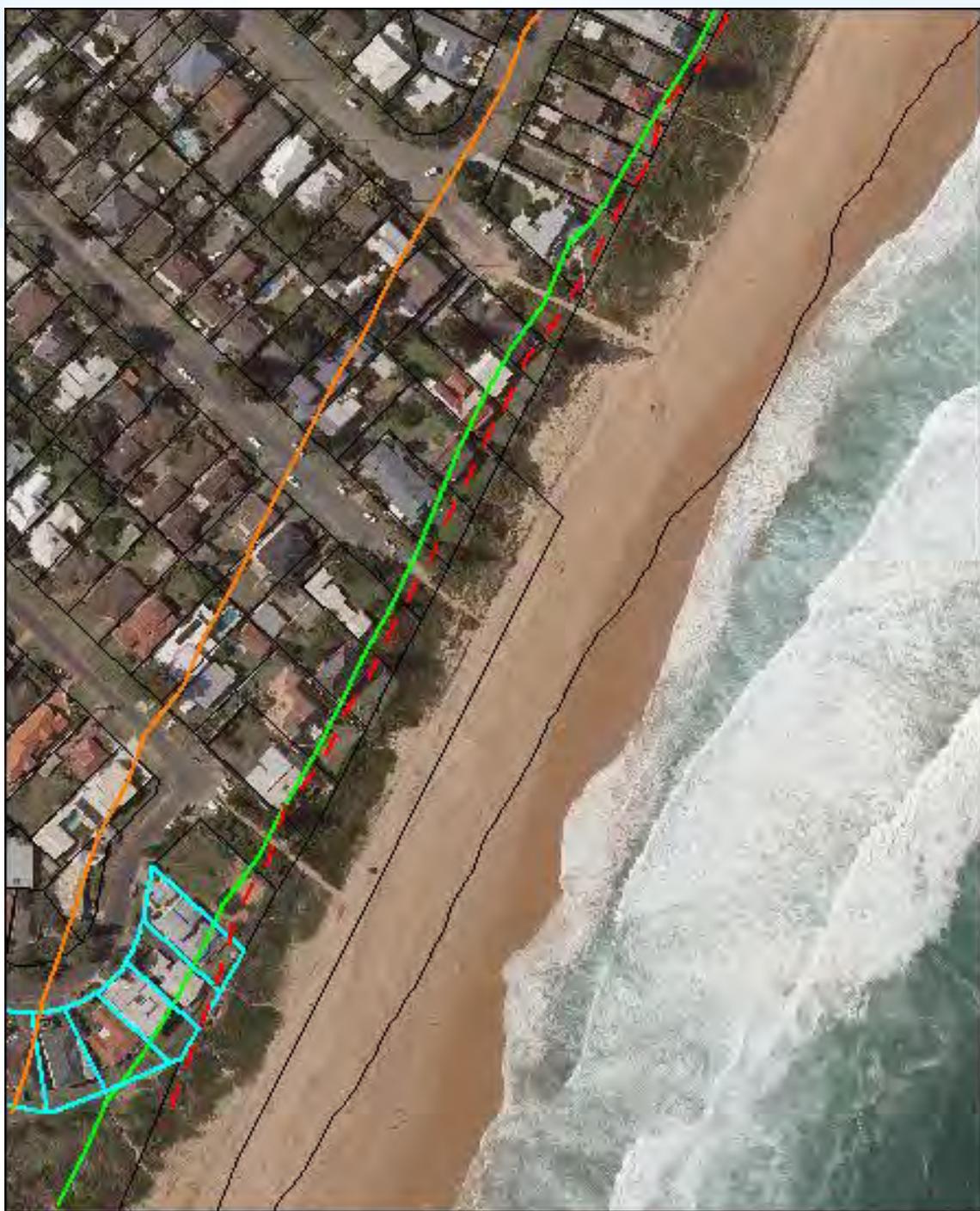
Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future risk of erosion risk to properties at North Avoca Beach	Allowing development landward of the 2050 Zone of Slope Adjustment with piled foundations into the 2100 Stable Foundation Zone (A4.1)	Short term
	Allowing development landward of a specially defined building line with piled foundations into the 2100 Stable Foundation Zone (i.e. similar to existing DCP, status quo, A4.2)	Short term
	Allowing development landward of the 2100 Zone of Slope Adjustment with piled foundations into the 2100 Stable Foundation Zone (A4.3)	Short term
	Erosion protection works to be allowed for properties for emergency protection (funded by residents) (A4.4)	Short to medium term, some of these properties already have protection installed
	Terminal seawall protection for all the properties (A4.5)	Short to medium term
	Terminal seawall protection for the properties north from the Surf Club only (A4.6)	Short – medium term (0 – 20 years)
	Beach nourishment to increase erosion buffer in this area (A4.10)	Short term
Immediate and future risk of inundation risk to properties at North Avoca Beach	Development controls for residences to be above inundation levels on redevelopment of properties (A4.12)	Short term
Scour erosion due to stormwater outlet	Scour protection in front of stormwater outlets (A4.13)	Short term
Immediate and future risk of erosion and inundation risk to the North Avoca SLSC and carpark	Repair damage to surf club carpark should storm erosion occur (A4.15)	As required
	Beach scraping to build vegetated dune in front of surf club and carpark (A4.17)	Short term (0-5 years)
	Build and maintain a dune in front of surf club above the wave runup level with vegetation and/or fencing (A4.19)	Short term (0-5 years)
	Redevelop surf club on deep piled foundations (A4.20)	Medium term (5 – 20 years)
All issues	Emergency Management (A4.21)	As required

Options which are off the table

- ▶ Planned retreat
- ▶ Compulsory or voluntary purchase of private property – high monetary and social cost. Off the table for both Avoca and North Avoca
- ▶ Relocation of the surf club or protection works of surf club in isolation
- ▶ Relocation of sewer infrastructure – higher cost to relocate than to repair
- ▶ Beach nourishment on small scale – high economic cost and environmental impact



- **Development controls**
- Council DCP 2013 6.2 Coastal Frontage;
- Which hazard line do we adopt for the basis of development controls?
- Existing DCP = green line (old 2045 erosion projection)
- Updated DCP – 2050 Zone of Slope Adjustment?



- **Development controls**
Council DCP 2013 6.2 Coastal Frontage;
- Existing DCP = green line (old 2045 erosion projection)
- Updated DCP – 2050 Zone of Slope Adjustment? Present Day?
- What planning horizon should we use?
- Tax Office allows the entire construction cost of a residential rental property to be deducted over a period of 40 years, it can be inferred that the economic life of a dwelling is 40 years
- If we use less than 40 years new development might be subject to future wave impact within its design life.



- **Development controls**
Council DCP 2013 6.2 Coastal Frontage;
- Which hazard line do we adopt for the basis of development controls?
- Existing DCP = green line (old 2045 erosion projection)
- Updated DCP – 2050 Zone of Slope Adjustment?



- **Development controls**
Council DCP 2013 6.2 Coastal Frontage;
- Which hazard line do we adopt for the basis of development controls?
- Deep pile foundations into Stable Foundation Zone
- Existing DCP = green line (old 2045 erosion projection)
- Updated DCP – 2050 Zone of Slope Adjustment?
- Special building line to be developed

Stable Foundation Zone

Zone of Reduced Foundation Capacity

Zone of Wave Impact & Slope Adjustment



Slab on ground, piers

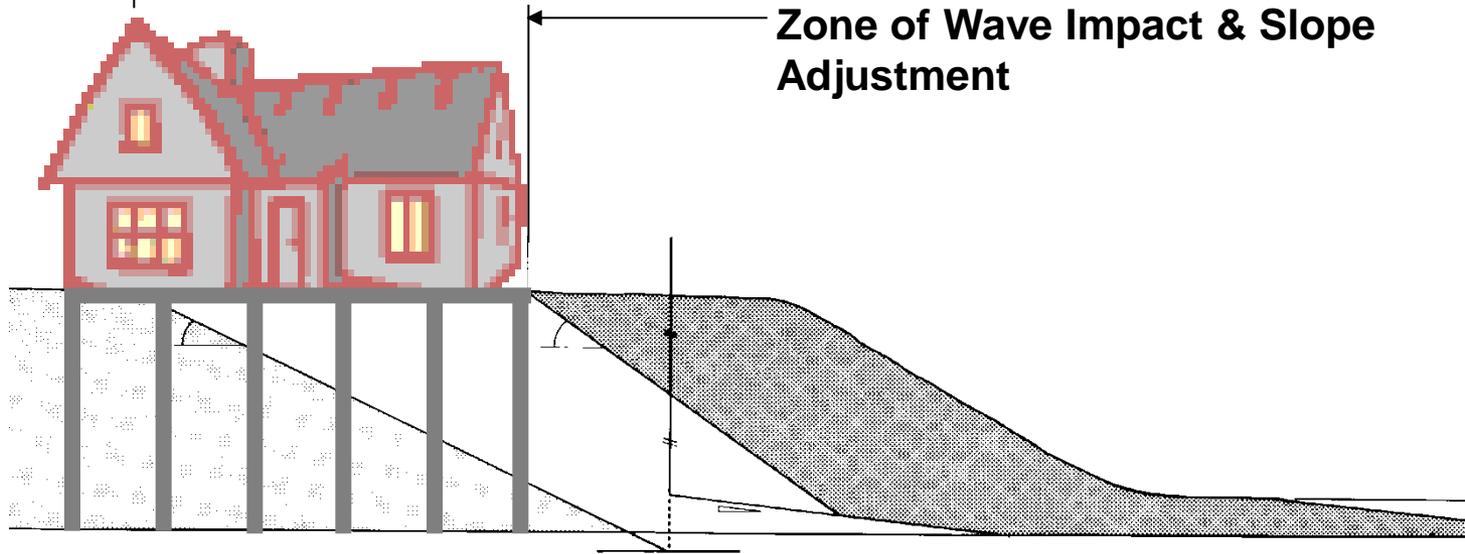
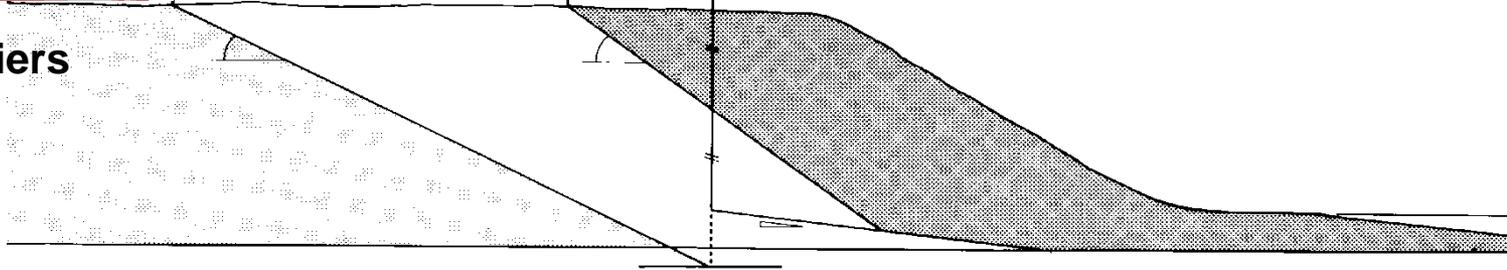
Stable Foundation Zone

Zone of Reduced Foundation Capacity

Zone of Wave Impact & Slope Adjustment



**Piling Founded into
Stable Foundation
Zone**



Buildings piled into stable foundation zone





Erosion protection works to be allowed for properties for emergency protection (funded by residents) (A4.4)

Terminal seawall protection for all the properties (A4.5)

Terminal seawall protection for the properties north from the Surf Club only (A4.6)

Beach nourishment to increase erosion buffer in this area (A4.10)

Repair of beach accessways and revegetation of dune following erosion in a large storm event (A4.11)

Development controls for residences to be above inundation levels on redevelopment of properties (A4.12)

Scour protection in front of stormwater outlets (A4.13)

Repair damage to surf club carpark should storm erosion occur (A4.15)

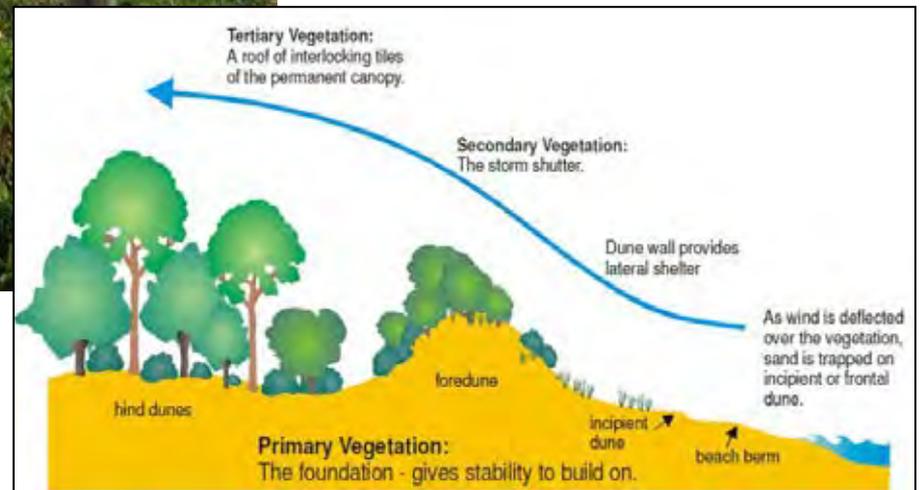
Beach scraping to build vegetated dune in front of surf club and carpark (A4.17)

Build and maintain a dune in front of surf club above the wave runup level with vegetation and/or fencing (A4.19)

Redevelop surf club on deep piled foundations (A4.20)

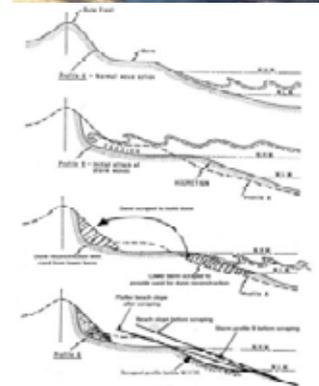
Emergency Management (A4.21)

Dune vegetation





Avoca Beach – Precinct 1 and 2



Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate risk of Inundation to Avoca Beach SLSC	Survey floor levels to determine degree of inundation hazard (A1.1)	Short term
Immediate and future risk of erosion and inundation damage to the surf club carpark	Repair damage to carpark and other infrastructure should storm erosion occur (A1.2)	As required
	Beach scraping to build vegetated dune in front of carpark (A1.4)	Short term (0-5 years)
	Future relocation of carpark to an area landward of the coastal hazard area (A1.5)	Short to medium term (0 – 20 years)
	Monitor performance of existing rock works in front of surf club and carpark following a large storm (A1.6)	Short term and as required
Immediate and future risk of erosion to properties on Avoca Drive	Development controls as per existing DCP i.e. defined building line (e.g. defined building line, or 2050 Zone of Slope Adjustment) with new buildings to be founded into 2100 Stable foundation Zone (A1.7)	Short term
	Development controls based on 2100 Zone of Slope Adjustment with new buildings to be founded into 2100 Stable foundation Zone (A1.8)	Short term
	Erosion protection works to be allowed for properties for emergency protection (funded by residents) (A1.9)	Short to medium term, some of these properties already have protection installed
	Terminal seawall protection for the properties (A1.10)	Short to medium term
	Relocate sewer infrastructure further landwards (A1.12)	Short term (0 – 5 years)
	Beach nourishment to increase erosion buffer in this area (A1.13)	Short term
	Beach scraping to build dune in front of residences (A1.14)	Short term (0 - 5 years, ongoing)
	Repair of beach accessways and revegetation of dune following erosion in a large storm event (A1.15)	Short term and following storms as required
	Development controls for residences to be above inundation levels on redevelopment of properties (A1.16)	Short term
	Immediate and future risk of inundation risk to properties (south of Austral Avenue)	Erosion protection works in front and around the stormwater outlet should storm erosion occur (A1.17)
Relocate stormwater outlets (A1.18)		Short term
Erosion risk to stormwater outlets	Relocate stormwater outlets (A1.18)	Short term
Inundation and erosion risk to Ficus Avenue carpark	Repair damage to carpark and other infrastructure should storm erosion occur (A1.19)	As required
	Beach scraping to build dune in front of carpark and properties 165 Avoca Drive to 1 Ficus Avenue (A1.20)	Short term (0 - 5 years)



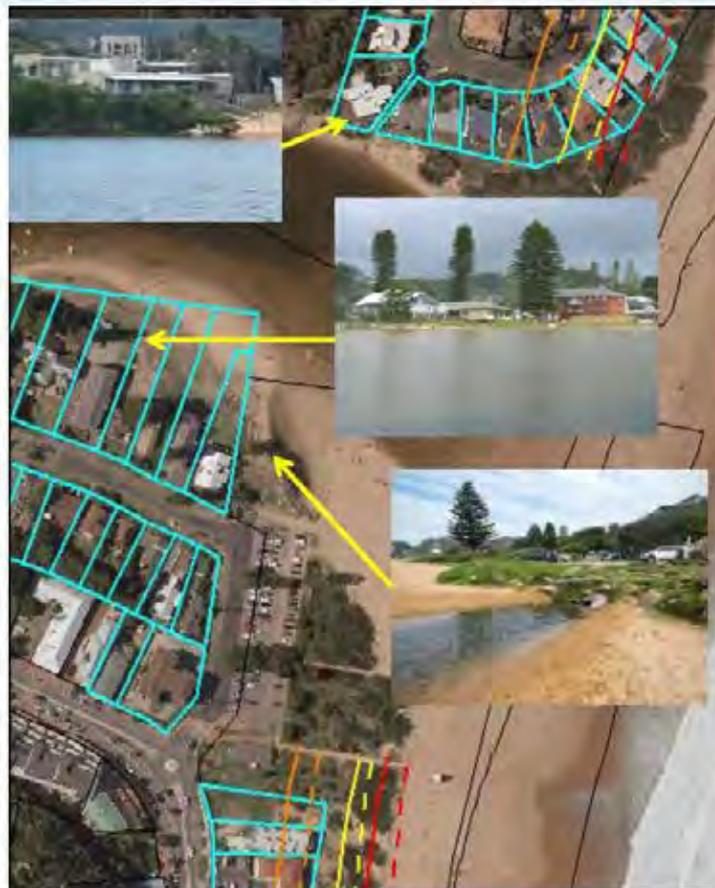
Erosion risk for sewer infrastructure



- **Development controls** Council DCP 2013 6.2 Coastal Frontage;
- Investigate effectiveness of existing **rock protection works** for Surf Club and at southern end of Avoca Lake entrance
- Investigate which properties have existing protection works and establish their effectiveness
- **Beach scraping** to help build up dune and provide cover for roots of Norfolk Pine trees – improve inundation protection
- Investigate relocation of sewer infrastructure

Beach scraping – speeding up the natural rebuilding process

Avoca Beach – Lagoon Entrance (Precinct 3)

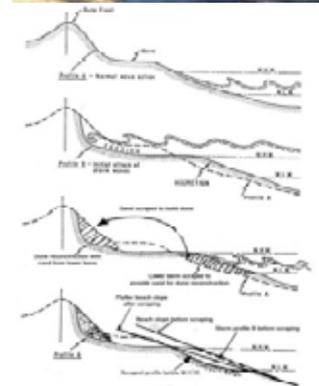


Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future erosion and inundation risk to properties and infrastructures at Avoca Lake Entrance	Development controls for residences to be above inundation levels on redevelopment of properties (A3.1)	Short term
	Review entrance management guidelines for mechanical opening of Avoca Lake (A3.2)	Short term
	Allow lagoon frontage properties to self-protect (A3.3)	Short term

North Avoca Beach – Precinct 4 and 5



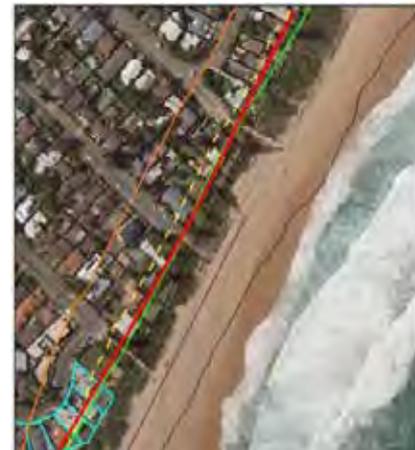
Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)	
Immediate and future risk of erosion risk to properties at North Avoca Beach	Allowing development landward of the 2050 Zone of Slope Adjustment with piled foundations into the 2100 Stable Foundation Zone (A4.1)	Short term	
	Allowing development landward of a specially defined building line with piled foundations into the 2100 Stable Foundation Zone (i.e. similar to existing DCP, status quo, A4.2)	Short term	
	Allowing development landward of the 2100 Zone of Slope Adjustment with piled foundations into the 2100 Stable Foundation Zone (A4.3)	Short term	
	Erosion protection works to be allowed for properties for emergency protection (funded by residents) (A4.4)	Short to medium term, some of these properties already have protection installed	
	Terminal seawall protection for all the properties (A4.5)	Short to medium term	
	Terminal seawall protection for the properties north from the Surf Club only (A4.6)	Short – medium term (0 – 20 years)	
	Beach nourishment to increase erosion buffer in this area (A4.10)	Short term	
	Repair of beach accessways and revegetation of dune following erosion in a large storm event (A4.11)	Short term and following storms as required	
	Immediate and future risk of inundation risk to properties at North Avoca Beach	Development controls for residences to be above inundation levels on redevelopment of properties (A4.12)	Short term
		Scour erosion due to stormwater outlet	Scour protection in front of stormwater outlets (A4.13)
Immediate and future risk of erosion and inundation risk to the North Avoca SLSC and carpark	Repair damage to surf club carpark should storm erosion occur (A4.15)	As required	
	Beach scraping to build vegetated dune in front of surf club and carpark (A4.17)	Short term (0-5 years)	
	Build and maintain a dune in front of surf club above the wave runup level with vegetation and/or fencing (A4.19)	Short term (0-5 years)	
	Redevelop surf club on deep piled foundations (A4.20)	Medium term (5 – 20 years)	
All issues	Emergency Management (A4.21)	As required	



Allow coastal protection works for properties most at risk from coastal erosion?



Management of stormwater scour



- Development controls**
Council DCP 2013 6.2 Coastal Frontage;
- Which hazard line do we adopt for the basis of development controls?
 - Deep pile foundations into Stable Foundation Zone
 - Existing DCP = green line (old 2045 erosion projection)
 - Updated DCP – 2050 Zone of Slope Adjustment?
 - Special building line to be developed

Beach scraping – speeding up the natural dune rebuilding process



WorleyParsons

resources & energy

Open Coast and Broken Bay Beaches

Coastal Zone Management Study Terrigal, Wamberal and Forresters Beach

Chris Adamantidis

9 February 2015

Outline of Presentation

- ▶ Coastal Processes and Hazards at Terrigal, Wamberal and Forresters Beach
- ▶ Coastal management issues and measures at each precinct
- ▶ Overview of Preferred Management Options

Terrigal



Terrigal

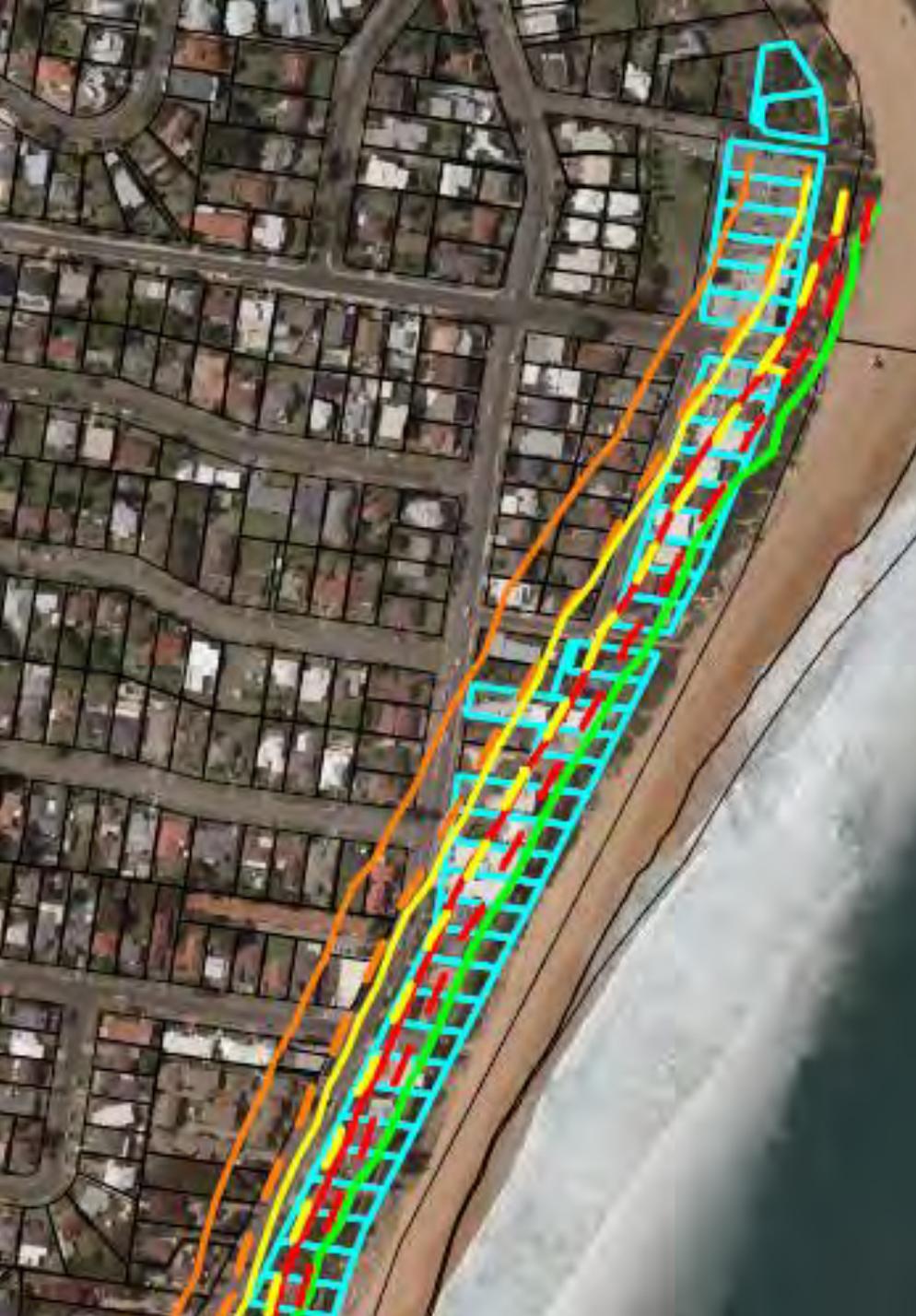
- ▶ Storm erosion demand lower than Wamberal due to sheltering from southerly waves – limited by seawall
- ▶ No long term recession as this is limited by the presence of seawall and adjacent rock bluff
- ▶ Wave runup level 4.0 m AHD – inundation risk to surf club

Wamberal



Wamberal

- ▶ Fully exposed to ocean wave climate
- ▶ Wave runup level 6.0 – 7.0 m AHD
- ▶ Long term recession (measured) 0.2 m/year
- ▶ Sea level rise recession 14.6 m (2050), 36.1 m (2100)
- ▶ Immediate Zone of Slope Adjustment line similar to 1995 Coastal Management Plan 2015 Hazard Line
- ▶ Over 75 oceanfront lots are affected by the Immediate Zone of Slope Adjustment.
- ▶ There is the potential for Ocean View Drive to be impacted by coastal erosion by 2050, with subsequent breakthrough into Terrigal Lagoon possible.
- ▶ All oceanfront lots at Wamberal have been assessed as subject to coastal inundation hazard.



Forrester's Beach



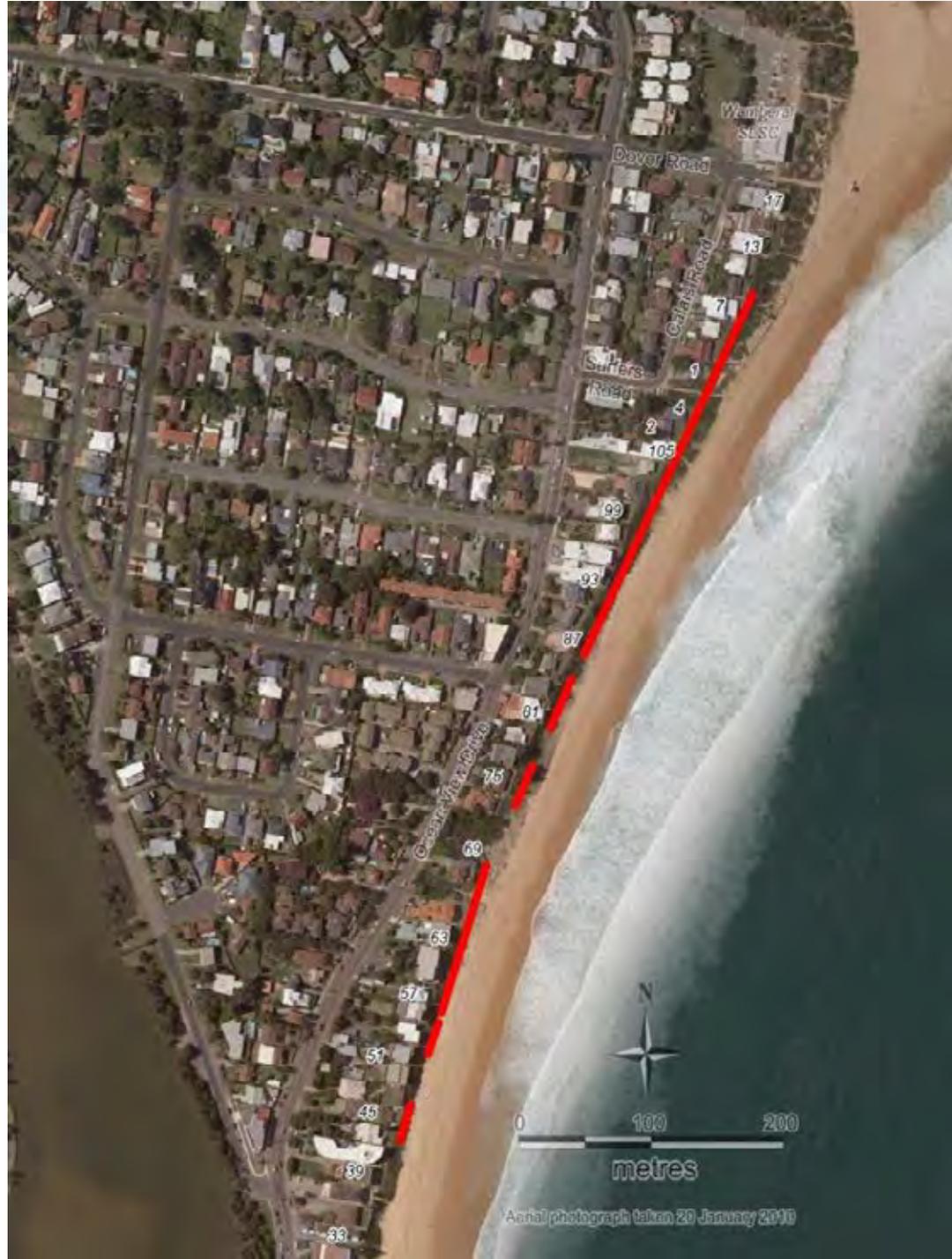
Forresters Beach

- ▶ Relatively exposed open coast beach but partially protected by nearshore reef
- ▶ Beach backed by steep dunes that contain indurated sands and stiff clays within the dune matrix
- ▶ Geotechnical investigation needed to determine location of Zone of Reduced Foundation Capacity – Zone of Slope Adjustment only shown
- ▶ Beach comprises rock reef below -2 m AHD – therefore active beach profile is very steep
- ▶ Sea level rise recession 1.6 m (2050) and 4.0 m (2100)
- ▶ No measured long term recession evident
- ▶ No lots subject to inundation
- ▶ Zone of Reduced Foundation Capacity could not be determined for Forresters Beach due to a lack of geotechnical data.



Notes about hazard mapping

- ▶ Hazard lines represent potential maximum extent of erosion in a design storm event – does not mean that erosion would be uniform back to that line along the whole beach
- ▶ Hazard lines do not take into account presence of rock and protection works under the dunes



Aerial photograph taken 20 January 2010

Terrigal-Wamberal Hazards

- ▶ **Coastal inundation** due to wave runup affecting the Terrigal Surf Club, future impact on the Terrigal commercial zone due to overtopping of existing seawall and beachfront residences along Wamberal Beach;
- ▶ **Coastal erosion** having the potential to impact on the beachfront residences along Wamberal Beach and minor structures such as dune fencing, viewing platform and accessways;
- ▶ **Slope Instability** having the potential to result in reduced foundation capacity for up to 87 lots and services including stormwater, sewer and water along Wamberal Beach, with this number increasing to 126 lots by 2100;
- ▶ **Future coastal erosion** and recession affecting up to 100 m length of Calais Road, 500 m length Ocean View Drive and 200 m length of Pacific Street by 2100, as well as dwellings, services including stormwater, sewer, water and power along the roads; and
- ▶ **Erosion associated with estuary entrance instability** at Terrigal and Wamberal Lagoon.

Coastal Management Issues at Terrigal-Wamberal



Figure 1: Stepped sandstone block seawall along the southern section of Terrigal Beach (left) and block seawall and promenade along the central section of Terrigal Beach (right)



Figure 2: Rock gabion and terracotta pipes (left) and concrete retaining walls (right) constructed in front of properties

Coastal Management Issues at Forrester's Beach



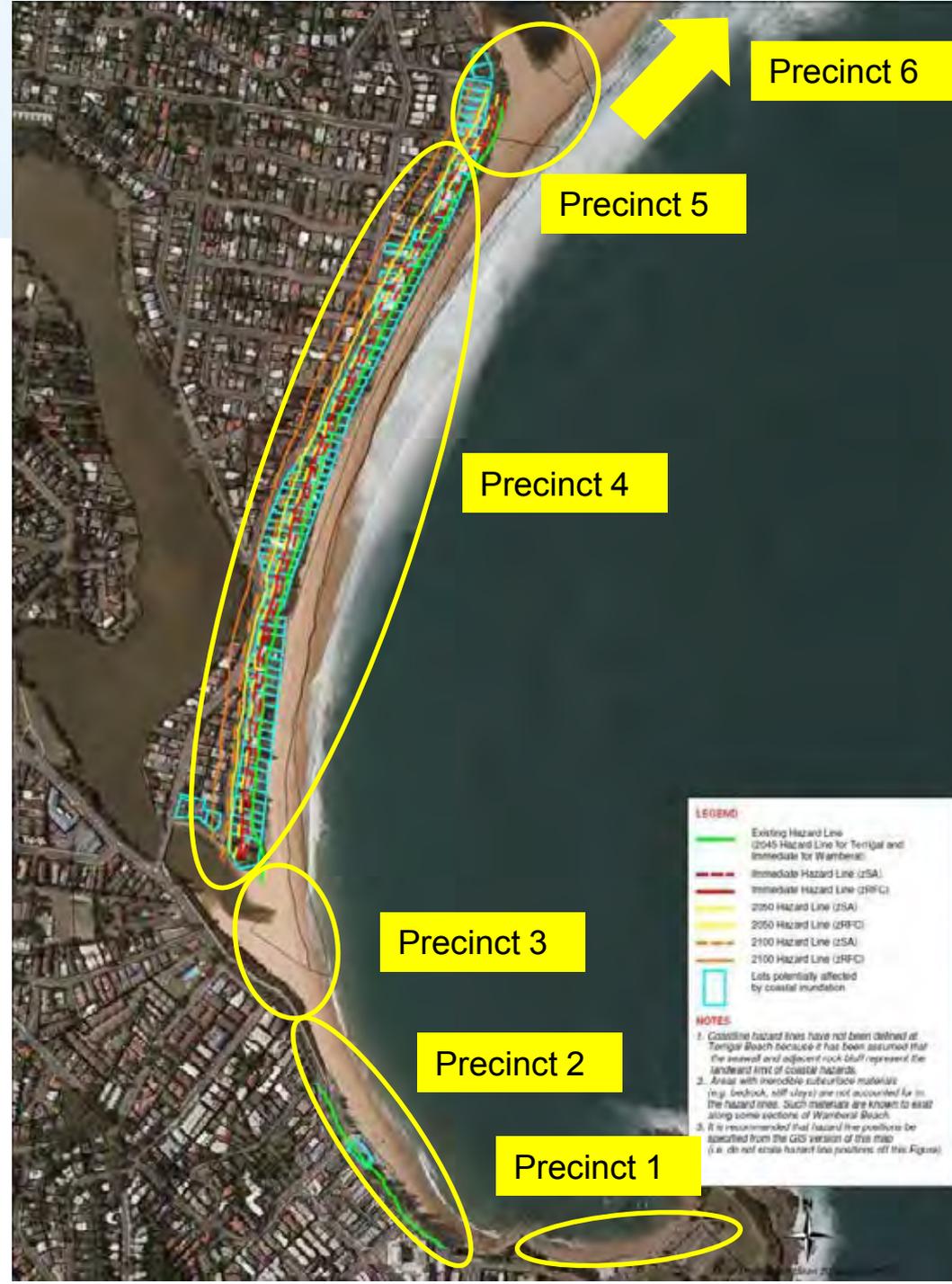
Figure 1: Well-vegetated dune along the back of Forrester's Beach. Properties located at the top of a high and steep embankment along the southern section of the beach (left) and at the top of a relatively lower embankment along the central section of the beach (right).



Figure 2: Piled stormwater outlet (left) replaced with a stormwater outlet within the dune system and a concrete apron in front of a stormwater outlet (right)

Beach Precincts

- ▶ **Precinct 1** – Terrigal Haven
- ▶ **Precinct 2** – Terrigal Beach;
- ▶ **Precinct 3** – Terrigal Lagoon to Wamberal Beach;
- ▶ **Precinct 4** – Wamberal Beach;
- ▶ **Precinct 5** – Wamberal Lagoon; and
- ▶ **Precinct 6** – North Wamberal Beach.



Specific Options for Terrigal Beach

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Beach erosion/inundation impacting on recreational amenity	Monitor performance of existing seawall in addressing erosion and inundation (TW1.1)	Short term, ongoing
	Monitor beach profile following significant storm events (TW1.2)	Short term, ongoing
	Beach nourishment to increase buffer against storm erosion (TW1.3)	Medium term
Immediate and future inundation risk to Terrigal Surf Life Saving Club and Terrigal commercial district	Survey floor levels to determine degree of inundation hazard (TW2.1)	Short term
	Monitor performance of existing seawall against erosion and inundation (TW2.2)	Short term/as required
Immediate and future erosion and inundation risk to properties north of the Terrigal Lagoon entrance	Review entrance management guidelines for mechanical opening of Terrigal Lagoon (TW3.1)	Short term
	Allow lagoon frontage properties at southern end of Pacific Street to self-protect (TW3.2)	Short term
	Beach scraping from lagoon entrance to reduce erosion and inundation risk to properties at southern end of Pacific Street (TW3.3)	Short term

Terrigal Beach

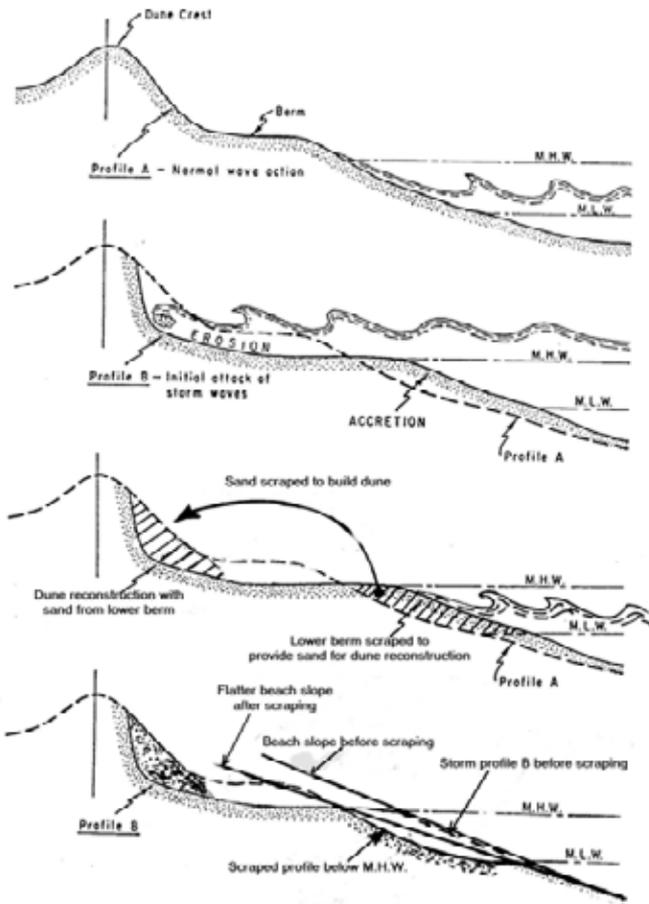


Terrigal Lagoon



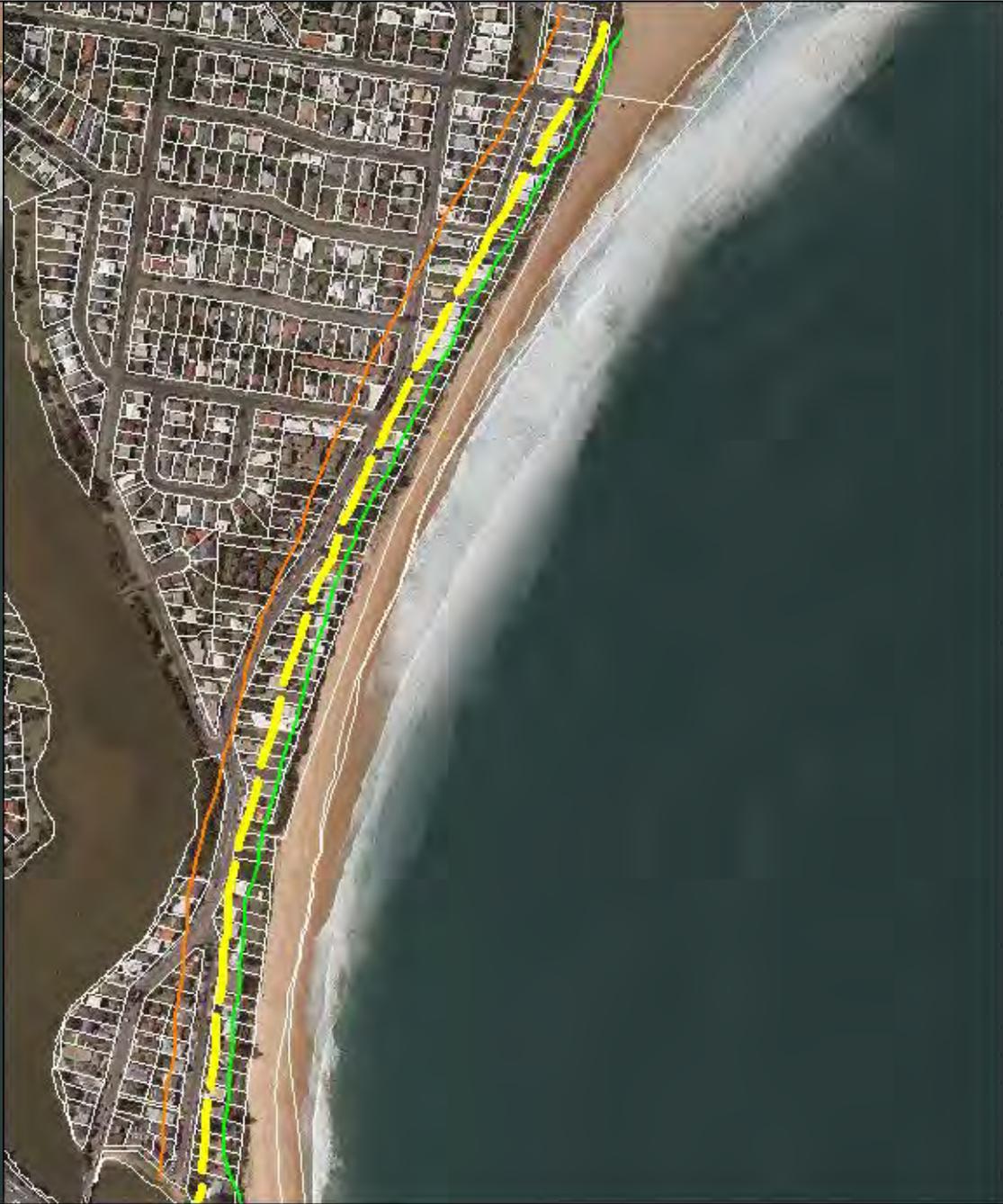
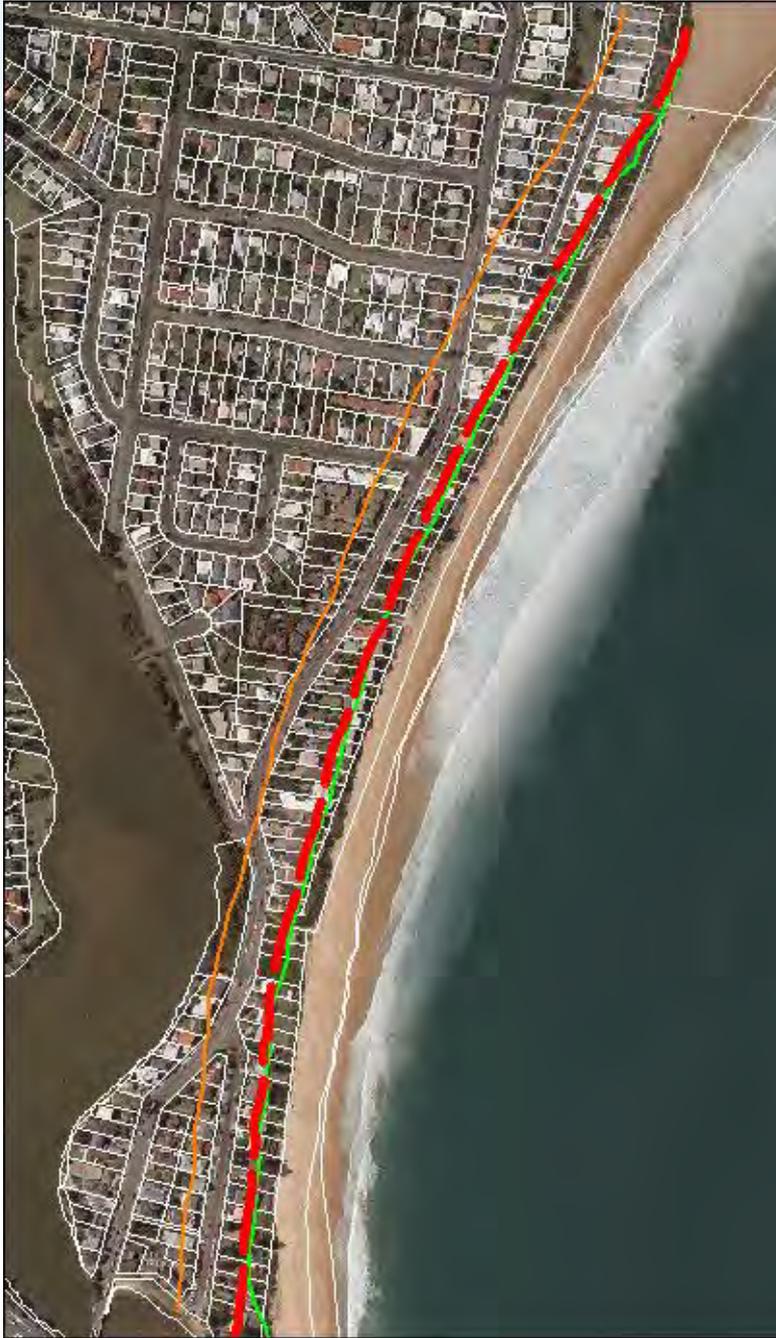
Beach scraping

- ▶ Speeding up the natural dune rebuilding process
- ▶ Increase local level of dune



Options for Wamberal Beach

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future erosion and inundation risk to properties and infrastructures along Wamberal Beach	Allowing development landward of the 2050 Zone of Slope Adjustment with piled foundations into the 2100 Stable Foundation Zone (TW4.1)	Short term
	Allowing development landward of a specially defined building line or Immediate Zone of Slope Adjustment with piled foundations into the 2100 Stable Foundation Zone (TW4.2)	Short term
	Allowing development as per existing DCP (i.e. 3 m or 7 m landward of revetment line depending on location) with piled foundations (i.e. status quo) (TW4.3)	Short term
	Allow residents to construct own permanent protection works combined with existing DCP controls (TW4.4)	Short term, ongoing
	Terminal protection (TW4.5)	Short –medium term
	Continue dune vegetation management (TW4.8)	Ongoing
	Beach nourishment to increase buffer against storm erosion (TW4.9)	Short term
Immediate and future erosion and inundation risk to properties south of the Wamberal Lagoon entrance	Review entrance management guidelines for mechanical opening of Wamberal Lagoon (TW5.1)	Short term
Future erosion and immediate inundation risk to Wamberal Surf Life Saving Club	Repair damage to surf club carpark should storm erosion occur (TW5.2)	As required
	Beach scraping to build vegetated dune in front of carpark (TW5.4)	Short term (0-5 years)
	Redevelop surf club on deep piled foundations (TW5.6)	Medium term (5 – 20 years)
All issues	Emergency Management (TW5.7)	As required





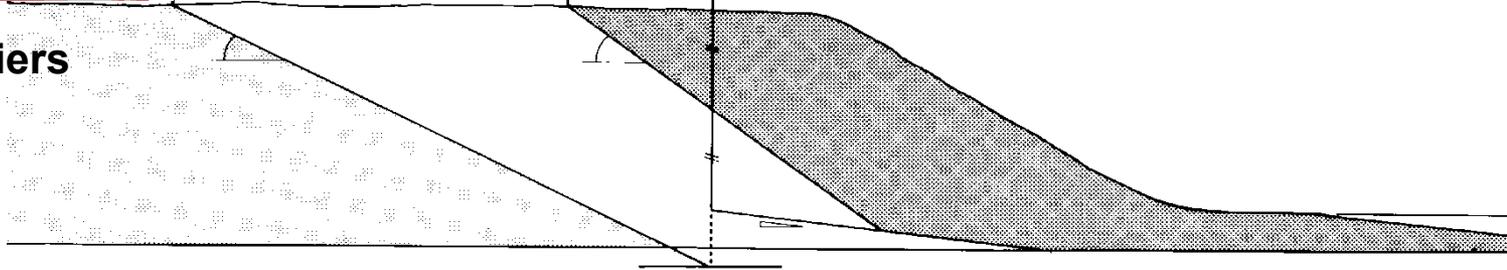
Stable Foundation Zone

Zone of Reduced Foundation Capacity

Zone of Wave Impact & Slope Adjustment



Slab on ground, piers



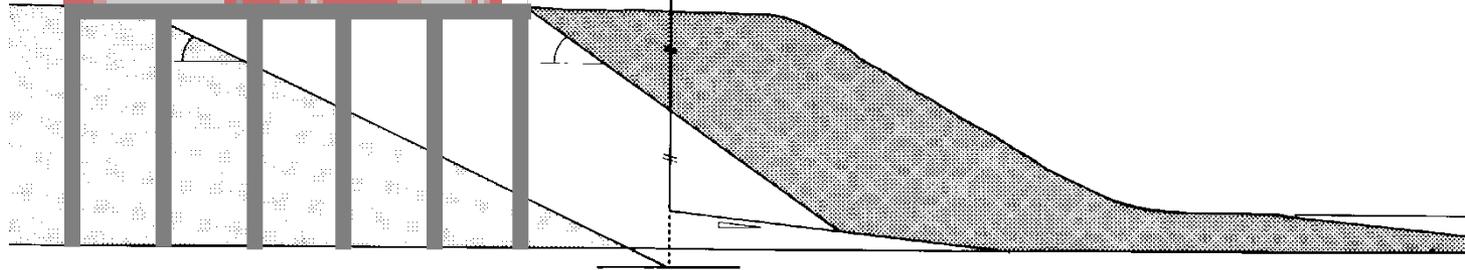
Stable Foundation Zone

Zone of Reduced Foundation Capacity

Zone of Wave Impact & Slope Adjustment



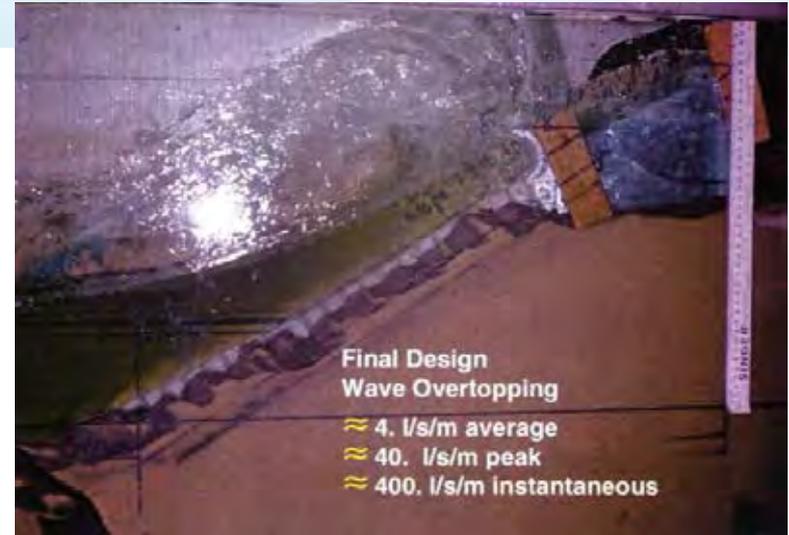
Piling Founded into Stable Foundation Zone



Buildings piled into stable foundation zone

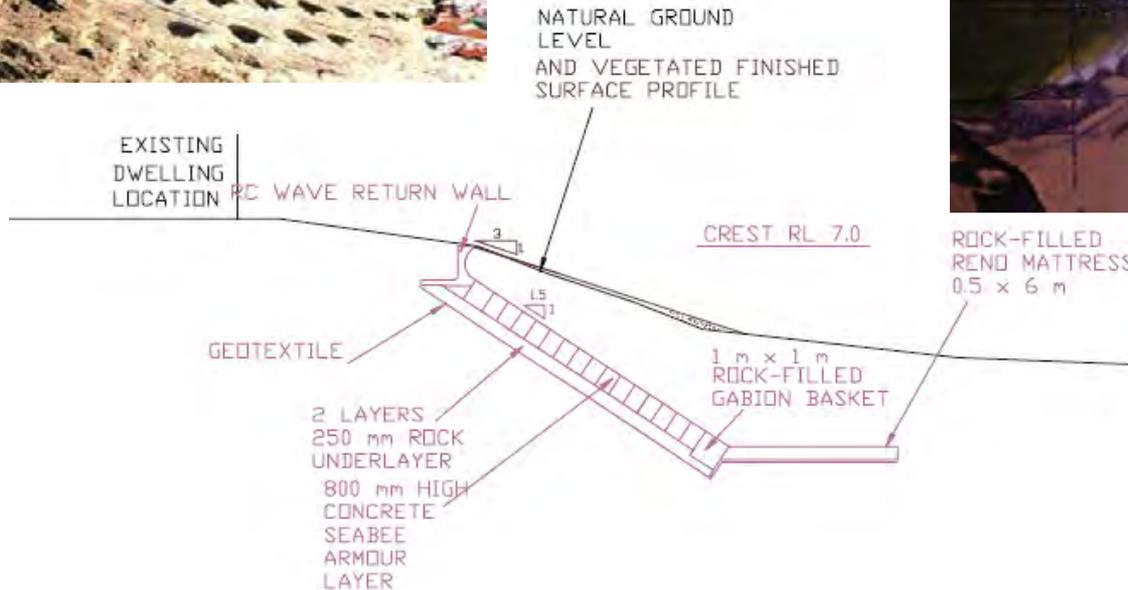


Wamberal TPS



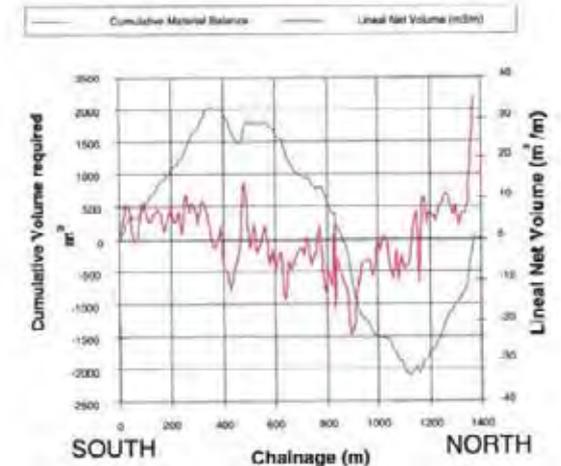
**Final Design
Wave Overtopping**

- ≈ 4. l/s/m average
- ≈ 40. l/s/m peak
- ≈ 400. l/s/m instantaneous



To maintain the beach amenity seaward of the terminal protection structure it will be necessary to undertake periodic beach nourishment. This periodic maintenance nourishment forms a part of this proposal.

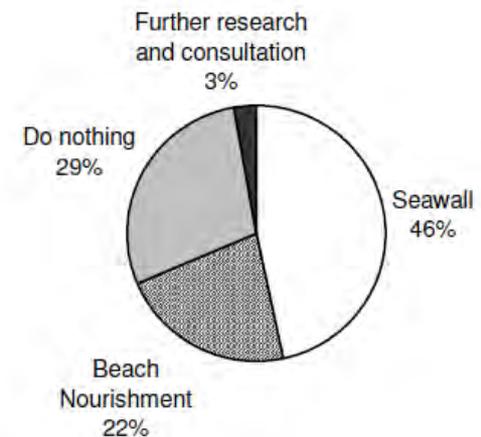
The project should provide for sufficient sand to support the revetment through its desired life span against the forces of storms, changes due to sea level rise and the natural losses from ongoing erosion.



Wamberal TPS

- ▶ Existing TCP allows building up to 3 m landward of proposed revetment – in some cases this is in the Immediate Zone of Slope Adjustment
- ▶ Design Study 1998 (WRL), EIS 2003 (MHL)
- ▶ Council has unsuccessfully attempted to secure funding from State and Federal Government and through the Coastal Management Program and Federal Natural Disaster Mitigation program
- ▶ Strategy Policy Paper (2004) recommended that the TPS be adopted as the preferred strategy for Wamberal
- ▶ Research study (Beavis et al 2009) – TPS is most viable option and preferred by community but funding yet to be secured

Community Preferences for beach protection at Wamberal



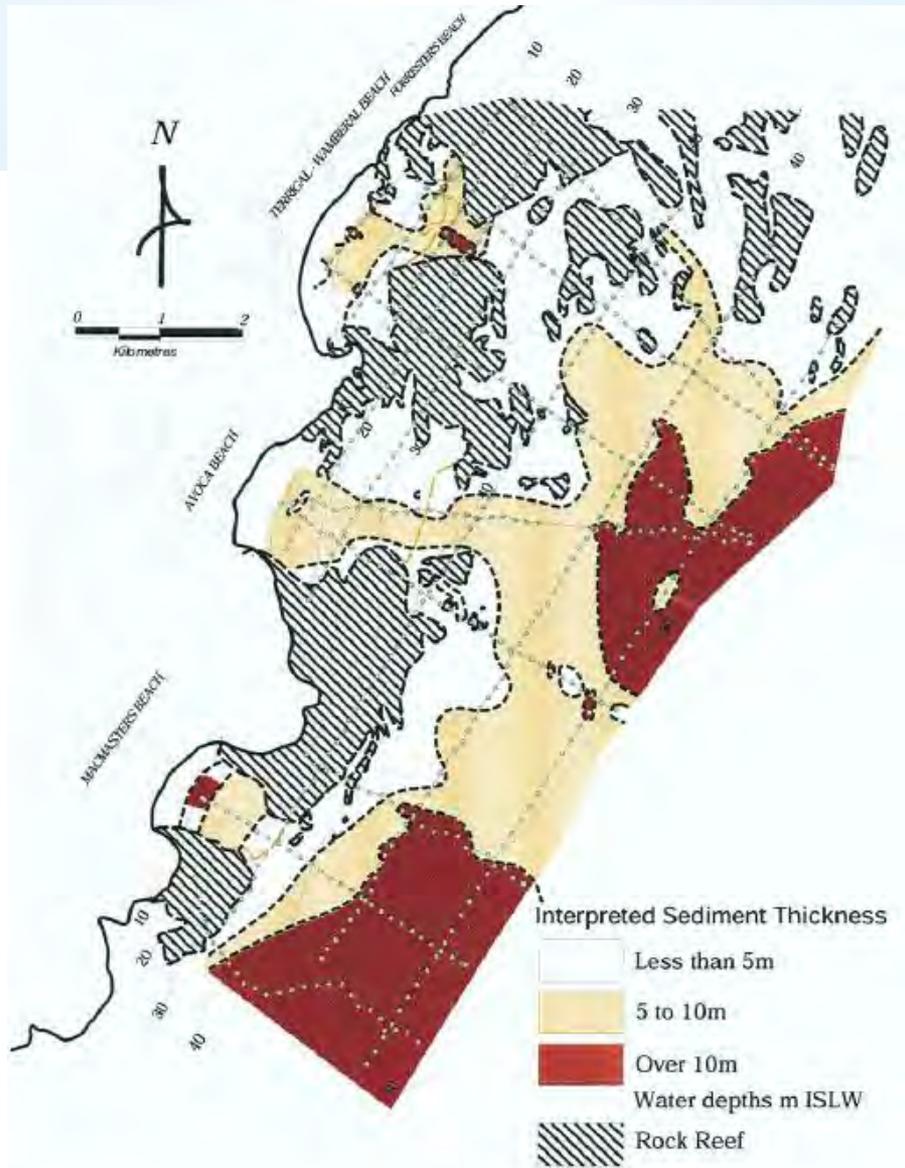
Wamberal TPS – Funding Options

- ▶ Total cost is around \$200k per property
- ▶ Part funding by NSW Govt. Council and residents?
Funding could apportion the costs to the parties that would benefit the most – e.g. through levies on Council rates?
- ▶ Phasing the project – constructing in stages?
- ▶ Publicly accessible easement at top of TPS to secure access along the beach and provide access for construction and TPS maintenance – works would then be partly on public land, some public benefit from improved beach access
- ▶ Financial mechanisms are being explored in the NSW Stage 2 Coastal Reforms

Beach Nourishment

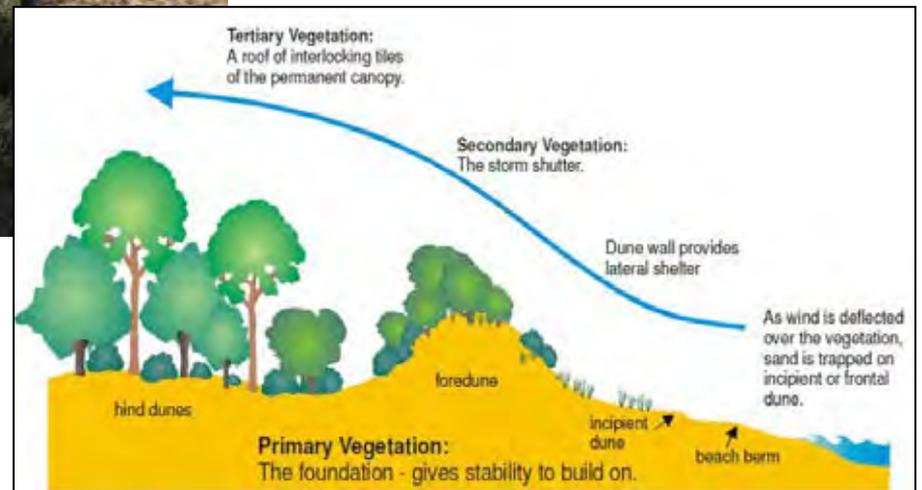
**Table 3.16 Terrigal Beach Nourishment Requirements
Assuming Delay in Wall Construction**

Time until Seawall Construction (years)	Initial Nourishment Volume required (m³)
10	1, 765,000
20	1, 114,000
30	1, 216,000
40	1, 318,000
50	3, 063,000



- ▶ Offshore deposits (not currently accessible due to legislation)
- ▶ Swansea Channel
- ▶ Stockton Dunes

Dune vegetation



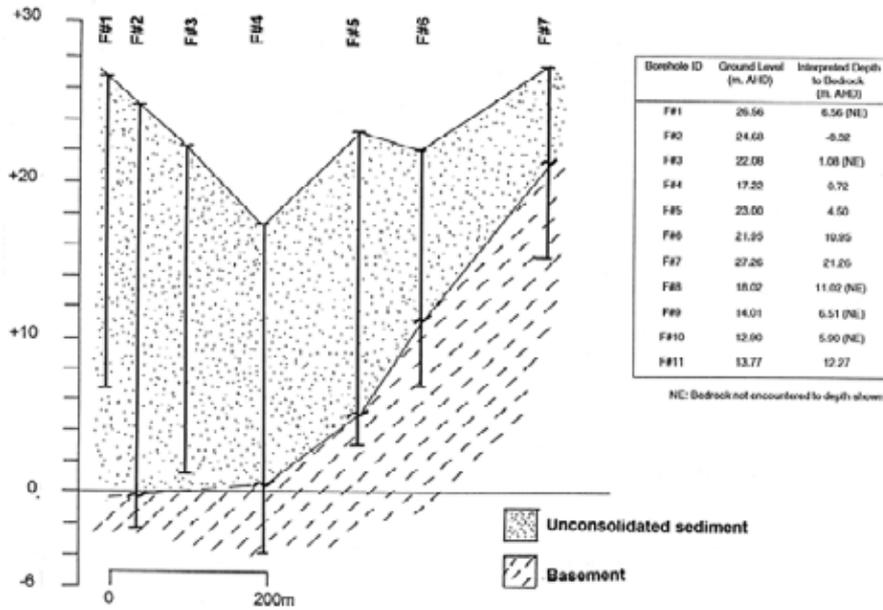
Options which are off the table

- ▶ Planned retreat
- ▶ Compulsory or voluntary purchase of private property – high monetary and social cost.
- ▶ Relocation of the surf club or protection works of surf club in isolation

Forresters Beach

Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate risk of erosion damage to properties and minor structures	Geotechnical investigation to determine the Zone of Reduced Foundation Capacity (F1)	Short term
	Development controls – status quo (F2)	Short term
	Erosion protection works (F3)	Short term
	Placement of sand to provide buffer against storm erosion (F4)	Medium term
	Continue dune vegetation management (F5)	Ongoing
All issues	Emergency Management (F6)	As required
	Monitor beach for erosion and cliff lines for instability (F7)	Short term, ongoing

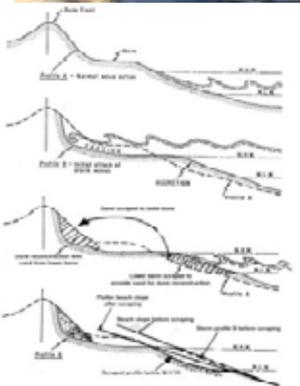
Forresters Beach



Terrigal Beach – Precincts 1, 2 and 3



Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Beach erosion/inundation impacting on recreational amenity	Monitor performance of existing seawall in addressing erosion and inundation (TW1.1)	Short term, ongoing
	Monitor beach profile following significant storm events (TW1.2)	Short term, ongoing
	Beach nourishment to increase buffer against storm erosion (TW1.3)	Medium term
Immediate and future inundation risk to Terrigal Surf Life Saving Club and Terrigal commercial district	Survey floor levels to determine degree of inundation hazard (TW2.1)	Short term
	Monitor performance of existing seawall against erosion and inundation (TW2.2)	Short term/as required
Immediate and future erosion and inundation risk to properties north of the Terrigal Lagoon entrance	Review entrance management guidelines for mechanical opening of Terrigal Lagoon (TW3.1)	Short term
	Allow lagoon frontage properties at southern end of Pacific Street to self-protect (TW3.2)	Short term
	Beach scraping from lagoon entrance to reduce erosion and inundation risk to properties at southern end of Pacific Street (TW3.3)	Short term



Beach scraping – speeding up the natural dune rebuilding process



Monitor existing seawalls at Terrigal Haven and Terrigal Beach



Accumulated seagrass wrack at Terrigal Beach

Beach amenity impacts of stormwater management

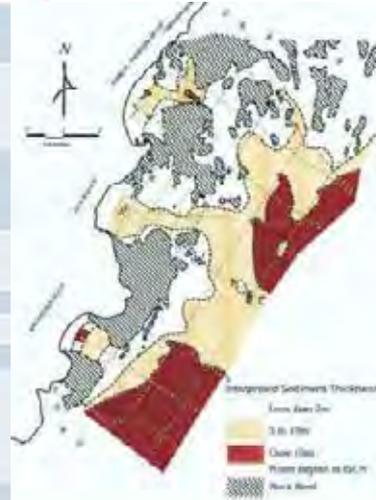


Management of Terrigal Lagoon entrance

Wamberal Beach – Precincts 4, 5 and 6



Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate and future erosion and inundation risk to properties and infrastructures along Wamberal Beach	Allowing development landward of the 2050 Zone of Slope Adjustment with piled foundations into the 2100 Stable Foundation Zone (TW4.1)	Short term
	Allowing development landward of a specially defined building line or Immediate Zone of Slope Adjustment with piled foundations into the 2100 Stable Foundation Zone (TW4.2)	Short term
	Allowing development as per existing DCP (i.e. 3 m or 7 m landward of revetment line depending on location) with piled foundations (i.e. status quo) (TW4.3)	Short term
	Allow residents to construct own permanent protection works combined with existing DCP controls (TW4.4)	Short term, ongoing
	Terminal protection (TW4.5)	Short-medium term
	Continue dune vegetation management (TW4.8)	Ongoing
Immediate and future erosion and inundation risk to properties south of the Wamberal Lagoon entrance	Beach nourishment to increase buffer against storm erosion (TW4.9)	Short term
	Review entrance management guidelines for mechanical opening of Wamberal Lagoon (TW5.1)	Short term
Future erosion and immediate inundation risk to Wamberal Surf Life Saving Club	Repair damage to surf club carpark should storm erosion occur (TW5.2)	As required
	Beach scraping to build vegetated dune in front of carpark (TW5.4)	Short term (0-5 years)
	Redevelop surf club on deep piled foundations (TW5.6)	Medium term (5 – 20 years)
	All Issues	Emergency Management (TW5.7)



Offshore sand deposits for beach nourishment – not currently accessible due to legislation

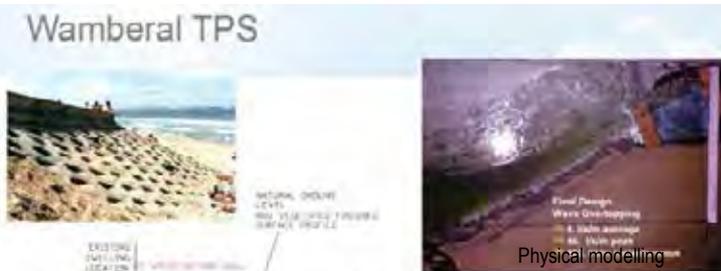
Table 3.16 Terrigal Beach Nourishment Requirements Assuming Delay in Wall Construction

Time until Seawall Construction (years)	Initial Nourishment Volume required (m ³)
10	1,765,000
20	1,114,000
30	1,216,000
40	1,318,000
50	3,063,000

Gosford Stage 2 Beach Nourishment Feasibility Study



Ad-hoc coastal protection works



(extract from Wamberal TPS, MHL 2003)

Balance of excavation cut and fill

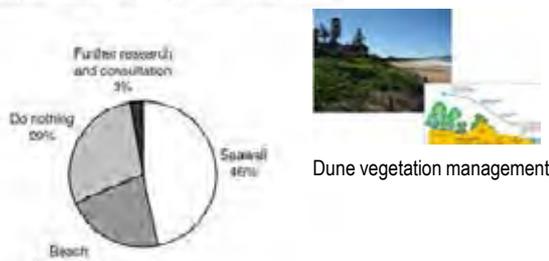


North Steyne Surf Club, Manly (1960s) – piling to withstand slope adjustment and reduced foundation capacity



Piling into Stable Foundation Zone – Gosford DCP

Community Preferences for beach protection at Wamberal



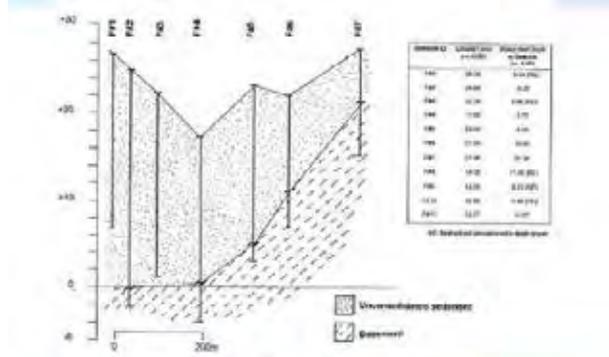
Source: Beavis et al. (2009)

Dune vegetation management

Forresters Beach



Hazard/Issue Addressed	Management Option	Timetable for adoption (short, medium, long term)
Immediate risk of erosion damage to properties and minor structures	Geotechnical investigation to determine the Zone of Reduced Foundation Capacity (F1)	Short term
	Development controls – status quo (F2)	Short term
	Erosion protection works (F3)	Short term
	Placement of sand to provide buffer against storm erosion (F4)	Medium term
	Continue dune vegetation management (F5)	Ongoing
All issues	Emergency Management (F6)	As required
	Monitor beach for erosion and cliff lines for instability (F7)	Short term, ongoing



Geotechnical investigation needed to establish Zone of Reduced Foundation Capacity

Stormwater runoff management



- Dune vegetation management
- Slope stability/cliff instability hazard



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COASTAL ZONE MANAGEMENT PLAN**

Appendix 5 Mapping of CZMP actions and beach access arrangements



DATE 24/07/15

0 50 100 metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Patonga Beach South Coastal Zone Management Plan Management Actions

PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

CREATED BY C. Adamantidis

LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces





DATE 24/07/15

0 50 100
metres

COORDINATE SYSTEM MGA Zone 56

PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

FIGURE TITLE Patonga Beach North Coastal Zone Management Plan Management Actions

CREATED BY C. Adamantidis

LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces






LEGEND

- Sewer infrastructure
- Water infrastructure
- Stormwater infrastructure
- Coastal protection structure
- Dune vegetation area
- Sand placement area

DATE 24/07/15 0 25 50 **COORDINATE SYSTEM** MGA Zone 56



FIGURE TITLE Pearl Beach South Coastal Zone Management Plan Management Actions

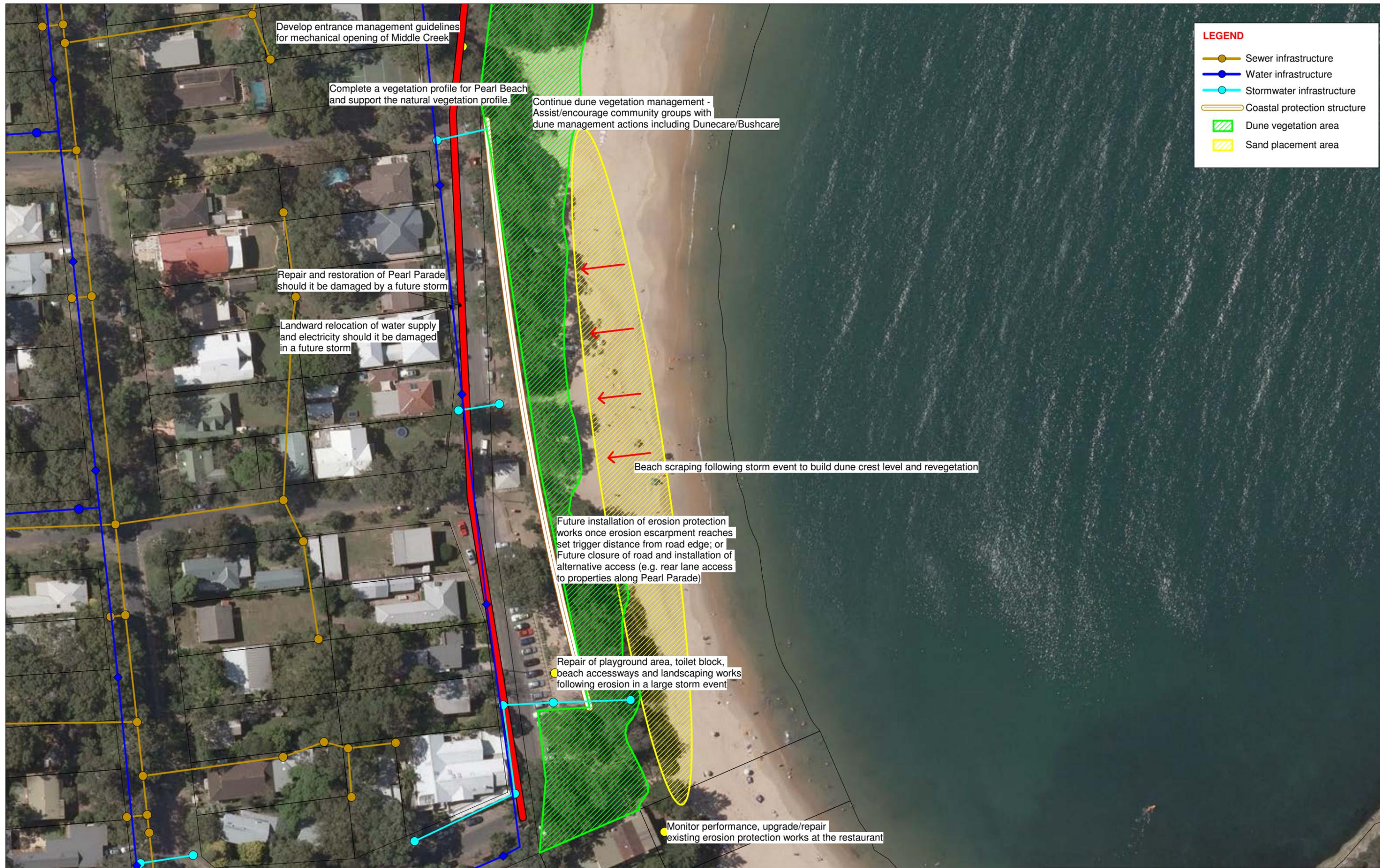
PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

CREATED BY C. Adamantidis

LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces





DATE 24/07/15

0 25 50 metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Pearl Beach South-central Coastal Zone Management Plan Management Actions

PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

CREATED BY C. Adamantidis

LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces





LEGEND

- Sewer infrastructure
- Water infrastructure
- Stormwater infrastructure
- Coastal protection structure
- Dune vegetation area
- Sand placement area

DATE 10/08/15

0 50 100
metres

COORDINATE SYSTEM MGA Zone 56

PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

FIGURE TITLE Pearl Beach North Coastal Zone Management Plan Management Actions

CREATED BY C. Adamantidis

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CENTRAL COAST



DATE 10/08/15 COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Umina Beach South Coastal Zone Management Plan Management Actions

PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

CREATED BY C. Adamantidis

LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces





LEGEND

- Sewer infrastructure
- Water infrastructure
- Stormwater infrastructure
- Coastal protection structure
- Dune vegetation area
- Sand placement area
- Beach access

DATE 10/08/15

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Umina Beach Precinct 2 Coastal Zone Management Plan Management Actions

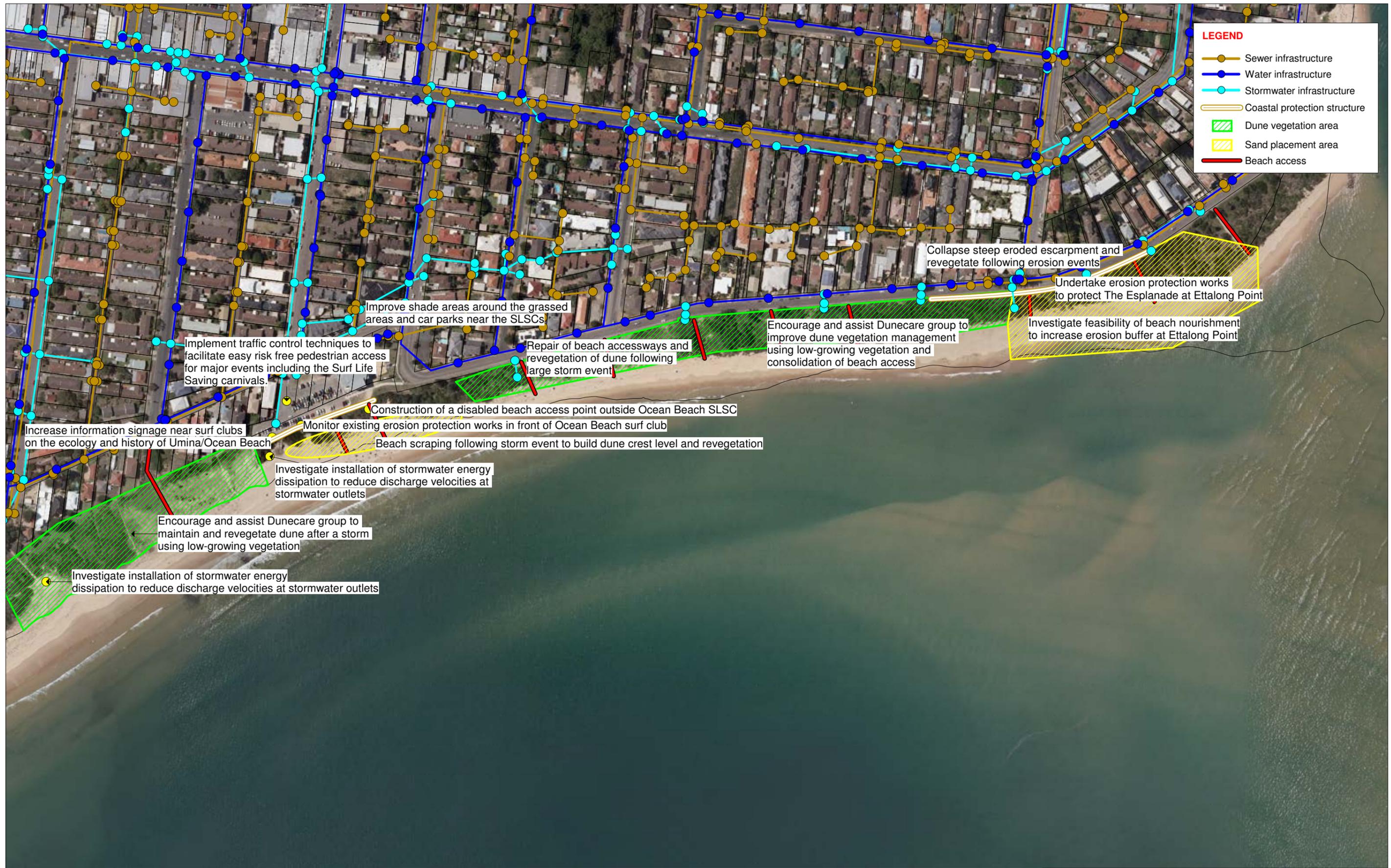
PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

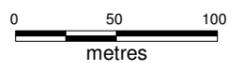
CREATED BY C. Adamantidis

LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces





DATE 10/08/15



COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Ocean Beach Coastal Zone Management Plan Management Actions

PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

CREATED BY C. Adamantidis

LOCATION W:\Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces





DATE 10/08/15

0 50 100 metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Putty Beach-Killcare Coastal Zone Management Plan Management Actions

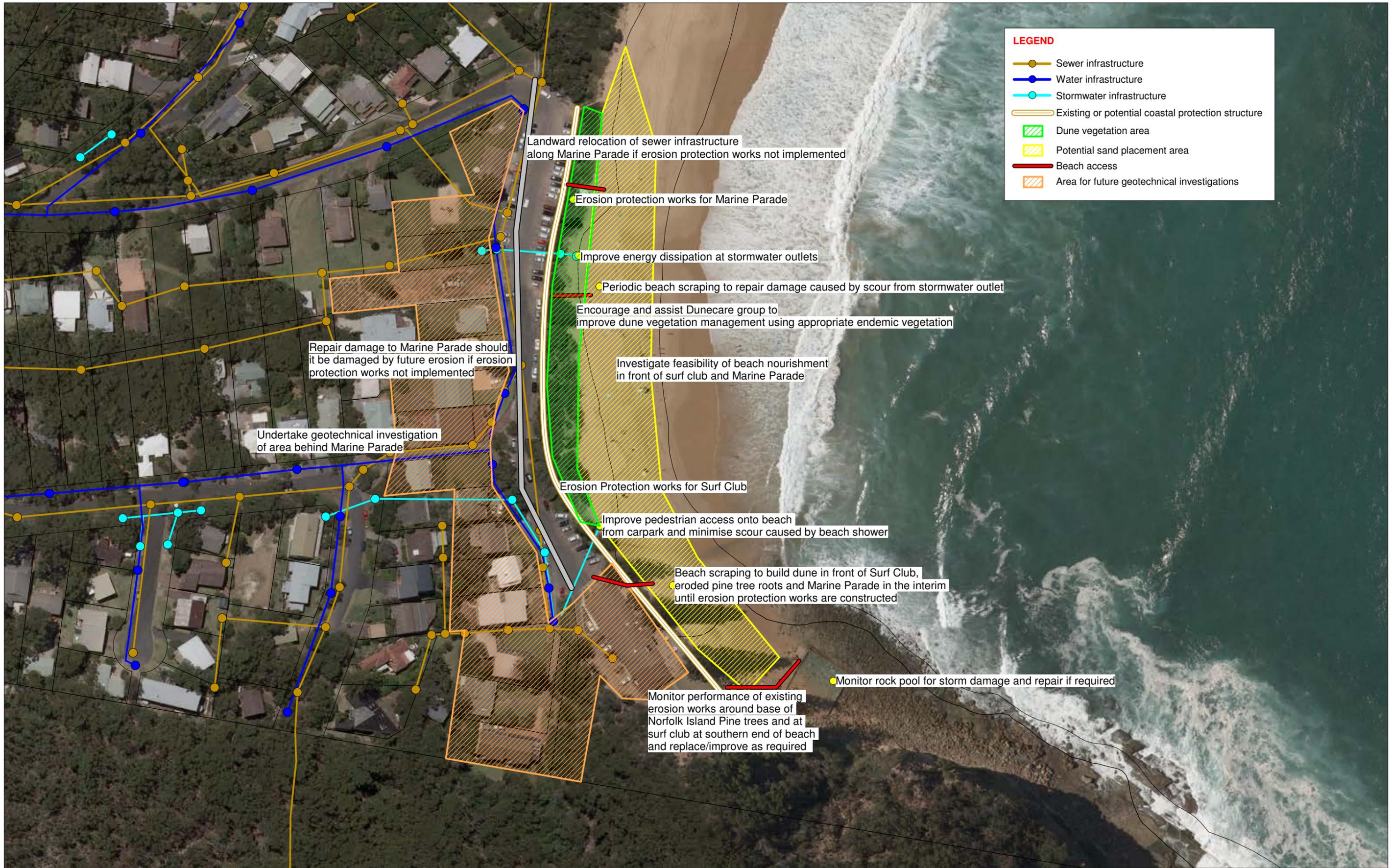
PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

CREATED BY C. Adamantidis

LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces





DATE 10/08/15

0 25 50
metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE MacMasters Beach (south) Coastal Zone Management Plan Management Actions

PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

CREATED BY C. Adamantidis

LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces





LEGEND

- Sewer infrastructure
- Water infrastructure
- Stormwater infrastructure
- Existing or potential coastal protection structure
- Dune vegetation area
- Potential sand placement area
- Beach access
- Area for future geotechnical investigations

Undertake review of entrance management procedure as recommended by Gosford Coastal Lagoons CZMP. Implement management actions as required

Seaward extension of existing training wall along southern side of entrance

Encourage and assist Dunecare group and local residents to maintain and revegetate dune

Not allowing further subdivision of properties on seaward side of Tudibaring Parade

Investigate feasibility of beach nourishment to increase erosion buffer in this area

Geotechnical investigation and stability of cliff between 45 and 65 Tudibaring Parade

DATE 10/08/15
 0 50 100
 metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE MacMasters Beach (north) Coastal Zone Management Plan Management Actions

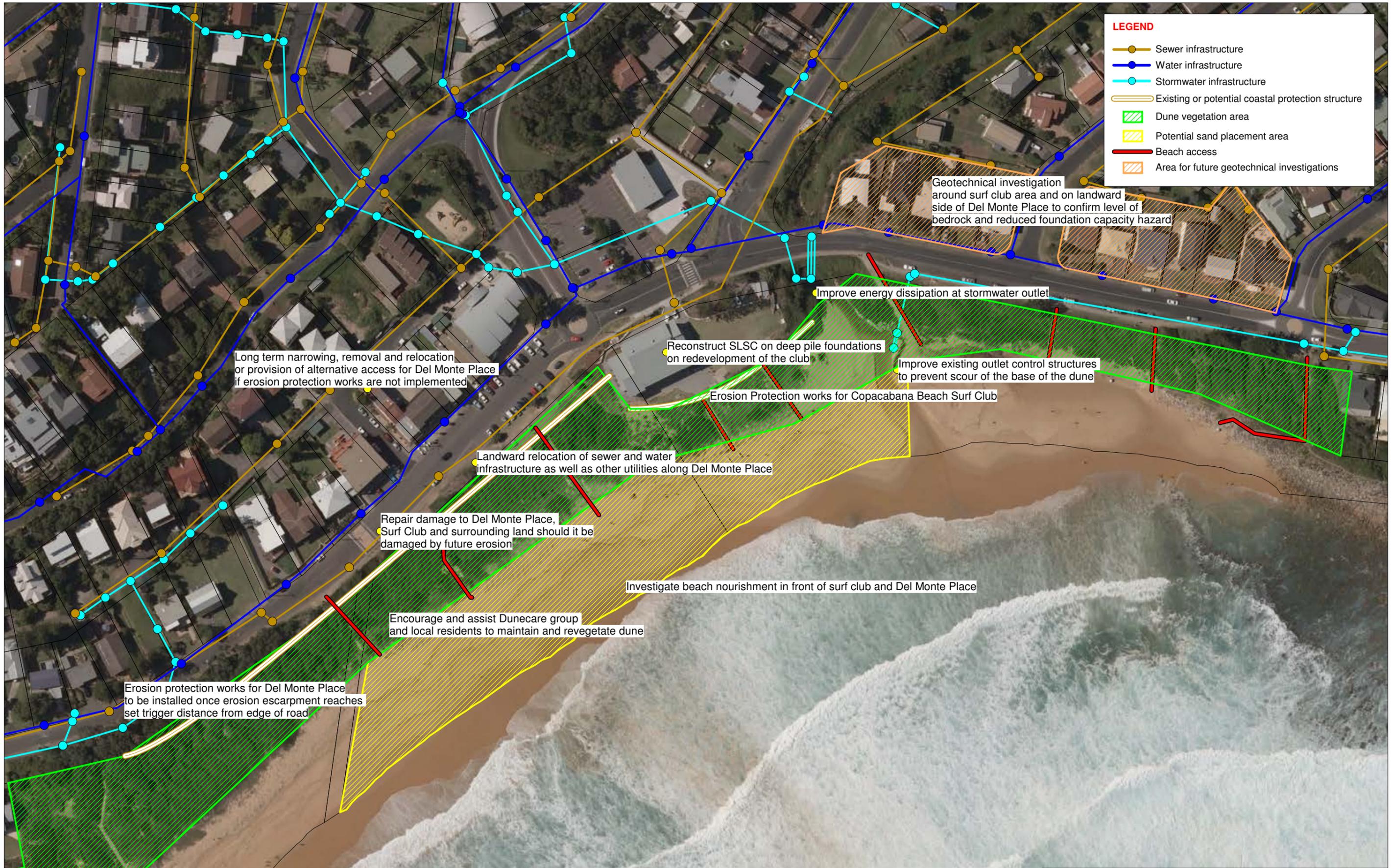
PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

CREATED BY C. Adamantidis

LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces





LEGEND

- Sewer infrastructure
- Water infrastructure
- Stormwater infrastructure
- Existing or potential coastal protection structure
- Dune vegetation area
- Potential sand placement area
- Beach access
- Area for future geotechnical investigations

Long term narrowing, removal and relocation or provision of alternative access for Del Monte Place if erosion protection works are not implemented

Reconstruct SLSC on deep pile foundations on redevelopment of the club

Improve existing outlet control structures to prevent scour of the base of the dune

Erosion Protection works for Copacabana Beach Surf Club

Landward relocation of sewer and water infrastructure as well as other utilities along Del Monte Place

Repair damage to Del Monte Place, Surf Club and surrounding land should it be damaged by future erosion

Investigate beach nourishment in front of surf club and Del Monte Place

Encourage and assist Dunecare group and local residents to maintain and revegetate dune

Erosion protection works for Del Monte Place to be installed once erosion escarpment reaches set trigger distance from edge of road

Geotechnical investigation around surf club area and on landward side of Del Monte Place to confirm level of bedrock and reduced foundation capacity hazard

Improve energy dissipation at stormwater outlet

DATE 10/08/15 0 25 50 metres **COORDINATE SYSTEM** MGA Zone 56

FIGURE TITLE Copacabana Coastal Zone Management Plan Management Actions

PROJECT NO. 301015-03417 **PROJECT TITLE** Open Coast and Broken Bay Beaches Coastal Zone Management Plan

CREATED BY C. Adamantidis

LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces





LEGEND

- Sewer infrastructure
- Water infrastructure
- Stormwater infrastructure
- Existing or potential coastal protection structure
- Dune vegetation area
- Potential sand placement area
- Beach access
- Area for floor level survey

DATE 10/08/15 0 25 50 metres **COORDINATE SYSTEM** MGA Zone 56

FIGURE TITLE Avoca (south) Coastal Zone Management Plan Management Actions

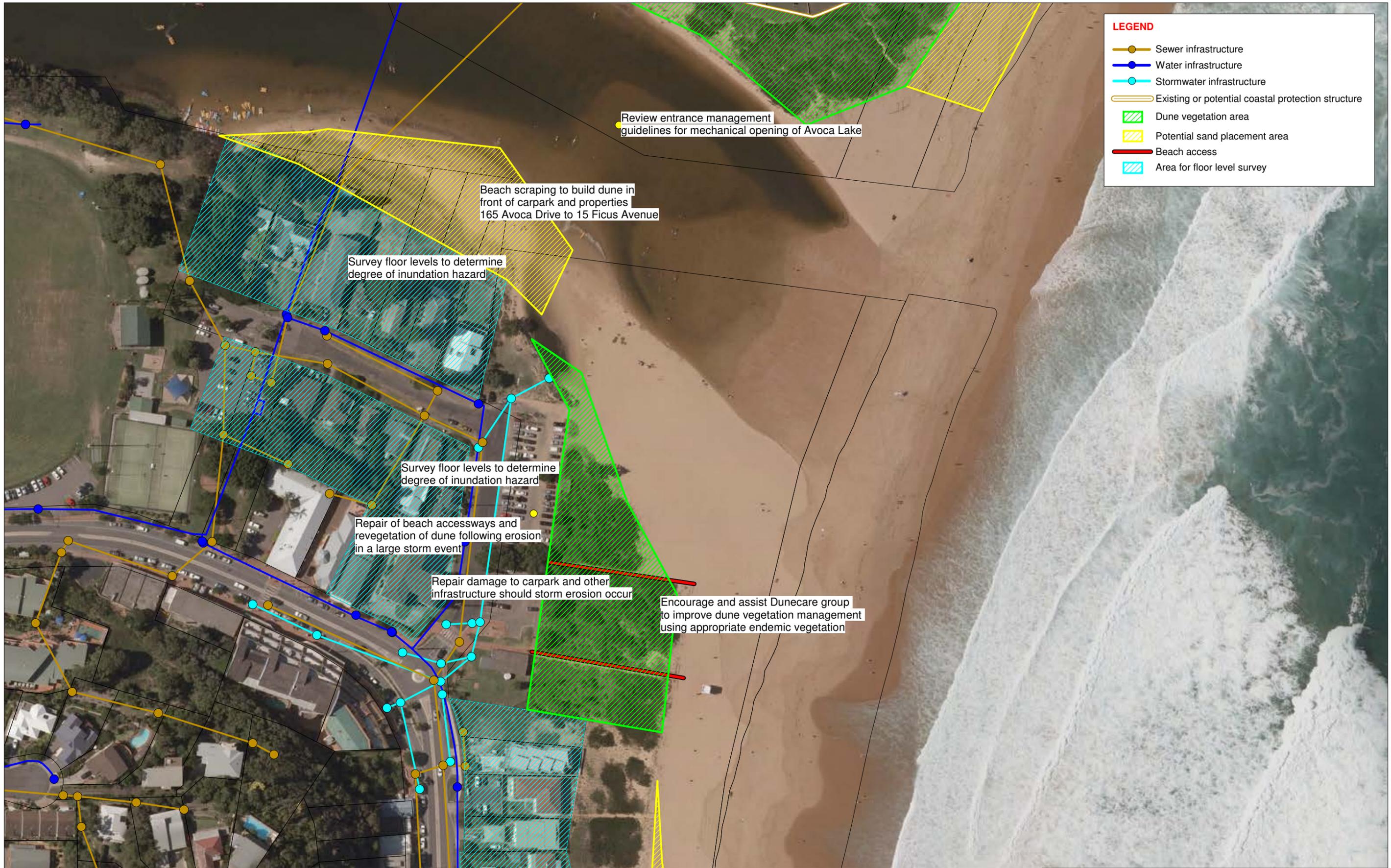
PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

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LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces





DATE 10/08/15

0 25 50
metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Avoca (lake entrance area) Coastal Zone Management Plan Management Actions

PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

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DATE 10/08/15

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metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE North Avoca Coastal Zone Management Plan Management Actions

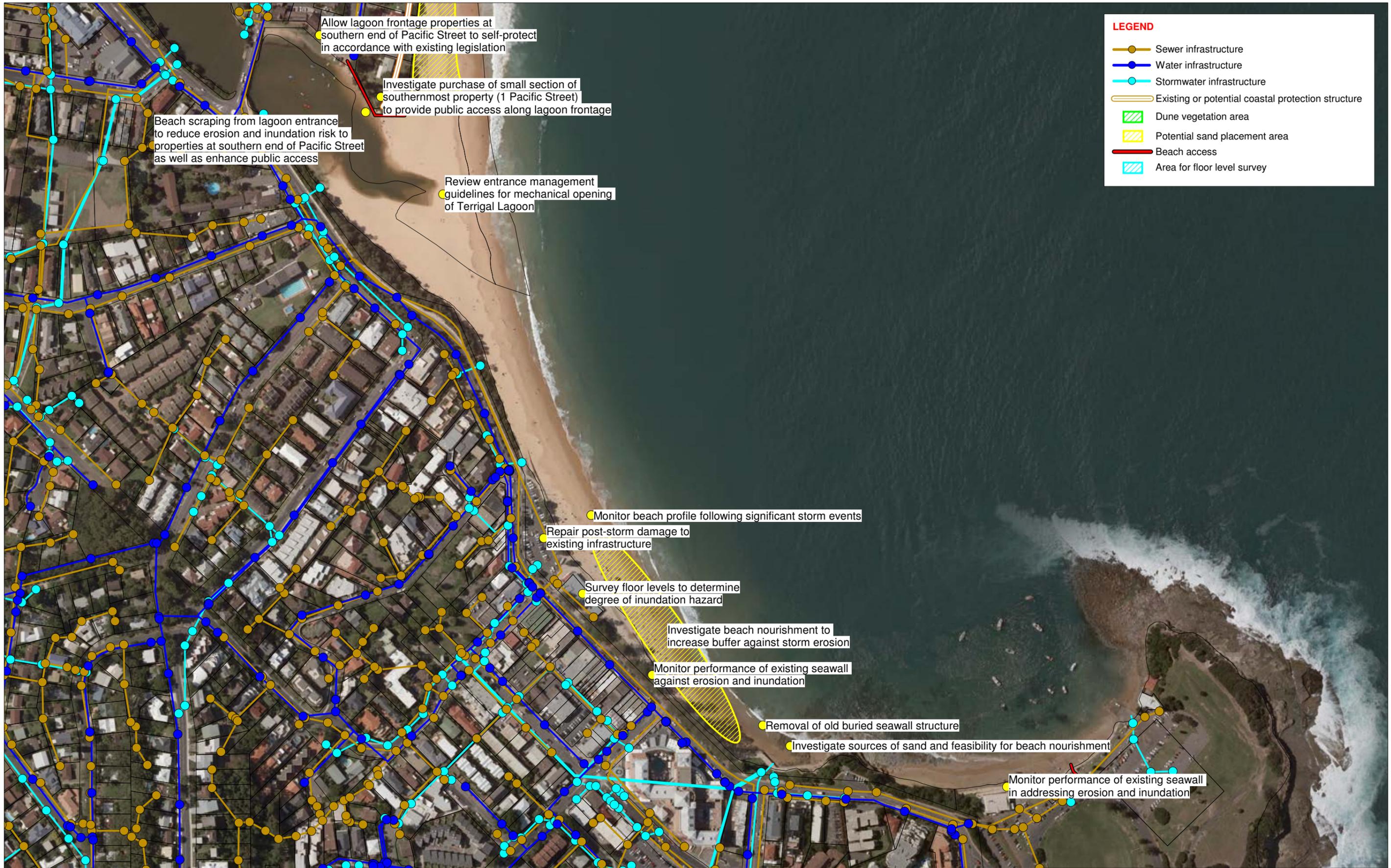
PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

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LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces





LEGEND

- Sewer infrastructure
- Water infrastructure
- Stormwater infrastructure
- Existing or potential coastal protection structure
- Dune vegetation area
- Potential sand placement area
- Beach access
- Area for floor level survey

DATE 10/08/15

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Terrigal Coastal Zone Management Plan Management Actions

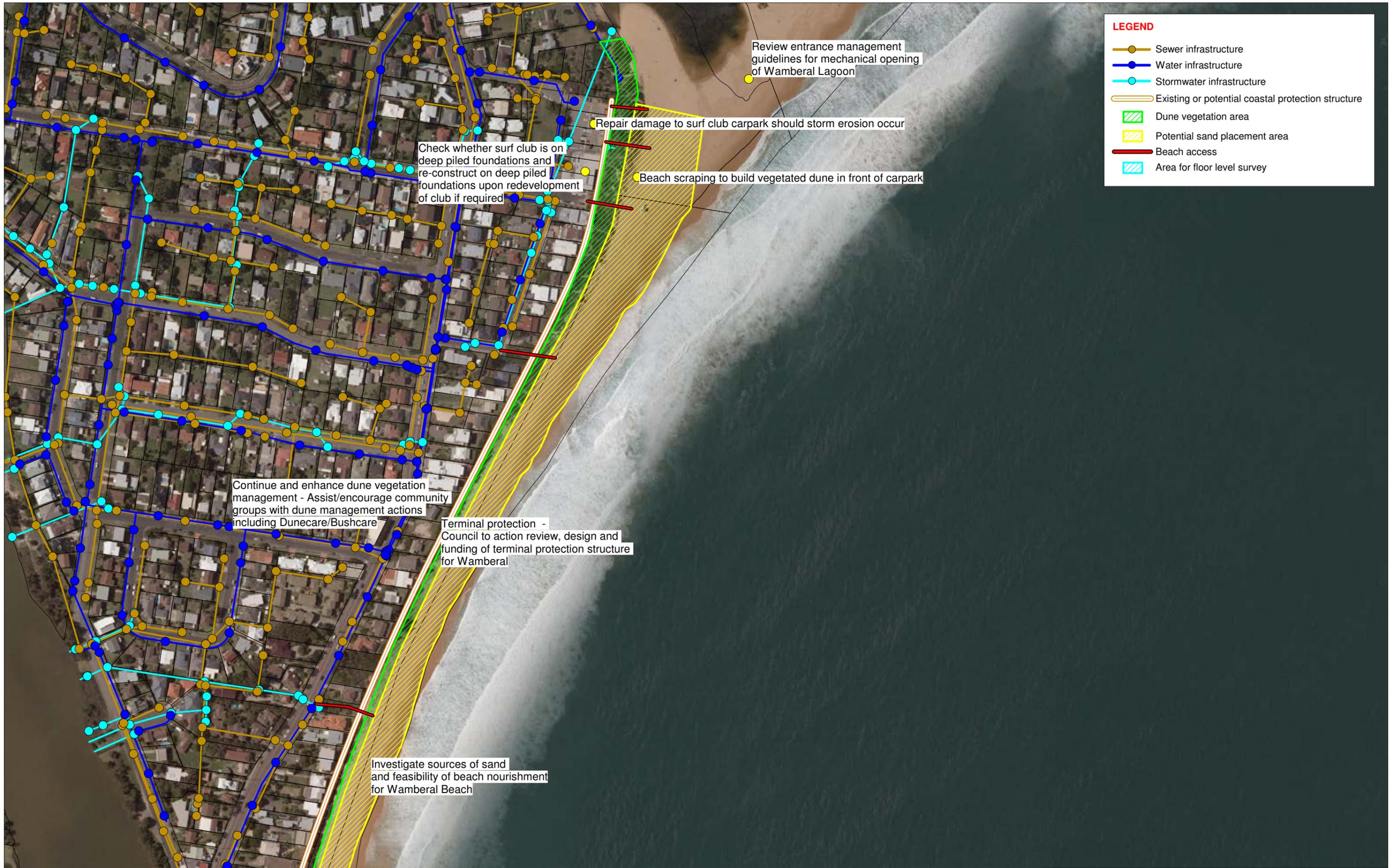
PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

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LEGEND

- Sewer infrastructure
- Water infrastructure
- Stormwater infrastructure
- Existing or potential coastal protection structure
- Dune vegetation area
- Potential sand placement area
- Beach access
- Area for floor level survey

DATE 10/08/15

0 50 100
metres

COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Wamberal Coastal Zone Management Plan Management Actions

PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

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LOCATION W:_Infrastructure\Projects\301015\03417 - GCC Open Coast-BrokenBayBeaches CZMP\3.0 Reports\GIS\Workspaces

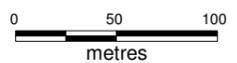


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COORDINATE SYSTEM MGA Zone 56

FIGURE TITLE Forrester's Beach Coastal Zone Management Plan Management Actions

PROJECT NO. 301015-03417

PROJECT TITLE Open Coast and Broken Bay Beaches Coastal Zone Management Plan

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COASTAL ZONE MANAGEMENT PLAN – APPENDIX 6**

Appendix 6 Summary of Public Submissions



1 Summary

This Appendix presents a summary of the public exhibition process for this CZMP, as well as a summary of how the various submissions have been considered in formulating the Plan.

The Draft Coastal Zone Management Plan was publicly exhibited over a six week period between 21 August and 2 October 2015. Consultation activities carried out as part of the exhibition of the Coastal Zone Management Plan included:

- Draft Coastal Zone Management Plan document made available for community review between 21 August and 2 October 2015.
- The Draft Plan document was made available in hardcopy format at Council’s Erina, Gosford, Kincumber and Woy Woy customer service centres during normal business hours.
- The Draft Plan was also available in the Items on Exhibition section of Councils webpage during exhibition.
- Letters were sent to 949 property owners identified as being affected by DCP Chapter 6.2 (Coastal Frontage) on 14 August 2015.
- Public Notices were placed in the Central Coast Express Advocate on 21 August and 4 September 2015 to inform the public of the place at which, the dates on which, and the times during which, the draft CZMP could be inspected by the public.
- Media Release distributed (5 August 2015)
- Promotion of exhibition in Central Coast Express Advocate via Gosford Connect – general info on exhibition (14 August 2015)
- Council held a series of five community drop-in sessions were held to seek public feedback on the proposed management actions for residents to have a say and find out more about how coastal hazards will be managed now and into the future. There were 85 people recorded in attendance during these sessions.

Approximately 85 people attended a series of 3 hour drop-in sessions which were held as indicated below in Table 1.

Table 1 – Community drop-in session attendance

Attendees	Dates	Location	Beach of focus
14	8 th September 2015	Umina SLSC	Umina / Ocean
24	9 th September 2015	Pearl Beach Progress Hall	Patonga - Pearl
18	10 th September 2015	MacMasters Beach SLSC	MacMasters/Copacabana – Killcare/Putty
12	14 th September 2015	Avoca SLSC	Avoca / North Avoca
17	16 th September 2015	Terrigal SLSC	Terrigal / Wamberal - Forresters



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A total of 19 submissions were received during the exhibition period. The following graph highlights the beach of focus for individual submissions, with some submissions being general and applying to all beaches:

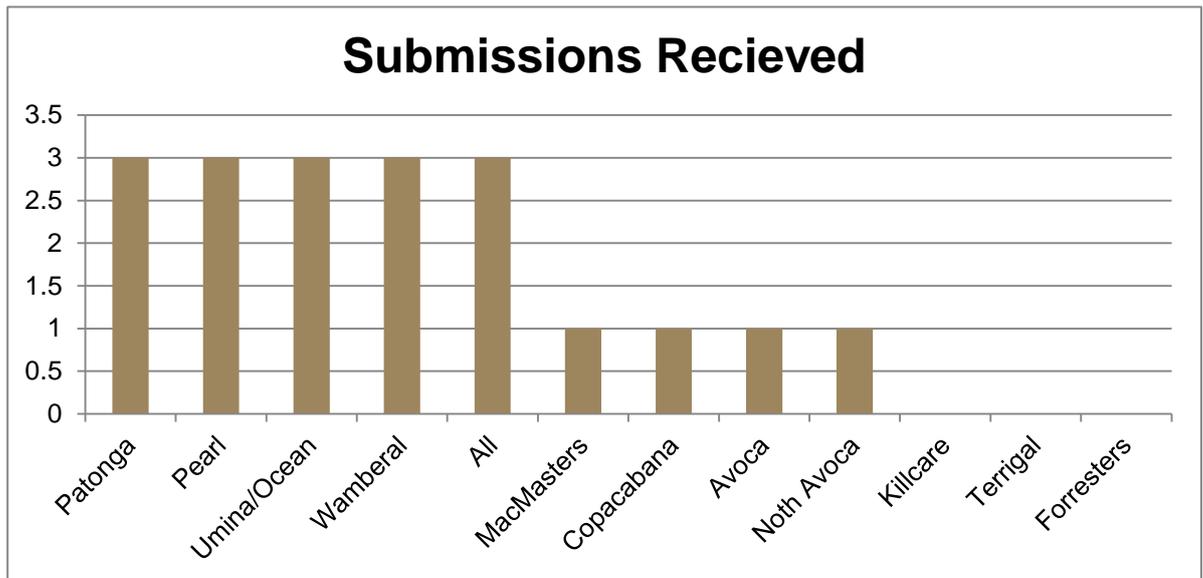


Figure 1 – Submissions received from each beach area

Table 2 provides a summary of the comments received in submissions received during the exhibition.



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Table 2 – Summary of submissions received

#	Comment Summary	Beach	How comments have been considered
1	<ul style="list-style-type: none"> • Support of CZMP • Need for defined process to implement beach scraping 	Pearl	<ul style="list-style-type: none"> • A defined process for implementing beach scraping at Pearl Beach is currently being developed. Council is looking to finalise the REF which defines this process within the coming months. • Additionally, a city-wide Dune Management and Beach Scraping Strategy has been included as an action in the Plan. This would involve investigation of reactive scraping following storm events and proactive scraping to build dune while there is sand available on the beach.
2	<ul style="list-style-type: none"> • Need to ensure floor level information is available to property owners 	Patonga	This has been addressed by providing Action “Pa13 - Upload flood/inundation information onto Council’s website for access by property owners” with the action to be undertaken in the short term (i.e. Year 1).
3	<ul style="list-style-type: none"> • Support of CZMP • Concern regarding stormwater scour Ocean Beach (Trafalgar Avenue) 	Umina & Ocean	The concern over the stormwater outlet has been addressed by providing Action “O31 Investigate installation of stormwater energy dissipation to reduce discharge velocities at outlet”. Currently the outlet causes scour after heavy rain and this could be addressed by installing energy dissipation blocks, rock apron, or by other methods to reduce velocity of outflows from the stormwater outlet. \$50,000 budget has been allocated toward addressing stormwater scour at this particular outlet in the next 5 years.
4	<ul style="list-style-type: none"> • Potential impacts of tripper structure need to be fully investigated • Concern over relaxing of SLR projections to 2050 • Concern over tree removal on dunes • Need for better compliance for tree vandalism 	Pearl	<ul style="list-style-type: none"> • \$10,000 has been allocated toward investigation of a tripper structure – an environmental assessment would likely be required which would ensure that impacts are fully investigated. • Sea Level Rise projections have been selected by Council based on independent advice • Tree removal and tree vandalism is to be targeted as part of the city-wide Coastal Zone Education Program for which \$20,000 p.a. has been allocated. A city-wide Beach and public



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#	Comment Summary	Beach	How comments have been considered
			<p>infrastructure monitoring program has also been included as an action in the CZMP which would improve Council’s ability to deal with compliance issues relating to dune vegetation.</p> <ul style="list-style-type: none"> • A city-wide Dune Management and Beach Scraping Strategy has been included as an action in the CZMP, which would provide funding for community engagement and involvement of dunecare/bushcare teams – community engagement will help reduce the incidence of tree vandalism.
5	<ul style="list-style-type: none"> • Support of CZMP • Support for tripper structure • Need for coastal protection along Gem Rod properties to minimise erosion of infrastructure and foreshore 	Pearl	<p>Coastal protection along Gem Road has been addressed with the inclusion of Action “Pe1 - Erosion Protection works to be allowed for four properties south of Green Point Creek entrance as well as for sewage pumping station and sewer line at end of Gem Road and south from Gem Road extending to protect infrastructure”. \$20,000 budget has been allocated in the short term to investigate this issue fully.</p>
6	<ul style="list-style-type: none"> • Support of CZMP • Support for reconsideration of blanket application of imposing indemnity and covenant provisions 	Copacabana	<p>The DCP currently requires property owners execute a positive covenant in favour of Council in order to issue a construction certificate for a minor and often unrelated building development. The CZMP has recommended that requirements in regard to supporting information to be provided for minor development (and requirement for the execution of a covenant) be reviewed as part of the revised DCP. Covenants/indemnities for property behind major infrastructure (i.e. roads, water, sewer etc.) currently apply – the requirement for these is to be reconsidered for minor developments landward of major infrastructure. Clauses will be retained but amended to enable some flexibility in their application.</p>
7	<ul style="list-style-type: none"> • Concern regarding sterilisation of development on Wamberal • Objection to Coastal Building Line • Support for implementation of TPS 	Wamberal	<ul style="list-style-type: none"> • Oceanfront lots at Wamberal will not be sterilised as a result of the application of the Coastal Building Line in the revised DCP, with development potential being improved for the majority of lots when compared with current rules. No parcel will be undevelopable under the revised DCP.



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GOSFORD BEACHES
COASTAL ZONE MANAGEMENT PLAN – APPENDIX 6**

#	Comment Summary	Beach	How comments have been considered
			<ul style="list-style-type: none"> At some of the beachfront lots within the Gosford LGA the projected coastal risk and resultant provisions of the DCP will limit development potential. To improve development potential in these lots, Council is considering the introduction into its DCP of specific location-based exceptions to established rules relating to development footprints, engineered design, cantilevering and setbacks from the street-side property boundary. This would enable ongoing development in the most severely affected lots in the short to medium-term. Cantilevering is to be recommended for all coastal frontage properties in the revised DCP Chapter. Additionally relaxing of setbacks is being recommended. Construction of relocatable dwellings is also considered, and maintaining existing dwelling and construction of new structures behind the Coastal Building Line is being investigated. Council has a duty of care to not allow development in areas which are at unacceptable coastal hazard risk until the risk can be mitigated e.g. with a revetment wall The Draft CZMP recognises the need to undertake a review of the design and planning for the TPS as well as undertake a rigorous social economic assessment of the management option to determine greater detail on benefits and beneficiaries.
8	<ul style="list-style-type: none"> Request for swimming enclosure 	Patonga	An action has been included in the CZMP for Patonga, Pa25, to investigate the feasibility of installation of a swimming enclosure
9	<ul style="list-style-type: none"> Need for low growing dune species Concern over car park alignment and functionality Object to any overtaking of oval area for car parking Support for swimming enclosure 	Patonga	<ul style="list-style-type: none"> The need for the use of low growing vegetation as part of supporting the natural dune vegetation profile has been highlighted in Action Pa23. The carpark fronting the shops has been identified as an area subject to coastal hazards. Short term actions in the CZMP include the re-instatement of the carpark, pedestrian pathway and beach berm should erosion occur using erosion resistant pavements which would reduce future maintenance requirements. In the longer term, the CZMP identifies the future re-



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			<p>location of the carpark to an area landward of the coastal hazard, the location of the future carpark would be chosen in conjunction with local stakeholders following the next review period for the CZMP if required.</p> <ul style="list-style-type: none"> An action has been included in the CZMP for Patonga, Pa25, to investigate the feasibility of installation of a swimming enclosure
10	<ul style="list-style-type: none"> Concern over pedestrian safety at The Esplanade Support for closing The Esplanade to become single lane and improved pedestrian access Support for dune management activities Public safety concern of overgrown vegetation and inappropriate use of dunes 	Ocean	<p>Actions have been included in the CZMP to undertake erosion protection works to protect The Esplanade and re-vegetate the dunes with appropriate vegetation in accordance with the city-wide Dune Management and Beach Scraping Strategy. Traffic arrangements for The Esplanade can be considered as part of the works to provide erosion protection at that location.</p>
11	<ul style="list-style-type: none"> Dissatisfaction with consultation approach Dissatisfaction with application of Triple Bottom Line approach Objection to Coastal Building Line Unclear on definition of beneficiaries to support implementation of works 	All/ Wamberal	<ul style="list-style-type: none"> Information provided to community consultation sessions was consistent and widely welcomed from those who attended. Scope and resourcing limitations did not allow for full-scaled detailed economic analysis to take place for all identified options. Further and more rigorous socio-economic analyses will be undertaken in the implementation process for large scale individual actions. Additionally, various planning approvals may also be required to address environmental, social and heritage considerations. A more rigorous socio-economic analysis is to be undertaken in coming 12 months. This will look at beneficiaries and provide detailed Cost-Benefit Analysis of status quo vs implementation of TPS/nourishment option etc. Development potential will be improved for the majority of lots when compared with current rules. No parcel will be undevelopable under the revised DCP.



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			<ul style="list-style-type: none"> Council has a duty of care to not allow development in areas which are at unacceptable coastal hazard risk until the risk can be mitigated e.g. with a revetment wall
12	<ul style="list-style-type: none"> Support for erosion protection works in front of SLSC Reconsideration of range of construction costs Confirmation SLSC not constructed on piles Rock protecting Norfolk Island Pines sufficient 	MacMasters	<ul style="list-style-type: none"> Actions M1 and M3 include the provision of erosion protection works for the SLSC. \$40,000 has been allocated for the design works for this project in Year 1, with budget identified for implementation in Years 5 – 10 of the CZMP. The range of construction costs has been widened in recognition of the availability of a wide range of design approaches. Action M2 is for the monitoring of existing rock protection around Norfolk Island Pines to assess future performance.
13	<ul style="list-style-type: none"> Objection to Coastal Building Line Concern over impact on development potential and property value 	North Avoca	<ul style="list-style-type: none"> Development potential would be improved for the majority of lots when compared with current rules. No parcel will be undevelopable under the revised DCP. Coastal Building Line has been based on the same level of coastal hazard risk as the previous established building line. Additionally, cantilevering is to be recommended for all coastal frontage properties in the revised DCP Chapter. Relaxing of setbacks is being recommended. Construction of relocatable dwellings is also being considered, and maintaining existing dwelling and construction of new structures behind the Coastal Building Line is being investigated. These measures are not currently available at North Avoca and would be expected to improve development potential when compared with the existing established rules. Council has a duty of care to not allow development in areas which are at unacceptable coastal hazard risk until the risk can be mitigated e.g. with a revetment wall
14	<ul style="list-style-type: none"> Support for exhibition of Beaches and Brisbane Water Flood Plans consecutively Need to ensure integration across planning processes 	All	<ul style="list-style-type: none"> Exhibition processes for the Beaches and Brisbane Water Plans are linked to grant applications, funding agreement and project brief/consultant deliverables which are already locked



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	<p>(and implementation)</p> <ul style="list-style-type: none"> • Suggestion to map actions against OEH risk management categories. • Suggestion to include LGA-wide measures in Executive Summary and in Table 1 • Suggestions for improving community information • Need to include information relating to insurance implications • Support for cost allocation – private vs public • Suggested difficulty in gaining federal financial support for implementation • Reconsider timing for CZMP review with links to other planning processes 		<ul style="list-style-type: none"> • Current funding mechanisms in NSW provide 2/3 funding for many flood management options (i.e. floor raising), however, this is not the case for the coast. • LGA-wide measures have now been included in a separate Table in Section 3.4 of the CZMP. • Additional information is to be provided to property owners in implementation of an LGA-wide coastal education program • Discussion on insurance is provided in the Coastal Zone Management Study • The funding section has been significantly expanded to provide an overview of Federal:State:Local and landowner potential contributions. The equitable apportioning of the funding will be determined through NSW Government guidance and more rigorous analysis of individual action, cost/benefit etc. • A new section has been included which articulates the timing of review processes for the CZMP, including a suggested 12-month review timetable for coastal hazard mapping and a 10-15 year review cycle for the actions within the CZMP.
15	<ul style="list-style-type: none"> • Concern of impact of CZMP on development, employment and focus to the region • Unclear on final impact / result of the proposed (drastic) measures • Support for a 'beach levy' to protect and maintain the beach environment 	Wamberal	<ul style="list-style-type: none"> • Oceanfront lots at Wamberal will not be sterilised as a result of the application of the Coastal Building Line in the revised DCP, with development potential being improved for the majority of lots when compared with current rules. No parcel will be undevelopable under the revised DCP. • At some of the beachfront lots within the Gosford LGA the projected coastal risk and resultant provisions of the DCP will limit development potential. To improve development potential in these lots, Council is considering the introduction into its DCP of specific location-based exceptions to established rules relating to development footprints, engineered design, cantilevering and setbacks from the street-side property boundary. This would enable ongoing development in the most severely affected lots in the short to medium-term. • Cantilevering is to be recommended for all coastal frontage properties in the revised DCP



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			<p>Chapter. Additionally relaxing of setbacks is being recommended. Construction of relocatable dwellings is also considered, and maintaining existing dwelling and construction of new structures behind the Coastal Building Line is being investigated.</p> <ul style="list-style-type: none"> • Council has a duty of care to not allow development in areas which are at unacceptable coastal hazard risk until the risk can be mitigated e.g. with a revetment wall • Concept of a 'beach levy' and options for raising such a levy has now been discussed within the Plan within Section 3.5.
16	<ul style="list-style-type: none"> • Support for flexible approach but could be broadened • Opposed to planned retreat • Support for piling forward of Coastal Building Line • Report lacks qualitative description of coastal processes and social-economic factors • Suggestion for an Engineering Steering Committee with economist 	All	<ul style="list-style-type: none"> • Technically it is possible to pile a building to make it safe from coastal erosion if it is forward of the Coastal Building Line. In some cases this piling would be in the wave impact zone (e.g. surf club after a large storm) however this can have an impact on erosion adjacent to the site. Should foundations of a dwelling be located seaward of the planning line then they would be subject to wave impact within the design life of the building and would therefore have some impact on erosion at adjacent land (even if this impact is relatively small). Within the proposed policy framework this could still occur if a storm larger than the design storm were to occur within the design life of the dwelling, but this is considered to be an acceptable risk. Thus the piling comes to play only in a storm larger than the design storm rather than being relied upon on a regular basis. • Qualitative descriptions of coastal processes and social-economic factors are provided in the Coastal Zone Management Study. The Plan is to be read in conjunction with the supporting information, including the Coastal Zone Management Study. • A discussion on the probability of exceedance of storm events and sea level rise projections which form the basis of the Coastal Building Line has been added to the CZMP document. • The existing situation is that Council engage suitably qualified expert coastal engineers to undertake the risk assessment and planning process. OEH provide peer review of



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#	Comment Summary	Beach	How comments have been considered
			documentation through expert coastal engineering advice and economic analysis. Concept of an engineering advisory Committee could be investigated in future. OEH/NSW Government are looking to provide expert advice centre to support council decision-making during planning and development assessment processes.
17*	<ul style="list-style-type: none"> Emergency Action Sub-plan – concern over exhibition and extent to which Draft CZMP meets requirements for emergency works Concern over application of (and opposition to) planned retreat Perceived lack of change from recent SLR projection review Need for greater clarity on ‘beneficiaries’ at Wamberal Concern over consultation Concern over protection strategy at Wamberal 	All	<ul style="list-style-type: none"> The Draft CZMP identifies the ability for property owners to minimise risk to their properties through a range of protective and avoidance strategies suitable for each precinct across the coastal frontage areas. The CZMP also includes the action to develop an LGA-wide Coastal Erosion & Inundation Emergency Response Plan. This will involve the development of emergency action processes which align with relevant combat agencies and expand approaches within the Terrigal/Wamberal Emergency Action Plan across the all beaches in the LGA. The building line has been calculated taking the revised SLR projections into account – the seaward distance that this equates to at each beach has been presented as a table within the CZMP The preferred Management measure for Wamberal Beach continues to be the construction of a terminal protection structure (TPS) coupled with beach nourishment. The Draft CZMP recognises the need to undertake a review of the design and planning for the TPS as well as undertake a rigorous social economic assessment of the management option to determine greater detail on benefits and beneficiaries.
18*	<ul style="list-style-type: none"> Concern over encroachments onto public land – need for compliance Support for suspended walkway in the lower section of the dune between SLSCs 	Umina	<ul style="list-style-type: none"> Compliance issues relating to encroachment onto public land are to be managed peripheral to the planning process and not directly within the CZMP. A suspended walkway in the lower section of the dune is not supported by many local residents as evidenced during the consultation process and so has not been included as a



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			proposal in the CZMP.
19*	<ul style="list-style-type: none">Request for improved management/protection of open space area adjacent to Pines	Avoca	Action “A11 Encourage and assist Dunecare group to improve dune vegetation management using appropriate endemic vegetation” applies to this section of the dune – however, the existing amenity of this area for passive recreation needs to be recognised and maintained when considering dune management at this location.