BMT WBM

"Where will our knowledge take you?"

Wollongong Coastal Zone Management Plan: Management Study

Final Report September 2017

wollongong
city of innovation

Wollongong Coastal Zone Management Plan: Management Study Final Draft Report

Prepared For:	Wollongong City Council
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

Offices

Brisbane
Denver
Mackay
Melbourne
Newcastle
Perth
Sydney
Vancouver

DOCUMENT CONTROL SHEET

BMT WBM Pty Ltd

BMT WBM Pty Ltd
126 Belford Street
BROADMEADOW NSW 2292
Australia
PO Box 266
Broadmeadow NSW 2292

Tel: +61 2 4940 8882
Fax: +61 2 4940 8887

ABN 54 010 830 421

www.bmtwbm.com.au

Document :	R.N1965.001.06.Mant_Study.docx
Project Manager :	Verity Rollason
Client :	Wollongong City Council
Client Contact:	Philomena Gangaiya
Client Reference	

Title :	Wollongong Coastal Zone Management Plan: Management Study Final Draft Report
Author :	Verity Rollason
Synopsis :	This Report presents management options for treating risks to assets and land within Wollongong's coastline from erosion and recession, coastal inundation and geotechnical hazards. The report presents a risk assessment and risk treatment options to manage coastal hazards at each beach in the LGA.

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE OF ISSUE	CHECKED BY		ISSUED BY	
0	29/04/2011	PEH		VPR	
1	16/05/2011	PEH		VPR	
2	30/06/2011	PEH		VPR	
3	November 2011	PEH		PEH	
4	January 2012	PEH		VPR	
5	June 2012	PEH		VPR	
6	December 2016	PMD		MF	
7	September 2017	WCC		WCC	

DISTRIBUTION

DESTINATION	REVISION						
	0	1	2	3	4	5	7
WCC	1e	1e	1e	1e	1e	2 + 1e	1
BMT WBM File	1e	1e	1e	1e	1e	1	
BMT WBM Library	1e	1e	1e			1	

Disclaimer : Wollongong City Council has prepared this document with financial assistance from the NSW Government through the Office of Environment and Heritage. This document does not necessarily represent the opinions of the NSW Government or the Office of Environment and Heritage.

EXECUTIVE SUMMARY

The Wollongong Coastline is characterised by a series of mostly small pocket beaches north of Port Kembla, and the larger sweeping sandy Perkins Beach extending south from Port Kembla to the Lake Illawarra entrance. The northern section of the LGA coastline comprises long sections of headlands and cliffs, with occasional pocket beaches. Wollongong has a long history of development, and as such, there is already significant development and infrastructure sited along the coastline, some of which is heritage-listed (including beach pavilions, Norfolk Island pines etc).

The interaction of natural coastal processes and the built environment results in hazards and associated risks along the Wollongong coastline. The Wollongong Coastal Zone Study (Cardno, 2010) identified the coastal hazards and the areas potentially impacted by 2100. Coastal hazards include storm-based beach erosion, longer-term shoreline recession, backwater inundation and overtopping due to elevated sea levels and waves during storms, and instability of cliffs and coastal headlands. Overprinted on these hazards are the potential impacts of future climate change, particularly sea level rise. Cardno (2010) produced coastal hazard lines (representing the combined effects of erosion, recession and sea level rise) for the years 2010 (immediate timeframe), 2050 and 2100. The hazard assessment adopted the NSW Government's standard sea level rise projections of 0.06m by 2010, 0.4m by 2050 and 0.9m by 2100 above 1990 mean sea level. Although the NSW standard sea level rise benchmarks are now revoked, on 26 August 2013, Wollongong City Council resolved to continue to use the same benchmarks for its planning and development decisions

The Wollongong Coastal Zone Management Plan has used the hazards assessment to identify and evaluate the risks to the Wollongong community associated with on-going coastal processes, and has developed a series of management strategies to manage and treat these risks to an acceptable level. The Australian Standard (ISO 31000:2009) Risk Management Principles and Guidelines were adopted as the framework for identifying and assessing coastal risks. Risks are considered to be the combination of the 'likelihood' of an event occurring, and the 'consequence' if that event actually occurs. Within the context of coastal risks for Wollongong, the 'likelihood' was determined from the Cardno (2010) hazard study, which identified vulnerable lands and the timeframe for impact. The 'consequence' was then determined by considering the land use and community values for that land being impacted. This step involved eliciting community and stakeholder input and perspectives, which helped prioritise the land and assets potentially at risk.

Giving consideration to both likelihood and consequence, coastal risks along the Wollongong Coastline were defined as 'Low', 'Medium', 'High' or 'Extreme'. Risks were established for immediate, 2050 and 2100 timeframes, highlighting a shift in risk profile with time, as sea levels rise and other climate change impacts begin to manifest. 'Extreme' and 'High' risks were considered to be intolerable. That is, these risks cannot be accepted by the community, and as such, require mitigation or treatment through specific risk management actions. The land and assets determined to have the highest levels of risk along the coastline include:

- Beaches themselves (in terms of amenity and social value) and associated coastal dunes.
- Wollongong's impressive list of ocean (rock) pools;
- Various Surf Club buildings, amenities and pavilions (some of which are heritage-listed);
- Existing seawalls and promenades;
- Stormwater infrastructure;
- Beach access and carparks, local roads servicing residential properties, and a couple of arterial roads (including Lawrence Hargrave Drive);

- The coastal cycleway that extends from Thirroul to City Beach;
- Infrastructure, such as Bellambi and Austinmer Boat Harbours, Bellambi STP and WIN stadium;
- Important habitat areas (such as EECs) and coastal vegetation; and
- Residential properties (some potentially affected by coastal erosion and recession, while many more are potentially affected by coastal inundation).

The Wollongong Coastal Zone Management Plan consists of two parts - a Coastal Zone Management Study and an Implementation Action Plan. The Coastal Zone Management Study evaluates all potential options and provides a list of recommended risk management options for managing the highest coastal risks to the lands and assets along the Wollongong Coastline. The Implementation Action Plan details the preferred actions for treatment of the highest priority risk areas, and lists timeframes or triggers, responsibilities, estimated costs and prior actions, to facilitate implementation of the Plan.

The recommended management actions incorporate a mix of treatment alternatives. Risks to future development and re-development can be managed through the application of development controls. Development controls are already in-place for managing other types of risk, including risks associated with flooding and geotechnical instability. Recommendations made in the Plan to address future development and re-development include:

- Preparation of a new Coastal DCP relating to areas at risk from coastal erosion and recession;
- Inclusion of coastal inundation areas into Council's existing Flood DCP Chapter E13; and
- Updating Council's existing Geotechnical DCP Chapter E12 to incorporate any additional risks associated with sea level rise and actions of the sea (i.e. wave impacts).

Managing the impact of coastal risks on existing development is considerably harder. Options available to address existing development generally fall into three categories.

- Protect: whereby engineered structural works are used to protect existing development and assets from erosion and recession and/or wave overtopping and inundation (e.g. seawalls and beach nourishment). Pro-active management of beaches and coastal dunes to maximise the volume of sand in front of existing development is also a protection option.
- Accommodate: whereby existing development is redesigned or retrofitted to withstand potentially different design conditions in the future, or is designed to be "relocatable" in the future once damage becomes imminent. Examples include raising houses to above inundation levels, installation of flaps on stormwater to prevent backflow inundation, or relocatable structures for lifeguard services.
- Retreat: whereby existing development along the coast is progressively abandoned and rebuilt further landward outside the hazard area (if rebuilt at all). Retreat from private property may involve voluntary acquisition, unless the retreat can be accommodated through future development controls.

'High' and 'extreme' risks at the current timeframe have been given priority for immediate attention, while for risks to lands and assets that are not expected to eventuate until sea level rise impacts start to occur, the most appropriate course of action at present is 'do-nothing'. A future intended action is signalled in the Plan, with a 'trigger' for implementation identified. This trigger-based approach limits the investment required until there is certainty of impact. Notwithstanding, any trigger for action needs to have sufficient lead-time to allow for potentially lengthy design and environmental impact assessments, and securing of funding required for some of the more major options recommended. Therefore, the Plan also details a suite of preliminary actions that

provide for the completion of relevant assessments, approvals and forward planning (such as through Council's Asset Management Plan) to enable the required action to be implemented smoothly at the time that a trigger is reached.

Furthermore, the plan takes advantage of asset management cycles, stating that when assets require maintenance or minor refurbishment, Council (or the asset owner) should start to 'accommodate' potential future risks. When assets reach the end of their functional design life and require replacement, options for retreating (i.e. relocating the asset to an alternative site) should be canvassed, if a replacement structure is deemed necessary.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Purpose of the Wollongong Coastal Zone Management Plan

The purpose and context for preparing the Wollongong Coastal Zone Management Plan (CZMP) is to manage the risks from coastal hazards along the Wollongong LGA coastline. The plan shall provide practical actions to address the risks from coastal hazards, including sea level rise, upon existing and future development and community assets and values in Wollongong. The CZMP shall provide guidance and strategies for effective consideration of coastal hazards within Council (and state) statutory and operational plans.

CZMPs are intended to focus upon coastal hazard risk management because this is not specifically addressed in other statutory planning processes (OEH, 2013). This CZMP will provide direction to managing recreational and community access where these aspects are affected by or affect the extent of coastal hazards. Recreational and community access and amenity is already managed across the Wollongong coastal zone through such strategic planning documents as *Planning People Places* (WCC, 2005) and various Plans of Management for community and crown land. Beach access arrangements are detailed in Appendix B.

Risks to estuary health are managed through the implementation of Council's Estuary Management Plans. More information on these existing policies and programs are given in Appendix B.

The Wollongong CZMP has been prepared in accordance with the *Coastal Protection Act 1979*, the NSW Coastal Policy, and the *Guidelines for Preparing Coastal Zone Management Plans*, as well as other legislation applicable to managing the coastal zone (refer Chapter 2). The plan shall meet the key objective of ecologically sustainable development which allows for equitable, balanced and co-ordinated use of the coastal zone and its unique physical, ecological, cultural and economic attributes.

The scope of the planning area is the Wollongong Coastal Zone, as described in Section 1.2. The plan will largely target the land based area of the Wollongong coastal zone, which is the area of key impact from coastal hazards and which is also the key area that may be influenced by Council and other stakeholders through management actions. Strategies implemented will also be considerate of any impacts upon the portion of the coastal zone below sea level.

In order to develop management strategies, a Risk Management Framework has been used to identify the risks from coastal hazards to the community and analyse the risk level based upon the likelihood and consequence of coastal hazards. The risk evaluation process was used to identify the priority coastal risks to be managed within the Wollongong CZMP.

Management strategies were derived in the context of managing coastal risks over the present to the 2100 timeframe. Triggers for implementing the strategies have been set with respect to this timeframe for coastal hazard impacts.

1.2 Study Area

The study area comprises the coastal zone of the Wollongong Local Government Area (LGA), extending from the shores of Lake Illawarra and Windang Peninsula in the south to Garie Beach in the north, excluding the following regions:

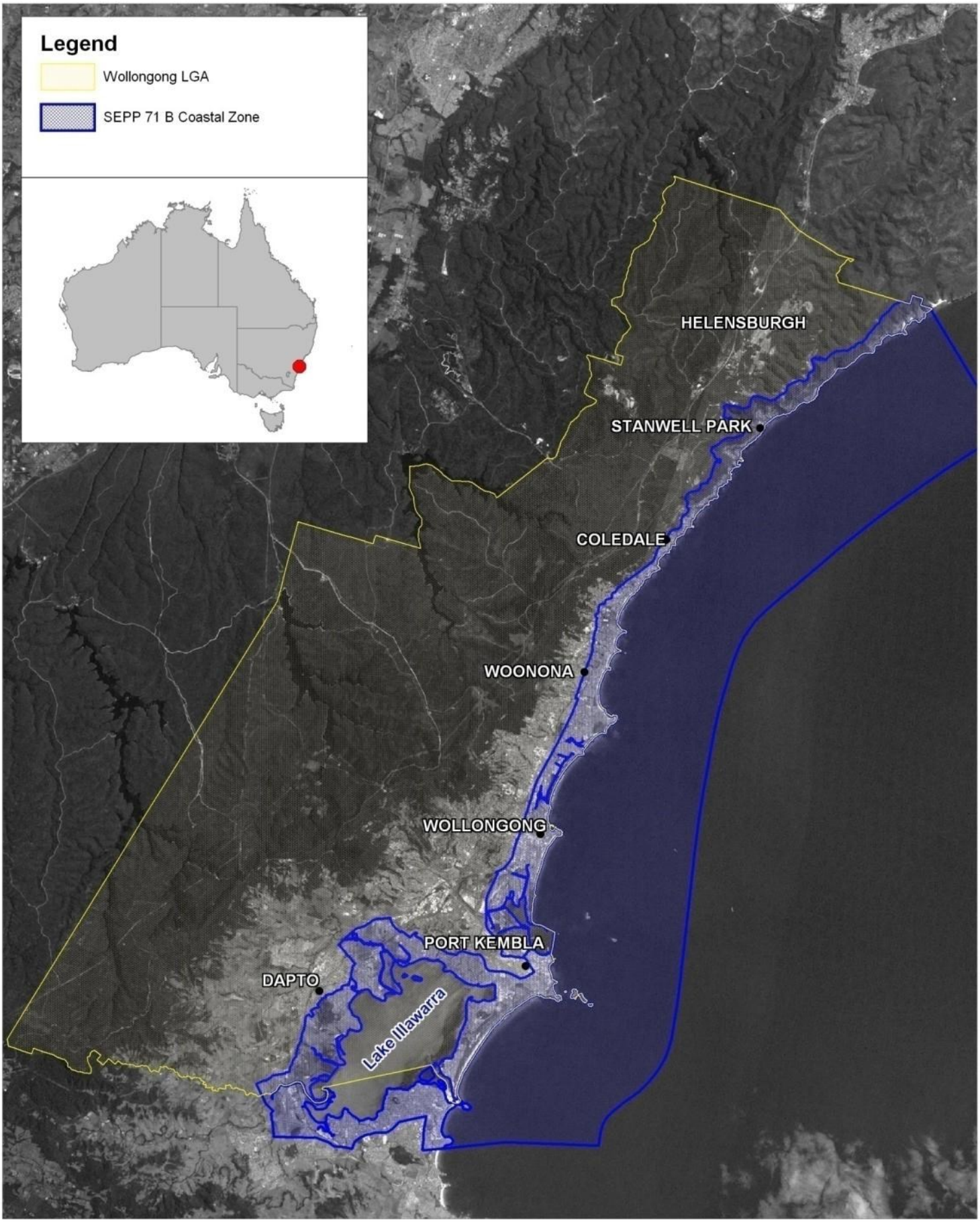
- Port Kembla port area, as this is managed under a separate policy and legislative framework; and
- Areas managed by NSW Office of Environment & Heritage (OEH) National Parks and Wildlife Service (NPWS) including the Royal National Park and the Five Islands Nature Reserve.

The coastal zone of Wollongong's LGA is identified on NSW Government gazetted maps delineating the zone covered by *State Environmental Planning Policy No. 71 – Coastal Protection* (SEPP71). The coastal zone is broadly defined in the NSW Coastal Policy 1997 to extend one kilometre inland measured from the shoreline, including along coastal rivers, lakes, lagoons, estuaries and islands, and three nautical miles seaward. The land area of the gazetted coastal zone for Wollongong is narrower than one kilometre in some areas, likely aligning with high topographic regions on the slope of the Illawarra Escarpment, which is situated very close to the shoreline in the northern part of the LGA. The Coastal Zone of Wollongong LGA given in the gazetted SEPP71 maps is illustrated in Figure 1-1.

The study area covers the immediate coastal environments such as beaches, dunes, headlands, bluffs, coastal entrances and waters to the extent that their management is affected by coastal processes and hazards and human activities. The lands within the Wollongong Coastal Zone include both public and private lands. The public lands include Crown lands which are either managed by Council (as Community Land, with associated Plans of Management defining permissible uses of these lands) or the Department of Industry – Lands & Forestry. Private lands of the coastal zone are predominantly residential, with some commercial and industrial uses also.

Wollongong's beaches are typically high energy sandy beaches with occasional rocky shorelines. Wollongong has in places steep and rugged cliffs and bluffs, creating small pocket beaches. In the far northern part of the LGA, cliffs and bluffs dominate the coastline, as the Illawarra escarpment trends eastwards to meet the coast.

The Wollongong coastline was largely developed (particularly for residential and community purposes) prior to widespread understanding of local coastal processes. Interactions between natural coastal processes and development on the shoreline are the principle source of hazard within the coastal zone.



Title:

Stydy Area - Wollongong LGA Coastline

Drawing: 1-1

Rev: A

N

0 5 10km

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_111_110414 Drawing A-11.WOR

1.3 Wollongong's Coastal Management Objectives

The NSW Coastal Policy 1997 sets nine goals for coastal management. These goals, along with site specific objectives for the Wollongong coastal zone are the basis for the plan's objectives. The objectives of the Wollongong Coastal Zone Management Plan are to:

- Recognise and accommodate natural coastal processes and hazards, including sea level rise and climate change, in the management of the coastal zone;
- Protect beaches, dunes and undeveloped headlands, permitting only minor development for essential public purposes;
- Manage and reduce the risks to existing and future development such that the value of assets at risk from coastal hazards is not increased over time; and
- Accord with the nine goals of the NSW Coastal Policy 1997.

The actions developed to treat coastal risks shall also meet the following objectives, in addition to treating coastal risks:

- The height, setback and scale of development shall enhance and protect the public's right to access the foreshore and ensure beaches and foreshores are not overshadowed, including acquisition of significant sites adjacent to the coastline to increase opportunities for access;
- The scale and setback specified for future and re-development shall not compromise the aesthetic and ecological values of the coastal zone;
- Cultural heritage, both indigenous and non-indigenous shall be protected and preserved;
- Lands identified to be of high conservation value shall be conserved, including through acquisition, dedication or reservation of such lands; and
- Actions that additionally provide opportunities to restore and enhance the amenity, recreational, ecological and cultural values of the coast shall be identified and given preference in treating coastal risks.

1.4 Community Involvement in Developing the Plan

The development of a Coastal Zone Management Plan requires the involvement of the community, including state agencies, stakeholders groups and directly and indirectly affected residents across the Wollongong LGA and greater region, who utilise the coastline in many different ways. Community involvement is crucial to the preparation of a plan that is considered acceptable, within financial and technical constraints. A careful and comprehensive consultation process has been conducted to ensure community values and priorities have been incorporated into preparing and selecting the management strategies and actions that will form the Wollongong CZMP. The following consultation activities have been, and will be, conducted.

- Following preparation of the Wollongong Coastal Zone Study (Cardno, 2010) Council undertook comprehensive presentation of the findings of this report to community, to assist in their understanding of the technical assessment of likely coastal risks to Wollongong's public and private land and assets.
- The first stage of the preparation of the CZMP was a series of informal workshops with the community and the Wollongong Estuary and Coastal Zone Management Committee ('the

Committee'), to gauge community values and priorities for assets and land along Wollongong's coastline. During the workshops, attendees were asked to indicate what they believed the consequence to specific assets would be, should hazards impacts occur. The outcomes from community were used directly to determine potential "consequences" of coastal hazards as part of the risk assessment (refer Section 4.3.2). These "consequence" values have played a key role in determining the priority assets and land requiring treatment to mitigate coastal risks.

- The next stage of consultation involved more formal Presentations to the community and the Committee, outlining those options considered viable for treating coastal risks (erosion and recession, coastal inundation, geotechnical failure). The draft Management Study report was made available to the community at this stage. The presentations and report aimed to provide better understanding by the community as to potential costs and benefits from the options (financial, social and environmental). Another key outcome from the presentations was to gather feedback from the community as to preferred options. The outcomes from the community workshops were used to determine the "community acceptability" of the various options (refer Section 5.5 and Chapter 6), which formed part of determining recommended options for implementation.
- The final stage of consultation shall be to present to community the recommended management actions that shall form the Wollongong CZMP. The selection of options will in part be based upon community's preference for options, within financial, technical and other constraints for implementing options. Any final concerns or input regarding the recommended actions will be gauged from community prior to finalising the Plan.
- Through ongoing consultation with the community, it is anticipated that the recommended actions for managing coastal risks will be fully understood and accepted by community, particularly where difficult decisions or trade offs are necessary. Conversely, there will be areas for which little to no action may be needed at the present time, and again, community have and will be involved in determining the level and type of action required to manage the coastal risks to their coastline.

1.5 Plan Structure

The structure and development of the Wollongong CZMP, as illustrated in Figure 1-2, utilised the Risk Assessment framework to determine high priority areas and assets for management across the coastal zone. The strategic framework for the management options is based upon a hierarchy starting from the whole of Wollongong Local Government Area perspective, determining management options for existing development, re-development and asset replacement and future development. The management options are then applied as appropriate to the different coastal risks, being:

- short-term storm erosion and longer-term recession;
- coastal inundation, including wave overtopping and backwater inundation through coastal creeks; and
- geotechnical failure relating to wave action.

The information provided in this report to support the risk assessment and development of management options is as follows.

- The legislative context for preparation of a CZMP and managing the coastal zone is outlined in Chapter 2.
- The coastal hazard extents, as taken directly from the previous stage study, being the Wollongong Coastal Zone Study, 2010 (Cardno, 2010), is given in Chapter 3;
- The risk assessment framework and its implementation for this CZMP is described in detail in Chapter 4.
- The management options that are available to treat erosion and recession, coastal inundation and geotechnical risks to existing and future development are presented in Chapter 5;
- The Risk Levels and Treatment Options for each risk at each beach are detailed in Chapter 6.
- Recommended options and implementation details are given in Chapter 7, which will be completed after stakeholders and community have reviewed and given input to preferred management options).
- Details for emergency action to provide safe beach access following storms, including activities such as re-contouring of eroded profiles is detailed in the Wollongong Emergency Action Sub Plan in Appendix G.

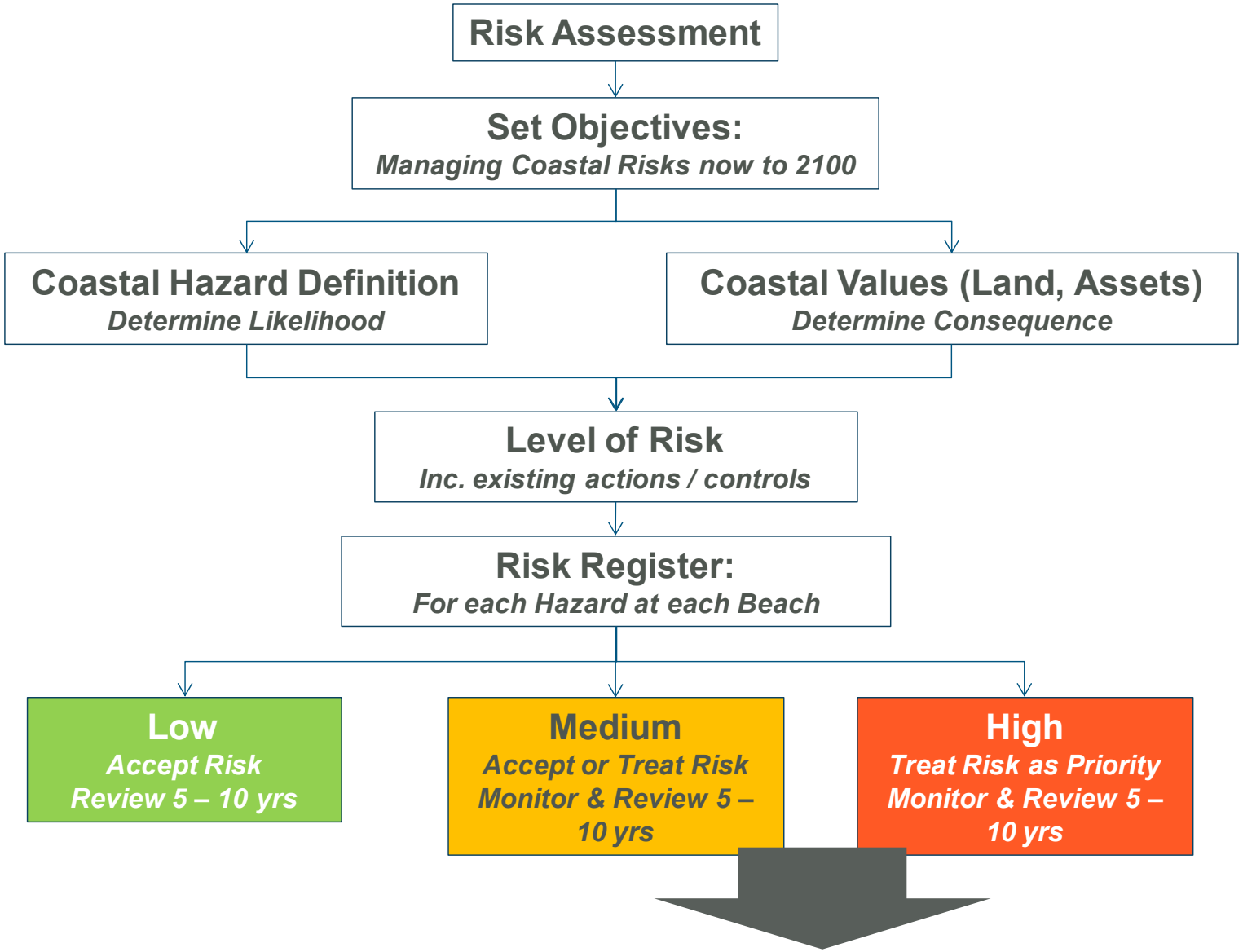


Figure continued overleaf

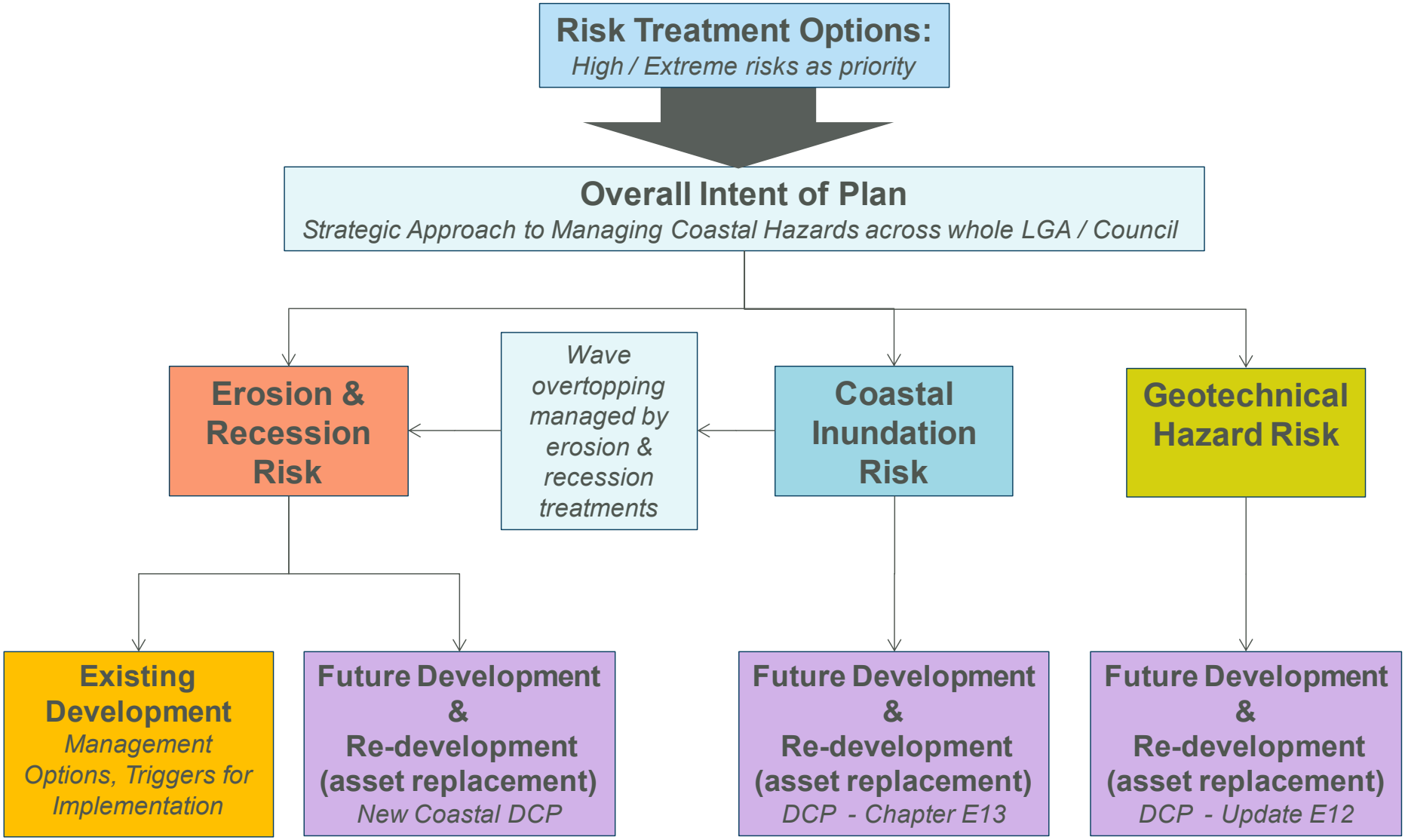


Figure 1-2 Plan Hierarchy / Framework for Management Options

2 LEGISLATIVE CONTEXT FOR COASTAL MANAGEMENT

2.1 NSW Coastal Management Framework

Coastal management in New South Wales is guided by the *NSW Coastal Protection Act 1979*, NSW Coastal Policy (1997), *State Environment Planning Policy No. 71 – Coastal Protection*, the *NSW Sea Level Rise Policy Statement (2009)* (which supersedes the NSW Coastline Hazard Policy 1988 with respect to sea level rise) and amendments to the *Coastal Protection Act, Local Government Act 1993 and Environmental Planning and Assessment Act 1979* relating to coastal protection (refer Chapter 2). Other guidance for land use planning in the coastal zone is given by the *NSW Coastal Planning Guideline: Adapting to Sea Level Rise* (DP, 2010) and the *Coastal Design Guidelines for NSW* (DP, 2003).

The requirements for the preparation of coastal zone management plans is outlined in the *Coastal Protection Act 1979* and recently adopted *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013) (the CZMP Guidelines). The CZMP Guidelines replace the Coastline Management Manual (NSW Government, 1990). A key change in the CZMP Guidelines (and supported by other recent NSW documents, as listed above) is the direction to adopt a risk-based approach to coastal management, which incorporates the uncertainty in hazards definition, and provides for prioritisation of management resources towards the greatest risks in the coastal zone.

The process to be followed in preparing Coastal Zone Management Plans is given below. This study forms Steps 3, 4 and 5 in the process, being the preparation of a Coastal Zone Management Study and Plan for the Wollongong LGA coastline.

1. Establish a Coastal Zone Management Committee;
2. Conduct a **Coastal Zone Study** to specifically identify and quantify hazards affecting the coastal area and investigate specific aspects of the coastal zone environment;
3. Prepare a **Coastal Zone Management Study** to consider all feasible management options whilst also assessing the social, economic, aesthetic, recreational and ecological issues associated with land uses of the coastal zone;
4. Prepare a draft **Coastal Zone Management Plan** consisting of the best combination of options for reducing the risks from coastal hazards and achieve the plan objectives, including the preparation of a strategy to implement the Plan;
5. **Review** the draft Plan through public exhibition and consultation,
6. Council to **adopt the Plan** and submit the Plan to Minister for the Environment for **certification in accordance with Part 4A of the *Coastal Protection Act 1979***
7. **Implement** the certified Coastal Zone Management Plan; and
8. **Review** the Coastal Zone Management Plan on a regular basis (5-10 years), to enable continued update and review of coastal risks and management measures.

2.2 Key Legislation, Policies and Guidelines

A short summary of the key legislation, policies and guidelines for this CZMP is given below, with more detailed summary provided in Appendix C.

While a detailed review is not applicable here, it is noted that in managing the coastal zone, other legislation needs also be taken into consideration, which may include: the *Environment Protection and Biodiversity Conservation Act 1999*; the *Threatened Species Conservation Act 1995*; the *Fisheries Management Act 1994*; the *National Parks and Wildlife Act 1974*; the *Water Management Act 2000*; and others.

2.2.1 Coastal Protection Act 1979

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

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

This Coastal Zone Management Plan is being prepared in accordance with the *Coastal Protection Act 1979*, including the objectives of the Act as outlined in Appendix C.

Amendments to the CP Act in 2010 and again in 2012 are outlined below.

2.2.1.1 Changes Occurring via the Coastal Protection and Other Legislation Amendment Act 2010

The Coastal Protection and Other Legislation Amendment Act 2010 provided for reforms to coastal erosion management in NSW through amendments to *the Coastal Protection Act 1979*, the *Local Government Act 1993* and the *Environmental Planning and Assessment Act 1979*. The amendments relate to both emergency and permanent coastal protection works. The bill was passed in October 2010, and amendments came into effect in January 2011.

Amendments were made under Part 4C of the Coastal Protection Act outlining emergency coastal protection works that landholders or public authorities are permitted to carry out. The emergency coastal protection works were to be consistent with a Code of Practise associated with this Part, which includes the Schedule of Authorised Locations for these works. The *Coastal Protection Amendment Act 2012* modified the allowances for such works, which were subsequently renamed to 'temporary protection works' (as detailed below). There are no authorised locations in the Wollongong LGA for emergency coastal protection works (now temporary protection works). If there are found to be locations within the Wollongong LGA that Council considers would be suitable for such coastal protection works at some time in the future, Council may request the NSW Government to add these locations to the Schedule.

Amendments were made to the *Local Government Act 1993* (Section 553B) to allow local councils to levy a coastal protection service charge to landholders where they have contributed to the

construction of new or expansion of existing coastal protection works. This charge covers council costs for maintaining the works and restoring the beach if the works cause erosion. The changes were accompanied by the Coastal Protection Service Charge Guidelines, refer Appendix C.

Of key note, residents must agree to pay the coastal protection service charge prior to the works being constructed. This annual charge is then attached to the land and becomes the responsibility of all future land owners for the life of the protection works. The amount of the charge is regularly reviewed depending on the cost of maintaining the works and in ameliorating any adverse impacts. Where works are implemented by Council and Council chooses to contribute to the cost of the works then Council also must accept liability for a portion of the future coastal protection service charge.

Legislative amendments were made that permit landholders to submit applications to erect long term coastal protection works, with approval contingent on the landholders demonstrating that potential offsite impacts can be managed (for example, with beach nourishment), refer Section 55M of *the Coastal Protection Act 1979*. The works can be fully funded by the landholders who submit the application. Ongoing maintenance can be facilitated through an annual coastal protection service charge (as above).

Effectively, a mechanism is now available to Councils whereby residents may promote and undertake coastal protection works (with approval) at their own expense to protect private property and land. Council in approving the works can establish a levy on the benefitting landowners for the costs of the works, their future maintenance and for the amelioration of any adverse impacts from the works that may occur into the future. There is no need for any cost for the works to be borne by local government and no contribution or responsibility emanating from the State as a result of the works or the coastal hazards.

Amendments were also made under Part 2A of the *Coastal Protection Act 1979* to establish a joint state-local body called the NSW Coastal Panel. The Coastal Panel is to act as a consent authority for long term protection works development applications where a council does not have a certified CZMP and / or requires further technical assistance in assessing such development applications. The Coastal Panel shall also assist the Minister when requested, such as for reviewing CZMPs.

2.2.1.2 Coastal Protection Amendment Act 2012

This *Coastal Protection Amendment Act 2012* permitted modifications to Part 4C of the *Coastal Protection Act 1979* relating to coastal protection works. The key change was renaming such works from ‘emergency’ to ‘temporary’ protection works, to enable authorised landholders to erect such works regardless of the impending occurrence of a storm, in response to coastal erosion. The works are not permitted on estuarine foreshores.

A Code of Practise associated with the placement of temporary coastal protection works was also revised. The Code of Practise outlines the height, materials and form for the placement of temporary coastal protection works, and the procedure for removal and remediation of such works. The Code of Practise contains a Schedule listing those locations at which temporary works are authorised. It is assumed that temporary works are not permitted at locations not listed in the Schedule. There are no locations within the Wollongong LGA listed on that Schedule.

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

The fines for inappropriate placement of sand or sandbags (such as associated with the erection of temporary coastal protection works) have been halved, to reflect the lesser nature of such incidences. The heavy fines for placement of other non-beach materials (e.g. rocks, car bodies, bricks etc.) remain as per the 2010 amendments to the *Coastal Protection Act 1979.*

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

2.2.2 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EPA Act) is the key NSW legislation for planning and land use. The Act provides a system of environmental planning and assessment for NSW, and involves developing plans to regulate competing land uses, through 'environmental planning instruments'. The objectives of the EPA Act are listed in Appendix C. The EPA Act establishes three types of environment planning instruments (EPI):

- Local Environmental Plans;
- Regional Environmental Plans; and
- State Environmental Planning Policies.

Approval processes for "development" and "works" in NSW are provided for in Part 3A (now repealed), Part 4, Part 5 and Part 5A of the EPA Act. Detail for these parts is given in Appendix C.

The Wollongong LEP, recently gazetted under the EPA Act, provides guidance as to land use in the Wollongong LGA, including the coastal zone.

2.2.3 Wollongong Local Environment Plan (2009)

The Wollongong Local Environment Plan 2009 (LEP) was adopted by the Minister for Planning in 2010, and provides local environmental planning provisions for land in Wollongong in accordance with the relevant standard environmental planning instrument under Section 33A of the EPA Act. The LEP also sets specific aims for the use and development of land in Wollongong, including "to ensure that significant landscapes are conserved, including…the coastline".

The LEP sets out the zonings for all land in the LGA, and the objectives and permitted development (with or without consent) given for each land zone. The LEP also guides the assessment and approval for Development Applications for lands within Wollongong. Land use zones specified in the LEP are given in Table 2-1. For each of these zones, the LEP specifies:

- Objectives for development within the zone
- Development that may be carried out without consent

- Development that may be carried out only with consent
- Development that is prohibited.

Most land in the Wollongong coastal zone is zoned for recreation (mostly public and some private), environmental conservation or management, or for residential uses. There is no rural land and very little industrial land within the coastal zone. There are small areas of commercial land, typically for restaurants, kiosks and cafes in the coastal zone.

Table 2-1 Land Zones in the Wollongong LEP

Rural Zones	Residential Zones	Business Zones	Industrial Zones
RU1 Primary Production	R1 General Residential	B1 Neighbourhood Centre	IN1 General Industrial
RU2 Rural Landscape	R2 Low Density Residential	B2 Local Centre	IN2 Light Industrial
RU4 Rural Small Holdings	R3 Medium Density Residential	B3 Commercial Core	IN3 Heavy Industrial
	R4 High Density Residential	B4 Mixed Use	IN4 Working Waterfront
	R5 Large Lot Residential	B6 Enterprise Corridor	
		B7 Business Park	
Special Purpose Zones	**Recreation Zones**	**Environment Protection Zones**	**Waterway Zones**
SP1 Special Activities	RE1 Public Recreation	E1 National Parks and Nature Reserves	W1 Natural Waterways
SP2 Infrastructure	RE2 Private Recreation	E2 Environment Conservation	W2 Recreational Waterways
SP3 Tourist		E3 Environmental Management	W3 Working Waterways
		E4 Environmental Living	

The LEP contains Miscellaneous Provisions for Development within the Coastal Zone (Section 5.5. of the LEP), which set objectives and matters for consideration by the consent authority prior to granting consent to development on land wholly or partly within the coastal zone. The objectives include implementing the principles of the NSW Coastal Policy, and which form the objectives for the CZMP (refer Section 1.3).

The LEP overrides (in that, the following plans do not apply to land within the LGA) SEPP No 1 – Development Standards, SEPP No 4 – Development Without Consent and Miscellaneous Exempt and Complying Development (Clause 6 and Parts 3 and 4), SEPP No 60 – Exempt and Complying Development and the Illawarra Regional Environmental Plan No 1. SEPP 71 does not apply to land within the Wollongong city centre. The provisions of any other SEPP and REP that apply to the Wollongong LGA prevail over the LEP (as provided by Section 36 of the EPA Act).

2.2.4 Wollongong Development Control Plan 2009

The Wollongong Development Control Plan 2009 (DCP) establishes objectives and planning controls for development on any land within the LGA, to supplement the provisions given in the LEP. The DCP provides specific controls for development relating to particular areas (e.g. Thirroul Village), development types (e.g. Residential Development) and / or particularly issues (e.g. flood planning controls), which governs the way that permitted development is conducted in the LGA. The 2009 DCP combined 89 separate plans into one document.

The DCP was prepared in accordance with Section 74C of the EPA Act and clause 16 of the Environmental Planning and Assessment Regulation 2000. Under Section 79C of the EPA Act, the consent authority is required to take into consideration the provisions of the DCP when determining a Development Application for land in Wollongong. The LEP and any relevant SEPPs that apply to lands in the LGA prevail over the DCP, in the event of any inconsistency.

Key chapters and sections of relevance to managing the coastal zone include the following.

- Chapter E12 – Geotechnical Assessment, which sets specific requirements for geotechnical investigations for lands within the LGA known or suspected to be subject to slope instability and geotechnical hazards. At present, coastal processes (waves, sea level rise) are not specifically stated to be included in the geotechnical hazard investigation.
- Chapter E13 – Floodplain Management, which sets development controls for low, medium and high risk floodplain areas, with prescriptive standards for development applying to those floodplains where flood studies have been completed to specify the low, medium and high risk flood areas, i.e. Towradgi / Hewitts / Slacky / Woodlands / Tramway/ Thomas Gibson Creeks, Minnegang Creek, Allans Creek, with Lake Illawarra and Mullet Creek due to be added shortly. At present, the flood planning area controls cover the coastal inundation extents in the majority of land affected by these hazards.

While recreational land is managed through Community and Crown Lands POMs, works on such lands need to also comply with the DCP.

There is no specific DCP chapter providing guidance and development controls for coastal hazards such as erosion and recession or coastal inundation, over any timeframe (e.g. immediate, 2050, 2100).

The DCP chapter for Residential Development (Chapter B01) contains a brief section (11.6) pertaining specifically to development near the Coastline. However, this section provides limited guidance for different development types and / or controls to manage the impacts of coastal hazards. The remaining DCP chapters for developments such as Business Zones (B04), Industrial Development (B05) and Residential Subdivisions (B02) do not reference controls for development in the coastal zone.

2.2.5 State Environmental Planning Policy No. 71 – Coastal Protection

State Environmental Planning Policy No. 71 – Coastal Protection (SEPP71) aims to protect and manage the natural, cultural, recreational and economic attributes of the New South Wales coast,

through appropriate and suitably located development in accordance with ESD principles. SEPP 71 applies to all lands within the coastal zone of NSW, defined on gazetted maps under the SEPP.

SEPP 71 outlines the conditions for which the Minister for Planning becomes the consent authority for 'significant coastal development'. SEPP 71 defines this as development in 'sensitive coastal locations' namely land within 100 metres of and below mean high water mark of the sea, a bay or an estuary.

SEPP 71 does not apply to land within the Wollongong city centre, however does apply to the remaining coastal zone land in Wollongong (as in Figure 1-1).

2.2.6 Crown Lands Act 1989

The *Crown Lands Act 1989* (the CL Act) provides for the administration and management of Crown land for the benefit of the people of NSW. Waterbodies such as beaches and foreshores and estuaries / creeks / lagoons below the mean high water mark are designated as Crown Land and managed by the Department of Industry – Lands & Forestry. In addition to this, there are many other parcels of land within the Wollongong coastal zone that are Crown reserves that are controlled and managed by Council. That is, Council is the reserve trust manager or trustee appointed by the Minister for Lands to care, control and manage the land in accordance with its public purpose and the principles of Crown Lands management, Section 11 of the CL Act as given in Appendix C.

In addition to these principles, the objectives of the Coastal Crown Lands Policy 1991 apply to Crown lands within the coastal zone of Wollongong (the policies objectives are given in Appendix C).

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

Plans of Management relating to Council managed Crown lands in Wollongong are discussed below in relation to the *Local Government Act 1993*.

2.2.7 Local Government Act 1993

The *Local Government Act 1993* (the LG Act) creates local governments and grants them the power to perform their functions, which involve management, development, protection, restoration, enhancement and conservation of the environment for the local government area. The functions of the local government are to be performed in a manner that are consistent with and promote the principles of ecologically sustainable development.

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

Plans of Management for Community Land need also to be prepared under Section 35 of the LG Act. Other aspects of categorisation, core objectives and use of Community Land are designated under Section 36 of the Act (refer Appendix C for more detail). Discussion of existing POMs for Community and Crown Lands is given below.

2.2.7.1 Plans of Management for Community, Crown and Recreational Land

Council has a generic plan of management (POM) and a range of site specific POMs that govern the permissible uses for Community Land (both Council owned land and Council managed Crown Lands). The relevant POMs for coastal Community Lands include:

- Stanwell Park Reserve and Bald Hill Plan of Management August 2009
- Wollongong City Foreshore Plan of Management, January 2008 (which incorporates former POMs for Andrew Lysaght Park (December, 2002), City Beach (July, 2001 and December 1995) and North Beach and Stuart Park (August, 2000))
- Coledale Beach Plan of Management, June 2004
- Judbooley Parade, Windang Plan of Management, June 2008
- The Community Land of Wollongong Generic Plan of Management 2010

The *Blue Mile MasterPlan* provides more detail regarding the improvements proposed within the Wollongong City Foreshore POM, outlining the series of improvements and actions proposed in the Wollongong City Foreshore POM area.

Planning People Places (WCC, 2005) provides the strategic framework to guide provision, development and management of open space and key recreation and community facilities in Wollongong over the next 20 years. The document also provides guidance to developers and State agencies considering developments that provide open space, recreation and community facilities. Planning Areas 1 to 5 and 7 in this document cover the Wollongong coastal zone. The objectives for these areas focus on enhancing existing important coastline recreational nodes, and improving connection between these nodes.

A review of *People Planning Places*, Wollongong's POMs and the *Blue Mile Master Plan* indicated that all documents except one do not outline the relationship between recreational land use and development, and the need to plan for or manage coastal hazards impacts when planning uses and facilities.

The plans provide for a range of improvements to community facilities, but do not indicate whether planning for coastal erosion or other hazards had been incorporated into decision making regarding improvement works. Coastal hazards and engineering assessments are being undertaken for the proposed Blue Mile Masterplan works, however decisions regarding location, type and improvement to facilities was made prior to determining the feasibility of these decisions with respect to coastal hazards impacts.

Only the Coledale Beach Reserve POM provided a strategy directly relating to the incorporation of coastal hazards in future planning. The strategy requires new development and activities to be located behind the 50 year hazard line and structural protection to protect existing assets seaward of the 50 year hazard line (although, the type of structural protection, or any costs or benefits associated with structural protection was not indicated).

The POMs and strategic plans for recreational land have not explicitly included coastal hazards as part of decision making as there has not previously been hazards definition available to guide such decisions.

2.2.8 The NSW Coastal Policy 1997

The NSW Coastal Policy 1997 (the Policy) sets the strategic framework for coordinated, integrated and ecologically sustainable development of the coast. The Policy details nine goals and associated objectives and strategic actions for achieving ecologically sustainable development in NSW. Preparation of coastal zone management plans is one of the strategic actions given by the Policy, with the plans to be consistent with the Policy's goals and objectives.

The nine goals of the NSW Coastal Policy (refer to policy for objectives associated with these goals) are:

- to protect, rehabilitate and improve the natural environment;
- to recognise and accommodate natural processes and climate change;
- to protect and enhance the aesthetic qualities of the coastal zone;
- to protect and conserve cultural heritage;
- to promote ecologically sustainable development and use of resources;
- to provide for ecologically sustainable human settlement;
- to provide for appropriate public access and use;
- to provide information to enable effective management; and
- to provide for integrated planning and management.

2.2.9 The Now Revoked NSW Sea Level Rise Policy Statement (2009)

The now revoked NSW (2009) Sea Level Rise Policy Statement (the Policy Statement) set the planning standards for projected sea level rise to 2100 that had to be adopted in all forms of coastal assessment, from development applications to coastal hazards definitions studies and coastal zone management plans. The adopted benchmarks were 0.4 m rise in sea level by 2050 and 0.9 m by 2100. These benchmarks were used to prepare the Wollongong Coastal Zone Study and hazard lines.

The revoked Policy Statement outlined the recommended risk based management approach and the commitments of the NSW government to assist planning and managing sea level rise, including:

- promotion of risk-based assessment approaches to sea level rise and coastal planning;
- provision of guidance to councils to support adaptation planning initiatives;
- encouragement of appropriate development on land at risk from sea level rise;
- provision of continued emergency management support for damaging storms and floods; and
- provision of ongoing updated information to the public about sea level rise and projected impacts.

This Wollongong CZMP is consistent with those commitments outlined above.

The Sea Level Rise Policy Statement (2009) superseded the 1988 Coastline Hazards Policy. Most of the objectives from the 1988 policy were included in the NSW Coastal Policy 1997, which remains current. With respect to managing sea level rise, NSW Coastline Hazard Policy was updated by the Sea Level Rise Policy Statement.

The Policy Statement also outlined the NSW Government's continued commitment to provide funding assistance to local councils for coastal hazard studies and management planning. Similarly, they shall continue to provide guidance and assistance to local councils on reducing the risk to private and public property from coastal hazards. However, when allocating funding assistance to local councils for coastal protection works, the Government will give priority to public safety and protecting valuable publicly-owned assets, and then to private land. The criteria stated for councils to apply to voluntarily protect private property included the:

- magnitude of current and future hazards
- cost-effectiveness of management actions
- contribution to the project's costs from the local council and benefiting landowners, taking into consideration genuine hardship for affected coastal residents
- effectiveness of the proposed arrangements for maintaining any proposed works
- ability of the project to accommodate sea level rise.

Where assistance is provided to reduce the impacts of coastal hazards, the Government does not assume any responsibility for these hazards.

Although the NSW standard sea level rise benchmarks are now revoked, Wollongong City Council resolved to continue to use the same benchmarks for its planning and development decisions.

2.2.10 Guidelines for Preparing Coastal Zone Management Plans (2013)

Guidelines for preparing Coastal Zone Management Plans (CZMP Guidelines) were published by OEH in July 2013. The CZMP Guidelines specify the requirements for preparing a coastal zone management plan (CZMP) in accordance with the *Coastal Protection Act 1979*, including requirements additional to those specified in the Act. The guidelines specify the use of a risk based approach to preparation of a CZMP and actions for managing coastal hazards. The CZMP Guidelines documents the ISO 31000:2009 risk process which requires the likelihood and consequence of coastal risks to be analysed and combined to determine the level of risk. The highest risks are then treated as a priority over lower risks.

The CZMP Guidelines outline the steps for preparing CZMPs for the open coast in Part B, with further technical notes to be released by the NSW Government in coming months.

Under Section 733 of the *Local Government Act 1993*, councils are taken to have acted in 'good faith' and receive an exemption from liability where their actions were done substantially in accordance with the coastal management principles given the CZMP Guidelines, as summarised below. Intended changes to the section 117 of the *Environmental Planning and Assessment Act 1979* will require the CZMP Guidelines be taken into consideration when councils prepare their local environment plans (LEPs).

The coastal management principles and how these principles have been addressed or achieved within this Wollongong CZMP are given in Table 2-2.

Table 2-2 Coastal Management Principles addressed by the Wollongong CZMP

	Coastal Management Principles	Addressed by Wollongong CZMP	Report Section
Principle 1	Consider the objectives of the Coastal Protection Act 1979 and the goals, objectives and principles of the NSW Coastal Policy 1997.	Wollongong's coastal management objectives are aligned with the NSW Coastal Policy. The sea level rise benchmarks were also used in deriving future hazard extents (2050, 2100)	2.2.8, 2.2.9
Principle 2	Optimise links between plans relating to the management of the coastal zone	By using a risk-based approach, existing controls within existing plans are reviewed and incorporated into the analysis of risk, and also used as starting point for developing risk treatments. Existing POMs address most beach amenity and access issues. This CZMP focuses on hazards issues that may not be addressed by such existing plans, as well as providing guidance for future and revised POMs.	4.4
Principle 3	Involve the community in decision-making and make coastal information publicly available	Comprehensive community consultation has been undertaken in developing this plan, including workshops, mailouts, website, and interviews with stakeholders and community	1.4
Principle 4	Base decisions on the best available information and reasonable practise; acknowledge the interrelationship between catchment, estuarine and coastal processes; adopt a continuous improvement management approach	The risk based approach is an internationally recognised framework for management because it incorporates the best available information and its uncertainty. Management options recognise the overlap between flooding and oceanic processes through estuaries, streamlining management into one approach. The adopted Risk Management Framework intrinsically requires ongoing monitoring of risks and review and tailoring of risk treatments (management options).	3.1, 1.5, 5 and 5.5
Principle 5	The priority for public expenditure is public benefit; public expenditure should cost effectively achieve the best practical long-term outcomes	Cost benefit analysis for management options has recognised the public benefit as priority for management options	5.4 and 5.5

	Coastal Management Principles	Addressed by Wollongong CZMP	Report Section
Principle 6	Adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risk where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions to manage high risks while long-term options are implemented	This plan has been prepared using the ISO 31000:2009 International Standard Risk Management Principles and Guidelines. Risks to public safety and assets have been analysed and mapped. Evaluation of the tolerability of risks has been evaluated. In certain cases risks that cannot be reasonably treated must be accepted. A triggered based approach to implementation has been applied, with "no regrets" options to build resilience implemented now, as well as signal intent and a plan for allow appropriate approvals and funding for more difficult options in the future.	Entire Plan: 4, 5, 5.5.
Principle 7	Adopt an adaptive risk management approach if risks are expected to increase over time, or to accommodate uncertainty in risk predictions	The adaptability of management options to future circumstances was a consideration in selection of preferred options. A triggered based approach has been applied	5.5
Principle 8	Maintain the condition of high value coastal ecosystems; rehabilitate priority degraded coastal ecosystems	Ability of a management option to provide environmental protection or benefit has formed part of cost benefit analysis of options. Specific options for prioritising rehabilitation for at risk coastal ecosystems have also been developed.	5.5 and 5.4.1
Principle 9	Maintain and improve safe public access to beaches and headlands consistent with the goals of the NSW Coastal Policy	This plan interlinks with existing community access plans (i.e. POMs) by recommending coastal hazards considerations be incorporated into existing community access planning.	5.4
Principle 10	Support recreational activities consistent with the goals of the NSW Coastal Policy	This plan interlinks with existing community recreation plans (i.e. POMs) by recommending coastal hazards considerations be incorporated into existing recreation planning.	5.4, 1.3

2.2.11 Other Policies and Guidelines

The remaining policies relating to the coastal zone of Wollongong LGA, as reviewed in Appendix C, include:

- *The NSW Coastal Planning Guideline: Adapting to Sea Level Rise*, which provides guidance by the Department of Planning and Infrastructure for risk based planning for sea level rise;
- *The Coastal Risk Management Guide – Incorporating sea level rise benchmarks in coastal hazards assessments*, which provides technical guidance for assessing sea level rise impacts using the NSW Sea Level Rise Policy Statement benchmarks, such as used for the Wollongong Coastal Zone Study (Cardno, 2010);

- *SEPP (Infrastructure) 2007,* which outlines works permitted without consent by public authorities particularly for environmental management purposes, including beach nourishment and erosion control;
- The Coastline Management Manual (1990) which guided the commencement of the Wollongong CZMP, most notably the completion of the Wollongong Coastal Zone Study, but which has since been superseded by the CZMP Guidelines

3 COASTAL HAZARDS ALONG THE WOLLONGONG LGA COASTLINE

3.1 Introduction

The coastal hazards extents as defined and mapped within the 2010 Wollongong City Council Coastal Zone Study (Cardno, 2010) have been adopted in preparing this Coastal Zone Management Plan. The 2010 Wollongong City Council Coastal Zone Study was adopted by Council and therefore provides an appropriate basis for this Plan.

The Wollongong City Council Coastal Zone Study provided definition and mapping of the Erosion and Recession Hazard extent for the 2010 (referred to herein as 'immediate'), 2050 and 2100 timeframes, the Coastal Inundation Extent for immediate, 2050 and 2100 and the Coastal-Influenced Geotechnical Hazard Zone for the present to 2100 timeframe. This mapping of hazard extents has been utilised to undertake the Risk Assessment in Chapter 4 that was subsequently used to prepare management options to treat the risks.

A Coastal Zone Management Plan is required to begin the process of long term strategic planning and future works to manage coastal hazards. The hazards definition should be updated as methodologies and scientific information (particularly relating to climate change) continues to improve into the future. It is intended that this Plan shall also be updated in conjunction with new hazards assessments, however, the approach to managing the risk from coastal hazards is aimed to be of a form that can be expanded, reversed or adapted as new hazards information becomes available.

3.2 Coastal Processes and Hazards

Coastal processes (natural and human influenced) are the principle source of risk in the coastal zone, as such processes can generate significant hazards to coastal land and assets.

Coastal processes include and are affected by:

- Regional geology (which sets the structure of the coastal zone) and geomorphology (which is both a product of coastal processes as well as affecting processes);
- Waves (particularly during storms);
- Water levels (from tides and during storms);
- Coastal entrances (for creeks, lagoons, lakes and estuaries);
- Sediment transport;
- Windborne sediment transport;
- Stormwater runoff; and
- Climate change, particularly sea level rise, which will affect all of the above coastal processes.

A summary of coastal processes acting along Wollongong's coastline is provided in Section 1.6 of the Wollongong CZMP: Implementation Action Plan.

Each of these processes interact to generate hazards, which include:

- Beach erosion (during short term storm event or events in close succession) and dune slope instability;
- Shoreline recession (particularly relating to sea level rise);
- Coastal inundation (during high tides combined with storms and sea level rise), which can manifest as both wave overtopping of the open coastline, or inundation of land behind the open coastline via coastal creeks and estuaries and stormwater systems connecting to the ocean;
- Cliff instability and geotechnical hazards;
- Coastal entrance instability;
- Erosion at stormwater outlets / drainage lines; and
- Sand drift.

All of the above hazards were assessed in the Wollongong City Council Coastal Zone Study (Cardno, 2010) for the immediate, 2050 and 2100 timeframes taking into account climate change, specifically sea level rise. The hazards as derived in the Cardno (2010) report have been adopted for use in developing this Coastal Zone Management Plan, without amendment.

3.2.1 Erosion and Recession

Beach (Storm) Erosion

In order to investigate the extent of erosion occurring under high waves and water levels (i.e. storms), the following process was undertaken by Cardno (2010):

- The Simulating WAves Nearshore (SWAN) numerical model was used to transpose waves from offshore into the surfzone of Wollongong's beaches, using measured peak offshore wave data statistics of 100 year ARI from Botany Bay (for wave height);
- The SBEACH modelling system was used to investigate storm erosion potential at individual beaches during a single 'design' storm, equivalent to the 1 in 100 year wave height and water levels in the ocean (between 2 – 4 cross-sectional profiles were modelled for each beach);
- Historical beach volume losses between closely spaced dates of photogrammetry were calculated and averaged within each beach (10 beaches have photogrammetric data), for comparison with the SBEACH model outputs (at some beaches the photogrammetric data was dated too far apart to represent a 'design' storm for comparison with SBEACH model output).
- SBEACH model outputs were scaled up according to the high and low storm demand values (250 m^3/m and 160 m^3/m respectively) given in NSW Government manuals.

A short summary of the approach to storm erosion, including limitations is given in Appendix D. A detailed explanation of the process used to calculate the beach erosion hazard can be found within the Wollongong Coastal Zone Study (Cardno, 2010).

Historical Shoreline Recession

The analysis of photogrammetric data by Cardno (2010) indicated there to be no signature of long term recession at any of the Wollongong beaches. In fact, there had been a noticeable increase in dune volumes at most locations between 1974 and 2010. The most eroded beach state at almost all

beach locations was recorded in 1974, and this is consistent with the historical storm records (Cardno, 2010).

Regional Longshore Sediment Transport

Cardno (2010) assumed there to be no longshore sediment transport between embayments. That is, each beach was assumed to be a closed system, with no significant transfer of sediment between embayments.

Future Recession Due to Sea Level Rise

Shoreline recession is generally expected to occur as a result of the projected rise in sea level to 2100 and beyond. Cardno (2010) utilised the Bruun Rule (1962) for estimating shoreline recession due to sea level rise. There are a number of widely documented limitations to the Bruun Rule, as given by Ranasinghe *et al*. (2007).

The closure depth is a parameter within the Bruun Rule, from which the nearshore slope and recession extents are measured. For use in the Bruun Rule, it was noted that the open NSW coast is generally considered to have a closure depth of 9 – 12 m below sea level, and this is the value utilised by Cardno (2010).

The recession analyses at each beach were included in the hazard lines for 2050 and 2100.

Erosion and Recession Hazard Mapping

The following Erosion and Recession hazards were mapped at the following timeframes:

- Immediate – landward extent of the eroded scarp following the design storm event;
- 2050 – shoreline recession due to 0.4 m SLR + landward extent of the eroded scarp following the design storm event; and
- 2100 – shoreline recession due to 0.9 m SLR + landward extent of the eroded scarp following the design storm event .

For each time period, the zone of reduced foundation capacity (ZRFC) was mapped as a separate hazard, beyond the erosion and recession hazard line. The zone of reduced foundation capacity is defined as follows. The near vertical erosion scarp left following a storm erosion event will over time slump through a zone of slope adjustment to the natural angle of repose of the sand (approx. 1.5 Horizontal to 1.0 Vertical). Immediately adjacent to and landward of the dune scarp exists a zone of reduced foundation capacity, which is unstable due to the potential for soil slip or undermining of the dune scarp, and is therefore unsuitable for building foundations.

Mapping of the erosion hazard and ZRFC at each time period was based upon either ALS data or the average photogrammetric profile condition. At the ends of beaches, the hazard extent was reduced to consider the presence of rock and cliffs, generally reduced wave exposure, and generally steeper slopes (Cardno, 2010).

Erosion of entrance berms was not included in the defined hazard. Instead, the erosion hazard through the entrance berm area was defined at the design water levels (Cardno, 2010). No erosion or recession hazard was defined for the Lake Illawarra foreshores.

The erosion hazard definition at all sites except the North Beach Bathers Pavillion seawall and Continental Pool wall, did not account for shoreline protection features. Shoreline protection features (e.g. Thirroul seawall) were not included as there was no definitive information available on the foundations of the works from which to judge the effectiveness during the design wave and water level conditions. Where site specific investigations for the existing protection structures indicated that the structure was suitably founded on rock or deep foundations and built to withstand wave attack, the erosion hazard line could be redefined at the line of the structure.

3.2.2 Coastal Inundation

Wave run up during storms may be of sufficient height to overtop the back beach area. The height of the overtopping wave depends not only on the wave conditions, but on the slope of the back beach area. Coastal inundation also relates to the ingress of water through coastal entrances to flood low lying land behind the coastline. The duration of inundation is much shorter than catchment flooding, usually lasting 1 – 3 hours over the peak of high tide. Likewise for wave overtopping, during the storm the irregular height and period storm waves would result in only the larger waves overtopping, and this would occur only during the peak of the storm water levels (including tide).

Wave inundation was modelled for immediate, 2050 and 2100 timeframes to identify the area subject to wave inundation (including wave run-up) during a 100 year ARI wave height and water level. Cardno (2010) used:

- nearshore wave modelling to determine the wave set up component of still water levels at each beach profile location in the study area;
- the Delft3D Flow model to investigate wave overtopping and coastal inundation in the study area;
- Overtopping rates were calculated using the computational methods of PIANC (1992), and to calculate overtopping rates, the back beach area was assumed to be eroded, as would be expected during the storm conditions (Cardno, 2010);
- Wave overtopping simulations were then modelled including the 2050 and 2100 sea level rise scenarios.

A Coastal Inundation Hazard zone for the immediate, 2050 and 2100 timeframes were mapped based upon the wave inundation model results at each of these time periods. The mapping has been utilised in the risk assessment and options development for this Plan.

The Delft 3D FLOW model was used to investigate the propagation of the overtopped wave in the back beach area. Cardno (2010) found that waves attenuated within 50 m of the top of the back beach area, depending on the back beach level. In only a few cases, a landward flow was identified beyond that distance in model results. The model results were said to be consistent with observations of wave overtopping, for example at Austinmer Beach (Cardno, 2010).

For Lake Illawarra, inundation levels inside the lake due to the ocean water level condition was also modelled (in Delft 3D FLOW). The model results showed inundation levels relating to ocean water levels to be consistently lower than water levels from 100 yr ARI catchment rainfall flooding event (not including ocean water levels), at all planning horizons (Cardno, 2010). The additional wave overtopping component was not investigated for Lake Illawarra, as waves were said to be typically

small wind waves. Instead, Cardno (2010) assumed wave run-up was attenuated within 10 m landward of the shoreline around the lake foreshores.

Flows from the catchment due to rainfall were not included in the modelling of coastal inundation (as is typical for coastal hazards studies), which may combine with high ocean water levels during a storm to influence inundation of lagoon, creek and lake waterways. Such investigations would typically be conducted as part of catchment flood studies. Likewise the effect of high water levels (without wave overtopping or run-up) into the stormwater system were also not assessed by the Wollongong Coastal Zone Study (Cardno, 2010), and again, this would typically be assessed during a flood modelling study.

The wave inundation modelling does not account for structures such as buildings and stormwater outlets that may modify the dissipation and flow of waves. Overtopping at seawall and coastal protection structures was not specifically calculated. However, the overtopping modelling is still considered suitable for use in preparing management actions to treat areas at high risk.

A detailed description of the Coastal Inundation assessment can be found within the Wollongong Coastal Zone Study (Cardno, 2010).

3.2.3 Geotechnical Hazards

Wollongong LGA has a long history of geotechnical landslip hazards, and long experience in assessing and managing such hazards. The investigations for the Wollongong Coastal Zone Study focussed upon the influence of coastal processes, including wave breaking, run-up and overtopping, sea level rise, and climate change induced shifts in rainfall intensity, upon the area affected by geotechnical hazards.

A Coastal-Influenced Geotechnical Hazard Zone representing the “areas where coastal processes (including climate change) will directly influence geotechnical hazards to 2100” was defined. Geotechnical assessments for proposed or future development should include specific assessment of coastal processes if located within this zone (GHD, 2010).

The geotechnical hazard considered the following coastal processes:

- Wave run-up on representative cliffs in the study region was calculated using empirical formulae for wave run up on rough impermeable slopes (wave run up implicitly includes wave set up), for up to the 100 yr ARI offshore wave height. Sea level rise was included at 2050 and 2100, to feed into the geotechnical investigations of the change in run-up affected areas over the next 100 yrs (Cardno, 2010);
- Wave inundation extents and storm erosion hazard extents were also considered in concert with the geotechnical hazard extent (Cardno, 2010); and
- Rainfall data was used in the geotechnical and slope stability assessments. The 90-days rainfall intensities were calculated using a frequency analysis for rainfall gauge sites in the study area (Bureau of Meteorology gauges at Woonona – Popes Rd, Wombarra – Reef Avenue and Port Kembla – BHP Central Lab), for use in land slip analysis. Climate change parameters incorporating an increase in rainfall intensities of 10% by 2050 and 20% by 2100 were then adopted and stabilities re-assessed (Cardno, 2010).

3.2.4 Coastal Entrances and Stormwater Erosion Hazards

While there are numerous entrances to small coastal creeks and lagoons along the Wollongong coastline, the erosion of coastal entrance berms was not defined separately or included in the assessment of beach erosion hazard lines for the study area. It was assumed that entrance breakout processes are being addressed within local catchment flood studies, because entrance breakout is driven by rainfall patterns in the catchment (Cardno, 2010).

For stormwater erosion surrounding outlets, following rainfall events, there is expected to be some scouring of the surrounding beach around the outlets. Cardno (2010) noted, however, that the impact of stormwater drains on the morphology of the whole beach is localised near each individual outlet, and as such did not consider this to influence the definition of the erosion hazard. Thus, stormwater erosion at outlets has not been included in the erosion hazard lines defined.

3.2.5 Sand Drift

The Wollongong Coastal Zone Study (Cardno, 2010) found that, while areas at Windang and Port Kembla had been subject to sand drift as a hazard in the past, extensive dune rehabilitation works at these beaches and elsewhere in the Wollongong coastal zone have effectively mitigated this hazard. Therefore, Cardno (2010) did not investigate sand drift further.

Dune rehabilitation works at City Beach, Bulli Beach and elsewhere have been observed by community to have mitigated the occurrence of windblown sand drifts across adjacent roadways, for example, at Flagstaff Hill. Changes in sediment supply between beaches that may have occurred in relation to dune rehabilitation (for example, between City Beach and Brighton Beach) were not investigated by Cardno (2010). However, dune rehabilitation to capture windblown losses of sediment from the beach system has improved protection for the beaches from storm erosion.

4 COASTAL RISK ASSESSMENT

4.1 Application of a Risk Framework to Coastal Management

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

The Risk Assessment process utilised for the Wollongong CZMP is adapted from the Australian Standard Risk Management Principles and Guidelines ISO 31000:2009, as described below and presented schematically in Figure 4-1. The use of a risk-based approach for managing coastal hazards is a requirement of the new CZMP guidelines, and accords with current international best practice for natural resource management.

- **Establish the Context –** the requirements of a coastal zone management plan set by NSW Legislation and Guideline documents provides the context for the risk assessment and intended outcomes. The purpose and context for the Wollongong CZMP, including the management objectives derived from the NSW Coastal Policy, are outlined in Chapter 1.
- **Identify the Risks –** the risks arise from the coastal hazards, as defined in the CZMP Guidelines and the Coastline Management Manual (1990), which will impact upon coastal values. Values and hazards assessments were combined with community and stakeholder consultation to identify the risks from coastal hazards, refer Chapter 3.
- **Analyse the Risks –** this involves considering the **likelihood** and **consequence** of the identified risks, to determine the overall level of risk (high, medium, low).

  The *likelihood* of risks is largely related to the extent of coastal hazards, now and in the future. Analysis of the likelihood of erosion and recession, coastal inundation at the immediate, 2050, 2100 timeframe and for geotechnical hazards up to 2100 is described in Section 4.2.

  The *consequence* of the risks will largely relate to the extent of existing or future development and the values (e.g. aesthetic, recreational, ecological) associated with land and assets within the coastal zone. The coastal assets mapping and incorporation of community consultation outcomes was used to determine consequence of coastal risks in Section 4.3.

  The consequence and likelihood were combined (using GIS processing) to determine and map the *level of risk* for assets and land in the coastal zone. The level of risk was revised to include existing controls that may reduce the level of risk. Risk analysis and mapping is illustrated in Appendix A.

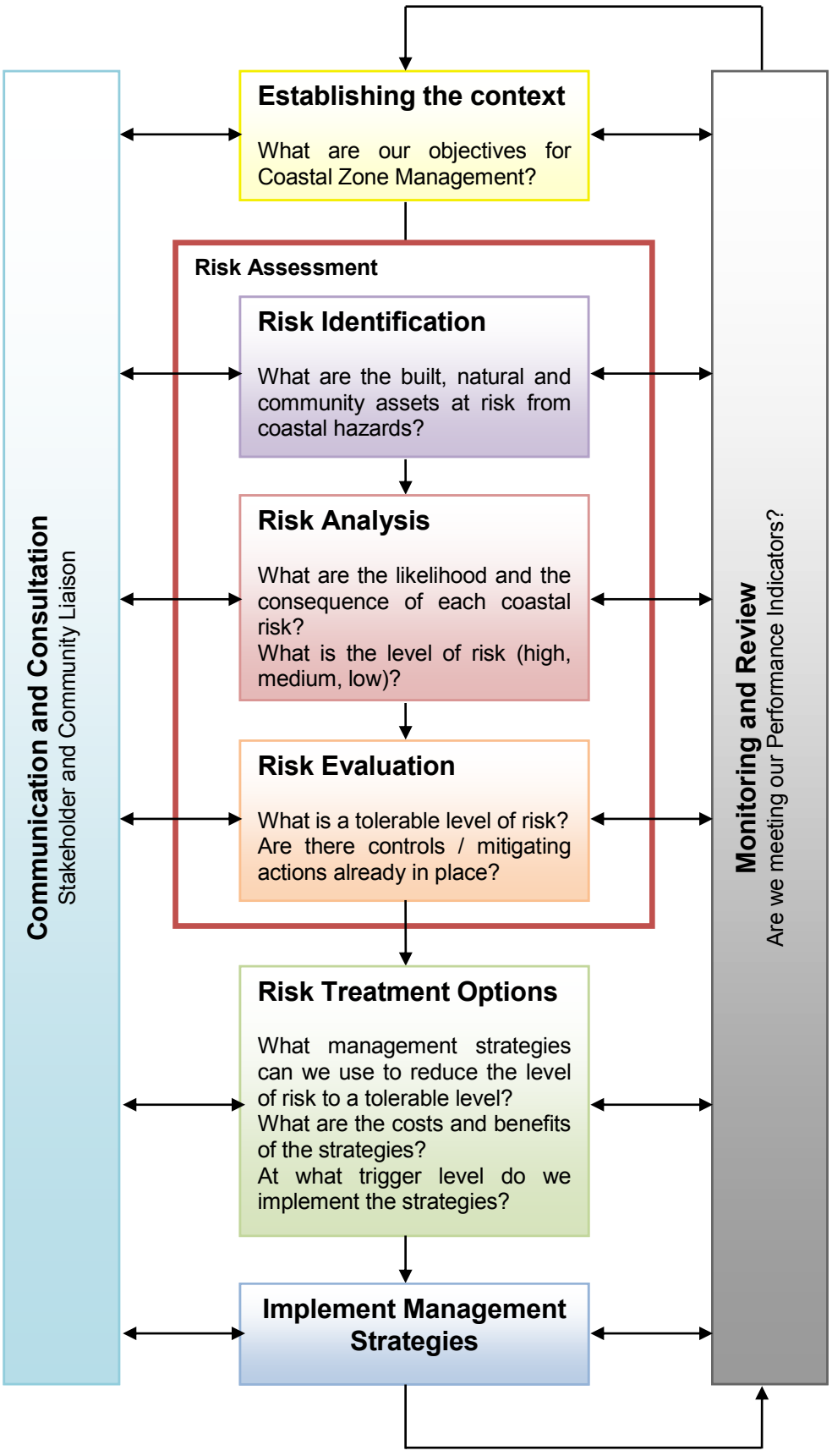


Figure 4-1 Risk Management Framework (ISO 31000:2009) adapted to Coastal Zone Management

- **Evaluate the Risks –** in consultation with Council and other stakeholders, the level of risk that is deemed acceptable, tolerable and intolerable was determined. The evaluation criteria determine the intolerable risks that must be treated as a priority, to which management effort shall be directed, refer Section 4.6.
- **Treat the Risks –** the process of developing coastal management options is directly related to reducing or eliminating intolerable risks where possible. Tolerable (low) risks can be flagged for monitoring, with no further resources necessary. Management options can be designed to reduce the likelihood of the risks (e.g. planning setbacks to reduce the likelihood of shoreline recession impacts), or reduce the consequence of the risk (e.g. emergency management to reduce the consequence of shoreline recession) or both. A cost benefit analysis is then used to determine the pros, cons and trade-offs for the options, based on economic, social and environmental goals. A strategic framework and management options is detailed in Chapter 5.

  For existing development given the uncertainty and timeframes over which hazards may manifest, a trigger for implementing the options has been flagged. Setting triggers ensures the management option and associated resources are not utilised until it is absolutely necessary to do so, which is particularly important for difficult and costly, but necessary, options. This is described further in Section 4.6.1.
- **Implement Management Strategies (Risk Treatments) –** The coastal zone management plan provides the forum to detail how the recommended management options (risk treatments) shall be implemented (costs, timeframes etc) and funded. Ongoing monitoring and review of both the risks and management options is also detailed. Plan implementation is detailed in Chapter 7.

4.2 Analysis of Risk Likelihood

The likelihood scale used for the risk assessment was developed specifically for this project, to account for both the timeframes over which coastal processes occur and present a hazard to property and coastal values, as well as the planning timeframes over which risk must be assessed and accounted for. The description of timeframes from Council's Enterprise-wide Risk Management Likelihood Table was too short to apply to landuse planning or the timeframes over which coastal hazards pose a significant risk. However, aspects relevant to the description of coastal hazard likelihood from Council's Likelihood Table have been incorporated into a customised scale given in Table 4-1.

4.2.1 Likelihood of Erosion and Inundation Hazards

The likelihood ascribed to the erosion / recession and coastal inundation hazard lines aims to incorporate the key concept associated with sea level rise, whereby the likelihood of an erosion or inundation impact increases over time and with proximity to the ocean. The concept of increasing likelihood overtime is demonstrated in Figure 4-2. The likelihood values ascribed to the hazard lines are given in Table 4-1. The likelihood values were assigned spatially (within GIS) to each of relevant hazard zones mapped in the Wollongong coastal zone.

At the present time (without sea level rise), the defined coastal erosion hazard is considered "possible". The erosion event described by the mapping is recorded in the photogrammetric survey record for the beaches. The hazard estimates for storm erosion at the immediate timeframe were determined based upon design storm criteria (a 100 year average recurrence interval wave height

and water level), which were then input to the cross-shore transport model SBEACH (refer Cardno, 2010). Such criteria will possibly occur again.

For the immediate timeframe, a likelihood has also been ascribed to the 2050 and 2100 hazard lines. This aims to incorporate historical erosion events that have been recorded further landward than the immediate hazard lines, for example, in the photogrammetric data at Coledale, Corrimal, City and Port Kembla / Perkins beaches. Ascribing an “unlikely” possibility to the 2050 hazard line is appropriate, as there has indeed been a history of isolated and infrequent occurrence.

As noted above, the immediate hazard estimates are based upon design storm criteria. However, design storm criteria do not necessarily produce a design or maximum storm erosion extent. For example, the design erosion may be due to a series of closely spaced storms. Wave direction may also be important in the potential extent of erosion, which drives longshore sediment transport and will result greater or lesser erosion at different sections of the beach. The SBEACH model used to derive the immediate estimates does not account for longshore sediment transport. Lastly, there is potential for storm events larger than historically recorded. For this reason, a “rare” likelihood was ascribed to the 2100 hazard estimates for the current time period, to account for potentially greater storm impacts than historically recorded or estimated, but clarifying that such events would indeed be highly unlikely(similar to the probable maximum flood used in flood mapping).

By the 2050 timeframe when the effects of sea level rise has begun to manifest as recession of the sandy shoreline and inundation into estuaries, it has become more likely that erosion to immediate, 2050 and 2100 defined hazard lines will be experienced. Indeed, erosion to the immediate hazard line is expected to be occurring frequently, but erosion beyond the 2050 line would still be relatively infrequent and isolated.

Likewise as sea level rise progresses to 2100 projections, further recession of the sandy shoreline and inundation into estuaries is expected to have occurred. Once again, the probability of experiencing erosion to the defined immediate, 2050 and 2100 lines will have increased. Indeed, the immediate erosion hazard line is likely to be occurring with every regular storm, or more often.

The possibility that sea level rise will not manifest is also catered for within this approach: at each timeframe, it is not assumed that the relevant hazard line for that timeframe is absolutely certain or even ‘almost certain’. The possibility that sea level rise will not occur needs also be considered when developing future management options. This is done through prescribing likelihood to hazard extents, as well as setting triggers for implementation of management actions (refer Section 4.6.1) that are event based rather than time based.

Table 4-1 Risk Likelihood / Probability, Coastal Hazards

Probability	Description
Almost Certain	There is a high possibility the event will occur as there is a history of frequent occurrence. The event is expected to occur in most circumstances.
Likely	It is likely the event will occur as there is a history of casual occurrence. The event has occurred several times or more in the past.
Possible	The event has occurred at least once in the past and may occur again.
Unlikely	There is a low possibility that the event will occur, however, there is a history of infrequent and isolated occurrence.
Rare	It is highly unlikely that the event will occur, except in extreme / exceptional circumstances, which have not been recorded historically.

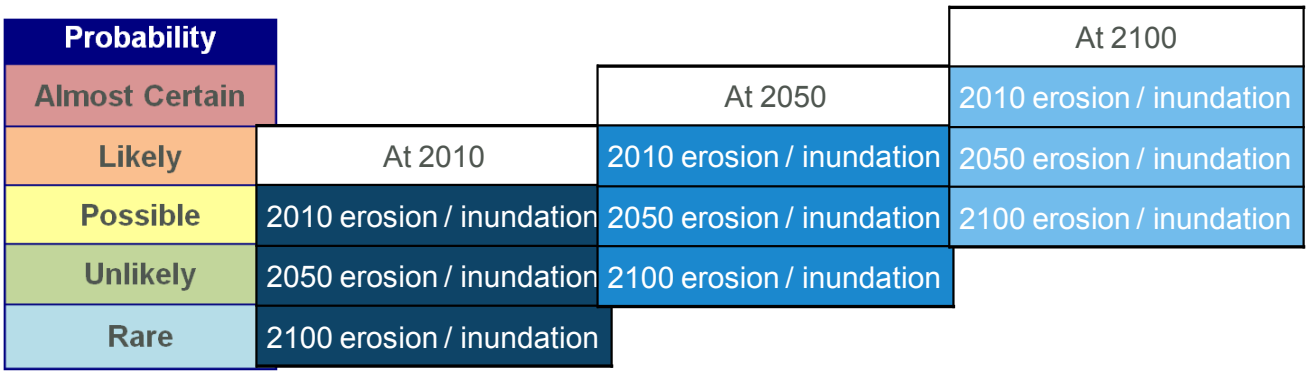


Figure 4-2 Increasing Likelihood of Hazards Over Time with Sea Level Rise

Table 4-2 Likelihoods Ascribed to Erosion and Coastal Inundation Hazards at Each Timeframe

Timeframe	Erosion / Recession Hazard	Coastal Inundation Hazard	Likelihood
Immediate	2010 ZRFC line	2010 OI line	Possible
	2050 ZRFC line	2050 OI line	Unlikely
	2100 ZRFC line	2100 OI line	Rare
2050	2010 ZRFC line	2010 OI line	Likely
	2050 ZRFC line	2050 OI line	Possible
	2100 ZRFC line	2100 OI line	Unlikely
2100	2010 ZRFC line	2010 OI line	Almost Certain
	2050 ZRFC line	2050 OI line	Likely
	2100 ZRFC line	2100 OI line	Possible

** Where ZRFC is the Zone of Reduced Foundation Capacity associated with an erosion escarpment; and OI refers to Oceanic Inundation, which is also referred to as Coastal Inundation*

4.2.2 Likelihood of Geotechnical Hazards

At all timeframes, the Geotechnical hazard line remains 'rare'. The methodology used to develop the coastal hazard area is considered conservative, and typically falls within areas of existing landslip hazard. Further, the zone was developed for the immediate to 2100 timeframe (specific immediate and 2050 hazards were not defined).

The likelihood values were assigned spatially (within GIS) to each of relevant hazard zones mapped in the Wollongong coastal zone.

Table 4-3 Likelihood Ascribed to Coastal Induced Geotechnical Hazard at Each Timeframe

Timeframe	Geotech Hazard Line	Likelihood
Immediate	Geotech Hazard Line	Rare
2050	Geotech Hazard Line	Rare
2100	Geotech Hazard Line	Rare

4.3 Analysis of Risk Consequence

A consequence scale was developed for this project to capture the community, cultural and essential services aspects that may be impacted by coastal hazards over the relevant planning timeframes, as given in Table 4-4. Council's existing Enterprise-wide Risk Management Risk Ranking Tool Severity Table was also utilised with respect to Property (economic) and Environment consequences, as given in Table 4-4. The scale was utilised in deriving a consequence value for the various assets and land in the coastal zone that is affected by the different coastal hazards.

4.3.1 Coastal Assets and Values

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

- spatial mapping of land zoning, land tenure, cadastre and aerial photography;
- mapping of stormwater assets, heritage items, parks, public buildings, cycleways, roads, vegetation condition, endangered ecological communities;
- information regarding assets (social, cultural, recreational, economic) from various reports, such as noted below; and
- details from community consultation, including meetings within Council's departments, Committee, Community Workshops including one-on-one conversations, which assisted in determining specific information about individual assets.

The assets delineated across the Wollongong coastal zone are listed in Table 4-5 .

Table 4-4 Risk Consequence Scale for Coastal Hazards

Consequence	Community	WCC Property (Economic)	WCC Environment
Catastrophic	Widespread permanent impact to community's services, wellbeing, finances, or culture (eg, > 75 % of community affected), or international loss, or no suitable alternative sites exist	Damage to property, plant and equipment, finances > $5 million	Catastrophic event (e.g. habitat destruction) with national impact (e.g. endangered species) for more than one year
Major	Major permanent or widespread medium term (somewhat reversible) disruption to community's services, wellbeing, finances, or culture (eg <50 % of community affected), or national loss, or Only a few suitable alternative sites exist	Damage to property, plant and equipment, finances >$2 million - $5 million	Major event (e.g. creek contamination) with regional impact (e.g. lake, escarpment) for more than one year
Moderate	Minor long term or major short term (mostly reversible) disruption to services, wellbeing, finances, or culture of the community (eg, <25 % of community affected), or regional loss, or Some suitable alternative sites exist	Damage to property, plant and equipment, finances >$100,000 - $2 million	Major event (e.g. creek contamination) with regional impact (e.g. lake, escarpment) for between one month and one year
Minor	Small medium – short term (reversible) disruption to services, wellbeing, finances, or culture of the community (eg, <10 % of community affected), or local loss, or many alternative sites exist	Damage to property, plant and equipment, finances >$10,000 -$100,000	Minor event (e.g. 20 lt oil spill) with localised impact (e.g. street, precinct) for less than one month
Insignificant	Very small short term disruption to services, wellbeing, finances, or culture of the community (eg, <5 % of community affected), or neighbourhood loss, or numerous alternative sites exist	Damage to property, plant and equipment, finances <$10,000	Negligible event (e.g. noise pollution) with localised impact (e.g. street, precinct) for less than one month

A series of maps of coastal assets in Wollongong were generated. The asset maps provided the blueprint for determining the values associated with coastal land and assets.

Information regarding the coastal assets was gathered to help value the assets. Detailed information for each asset at each beach (where available) was tabulated into a series of Beach Asset and Consequence Tables, as provided in Appendix E.

The detailed information drew upon the following information sources:

- Review of relevant reports, plans and documents for the Wollongong Coastal Zone, including available estuary management plans, Plans of Management for community and crown lands, masterplans and recreational strategic plans, floodplain management plans, regional biodiversity strategies, and the Wollongong Coastal Zone Study (Cardno, 2010), which is summarised in Section 1.7 of the Wollongong CZMP: Implementation Action Plan. The reference list to this document includes the reports utilised;

- Detailed meetings with individual departments within Council;
- Outcomes from four community workshops, utilising both a generic worksheet task plus one-on-one conversations; and
- Workshop with the Committee.

The values information and outcomes of community consultation formed the basis of determining the consequence of impact from the coastal hazards.

Table 4-5 Coastal Asset Categories and Items

Coastal Assets Categories and Asset items	
Parks, Beaches and open space	***Transport Infrastructure***
Beaches	Major (arterial) roads, bridges
Parks, Public open space / reserves	Local Roads, (including car parks)
Private recreational land (e.g. golf courses, football grounds, bowls clubs, tennis courts)	Railway systems
Wetlands / Forests / Other Habitats (including estuary entrances)	Jetties, wharves, boat ramps
Coastal Dune Systems	Harbours
Community Infrastructure	***Water and sewage infrastructure***
Surf Clubs	Stormwater outlets and pipes
Caravan Parks	Sewage Treatment Plants, sewage pumping stations, water supply networks
Heritage / Historic Sites and Significant Aboriginal Sites	***Residential Development***
Heritage Norfolk Island Pines	Existing Residences
Cycleway / Shared Pathway	Vacant Land (Future Development)
Ocean Pools	***Commercial and Industrial Development***
Community halls, libraries, other public buildings	***Institutional Infrastructure***
Amenities blocks, sheds, etc (Council facilities / assets)	Hospitals, Hospices
Lifeguard towers	Schools, child care facilities
	Aged care facilities

4.3.2 Consequence from Coastal Hazards

The coastal assets and values information for the different asset categories was used to determine:

- a generic consequence value for each asset type and each hazard, as given in Table 4-6; and
- a separate consequence value for specific assets where it was apparent from the values assessments that a higher or lower consequence should be applied (i.e. because the specific asset or value was determined to be exceptional from other similar assets in the LGA), as given in the Beach Asset and Consequence Tables, Appendix E.

The consequence values were assigned spatially (within GIS) to each of the generic and specific assets mapped across the LGA.

A separate consequence value was ascribed for the erosion and geotechnical hazards compared with the coastal inundation hazard, as the types of impacts are different, even though the value of the land may be the same. The impacts from both erosion and recession and geotechnical land failure are permanent and irreversible. That is, once recession has undermined a house on a sandy dune or landslip has undermined a house on a cliff, the loss of the land is permanent. In contrast, coastal inundation resulting in flooding of property is a short term reversible phenomenon, as the water recedes after the storm surge and tide ebbs.

It is worth emphasising that the coastal inundation hazard is different from permanent inundation due to sea level rise. The coastal inundation hazard refers to elevated water levels during a coastal storm that may overtop dunes, or penetrate into estuaries, causing flooding of adjacent property. Coastal inundation will be exacerbated over time by sea level rise, causing an increase in the frequency and water depth during such events.

This plan has attempted to consider permanent inundation due to sea level rise where feasible in developing management options. That is, many of the treatment options for inundation or recession would additionally manage permanent inundation. However, specific focus to address permanent inundation due to sea level rise is not within the context of this CZMP.

Table 4-6 Consequence Ascribed to Assets and Land in the Wollongong Coastal Zone

Coastal Assets	Consequence	Reason: Erosion & Geotechnical Hazards (i.e. permanent loss of land)	Consequence	Reason: Coastal Inundation Hazard (i.e. periodic inundation during storms)
Parks, Beaches and open space				
Beaches	Major	From all sectors of community, the beach amenity itself is rated extremely highly. Regardless of peoples interest point, whether this be for scenic amenity, recreation, tourism or environmental reasons, virtually every respondent noted the beauty and importance of Wollongong's beaches both to them and to the region's visitors. At the current time period, the beach will generally recover from storm erosion events, although following large storm events this can take a number of years, during which time the beach may be less usable by community. Sea level rise has already commenced at measured rates, therefore we may expect recovery following storms to become increasingly subdued until such point as the loss of sand is irreversible.	Insignificant	The impact of inundation (as separate from erosion) would occur over a short period (a few hours), resulting in a minor nuisance to the community, and causing little to no damage to the value of this asset.
Parks	Moderate	These areas will still remain functional even if reduced in size by erosion. They also serve as a buffer to allow roll back and therefore retention of the beach amenity. There may be some financial and social costs associated with specific facilities within parks (e.g. sports grounds, shelters, sports pitches etc), that make impacts of greater consequence to community.	Minor	The impact of inundation (as separate from erosion) would occur over a short period (a few hours), resulting in a minor nuisance to the community, and causing little to no damage to the value of this asset.
Public open space / reserves	Minor	These areas will still remain functional even if reduced in size by erosion. They also serve as a buffer to allow roll back and therefore retention of the beach amenity.	Insignificant	The impact of inundation (as separate from erosion) would occur over a short period (a few hours), resulting in a minor nuisance to the community, and causing little to no damage to the value of this asset.
Private recreational land (e.g. golf courses, football grounds, bowls clubs, tennis courts)	Minor	As per the Committee's response, private recreational land may have some economic value but to limited users, thus should therefore be ranked below Community's land.	Minor	The impact of inundation (as separate from erosion) would occur over a short period (a few hours), resulting in a minor nuisance to the community, and causing limited damage to the value of this asset.
Wetlands / Forests / Other Habitats	Moderate	Where beach recession occurs slowly enough, habitats will have the ability to migrate. However, areas that are backed by development will not be able to migrate. Areas of high habitat value (where identified through EEC or vegetation mapping) have been highlighted where possible. It is noted that The Illawarra Regional Biodiversity Strategy in determining priorities and habitat value did not account for the impacts of existing coastal processes, sea level rise or periodic inundation that may affect habitat value and areas for priority rehabilitation.	Minor	Given that inundation during storms may last for only a short period, most habitats should withstand such impacts. There are some wetland habitats that may be improved by inundation due to sea level rise, particularly where they are afforded area for migration. However, areas that are backed by development will not be able to migrate. Areas of high habitat value (where identified through EEC or vegetation mapping) have been highlighted where possible. It is noted that The Illawarra Regional Biodiversity Strategy in determining priorities and habitat value did not account for the impacts of existing coastal processes, sea level rise or periodic inundation that may affect habitat value and areas for priority rehabilitation.

Coastal Assets	Consequence	Reason: Erosion & Geotechnical Hazards (i.e. permanent loss of land)	Consequence	Reason: Coastal Inundation Hazard (i.e. periodic inundation during storms)
Coastal Dune Systems	Major	It is recognised across the broader community that dunes are vitally important, providing sand reserves to buffer land and property from the impacts of erosion. Many of the dunes were established since the 1970s. In many places the dunes have limited ecological value, and / or said to be infested by weeds and pests. However, they have significant value as an erosion buffer requiring maintenance into the future.	Insignificant	The impact of inundation (as separate from erosion) would occur over a short period (a few hours), resulting in a minor nuisance to the community, and causing little to no damage to the value of this asset.
Community Infrastructure				
Surf Clubs	Major	Many community members noted the importance of the surf clubs both as assets to bring a sense of community, as well as tourism assets based upon the provision of patrolled beaches for visitors. There may be commercial value through the use of clubs to provide restaurants / kiosks/ bars for community and visitors also, in sought after beach setting. Loss of this asset through erosion or geotechnical landslip would be irreversible.	Moderate	The impact of inundation (as separate from erosion) may cause damage to this asset and its interiors, however the damages are repairable.
Caravan Parks	Minor	These facilities, while often being commercially / financially important to Council, may be important to visitors, but less so to the resident community. They are also easily relocated or adapted.	Minor	The impact of inundation (as separate from erosion) may cause damage to this asset and its interiors, however the damages are repairable.
Heritage / Historic Sites and Significant Aboriginal Sites	Major	There are many different public buildings, other built structures and sites/areas of local to state significance. In general, the sites have a range of community values, such as cultural, aesthetic and even commercial /tourism value. Further, damages and losses from erosion or geotechnical landslip are irreversible.	Moderate	The impacts of periodic inundation during storms (including sea level rise) may cause damage to interior and items within the buildings, however is largely reversible and repairable. There are many different public buildings, other built structures and sites/areas of local to state significance. In general, the sites have a range of community values, such as cultural, aesthetic and even commercial /tourism value.
Heritage Norfolk Island Pines	Minor	Norfolk Island Pines are a marker of settlement in the coastal zone and the foreshore and there are currently restrictions on development near the pines or their removal. However, the pines have a limited lifespan and many of the pines are aging and likely to perish over the next 100 years. The trees can and will be replanted over the future, in which case they could be relocated. In a relative sense then, the pines would be considered lower importance / value than other assets, particularly as only a few specific trees may be affected and which shall need to be replaced over time regardless.	Insignificant	Inundation of Norfolk Island Pines over a short period during a storm would cause little if any long term impact. Norfolk Island Pines are a marker of settlement in the coastal zone and the foreshore and there are currently restrictions on development near the pines or their removal. However, the pines have a limited lifespan and many of the pines are aging and likely to perish over the next 100 years. The trees can and will be replanted over the future, in which case they could be relocated.
Cycleway / Shared Pathway	Moderate	The cycleway / shared pathway is an important, highly utilised community asset. It also offers an effective use of high risk coastal land that can be relocated in the future (e.g as part of maintenance scheduling). Sections of cycleway have been relocated or maintained for coastal erosion in the past (e.g. Waniora Point)	Minor	The cycleway / shared pathway is an important, highly utilised community asset. It also offers an effective use of high risk coastal land that can be periodically inundated during high water levels during storms. Permanent inundation due to sea level rise however would have a permanent impact upon the value of this asset, however this would be accompanied by erosion impacts (thus can be managed through this process).

Coastal Assets	Consequence	Reason: Erosion & Geotechnical Hazards (i.e. permanent loss of land)	Consequence	Reason: Coastal Inundation Hazard (i.e. periodic inundation during storms)
Ocean Pools	Major	Various pools have been rated more or less highly, relating to their patronage and potential to withstand future impacts. Permanent inundation due to sea level rise would have a permanent impact upon the value and effectiveness of this as a public asset. Impacts from storm waves may also cause damage to these assets (albeit reversible).	Minor	Various pools have been rated more or less highly, relating to their patronage and potential to withstand future impacts. Periodic inundation during storm events is unlikely to affect the value and effectiveness of this as a public asset in the long term.
Community halls, libraries, other public buildings	Moderate	These facilities are considered in a similar manner to commercial and industrial development with respect to consequence of impact for the community.	Moderate	The impact of inundation (as separate from erosion) may cause damage to this asset and its interiors, however the damages are repairable.
Amenities blocks & sheds (Council facilities / assets)	Minor	It is important for such facilities to be provided to the community, however the buildings themselves are not of high value, and can be relocated or replaced.	Insignificant	The impact of inundation (as separate from erosion) may cause minor damage to this asset and its interiors, however the damages are repairable. It has been assumed that the level of inundation to amenities blocks would not affect the workings of the sewerage system at these sites.
Lifeguard towers	Minor	These assets can be replaced easily, the structure itself is of low value (the lifeguard services is the item of value)	Insignificant	Lifeguard towers are typically located high above ground, therefore the interior of the asset is protected from damage from periodic inundation.
Transport Infrastructure				
Major (arterial) roads, bridges	Major	Arterial roads are the key conduits for traffic flow within the regional community. Damage or loss that blocks or impedes these routes would indeed cause major disruption to the community.	Major	Inundation across major traffic routes may have impacts upon the safety and access for community particularly during storms where access is important
Local Roads, (including car parks)	Minor	So long as access to the beach, to private property or effective transport routes to major roads for residents can be maintained, the permanent loss of local roads is of lesser importance to the functioning of the greater community.	Moderate	Inundation across minor traffic routes may have impacts upon the safety and access for community particularly during storms where access is important
Railway systems	Major	Railway assets are of regional economic and social importance	Moderate	Inundation across railway systems may have greater regional economic and community impacts while such systems are affected, however the impacts are reversible and not permanent.
Jetties, wharves, boat ramps	Minor	These features typically service few community members, compared with other transport infrastructure (and they can be raised or relocated easily)	Minor	These features typically service few community members, compared with other transport infrastructure (and they can be raised or relocated easily)
Harbours	Major	There are very few such features on the open coast, therefore they are of high community and economic value. The majority of harbours are also heritage listed. Permanent inundation due to sea level rise would have a permanent impact upon the functionality of the harbours as a community asset. Impacts from storm waves may also cause damage to these assets (albeit reversible).	Minor	There are very few such features on the open coast, therefore they are of high community and economic value. The majority of harbours are also heritage listed. Periodic inundation during storms would typically be expected over the life of the harbour, and unlikely to permanently affect the functionality of the harbours as a community asset.
Water and sewage infrastructure				

Coastal Assets	Consequence	Reason: Erosion & Geotechnical Hazards (i.e. permanent loss of land)	Consequence	Reason: Coastal Inundation Hazard (i.e. periodic inundation during storms)
Stormwater outlets and pipes	Major	These assets provide an important service to the community, and are often very expensive infrastructure with long expected design life (75 -100 yrs). Replacement can be difficult and costly. Careful design to maintain future functioning of this service will be required	Major	These assets provide an important service to the community, and are often very expensive infrastructure with long expected design life (75 -100 yrs). Replacement can be difficult and costly. Careful design to maintain future functioning of this service will be required
Sewage Treatment Plants, sewage pumping stations, water supply networks	Major	Provide a vital service to social health and functioning.	Major	Provide a vital service to social health and functioning. The impacts from inundation may potentially have significant environmental and community impacts, even where this is reversible.
Residential Development				
Existing Residences	Moderate	For the general public, other community assets would be rated more highly. For the individual owner, this asset is of very high importance. Losses in relation to erosion or geotechnical landslip are irreversible.	Moderate	For the general public, other community assets would be rated more highly. For the individual owner, this asset is of very high importance. The economic impact from inundation of private residential property could potentially be substantial. However, damages are repairable.
Vacant Land (Future Development)	Minor	There may be financial implications for the owners of such land, however impacts to vacant land have minimal effect upon the broader community.	Insignificant	Periodic inundation of vacant land may have minimal effect upon the broader community and cause little if any damage.
Commercial and Industrial Development	Moderate	Commercial and Industrial development is largely relocatable, and while it contributes to the greater economic good, many businesses would expect to move or relocate over the typical life of a business	Moderate	Commercial and Industrial development is largely relocatable, and while it contributes to the greater economic good, many businesses would expect to move or relocate over the typical life of a business. The economic impact from inundation of businesses could potentially be substantial. However, damages are repairable.
Institutional Infrastructure				
Hospitals, Hospices	Major	Such facilities are socially vital, while the building is typically highly financially costly to build and fit out, making relocation of the physical asset difficult.	Major	Such facilities are socially vital, while the building is typically highly financially costly to build and fit out, making relocation of the physical asset difficult. During periodic inundation events, damages or loss of services from this asset is of significant impact to community.
Schools, child care facilities	Moderate	Such facilities are highly important to the community, however the grounds and buildings can be relocated / replaced	Moderate	Such facilities are highly important to the community, however the grounds and buildings can be relocated / replaced
Aged care facilities	Moderate	Such facilities are highly important to the community, however the grounds and buildings can be relocated / replaced	Moderate	Such facilities are highly important to the community, however the grounds and buildings can be relocated / replaced

4.4 Incorporating Existing Controls

Existing controls such as provisions in the LEP or DCPs, POMs, or other strategic plans, including estuary and floodplain management plans need to be incorporated into the assessment of risk, as such controls may reduce the level of existing risk (likelihood and / or consequence).

The review of the legislative context for the CZMP given in Chapter 2 has provided details regarding the key legislative and policy controls applicable to the coastal zone, including the LEP, DCP and POMs for Wollongong. The range of existing management strategies has been reviewed and incorporated where possible within the assessment of risk to specific and generic assets, such as detailed within the Beach Asset and Consequence Tables, in Appendix E. This includes those aspects of the existing estuary management plans, floodplain management plans, biodiversity strategy, masterplans and POMs for the coastal zone.

In most cases, however, the existing controls require some modification or update to adequately modify the level of risk from coastal hazards. In their present form, the existing LEP, DCP and POM provisions are inadequate to manage the risk from erosion and recession. With minor modification, DCP Chapter E12 – Geotechnical Assessment would adequately manage the coastal influenced geotechnical hazard area. Existing provisions in DCP E13 – Floodplain Management provide controls for those areas affected by backwater inundation from the sea where such areas are coincidentally at risk from catchment flooding. The provisions could be expanded to apply to those areas affected by backwater inundation from the sea that currently do not have any flood planning controls, to manage future development and re-development.

The preparation of management options has included both recommended changes to existing controls that may better address coastal risks and made note of synergies between management options and existing strategic plans where relevant.

4.5 Analysis of the Level of Risk

The Risk Score Matrix from Council's Enterprise-wide Risk Management Risk Ranking Tool was utilised to determine the level of risk as a result of *likelihood* x *consequence*, given in Table 4-7.

Risk maps for the Wollongong coastal zone demonstrating the level of risk to assets from coastal hazards have been prepared. . As noted above, the likelihood and consequence values were assigned spatially (in GIS) to the hazard zones and assets respectively. Through GIS processing, the two spatial values (consequence and likelihood) were combined to produce an overall level of risk, using the risk matrix scores in Table 4-7. Separate Risk Maps for Erosion and Recession, Coastal Inundation and Geotechnical hazards for the immediate, 2050 and 2100 timeframes are provided in Series A to C, Series D to F and G respectively in Appendix A.

A risk register for each beach listing the assets predicted to be affected by hazards, and the level of risk associated with each hazard has been derived from the risk maps across the coastal zone. The risk register and risk maps form the basis for prioritising and specifying management options for the various assets at each beach, in the following chapter. The risk register, immediate risk map and management options are presented for each beach in Chapter 6.

Table 4-7 Risk Score Matrix

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

4.6 Risk Evaluation: Priorities for Treatment

Determining which risks to treat as part of the CZMP is based upon Council (and the community's) tolerance to risk. In most cases it would be expected that low risks can simply be monitored, rather than demand valuable management resources, while extreme or high risks require more immediate management attention. A risk tolerance scale is used to determine which risks/locations/assets must be addressed as a priority.

The risk tolerance scale utilised in this project is taken from Council's Enterprise-wide Risk Management Risk Ranking Tool, which in discussion with Council was determined to be appropriate for this project. The risk tolerance scale outlines the action required for different levels of risk, as given in Table 4-8.

Table 4-8 Risk Tolerance Scale

Risk Level	Action required	Tolerance
Extreme / High	Immediate action required; **Eliminate or Reduce** the risk or Accept the risk provided residual risk level is understood	**Intolerable**
Medium	**Reduce** the risk or **Accept** the risk provided residual risk level is understood	**Tolerable**
Low	**Accept** the risk; Manage by routine procedure	**Acceptable**

4.6.1 Timeframe and Triggers for Action

The timeframe over which risks may manifest offers an additional consideration in the prioritisation (and implementation) of management action. For example, the risk level may be tolerable (medium) at the current time (2010), however, it may be predicted to increase to intolerable (high) by the 2050 timeframe. In this case, a management action introduced now may be premature, particularly as there is uncertainty as to the exact timing of the hazard impact.

Particularly where the most suitable management options are costly, difficult to implement or unpalatable for community to accept, determining when to act will be important to ensure that such actions are only implemented when it becomes necessary. The trigger approach is most applicable to existing development, while future developments can be managed through development controls.

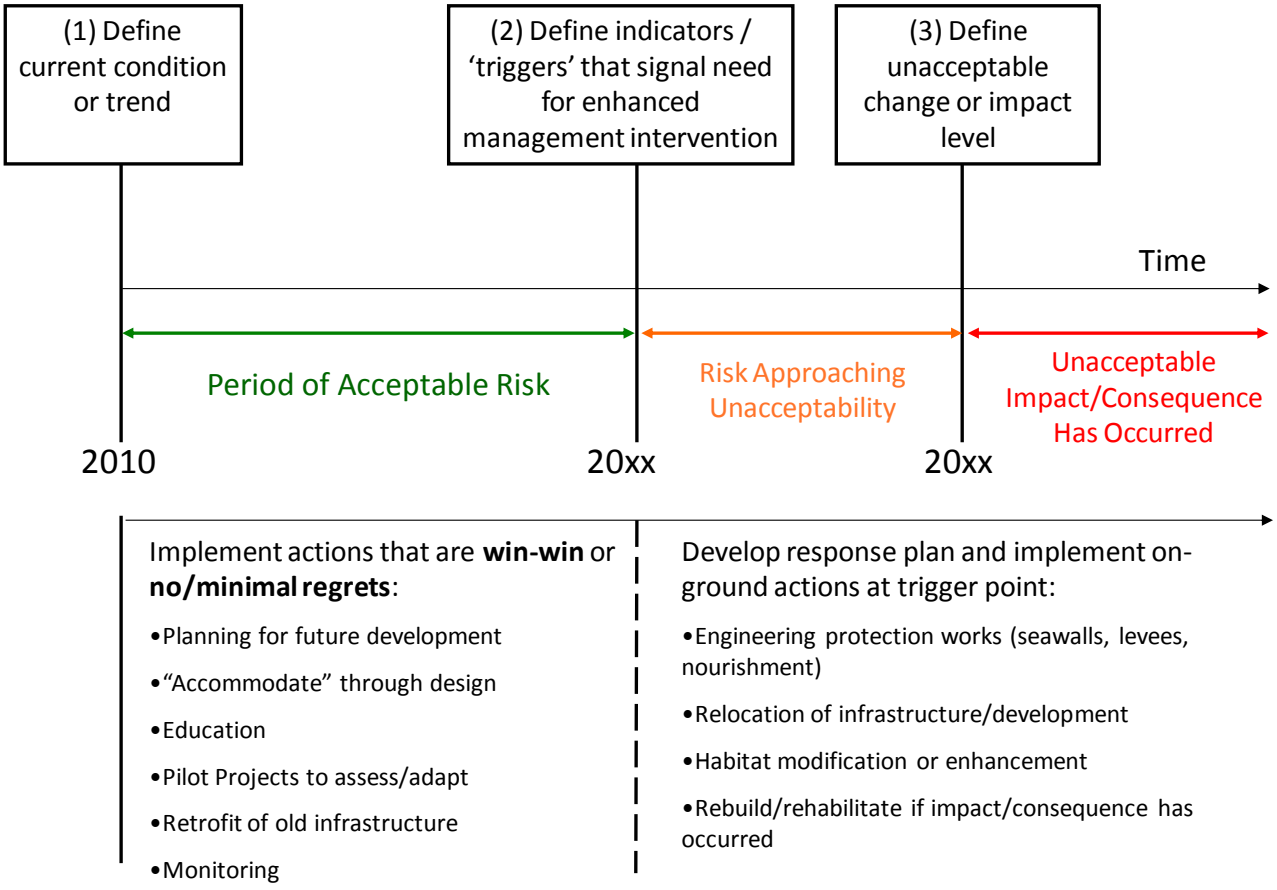


Figure 4-3 Adaptation Action Continuum Model (Fisk and Kay, 2010)

Fisk and Kay (2010) developed the Adaptation Action Continuum Model (see Figure 4-3) as part of climate change adaptation planning, however, this method is also equally applicable to coastal hazards management. The method was developed in recognition that at some point in the future, difficult decisions with more significant trade-offs will need to be made.

For risks identified as intolerable in the future, the method involves identifying one or more trigger points that are a flag to managers for when more aggressive or decisive actions must be

implemented in order to avoid the undesirable risk outcome. Monitoring is then conducted to determine if and when a trigger is activated (for example, measuring erosion escarpments and distance to important assets). Setting triggers also recognises that some hazard or climate change impacts may not eventuate. If this is the case, the community has not been unnecessarily burdened by having to adopt costly management responses.

The risk register and risk mapping for assets at each beach demonstrates the risk level over the immediate and future (2050 and 2100) timeframes. Management options have been flagged for those existing assets / development types deemed to be at an intolerable level of risk from coastal hazards. The timeframes over which intolerable risks are expected to manifest can be used to determine triggers for existing development. If the expected timeframe is sufficiently long (or risk is low at the present time), the asset replacement or redevelopment cycle may be used as a trigger to implement controls. Where the timeframes for impact are shorter, triggers relating to the hazard itself will be more appropriate. Management options and relevant triggers are presented in Chapter 5.

5 MANAGEMENT OPTIONS

5.1 Introduction

This Chapter describes the available options to treat coastal risks for future and existing development. The options are separated according to the type of option, and may treat more than one risk, that is, erosion and recession as well as coastal inundation. The options as they apply to individual assets at each beach, according to the risk level, are presented in Chapter 6.

The management options were developed from various sources including the NSW Coastline Management Manual (1990), NSW Guidelines for Preparing Coastal Zone Management Plans (OEH, 2013), the First Pass National Assessment of Climate Change Risks to Australia's Coast (2009), the NSW Coastal Planning Guideline: Adapting to Sea Level Rise (2009) and other coastal management plans and studies. Following on from this, discussions with the Committee and Council enabled further refinement, as well as more local and site specific options to be developed.

5.2 Whole of Council Approach to Coastal Risk Management

In the past, without a whole of LGA coastal hazards assessment or management plan, consideration of coastal hazards in Council decision making has been undertaken on an as needs basis. In some cases this has meant decisions are made prior to assessing risk from coastal hazards, then retrospectively designing the asset or infrastructure to cater for a hazards impact. For example, only one of the existing Community and Crown Lands Plans of Management (POMs) for coastal areas specifically note coastal hazards as an issue requiring consideration in planning new facilities, structures or uses of the land.

With a CZMP in place, including hazard lines, coastal risks can now be considered at the outset in Council decision making. From a whole of Council / LGA perspective, this is a crucial milestone, particularly as Council is the owner of key assets affected by coastal hazards, and can set the benchmark for private landholders and community in the coastal zone.

While specific public assets at risk are discussed in Chapter 6, listed below are over-arching actions that should be undertaken by Council to better incorporate coastal risk management into Council decision making processes.

1 Consideration of coastal hazards in all levels of Council decision making.

Key areas where better consideration of coastal hazards is needed include:

- *Preparation of Community & Crown Land Plans of Management and Masterplans*. In the past, decisions regarding facilities and works as described in such plans considered hazards once the decision to refurbish or construct a facility had been made from the Masterplan perspective. Now that hazard lines are available, the development of such plans should consider the hazard extents and timeframes prior to specifying actions within such plans. That is, depending on the expected life of a facility it may or may not be appropriate to construct within a 2050 hazard area. Once again, guidance as to appropriate timeframes for development is given in the Future Development section.

- *Consideration of hazards and development controls for Council works not requiring development consent*. Where development consent is required for a Council action, then the DCP controls apply. However, there are many works undertaken by Council where development consent is not required (for example, environmental management works under SEPP Infrastructure (2007)). In this case, there needs to be an internal process for taking consideration of coastal hazards constraints when undertaking exempt development by Council. Part of this will be through internal Council education (see below), however, a checklist or guideline should be prepared for internal Council use for exempt developments.
- *Asset Management*: At the present time, the management of assets does not take into consideration the risk to an asset from coastal hazards when prioritising asset replacement or maintenance, nor are replacement assets flagged as requiring redesign to accommodate coastal hazards. This applies to all types of council assets (public buildings, stormwater, roads, footpaths, etc). This is considered further as a separate "No regrets" action (refer NR1 in Section 5.4.1), to ensure that the timeframe for and type of hazard impact is factored into Council's prioritisation of asset replacement and maintenance schedules, particularly for larger, more costly assets such as stormwater infrastructure or public buildings.

2 Conduct internal Council training to educate the different departments about coastal hazards and the coastal hazard lines, to support greater consideration of hazards in Council planning.

The aim of internal education is two-fold. First, this allows better use of the existing hazard mapping in preparing decisions internally by Council, for example, in prioritising asset replacement or designing assets for hazard impacts. Second, it will facilitate explanation of the hazards to community by Councillors, particularly as planning and other actions may affect the general community.

There is a need for better education within Council (and the general community, see below) regarding what the hazard lines mean and how they should be utilised and applied.

3 Prepare a foreshore building line for entire LGA based upon the existing hazard lines

The foreshore building line would present the starting point from which setbacks for development can be drawn. This would be a key tool for use in managing future development and redevelopment in conjunction with a Coastal Management DCP (refer Section 5.3). The foreshore building line may be modified in the future in concert with implementation of specific management actions, such as construction of a seawall for a specific beach.

For those beaches where seawall protection is being considered as an option, a recommended seawall alignment has been mapped. At all other locations, the immediate ZRFC line is recommended as an appropriate foreshore building line to be adopted by Council. The foreshore building line should be updated as and when coastal hazard zones are redefined as part of the revision of the CZMP (e.g. every 5 to 10 yrs). . This will ensure that the foreshore building line progressively retreats in line with the impacts of sea level rise over time.

4 Community Education – Resilience Building

To support the implementation of this Plan, there will need to be ongoing community education about coastal risks. The risk approach is a valid way of expressing to community both likelihood and consequence from coastal hazards. This will assist community to make their own judgements

regarding how they perceive the risk from coastal hazards, and make decisions regarding this risk over likely timeframes of impact. It is important that community begin to understand now the types of impacts relating to storms and how Council proposes to manage this, as well as how such risks may change with sea level rise. This supports the overarching approach to implement resilience building actions now, and delay more difficult or costly options for when impacts occur. There may be many years before impacts eventuate, however, at that time, the community will be better prepared to accept and implement the actions required.

5 Monitoring - Long term baseline monitoring and event based monitoring following storm erosion events

This option enables Council to assess the frequency and severity of events, the impact and consequences on various land uses, to revise risk levels and determine the effectiveness or appropriateness of management actions/options over time. Regular monitoring shall also support the identification of triggers for management actions to be implemented.

For the whole of the coastline, a baseline monitoring program should be set up to chart long term trend and condition following major events.

- For coastal erosion risks, monitoring should consider the zone of reduced foundation capacity behind the erosion escarpment following storm events in relation to at risk land / infrastructure. The monitoring should be conducted every three years, or following major storm events.
- At estuary entrances, the breakout level, frequency and berm height should be monitored over time, as sea level rise (including recession) impacts upon the entrance configuration.
- For coastal inundation risks, monitoring should consider the depth and frequency of events over time. This should include data on inundation levels and extents following major events, and should be mapped against continued monitoring for mean sea level.

The results of monitoring should be analysed and published, this could be included in State of the Environment reports, or could be completed at the Plan review stage. The monitoring at specific assets should be reviewed more regularly to provide warning for when a trigger will or has been reached.

At Plan review stage, the monitoring shall provide key data to re-run the risk assessment and revise management response if risk level changes (for either an increase or decrease in level of risk).

This action has been repeated as NR14 (see “No regrets” options Section 5.4.1), to more specifically identify assets that should be monitored prior to the next plan revision.

5.3 Future Development and Re-Development

Wollongong’s coastal zone is largely developed, with very few land parcels as yet undeveloped (including “greenfields” sites). In this case, most development applications will consist of either complete redevelopment of a site, including subdivision, or major alterations or refurbishments to existing structures. The re-development of land within Wollongong offers an opportunity to apply development controls that mitigate or accommodate coastal risks to an extent that is consistent with the expected lifetime of the development.

Applying development controls as properties are redeveloped improves the compatibility and therefore the longevity of the developments. Applying development controls does not affect future ability to protect or retreat from the properties. The development controls can be revised in the future in line with improved estimation of hazards and future changes.

Development controls apply equally to future development and redevelopment of existing structures. For this reason, a Coastal Management DCP is also included as an option to manage existing development, particularly where such development is currently at low risk.

The following recommendations are made for preparing a Coastal Management chapter within the Wollongong DCP, to manage future and re-developments:

- *Determine Development Controls applicable to the Level of Risk and Type of Development.*

In a similar format to Council's DCP Chapter E13, the development controls should relate to the level of risk (high, medium, low) and the type of development (including whether a development type is permissible, and including alterations and additions).

For coastal hazards, the level of risk increases over time, in relation to sea level rise. Therefore, the expected life of the development can be used to determine at what timeframe (i.e. immediate, 2050 and 2100) the level of risk should be applicable to the proposed development. The expected life of the development should be determined by Council, and should relate to the type of development. For example, a residential development may be expected to last up to 100 years. Therefore, the risk level determined for 2100 would apply, and subsequent development controls dependent upon this level of risk. Likewise, where a surf club is intended to be refurbished with an expected design life of 25 years, then the immediate risk level would apply, and subsequent development controls dependent upon this level of risk. A suggested timeframe and risk is given in Table 5-1.

- *Specify Assessment or Performance Criteria for the Development (based on Risk Level and Development Type)*

Similarly to the Chapter E13 where prescriptive controls are specified for building components, etc, assessment or performance criteria and prescriptive controls should be specified within the DCP, as applicable to a development type and level of risk. Example considerations include:

  - Setbacks for development landward of specified hazard zone, proposed seawall alignment or, Foreshore Building Line;
  - Minimum floor levels and acceptable size for alterations and additions;
  - Foundation capacity requirements within hazard zones, triggering a geotechnical assessment for depth to bedrock;
  - Where foundation capacity cannot be provided (based on geotechnical assessment), a set of alternative criteria could apply, for example:
    - Alternative designs for temporary or sacrificial structures or relocatable structures, as considered suitable for the type of development (e.g. SLSCs, caravan park cabins etc);
    - For public assets, an assessment of alternative locations for the structure;

- Approvals bound to a distance from an erosion escarpment or frequency of wave overtopping, which may apply where the risk over the expected life is high, but development could be accommodated until that time.

The format and content of a Coastal Management DCP will be determined by Council at the time of its preparation. However, as the above examples demonstrate, the Coastal DCP can be tailored to the level of risk and type of development. The Coastal DCP can then be used to manage future development and existing developments when they are redeveloped or assets replaced.

Table 5-1 Suggested Timeframe and Risk Level for Development Types

Land Use Categories**	Design Life (yrs)	Risk Level*	Coastal zone land uses / assets in this Development Type
Essential Community Facilities	75 -100	Refer 2100 Risk Levels - Map Series C	Hospitals, Hospices, Nursing Homes
Critical Utilities	75 -100	Refer 2100 Risk Levels - Map Series C	Major (arterial) roads, bridges, stormwater infrastructure, water supply networks, wastewater infrastructure
Subdivision	100	Refer 2100 Risk Levels - Map Series C	Existing and vacant residential land
Residential	75 - 100	Refer 2100 Risk Levels - Map Series C	Residential properties (including existing residences, vacant residential land), schools, childcare facilities, aged care facilities, university campus, caravan parks (long-term sites only), additions or alterations to existing dwellings > 40m2
Commercial & Industrial	50	Refer 2050 Risk Levels - Map Series B	Commercial buildings (e.g. WIN Entertainment Centre, WIN stadium), Industrial sites, public libraries, other public buildings, University campus, private recreational premises / buildings (e.g. RSL, Bowling, Golf club houses)
Tourist Related Development	10 - 25	Refer Immediate Risk Levels - Map Series A	Caravan parks (short term sites only)
Recreation & Non-Urban	25	Refer Immediate Risk Levels – Map Series A	Parks, Public open space / recreation, private recreational land, Cycleway / shared pathway, recreation facilities (e.g picnic shelters, minor storage sheds), jetties, wharves, boat ramps
New Landuse Category			
Public recreational facilities / buildings	25	Refer Immediate Risk Levels - Map Series A	SLSC buildings, lifeguard towers, beach kiosks / pavilions, ocean pools, amenities blocks / buildings, storage buildings

*** the Land Use Categories are taken from Councils existing DCP Chapter E13. Map Series A, B and C are provided in Appendix A.*

5.4 Existing Development

A range of management options to treat existing development (assets and land) at risk are detailed below. The options have been separated into the traditional 'protect', 'retreat' and 'accommodate' categories for coastal management options. However, unlike the traditional approach, these options are specified as applicable to the level of risk to an asset, and a trigger at which the option should be implemented is also specified (refer Chapter 6).

A range of "no regrets" options that provide for further investigations to both improve understanding of the best management option applicable and the extent of risk are also provided, which enables Council to build resilience and be adequately prepared for when impacts eventuate at some point in the future.

Current actions listed for the "no regrets" and other options are intended to be implemented within the timeframe prior to the review of this CZMP. There are a number of actions that Council and others can undertake now that either improve resilience or assist in being prepared to implement more substantial actions as and when needed. Prioritisation for implementing the current actions will be determined as part of selecting recommended options at the next stage of preparing the CZMP.

While the management options presented below are targeted at existing development, in some cases the most appropriate way to manage existing development is through controls on future re-development, that is, as assets are being replaced, houses redeveloped, council buildings refurbished etc. As explained in Section 4.6.1, where expected timeframes for impacts are long, this is a cost effective and sensible approach to implementing management action, and the "trigger" is then asset replacement or redevelopment.

Description of aspects of the costs and benefits of the various options is given with the management options below. This aims to provide more detail regarding the option to support the cost benefit assessment given for each beach in Chapter 6.

5.4.1 "No Regrets" Options

The "No regrets" options provide for a range of assessments and works that shall provide further information (including approvals) required prior to implementing larger scale options at specific assets, particularly where a more costly or difficult option may be needed, or better understanding regarding the level of risk to an asset. The "no regrets" options also provide for activities that will improve resilience and preparedness for coastal hazards.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Potential Locations / Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
NR1	Include notation of coastal hazard type and timeframe on Asset Management Plan	No Regrets	Council's Asset Management Plan shall be updated to make note of which assets lie within a coastal hazard area: detailing the type of hazard i.e. erosion, recession, inundation, or geotechnical hazard; and the estimated timeframe for impact (i.e. Immediate, 2050, 2100), bearing in mind that impacts may occur prior to this. This information shall then be included within prioritisation for asset replacement and maintenance schedules. The assets shall include public buildings, heritage items, stormwater infrastructure, roads etc as managed variously by Council.	This option enables coastal hazards to be flagged in Council decision making processes. At the present time, the management of assets does not take into consideration the risk to an asset from coastal hazards when prioritising asset replacement or maintenance. The option is easy to implement as the information is already available to Council. This option is a "no regrets" action that provides a preliminary step prior to undertaking more detailed assessment of assets to determine which can be relocated or require redesign to accommodate coastal hazards, and which may be managed as planned retreat.	All types of council assets (public buildings, stormwater, roads, footpaths, parks/beaches etc) within a coastal risk area.	Current Action 1. For all Council assets, add a notation to all assets within the hazard zones as to coastal hazard type (erosion, recession, inundation, geotechnical) and estimated timeframe for impacts (immediate, 2050, 2100). 2. Utilise this information within prioritisation for asset maintenance & replacement This action is required prior to other "no regrets" options.
NR2	Conduct audit of existing seawall structures, to determine their current condition, effectiveness and future protection potential	No Regrets	A seawall audit shall determine the condition of existing seawalls and their effectiveness to mitigate storm erosion, and recession and wave overtopping with sea level rise, depending upon accessibility (e.g. where the toe of the structure is buried etc). The estimated remaining life of the walls shall also be specified, and recommendations as to revision of hazard estimates for immediate, 2050 or 2100 provided where practical. The assessment should be used to guide subsequent decisions at the relevant beaches, including future replacement with seawall protection or "manage to fail" (planned retreat) options.	There are some existing seawalls that may already provide protection to coastal assets. Depending upon the expected life and future protection from existing walls, there may be updates to the hazard estimates (immediate, 2050) which assumed no protection provided. This will flow on to affect other coastal management options, including implementation of the Coastal DCP and decisions regarding seawalls at those beaches. The audit therefore offers a "no regrets" option by providing more information on which to base decisions regarding other coastal management options.	Austinmer, Thirroul, Bellambi Beaches	Current Action 1. Conduct audit of seawalls 2. Update hazard lines where relevant to account for existing seawall protection 3. Update CZMP proposed actions to account for condition (life) of existing seawalls 4. Seawalls added to Council's Asset Management Plan, and outcomes of audit used to determine asset replacement and maintenance schedules for the structures. This action is required prior to implementing S1, S2 and or DCP.
NR3	Conduct audit of substantial public buildings to determine site constraints, including foundation capacity, and land availability to relocate the structures.	No Regrets	This option shall investigate the foundation capacity of existing buildings to withstand erosion and wave overtopping and determine if and where land is available to relocate the structure. Where both aspects are constrained, the audit shall identify the possibility of replacement with a relocatable structure. The outcomes of the audit shall specify for each asset the future action being "relocate", "redesign", "retrofit" or "relocatable". The audit shall also make note of suitable triggers for implementation of future action. The outcomes of the audit shall guide implementation of A2 or A3, and prioritisation for asset maintenance and replacement schedules	Relocation and redesign options (A2, A3) for existing public buildings (i.e. surf clubs, kiosks, pavilions) are contingent upon the capacity of existing foundations to support a structure during a storm event; and the availability of land to relocate the structure. This option is a "no regrets" option as it facilitates better planning for asset replacement and maintenance that additionally considers coastal hazards impacts while potentially allowing continued use of at risk structures. The investigations can flag suitable options now, but which do not need to be implemented until the hazard impacts occurs (refer to triggers for specific assets at specific beaches).	Key locations include Thirroul SLSC, Thirroul Pavilion, Bulli SLSC, Bulli Kiosk, Coalcliff SLSC, Stanwell Park SLSC, refer individual beach maps / tables for all locations.	Current Action 1. Determine priority for this action from Council's Asset Management Plan. 2. If supported by the Asset Management Plan, undertake audit of all public buildings affected by erosion / recession 3. Update Asset Management Plan to specify future action being "relocate", "redesign", "retrofit" or "relocatable" and identify the trigger for implementation of future action. 4. Utilise findings for prioritisation of asset maintenance and replacement schedules. This action is required prior to implementing PR2, A2 or A3.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Potential Locations / Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
NR4	Undertake audit of all Ocean Pools in LGA	No Regrets	The audit shall investigate the relative sensitivity of the pools to wave impacts and sea level rise, in addition to their current condition, maintenance regime, and community usage. Where necessary, future adaptation/modification should be identified e.g. raise seaward parapet wall, modify inlet/outlet system etc.)This audit shall build upon the review of tidal pools recommended in *Planning People Places* (WCC, 2005). The audit shall prioritise pools based on their ability to withstand hazard impacts versus maintenance regimes and other community needs. The audit shall also ensure that the pools are added to Council's Asset Management Plan, with the outcomes of the assessment also noted to guide future maintenance plans and priorities.	This option is a "no regrets" option as it facilitates the formal inclusion of the ocean pools within Council's Asset Management Plan, and their prioritisation for maintenance based upon community usage and likelihood of hazard impacts. Further, it will recognise the future usability based on sea level rise scenarios.	All tidal and other ocean pools along the coastline	Current Action 1. Determine priority for this action from Council's Asset Management Plan. 2. If supported by the Asset Management Plan, review audit of all tidal pools affected by erosion / recession and sea level rise. 3. Update Asset Management Plan to include future action ("managed to fail" or "retrofit") and identify the trigger for implementation of future action. 4. Utilise findings for prioritisation of asset maintenance and replacement schedules. This action is required prior to implementing PR2 or A2.
NR5	Undertake traffic assessments to determine the feasibility and costs associated with redirection compared with redesign/protection of roadways at risk of recession.	No Regrets	Traffic assessment is required for those local roads and major roads (Lawrence Hargrave Drive) that may be affected by recession in the future. The focus of this option is to determine the technical feasibility of redirecting traffic from a local road that will be at risk, which will govern subsequent actions. The assessment needs to consider the impact of redirection of traffic onto other roads and feasibility of maintaining access to residences. Redirection options may also include purchase of land to construct a new roadway connection. Where redirection is unlikely to be possible due to road/traffic constraints, protection and /or accommodation options for the roadway shall be considered.	This is a "no regrets" option as it provides the technical feasibility for redirection from which further management options can be determined (i.e. implementing retreat (PR2), protection (S1, S2) or redesign (A2) options). The costs/practicality associated with either redirection onto existing roads, redirection onto a newly planned road section (including property purchase) and protection or accommodation options will need to be compared. The decisions regarding existing roadways will then need to take into consideration the effect upon adjacent land uses, for example where utilities or residential property is located next to the roadway. The advantages/disadvantages, costs-benefits identified in this plan for the viable coastal management alternatives (PR2, A2, S1/S2) will also need to be taken into consideration when determining the appropriate final action.	Key locations: Lawrence Hargrave Drive at Austinmer & Little Austinmer, local roads at Bulli, Woonona, Towradgi. Refer individual beach maps / tables for all locations.	Current Action 1. For all roads identified as likely to be at risk of recession, if supported by the Asset Management Plan, determine the feasibility of options (redirecting, protecting or redesigning) to retain residential access. 2. Update relevant strategic plans to include future action determined, including triggers for implementation. This action is required prior to implementing PR2, A2 or S1 / S2.
NR6	Undertake audit of cycleway to guide future maintenance options.	No Regrets	The audit shall determine which sections of cycleway identified at risk can be relocated, and planning commenced to secure land to relocate the path. Where relocation is not possible due to constraints from other land uses, the feasibility (technical and financial) for rock protection and / or raising the cycleway should be determined. Outcomes of the audit should be noted on Council's Asset Management Plan, to guide future maintenance plans and priorities (e.g. notation where relocation or retrofit is required, with set triggers for implementation).	Where parts of the cycleway route become disconnected following erosion, the value of the cycleway becomes compromised. The whole route needs to be maintained as a continuous path to remain functional. This "no regrets" option allows for specific investigation of the cycleway capability for either relocation or retrofit, should impacts occur in the future. The investigations can flag suitable options now, but that do not need to be implemented until the hazard impacts occur.	Key locations include Sandon Point Beach (Waniora Point), Bulli Beach North Beach, Woonona, refer individual beach maps / tables for all locations.	Current Action 1. Determine priority for this action from Council's Asset Management Plan. 2. If supported by the Asset Management Plan, undertake audit of cycleway sections within the erosion / recession and inundation hazard areas, to determine suitable area for relocation or retrofit design alternatives as required. 3. Update Asset Management Plan to note future action ("relocate" or "retrofit") and identify the trigger for future action. 4. Utilise findings within prioritisation of asset maintenance and replacement schedules. This action is required prior to implementing PR2, A2 or S1 / S2.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Potential Locations / Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
NR7	Investigate appropriate design elements for stormwater, infrastructure for periodic inundation with seawater and / or wave action and utilise as assets are replaced.	No Regrets	This option involves noting where and when stormwater assets will be affected by permanent inundation with sea level rise, to determine if certain systems may become unviable. The option also involves investigating the capacity for stormwater infrastructure to withstand periodic inundation by seawater and / or periodic wave attack during ocean storm events. Asset replacement and maintenance schedules shall be updated to reflect the expected timeframe for inundation when substantial upgrade is required, noting that seawater is expected to yield shorter design life. For assets affected by erosion, the recommended upgrades to withstand wave impacts / erosion will need to consider the design life for the stormwater asset compared with the expected timeframe for the erosion hazard to occur. Loss to erosion of land around the stormwater asset may make it unviable irrespective of the robustness of design.	This option targets assessment towards critical infrastructure for which the risk of inundation with seawater may not be adequately managed or identified at present. The option also recognises the cost savings for such design elements to be implemented based upon the programmed asset maintenance / replacement timeframe. NB - Erosion impacts to stormwater outlets shall be noted in NR1, with expected action through PR2.	All stormwater infrastructure affected by coastal inundation (ie, within the coastal inundation hazard area) or by erosion and recession.	Current Action 1. Determine priority for this action from Council's Asset Management Plan. 2. If supported by the Asset Management Plan, conduct mapping to determine changes in frequency of inundation within stormwater systems with sea level rise (separate from coastal inundation). 3. Investigate design elements to enable functioning of stormwater assets inundated by seawater, and wave attack (over short term), and utilise when replacing assets (see A2). 4. Update Asset Management Plan to reflect changes in frequency of inundation over time due to sea level rise (i.e. storm surge), and use as part of prioritisation for asset maintenance and replacement. 5. Develop long term strategy for replacement and upgrade to systems that will become unviable with sea level rise. Relevant triggers for future action will depend on the nature of the impact and future maintenance requirements. This action is required prior to implementing PR2 or A2.
NR8	Investigate design elements for water supply and wastewater infrastructure and electricity infrastructure to withstand inundation with seawater and / or wave action, and implement action as required.	No Regrets	This is similar to option NR7 but applies to wastewater, water supply and electricity infrastructure which are managed separately by Sydney Water Corporation and the local power supply owners for Wollongong. This option is proposed separately from Council's assets, due to the different asset types and Sydney Water Corporation's existing climate change assessments.	Initially the existing risk and subsequently the potential impact of Council management strategies should be brought to the attention of the relevant authority. Prior to finalising the management strategy, future performance (protection, relocation, adaptation) of affected infrastructure must be considered.	Key Locations include Trinity Row (Sandon Pt Beach), Woonona Beach (Beach Drive, Kurraba Road), STP at Bellambi, Marine Parade (Towradgi Beach), and other locations where erosion may affect roadways and properties	Current Action 1. Council shall advise relevant authorities of the extent of current and future hazards. 2. Management as in NR7 above, with responsibility of implementation falling to SWC and electricity utilities. 3. Opportunity for clear strategies to be developed should be provided and where practical, feed into determining future management elements by Council. This action is required prior to implementing PR2 or A2, and in some locations may govern implementation of S1 / S2.
NR9	Develop evacuation plans for local roads and property affected by coastal inundation outside of existing flood planning areas.	No Regrets	Where extensive area of roads and property may be affected by coastal inundation, and are not identified within existing flood planning areas, or Local Emergency Management Plans, evacuation plans will be important for managing traffic flows around roads affected by future inundation, and for ensuring the safety of residents.	This option addresses the changing consequence of coastal inundation to people's safety, as climate change impacts occur.	Priority Locations: Thirroul (Lawrence Hargrave Drive, local roads, affected properties especially in Flanagans Ck catchment), Sandon Point to Bulli Beach (Whartons Ck), Woonona (Beach Dr, ppty), Bellambi Lagoon, (local roads & property).	Current Action 1. Develop evacuation plans for catchments without existing flood mapping as a priority. 2. Update evacuation plans with existing flood mapping or Local Emergency Management Plans to include coastal inundation area 3. Collate evacuation plans on an LGA-wide scale, to ensure consistency and safety across LGA Trigger Implement evacuation plans as needed.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Potential Locations / Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
NR10	Update or commence flood studies at all catchments that are impacted by elevated ocean water levels in flood mapping and management.	No Regrets	This option involves conducting a combined assessment for catchment flooding with oceanic water level events, including the latest sea level rise predictions (refer NSW Sea Level Rise Policy Statement 2009) and ocean water level scenarios (refer DECCW 2009, Cardno 2010) as per guidance given by NSW Government . The combined flood modelling shall then by used to determine the level of risk from such hazards (i.e. clarify Flood Risk Precincts) and therefore the appropriate planning controls that should apply (i.e. based on DCP Chapter E13).	This option provides for a more detailed assessment for properties that are currently at risk of coastal inundation, to determine any increased future risk as sea level rises. This will better constrain the types of planning and other controls most appropriate to identified coastal inundation risk areas. It will offer residents affected by coastal inundation better clarity of the likelihood and consequence of future impacts. This option is a "no regrets" option, as catchment flood modelling is required at a number of catchments without flood mapping at present, while existing flood mapping needs to be updated to better consider ocean water levels based upon current best practice, and NSW Government requirements.	Priority locations include: Hargraves & Stanwell Creeks Flanagans Creek; Thomas Gibson Creek (requires update), Whartons Ck, Collins Ck. Woonona, Bellambi Gully and Lagoon, Fairy Lagoon. Existing flood planning areas also require update for sea level rise and oceanic elevated water levels.	Current Action 1. Utilise design ocean water levels specified by NSW Government and within the Cardno (2010) study within appropriate catchment flood modelling scenarios. 2. Update Flood Planning Areas (for catchment and coastal inundation effects), flood risk precincts and development controls for affected areas, such as through the Floodplain Risk Management Plan process. Trigger: Conduct studies at the earliest opportunity.
NR11	Undertake an audit of all EECs and important habitat areas within the hazard zones and implement buffers and rehabilitation as appropriate.	No Regrets	This option would involve: - Identifying important flora/fauna species that, due to their limited distribution, will need to be translocated; - Prioritising rehabilitation requirements based upon the relative threat to distributions from coastal hazard impacts, to ensure lower risk distributions are protected and enhanced; and - identifying areas that can be designated buffers around important habitats, to enable migration in response to hazard impacts, i.e. erosion and recession, as well as migration in response to sea level rise. The outcomes of the audit should feed into existing biodiversity strategies (e.g. *Illawarra Regional Biodiversity Strategy, 2010*). Hazards impacts investigated should include both permanent inundation as well as recession due to sea level rise.	The option will improve resilience of important habitats to withstand future impacts from recession and inundation due to sea level rise, particularly if the recommendations for biodiversity are implemented as soon as possible. The implementation of buffers must consider cost or land use conflicts, although there will be areas where buffers can be readily established with little cost or conflict.	All habitats affected by coastal hazards (refer Management options Maps), particularly estuary entrance areas	Current Action 1. Identify important flora/fauna species that require relocation 2. Prioritise rehabilitation requirements based upon the relative threat to distributions from coastal hazard impacts, to ensure lower risk distributions are protected and enhanced 3. Identify and implement buffers for migration, in consultation with community. 4. Update existing biodiversity strategies to reflect findings within prioritisation for rehabilitation.
NR12	Utilise Norfolk Island Pines in new coastal plantings.	No Regrets	Norfolk Island Pines continue to be used in coastal plantings by Council. This would ensure continued use of this plant as a marker of coastal settlement. Where possible, new plantings to replicate or replace perished or eroded trees should be sought, outside of hazard zones.	This option recognises the cultural importance of Norfolk Island Pines in coastal development. Continual replacement of existing plantings would become Council practice.	Key locations include Thirroul Beach, North Beach, Bulli, Stanwell Park. Refer individual beach maps / tables for all locations.	Current Action Implement now and into the future.
NR13	Develop a decision framework for managing Aboriginal and Non-Indigenous Heritage Items affected by hazards	No Regrets	In cooperation with local Aboriginal Groups and NPWS, prepare a Decision Framework for managing heritage sites and items that are uncovered by erosion or affected by inundation where such sites are previously unrecorded. The plan should provide clear direction as to the actions required as relevant to the type of item. This may include relocating the item (for example, as is conducted for burial sites), burying the item (for example as is done for midden sites), sacrificing the item or protection the item (as is done for midden sites also).	This option aims to provide a clear decision framework for actions and approvals required to manage important heritage assets, as they are affected by erosion or inundation over time, in consultation with local Aboriginal groups. It is noted that where non-indigenous heritage sites are already known to exist, the sites have been included in the asset registers for each beach. Aboriginal heritage items are confidential, therefore general areas only have been discussed (and management options also provided) at each beach.	Specific sites have not been identified for privacy reasons. Further, this option aims to manage assets that are currently unidentified.	Current Action: 1. Consult with Local Aboriginal Groups as to the preferred methods for managing different types of heritage assets 2. Develop a decision framework to enable a clear pathway of action and approvals, to manage sites as they are discovered Trigger: Implement as heritage items are uncovered by coastal hazards

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Potential Locations / Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
NR14	Long term baseline monitoring and event based monitoring following storm erosion events	No Regrets	For coastal erosion risks, monitoring should consider the zone of reduced foundation capacity behind the erosion escarpment following storm events in relation to at risk land / infrastructure. At estuary entrances, the breakout level, frequency and berm height should be monitored over time, as sea level rise (including recession) impacts upon the entrance configuration. For coastal inundation risks, monitoring should consider the depth and frequency of events over time.	This option enables Council to assess the frequency and severity of events, the impact and consequences on various land uses, to revise risk levels and determine the effectiveness or appropriateness of management actions/options over time. Regular monitoring will support the identification of triggers for adaptation measures to be implemented.	Whole coastline, Thirroul Pool and Pavilion, Beach Dr at centre of Woonona, Trinity Row southern end of Sandon Pt Beach	Current Action 1. Set up a baseline monitoring programme for long term trend and condition following major events. 2. Review results for particular asset triggers regularly, eg within SoE reporting. 3. Re-run risk assessment based on monitoring results and revise management response if risk level changes (i.e. increase or decrease in level of risk). Trigger 1. Erosion – Beach surveys and distance from scap to structures every three years or following major events 2. Inundation – Monitor inundation levels and extents following major events, and compare with continued mean sea level monitoring.

5.4.2 Protection Options

Protection options are aimed at protecting coastal development (private or public) from damaging erosion and recession and / or wave overtopping. The options should also enhance or preserve beach amenity. Protection may be of the form of hard structures (seawalls of various kinds, groynes, offshore breakwaters or reefs, artificial headlands) or soft measures (beach nourishment), as is compatible with both the coastal processes and amenity of the proposed

site. Protection works can cause impacts to adjacent areas ('offsite impacts'), for example erosion at the edge or base of seawalls. Therefore, the decision to implement a 'protect' option must consider potential offsite impacts and include measures to manage such impacts, in accordance with NSW legislation.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Potential Locations / Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
DV	Revitalise and continue Dune Care Programs	Protect	Revitalisation of dune care programs would allow for ongoing capture of sand to provide sediments stores for protection during storm events, and as a barrier to wave overtopping at key locations. Where existing dune vegetation is sufficient or substantial, the Dune Management Strategy shall focus on weeds and vermin removal, plant species diversity and vegetation height management, to ensure beach amenity values are not substantially degraded. For example, where monocultures of *Acacia sophorae* (or other species) are found, the Dune Management Strategy provides a mechanism for Council to introduce greater species diversity to reduce the proliferation of the species. Dune vegetation programs must be considerate of sightline requirements of all Surf Clubs in the LGA, such as detailed in Council's Draft Beach Sightline Strategy (2007). Liaison with SLSC and use of appropriate low-growing species across key sightlines is required (in some cases this may involve replacement of existing tall species with suitable low growing species). The Coastal Dune Management Manual (2001) shall also be a reference document for Council in developing and implementing a dune vegetation strategy.	Dune rehabilitation is suitable for buffering short term erosion and has other environmental benefits without irreversible long terms impacts. Over the short term, dune vegetation captures sediments that may otherwise be blown out of the beach system, ensuring beach volumes are retained to buffer against storm erosion. However, enhanced dune vegetation will not manage long term recession. It is noted that species such as spinifex and *Acacia sophorae* have been of concern to community when growing across the beach berm, causing a perceived narrowing of beach width. The plants form part of the cyclic growth of incipient dunes, which is a sign of accreted beach volumes. Similar to the occurrence of storm erosion, this should be considered relatively short term and periodic. There is a need to improve community education regarding the growth of dune volumes and value as beach protection. *Acacia sophorae* is a commonly found dune species that can occassionally form monocultures, such as currently found at Woonona and other beaches. A dune vegetation strategy would enable Council to manage such outbreaks and reduce the occurrence of monocultures, which damage beach amenity. The increase of dune height which occurs as dune species capture sediments within the beach system additionally provides a higher barrier to mitigate wave overtopping effects. Reducing dune heights (for example, through re-profiling of dune sands) reduces the protection from wave overtopping.	All beaches	Current Action: 1. Prepare and implement an LGA-wide Dune Management Strategy, including: • review and enhancement of current dune care program, • Involving local volunteers, particularly SLSC members in dune care works, to additionally provide an opportunity for education regarding coastal processes and environments, and • Prioritising locations to ensure beaches with limited vegetation or weed species are rehabilitated as a priority. 2. Implement improved program.
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Protect	Management of beach sands through re-contouring and scraping sands into the upper beach (beach scraping or nature assisted beach enhancement). The objective is to redistribute sand from areas of accretion to depleted or at risk areas. Beach scraping is carried out when the beach begins to recover following beach erosion events, as sand is won in thin layers from the intertidal zone and moved above the area of fair weather wave action. It can be used to build a buffer against storm erosion and dune overtopping. Beach scraping does not add to overall beach volumes. This option can also incorporate Council policies to ensure that all sand is retained in the active beach systems. Sand removed from estuary/lagoon entrances can be returned to the adjacent beaches. Construction excavation of suitable beach size sand can be disposed to the adjacent beaches.	Beach scraping can be undertaken on an opportunity basis by Council when beaches are accreted and appropriate equipment and resources are available. Undertaken properly it is unobtrusive and cost effective. It is used to maximize the benefit of existing beach sand reserves. The activity should be undertaken in combination with revegetation, to reduced the risk of loss of sand to windborne transport. Cost for small exercises completed elsewhere in Wollongong LGA were up to $7,000 for a single event. Sand retention policies ensure that available and suitable sand is used for beach building (for example, after small scale dredging exercises) This can be a win-win exercise, providing cheap and environmentally friendly opportunities for disposal of small quantities of suitable beach sand within the littoral system, near the extraction location.	Beaches with limited sand reserves and or to assist protection of assets identified at risk.	Current Action: The feasibility of sand retention policies can be investigated by Council. If adopted they become an ongoing part of Council operations as excavation or dredging activities are undertaken that win suitable beach sands. These actions will need to be incorporated into Council's Asset Management Plan Trigger: Beach scraping is undertaken on an opportunity basis during periods of beach accretion. Monitoring (NR14) using beach survey is required to identify periods of beach accretion, suitable for BM. Accretion typically follows calm weather periods when the intertidal zone is full and beach width has increased. This commonly occurs at the end of Summer following build up from north east winds.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Potential Locations / Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
N	Beach nourishment	Protect	Beach nourishment shall involve placement of beach sands on the upper beach face and dunes, to re-establish a sandy beach after a storm event and to provide a sediment supply for subsequent storm events. Nourishment programs should address wave overtopping in the design profile adopted for placement of nourishment sands. Along the Illawarra coast, the placement of sand is recommended to be along the upper beach profile and dunes, to maximise sand retention within each compartment Where the objective is to increase the overall beach width, the whole profile must be nourished (from the offshore base of the profile to the dune).	Suitable sand sources are not likely to be available for large scale beach nourishment in the local area. This significantly increases the cost of this option and may therefore constrict the use of this option to localised spots across the LGA, to protect assets on as needs basis. Nourishment costs have been estimated at \$25/m^3, with typical volumes of up to 200 m^3/m length of beach required to widen the beach by 20 m. For a single nourishment event across half of Thirroul Beach this would equate to roughly 100,000 m^3, costing \$2.5 million. Nourishment is a necessity to retain a sandy beach in combination with Seawall S1 (in keeping with new NSW legislation, see below). Refer to S1 for economic analysis for a combined S1 and N event at Thirroul. Under NSW legislation, Council can apply a rate payers levy to landholders who directly benefit from this action where private property (e.g. residences) or state-owned assets (e.g. RTA road, sewage infrastructure) is being protected by nourishment or where the nourishment is addressing the impacts of a protective structure on beach amenity or adjacent property. The percentage of the levy individuals can be required to pay for this option relates to the extent of property protected. Council may also contribute where the community is considered to benefit from retaining the sandy beach. The first nourishment event is typically larger, followed by ongoing smaller nourishment episodes (as and when required to maintain the agreed level of protection/amenity). Initially, nourishment may only be required infrequently (e.g. following major events, refer triggers). However, as sea level rises, if the beach alignment and width is to be maintained in its current form, nourishment requirements may substantially increase in the future. Costs to community and private landholders would likewise increase substantially. This reduces the economic viability of this option further, particularly if a local and inexpensive sand source is not available. In NSW, there has historically been a government stance against the sourcing of sand from offshore, and sand for nourishment must be sourced from licensed sand extraction operations.	Wollongong City Beach (adjacent to WIN Stadium extending to City Beach SLSC); Thirroul, Austinmer, Little Austinmer, refer individual beach maps / tables for all locations.	Current Actions: 1. Undertake investigation of sand sources for detailed costing, detailed design of nourishment profiles, planning approvals and to determine funding mechanisms. 2. Implement DCP (prior to implementing N) 3. Continued monitoring (NR14) for trigger point Trigger Renourishment will be site specific and dependent on the beach width/sand volume required and the objective (protection/ amenity). Could be expressed as a beach distance from the most recent beach erosion escarpment to development or as an average beach sand volume providing protection to assets at risk or a recreational beach width available.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Potential Locations / Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
S1	Construct seawall (revetment) along specified alignment covering majority to all of beach length	Protect	This option involves the construction of a seawall along an entire section of shoreline, e.g. a whole beach embayment. If a sandy beach is to be retained, this seawall option must be accompanied by ongoing beach nourishment. The proposed alignments where seawall protection is technically viable are illustrated on maps for individual beaches. The design profile and height of the seawall shall additionally include consideration of wave overtopping and inundation, to ensure such impacts are also mitigated at present and into the future as sea level rises. For example, the slope of the wall can be designed to minimise run up, or wave deflection barriers can be added at the top of the wall, without impacting negatively upon use of a seawall promenade, or catchment flooding through coastal creeks. Seawalls can be constructed from a range of materials and to different designs. They can be vertical or sloping, designed to be overtopped or to prevent wave overtopping. Construction materials includes rock, concrete armour units, sand filled geotextile bags, reinforced concrete, sheet piling, contiguous bored piles. Armour units can be randomly placed, pattern placed or in blockwork. They can incorporate graded filters or geotextile filters and various toe designs. They can include walkways, cycleways and parapet walls. The appropriate design and materials are site specific and selected during the design process. The most common seawalls are usually of random placed rock. These are well understood from a design perspective, easy to construct with locally available materials, relatively cheap and their flexibility allows them to absorb wave events bigger than the design condition with comparatively little damage, and to minimise wave run up. Repairs and upgrading are also relatively straightforward.	While seawalls are expensive to build, this needs to be weighed against the value of assets being protected. Seawalls extending the majority of beach length require ongoing beach nourishment if a sandy beach amenity is to be maintained over time. In this case, issues associated with beach nourishment noted above are also applicable here. Seawall costs are of the order of $5,000 - $10,000 per m length of wall. For a 500 m wall along half of Thirroul Beach, this would equate to $2.5 - 5 million, and doesn't include the costs of nourishment (see above), ongoing maintenance and future upgrading. If the seawall is to be abandoned at some time in the future, the costs for removal and repair of the beach must also be included. At Thirroul Beach, assuming unlimited funds for all options, Gillespie Economics (Appendix F) found the S1 + N option to be economic as nourishment ensures the beach amenity is retained and Thirroul Beach Reserve is retained. Beach use values were estimated at $142 million (see PR1 below). However, funding is limited, and Gillespie Economics found that compared with both S1 & N and S2 options, planned retreat (including relocating assets and loss of park land) has a substantially higher net present value (i.e. value of benefits less value of costs) per dollar invested. While S1 retains the use of Thirroul Beach Reserve, avoided loss of the reserve would need to be worth 520% higher before the net present value per dollar invested is greater than the planned retreat option. Given the number of public assets and private properties affected at Thirroul is greater than other beaches, this economic analysis is likely to be valid at other locations where extensive seawalls are proposed. Following recent changes to the NSW Coastal Legislation, the NSW Government places a low priority on allocating funding to protection options for private property. The Government also requires that any adverse impacts from protection works (such as beach sand loss or erosion of adjacent properties) must be addressed and remedied by the applicants for the protection works. In approving these works Council must ensure that a funding instrument (including future maintenance and remediation as required) is in place. This can include a levy on individual property owners which attaches to the property title in perpetuity. The clear objective of the recent NSW legislation is for seawalls that protect private property to be funded by those landholders benefiting from the wall. This may include state agencies, e.g. for RTA Roads, Sydney Water sewage infrastructure etc. Council would fund those sections of wall that protect public assets (road ends, reserves, public buildings and infrastructure). Government assistance may be available though the Local Government Grants programs on a competitive statewide priority basis. Restrictions on re-development (i.e. DCP) should be used until protection works are in place.	Thirroul (S end of beach); Austinmer (length of beach), Sandon Point Beach (southern half of beach). Refer to beach maps for proposed seawall alignments.	Current Actions: 1. Undertake NR2, to investigate viability of existing walls on beaches. 2. Consider outcomes of NR3, NR5, NR6, NR7 & NR8 to determine protection needs for assets (refer beach tables for more specific locations), which shall be consistent with Council's Asset Management Plan. 3. Undertake investigation of rock and sand sources for detailed costings, detailed design of seawall & nourishment requirements, planning approvals and to determine funding mechanisms. 4. Implement DCP (prior to implementing S1) 5. Continued monitoring (NR14) for trigger point Trigger 1. For private development and significant public development where the present day impact line (including foundation stability allowance) encroaches on the existing development foundations. 2. Alternatively for private development where the most recent erosion escarpment crest encroaches the seaward property boundary. 3. For undeveloped reserve or public land, where the most recent erosion escarpment encroaches the predetermined protection line along the beach.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Potential Locations / Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
S2	Construct seawall (revetment) along specified alignment to protect specific asset(s)	Protect	The objective for this option is to protect specific assets along the beach when or prior to their being considered at risk. This strategy accepts that there will be recession of the beach between the protected areas which may or may not be nourished. Provided any enhance recession effects relating to the seawalls can be managed, this would be permissible under current legislation. Examples where selective protection options are technically viable are illustrated on maps for individual beaches. All or some of the assets identified may be protected. In one particular case (North Beach), the seawall section would essentially form an "artificial headland", to retain the current shoreline position. This may also be considered in certain locations to treat the geotechnical risk (cliff retreat). Generic comments relating to seawall types and construction for S1 are also applicable.	Seawall costs are of the order of $5,000 - $10,000 per m length of wall. For sections of wall along Thirroul Beach, this would equate to $2.25 - 4.5 million, and doesn't include the costs of ongoing management of offsite impacts (small scale nourishment) and future upgrading. If the seawall is to be abandoned at some time in the future, the costs for removal and repair of the beach must also be included. Even if the $ value of the beach (estimated at $142 million, refer PR1) is reduced by 80 %, planned retreat remains the more economically viable option at Thirroul (Gillespie Economics, Appendix F). At Thirroul Beach, compared with both S1 & N and S2 options, planned retreat was found to have a substantially higher net present value (i.e. value of benefits less value of costs) per dollar invested, particularly as funds for action are constrained. S2 may be economic on a small scale, and where minimal offsite impacts requiring nourishment are expected (e.g. McCauleys Beach). Another potential benefit is that only the high value assets are protected while natural beach embayments are permitted to develop between wall sections. However, under NSW legislation offsite impacts (edge effects) caused by seawalls must be mitigated, and this may negate this action. If feasible or required at some future time revetment sections could be joined to increase the overall security of assets further behind the beach (i.e. implement option S1). Comments in S1 above relating to funding (who pays) for specific protection structures are equally applicable. Where they are only designed to protect private property, individual owners will need to meet all associated costs, including future maintenance, remediation and removal. Restrictions on re-development (i.e. DCP option) should be used until protection works are in place.	Thirroul Beach, McCauleys Beach (northern end if headland also completed) Woonona Beach (along Beach Drive to Dorrigo Ave), North Beach (inc. as an "artificial headland"), Bellambi Point Beach & Harbour,	Current Actions 1. Undertake NR2, to investigate viability of existing walls on beaches. 2. Consider outcomes of NR3, NR5, NR6, NR7 & NR8 to determine protection needs for assets (refer beach tables for more specific locations), which shall be consistent with Council's Asset Management Plan.. 3. Undertake investigation of rock and sand sources for detailed costings detailed design of seawall & nourishment, planning approvals and determine funding mechanisms. 4. Implement DCP (prior to implementing S2). 5. Continued monitoring (NR14) for trigger. Trigger 1. Where walls are to be developed in sections a common alignment and design needs to be agreed. 2. For development, triggers outlined in S1 are applicable for seawall implementation.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Potential Locations / Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
R	Construct a nearshore artificial reef or breakwater in surfzone to reduce shoreline wave impacts	Protect	Artificial reefs are constructed to be submerged (such as multi-function reefs) or emergent (such as detached breakwaters or islands). They can be constructed from a range of materials and in a range of shapes, sizes and locations depending on the outcome required. Emergent reefs effectively block wave energy, with wave impact being absorbed on their seaward side. They create a lower wave energy section on the beach immediately in the lee of the reef which is characterised by a salient (or bump in the beach) where sand accretes in the low energy environment. They are rarely favoured in Australia due to their obtrusive appearance and interference with beach surf conditions. Submerged reefs act to refract waves causing them to break on the reef and reducing wave energy on the leeward side, similar to the emergent reef. They are less effective than an emergent reef as they do not block the waves and during storm events water depths over the reef may be sufficient to allow waves up to several metres in height to pass over the reef without breaking, reducing their effectiveness in protecting the beach from erosion. They offer the opportunity for other objectives such as creating marine habitat and improving surfing conditions. Both types of structures are more suited to embayed coastlines (such as the Illawarra) where low or negligible net alongshore sediment transport reduces the impacts of the structure down drift on the beach, away from the reef location. The location of bedrock close to the surface provides an opportunity to reduce scour and slumping of the reef once constructed, reducing maintenance costs.	Constructed reefs are typically very expensive and on a low littoral drift coastline will provide protection to a relatively short section of the coast, possibly increasing erosion at immediately adjacent areas of the beach. They are difficult to design to operate effectively across a range of wave directions and conditions and varying water levels. They generally have high maintenance costs. Importantly, they may not provide the level of protection sought during design erosion conditions. In particular for a submerged reef, the ability of the reef to dissipate wave energy will progressively reduce as sea levels rise. The reef would require upgrading to raise the crest level in the future with sea level rise. Costs (capital and maintenance) are well beyond the resources of an individual or group of individuals and such structures elsewhere in Australia and around the world are constructed as a part of a regional strategy with Local, State or National funding. Reefs built for a multi-purpose (i.e. creating marine habitat, provide surfing break) have to date had limited success in meeting all such objectives. Therefore, while there may be some locations identified within the Illawarra that are suitable for reefs, the technical difficulties and associated high costs of achieving a structure which meets its intended function are prohibitive.	No locations were identified where an offshore reef would be a financially and technically viable protection option.	N/A
G	Construct a groyne(s) shore normal to capture sediment to protect the shoreline	Protect	Groynes are shore normal structures constructed from the beach through the surf zone to a sufficient depth to stop or restrict the movement of sand around the end of the structure. They can be constructed from a range of materials and in a range of shapes, sizes and locations depending on the outcome required. They are usually employed on high littoral drift coastlines to trap sand on the updrift side, providing a sand buffer to protect property and assets behind the beach. On a low or zero drift coastline, the groynes need to be closely spaced and (usually) nourished to provide the required sand buffer between the groynes. As such they are intrusive and expensive by comparison with revetments or nourishment options. The Wollongong Coastal Zone Study (Cardno, 2010) has stated there to be no net longshore sediment transport within the Wollongong coastal zone. As a primary protection option, therefore groynes are not technically viable options for the beaches considered. That is, it is assumed that cross-shore (i.e., shore normal) sediment transport predominates on the Wollongong beaches. Without a longshore sand supply, the groynes merely act as retention structures containing the nourishment sand.	The groynes are an additional cost on top of the massive sand nourishment option (N). They are expensive and obtrusive, effectively changing the nature and appearance of the beach. Costs (capital and maintenance) are well beyond the resources of an individual or group of individuals and such structures elsewhere in Australia and around the world are constructed as a part of a regional strategy with Local, State or National funding.	No locations were identified where a single groyne or groyne field would be considered a technically viable and economically effective protection option.	N/A

5.4.3 Planned Retreat Options

'Planned Retreat' options are aimed at preserving beach amenity by allowing natural retreat in response to coastal processes, particularly sea level rise. The options for existing development

involve relocating or sacrificing infrastructure, public assets or private property, if and when erosion and recession impacts occur (in combination with wave overtopping). The planned retreat options offered include methods to compensate private property owners where feasible.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Suitable Locations / Applicable Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Planned Retreat	Planned retreat to allow the natural recession of the shoreline over the long term, is particularly considered for the following land uses: - Parks, public open space, private recreation (e.g. golf courses) and coastal dunes, as the remaining land is still able to be used even where reduced in size through erosion. Existing recreational infrastructure such as picnic shelters, footpaths, BBQs and amenities buildings would be relocated as impacts occur. - Norfolk Island Pines, as the trees have a finite lifespan (~ 100 yrs). - For certain heritage items (e.g. ocean pools) where inundation by seawater enables "burial" as a viable long term option to preserve the heritage asset. - For creek / lagoon entrances, to allow the natural process response to recession.	Gillespie Economics (refer Appendix F) found that the asset with the highest economic value is the beach itself. Based on both local resident and visitor use (domestic day visitors, overnight visitors and international visitors whose main activity is spending time at the beach (TRA, 2007)), Thirroul Beach alone was valued at over $142 million over the next 100 years. Therefore, any option which retains this asset shall be preferred for economic reasons. This is in addition to the community and environmental values associated with the beach. Planned retreat is a particularly viable option where adjacent back beach land uses (such as public open space, parks and coastal dunes) offer the opportunity to permit the beach to retreat over time, retaining the sandy beach amenity. The cost of loss of this land is far outweighed by the gains from retaining the economic values associated with the beach, as shown at Thirroul Beach by Gillespie Economics. This is in addition to the community and environmental benefit of retaining the beach. At Thirroul Beach, compared with both S1 & N and S2 options, planned retreat (including relocating assets and loss of park land) was found to have a substantially higher net present value (ie value of benefits less value of costs) per dollar invested. Particularly as funds are constrained, the option of planned retreat is far more viable than both "do nothing" and protect options such as S1 & N or S2. Even if the $ value of the beach is reduced by 80%, the S2 option, planned retreat remains the more economically viable option at Thirroul. Given the number of public assets and private properties affected at Thirroul is greater than other beaches, this economic analysis is likely to be valid at other locations where extensive seawalls are proposed. S2 may be economic on a small scale, and where minimal offsite impacts requiring nourishment are required (e.g. McCauleys Beach). Gillespie Economics did find high costs associated with the loss of Thirroul Beach Reserve (refer S1 above). However the cost of protecting such land uses (which will likely remain modified but tenable land uses after erosion) is not economic due to the associated loss of beach amenity and use values. . Norfolk Island Pines have a finite lifespan (~ 100 yrs) and may perish prior to being affected by erosion, in which case accepting retreat is viable. The feel of the existing beach can be maintained by ongoing, selective planting (NR11). For some heritage items (e.g. ocean pools) retreat may involve "burial" by inundation with seawater, which is a viable option for long term preservation of the heritage asset. For creek / lagoon entrances, the impact of erosion and recession due to sea level rise upon entrance breakout frequency and location will be best managed by allowing the natural process response. However, there may be constraints on entrance configuration changes (e.g. migration of berm) due to surrounding land uses.	Key locations include: Stanwell Park, Coalcliff, Scarborough, Wombarra, Coledale, Sharkies, Macauleys, Secondary: Austinmer, Little Austinmer, Thirroul, Sandon Point Beach, refer individual beach maps / tables.	Current Action: 1. Undertake NR3 – NR7 to determine specific and assets that deemed are sacrificial (compared with those that will be relocated, refer action below) and consult with the community. 2. Monitoring (NR14) to identify when trigger is reached. Trigger 1. Low key structures can be repaired, maintained, upgraded until such time as they are "at risk". 2. This could be determined by the movement of the immediate impact line over time (including reduced foundation capacity for larger structures) which should then be demolished / removed. 3. Indicative removal timelines should be continually updated in Councils Asset Register (i.e. following NR1, NR3 – 7).

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Suitable Locations / Applicable Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
PR2	Relocate structure / service outside of hazard zone	Planned Retreat	This option applies to structures which are either: easily relocatable (e.g. cabins in caravan park, lifeguard towers); have an asset value that is far lower than the value of beach amenity (e.g. a public amenities building); or for assets where it is technically and financially impractical to design the structure to withstand erosion/inundation within the hazard area, instead of relocating the structure. This option is also applicable to infrastructure such as stormwater outlets where the outlet may need to be relocated further landward to avoid ongoing damage from erosion of surrounding land and / or wave action. For local roads, this option refers to re-routing traffic off the affected road where alternate routes and access to residential property is available. Applicable assets/ locations are identified upon beach maps, however this will need to be confirmed by investigations NR2, NR3, NR4 and NR5.	This option allows for the beach amenity to be retained, which has community and financial benefits, as assets and lower value land uses are relocated. See PR1 above for details regarding the financial values associated with retaining the beach. In many cases this option can be implemented when public asset replacement is required, which would additionally enable a rejuvenation of a failing asset in combination with the reduction of risk from coastal hazards (e.g. a SLSC, new stormwater treatment outlet onto beach). This is a "win-win" solution where the erosion risk is reduced in conjunction with replacing a failing asset. Further, the cost of mitigating erosion impacts through relocation is shared with the cost of asset replacement. This reduces the overall cost now, and in the future, as relocating an existing asset with remaining life is far more costly than implementing the risk treatment as it is being built. However, there are some locations where erosion or inundation impacts may occur prior to the asset replacement cycle.	Bulli Tourist Park cabins, Lifeguard Towers, Caravan Parks, Cycleways, Stormwater Outlets, Local Roads (where it is identified that access to property can be maintained), Bulli SLSC, Thirroul SLSC.	Current Action 1. Undertake NR3 – NR7 to determine specific assets that can be relocated, and update Asset Register to reflect likely timeframe for impact, to assist in prioritising asset relocation. 2. Prepare planning approvals for new locations, design of new structures and generate funding to rebuild, in priority order based upon existing asset replacement requirements and expected timeframes for impact. 3. Monitoring (NR14) to identify when trigger is reached. Trigger for Implementation: • When asset replacement is required **OR** • When immediate impact zone encroaches the asset location (e.g. erosion escarpment < 10 m from asset) (as identified through NR14) **OR** • When frequency / extent of storm inundation becomes unacceptable (e.g. frequency of inundation > 6 times /year). • whichever occurs sooner.
PR3	Prohibit expansion of existing use rights	Planned Retreat	This option would enable an existing landholder to remain on land until such time as an impact occurs. Up until that time, further expansion of the development footprint (e.g. extensions or renovations, subdivision, change of use) would not be permitted, as specified in a Coastal Management DCP.	Application of this option is not viable for all locations. It is being considered at the few sites where private property(s) are located within a land use that would otherwise be permitted to retreat to retain beach amenity; and where seawall protection is not viable for the property and adjacent land. Limiting use to existing rights would ensure there is minimal increase in asset value at risk from hazards, while still enabling use of the development during the time before an impact is imminent. The actual cost of this option to property value relates to the length of time before an expected impact (e.g. immediate, 2050 or 2100). However, the cost of this option would be borne by the property owner, with land remaining in private ownership despite limitations on future development.	Thirroul existing residences (1 ppty centre of beach)	Current Action Implement Now, through Coastal DCP
PR4	Voluntary acquisition	Planned Retreat	This option would involve Council applying for funding (from the NSW Government's Coastal Lands Protection Scheme or Coastal Management Program) to acquire affected properties, on a voluntary basis. However, the rate shall be based on market value, which means that purchase price would be lower should the owners wait until erosion impacts manifest before accepting the offer.	Application of this option is being considered at only the few sites where private property(s) are located within a land use that would otherwise be permitted to retreat to retain beach amenity (see PR1 above); and where alternative options (i.e. protect, accommodate) are not viable for the property and adjacent land (see S1 and S2). This option has been offered in other location along the NSW coastline with limited success. For example, at Collaroy, Council had limited funds and there was little available assistance from NSW Government. Typically, coastal land is viewed as too valuable and the risks too remote. The Coastal Lands Protection Scheme has been used to purchase isolated residential blocks but is predominantly used for rural land repurchase and addition to national park estate. NSW Government annual funding for the Coastal Lands Protection Scheme and Coastal Management Program is very limited, constraining implementation of this option. That is, the option may only be possible at a limited / isolated number of locations.	Thirroul existing residences (1 ppty centre of beach, 3 ppties at southern end, refer maps); Woonona existing residences (4 at centre of beach, refer Maps)	Current Actions 1. Apply for funding through Coastal Lands Protection Scheme and Coastal management Program for acquisition of priority properties 2. Offer voluntary acquisition at current market rates. This rate shall progressively discount as impacts manifest, to accurately reflect the reduction in asset value.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Suitable Locations / Applicable Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
PR5	Buy back – lease back	Planned Retreat	This option would involve Council applying for funding through typical mortgage arrangements to acquire affected property(s) at market rates, on a voluntary or compulsory basis. The property would then be leased out at market rates until such time as the hazard impact is imminent. The offer shall be discounted in accordance with the length of time remaining before the property becomes uninhabitable due to erosion. At that time the development shall be demolished, and land returned to Community Land, to enable continued retreat of shoreline and for use by the community. Council would absorb any profit/loss over that period.	The offer shall be discounted in accordance with the length of time remaining before the property becomes uninhabitable due to erosion because this option is dependent upon Council leasing the property at market rates to assist loan repayments prior to erosion impacts. This option is likely to only be applied at the few sites where private property(s) are located within a land use that would otherwise be permitted to retreat to retain beach amenity (see PR1 above); or where alternative options (i.e. protect or accommodate) are not viable (see S1 and S2). Further, the option may only be financially possible at a limited number of locations. This option allows existing property owners to be compensated at market rates. The existing owners could also have the option of leasing back the property from Council until the hazard is imminent. The option also ensures that natural retreat of the shoreline can be facilitated, by demolishing the development and returning the land to the general public once the property can no longer be inhabited. This option is as yet untested.	Thirroul existing residences (1 ppty centre of beach, 3 ppties at southern end, refer maps); Woonona existing residences (4 at centre of beach, refer Maps)	Current Action 1. Apply for loan 2. Offer voluntary acquisition at current market rates. This rate shall progressively discount as impacts manifest, to accurately reflect the reduction in asset value. 3. Rent property at market rates 4. Monitoring (NR14) to identify when trigger is reached. Trigger Demolish the property when the immediate impact zone (including allowance for reduced foundation capacity) encroaches the building foundations.

5.4.4 Accommodate Options

'Accommodate' options are aimed at methods to re-develop existing infrastructure, public assets and private property in a manner that mitigates potential impacts (e.g. foundation piles) or allows for impacts to occur (relocatable structures) through structure design, and which can then lead into 'protect' (e.g. future seawall) or 'planned retreat' alternatives (temporary or sacrificial structures, distance based development approvals) at a later time.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Suitable Locations / Applicable Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
DCP	Prepare a Coastal Management Development Control Plan (DCP) Chapter to implement controls upon future development and re-development (including minor and major alterations) in erosion / recession risk areas.	Accommodate	This option involves applying development controls through a Coastal Management DCP Chapter to existing developments at risk. The controls will be applied at the time of property and asset redevelopment or replacement, including alterations and extensions. The development controls will reflect the level of risk to an individual property. That is, less stringent controls are applied to land at lower risk and / or land uses considered to have a shorter timeframe (design life), and vice versa. The types of controls may relate to foundation capacity (bedrock), structure design (relocatable or permanent), floor levels, distance to hazard zones or distance based approvals, as in Section 5.3. The controls shall manage wave overtopping as well as erosion, as existing Flood DCP controls may not be applicable to the overtopping risk. The controls apply to all land uses including roads and stormwater infrastructure, and both private and public landholders. The DCP shall also apply to properties where a protection option is proposed (e.g. seawall) until such time as the protection option is implemented and risk level for properties revised.	The costs to develop a DCP are minimal, however the costs to implement the development controls are borne by the property owners – this includes Council who owns many assets and land in the coastal zone. Applying development controls does not affect future ability to protect or retreat from the properties, and management options can be revised in the future, as the estimates for hazard impact change or impacts become imminent. Development controls facilitate the replacement of existing assets and properties with more resilient structures to accommodate risks over time. Particularly where assets are currently at low risk, there is no immediate need for action. When asset replacement or redevelopment is required, the DCP will trigger investigations and controls that will govern whether the asset needs to be relocated (e.g. PR2), or redesigned to withstand impacts (A2 or A3). This allows Council to prioritise efforts towards other locations presently at high risk. This is also more cost effective as actions are done in conjunction with the expected cost for asset maintenance and replacement. The cost of the alternative over the designated planning period (i.e. "do nothing") may be substantially greater than the current cost of implementing planning controls, as development is intensified (i.e. property continues to be developed, land subdivided and development density increased). This strategy places the cost upon the current generation to enable a reduction in the likelihood, consequence and therefore cost of coastal risks for future generations in accordance with the principles of Ecologically Sustainable Development.	All land identified "at risk" from erosion / recession in the coastal zone over the designated planning period.	Current Action Following completion and endorsement of CZMP by Council, prepare a Coastal Management DCP, including: 1. Determining level of risk to apply to development types 2. Determining appropriate controls for erosion and wave overtopping to be specified in the DCP, or Foreshore Building Line 3. Approval of the DCP chapter by Council, ready for implementation 4. Apply DCP to all properties within all hazard risk zones in the LGA Trigger: • Implement DCP as properties are redeveloped and assets are replaced **OR** • As existing assets are affected by hazards, requiring repair.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Suitable Locations / Applicable Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
A2	Redesign structures in current location to withstand impacts.	Accommodate	Where relocation of a structure is not possible due to other site constraints, further redesign options may need to be considered. This may be applicable to the coastal harbours where the structures/assets are necessarily at the waters edge; stormwater infrastructure, for some surf club locations where suitable foundations exist and there are relocation constraints; or for major road redesign, where there are no alternatives for redirection of the road. Redesign of existing structures shall necessarily include provisions for managing wave overtopping and inundation, as well as erosion and recession impacts. Typical measures could include deep seated pile foundations, elevated floor levels, clear air space below the floors to limit risk of wave inundation, bunding to reduce wave run-up, use of appropriate materials, elevation of occupied areas within the development etc.	This option aims to retain existing community services in needed locations but reduce the risk (consequence) of coastal hazards. In some cases this option can be implemented when asset replacement is required, enabling a rejuvenation of a failing asset in combination with the reduction of risk from coastal hazards (e.g. a new SLSC, improved roadway). The cost of mitigating erosion impacts through redesign may be shared with the cost of asset replacement. This reduces the overall cost now, and in the future, as retrofitting an existing asset is far more costly than implementing the risk treatment as it is being built. In some locations this option shall involve a retrofit of an existing structure (e.g. coastal harbours, selected ocean pools). It is not applicable to design residential dwellings seaward of the Immediate Impact zone to withstand ocean wave attack.	Bellambi Boat Harbour, Sharkies (Austinmer) Boat Harbour, Lawrence Hargrave Drive at Austinmer & Little Austinmer, Sandon Point SLSC, North Beach SLSC. This option is not applicable to residential dwellings seaward of the immediate impact zone.	Current Action 1. Undertake NR1 – NR7 to determine specific assets that must be redesigned / retrofitted, and update Asset Register to reflect likely timeframe for impact, to assist in prioritising asset maintenance/replacement. 2. Prepare planning approvals and design for replacement structures and generate funding to rebuild /retrofit, in priority order based upon existing asset replacement requirements and expected timeframes for impact. 3. Monitoring (NR14) to identify when trigger is reached. Trigger for Implementation: • When asset replacement is required **OR** • When immediate impact zone encroaches the asset location (e.g. erosion escarpment < 10 m from asset when identified through NR14) **OR** • When frequency / extent of storm inundation becomes unacceptable (e.g. frequency of inundation > 6 times /year). whichever occurs sooner.
A3	Replace existing structure with relocatable structure.	Accommodate	Where relocation or redesign of a permanent structure “at risk” is not possible due to other site constraints, investigate option of constructing a relocatable structure.	In some cases, designing a structure to withstand erosion and wave impacts may be prohibitively expensive or not technically possible. However the asset cannot be relocated permanently, in which case building a relocatable structure may be a viable option. Relocatable structures are typically relatively inexpensive, compared with hard structures (e.g. foundation piles to bedrock). The relocatable structure also enables natural retreat of the shoreline, offering a community and environmental benefit also. For example, at Coledale Beach, the relocatable SLSC structure is inexpensive (~ $30,000) and can be moved prior to a storm (where there is sufficient warning). The structure provides power, water and sewer services, in addition to storage and viewing platforms. However, the relocatable structure may not provide for additional commercial enterprise (e.g. function centres, restaurants) that can be associated with surf club developments. Ongoing monitoring is essential to ensure that later changes (renovations, supply of services, ancillary structures/landscaping etc.) do not compromise the speedy and efficient removal/return of the structure during and following storm events.	Coledale, Stanwell Park, Bulli SLSCs.	Current Action 1. Undertake NR1 and NR3 to determine specific assets that could be replaced with relocatable structures, and update Asset Register to reflect likely timeframe for impact, to assist in prioritising asset redesign. 2. Prepare planning approvals and design for relocatable structures and generate funding to build, in priority order based upon existing asset replacement requirements and expected timeframes for impact. 3. Monitoring (NR14) to identify when trigger is reached. Trigger for Implementation: • When asset replacement is required **OR** • When immediate impact zone encroaches the asset location (e.g. erosion escarpment < 10 m from asset, when identified from NR14) **OR** • When frequency / extent of storm inundation becomes unacceptable (e.g. frequency of inundation > 6 times /year). whichever occurs sooner.

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Suitable Locations / Applicable Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	Accommodate	This option involves assigning areas within the Coastal Inundation Area but outside of the existing Flood Planning Area into the Low Flood Risk Precinct of the Flood Planning area, then managing this area according to the provisions in DCP Chapter E13 – Floodplain Management. This will include flood proofing or relocatable structures etc as required on a site by site basis as assets are redeveloped or replaced. Controls for flood inundation, as specified in DCP E13, would adequately manage coastal inundation backwater impacts, but not wave overtopping impacts. Properties affected by wave overtopping will need to be managed through erosion / recession controls, as per the Coastal Management DCP chapter (see DCP above).	This option facilitates the redesign of existing public assets (e.g. public buildings), infrastructure (e.g. stormwater) and development (e.g. existing residences, commercial / industrial property) to accommodate coastal inundation through coastal entrances and creeks (ie backwater inundation). Existing flood DCP controls may not be applicable to wave overtopping. The development controls are applied to existing development and implemented as assets and properties are replaced and upgraded, spreading the burden of managing the risk across the community. This option provides for coastal inundation impacts to be managed under an existing, tested program. The option accepts the consequence of impacts that occur prior to redevelopment / retrofit of existing assets, however this is already accepted largely by community in accepting the risk of catchment flooding. Where an existing Flood Planning Area exists, the majority of areas identified as likely to experience coastal inundation at the immediate, 2050 and 2100 timeframes lie within the Flood Planning Area (this may change as Flood Studies are reworked to include climate change, refer NR10), therefore only a small area is being added to those existing FPAs.. For areas without existing flood mapping, the coastal inundation area provides a “first pass” assessment of low-lying areas likely to also be affected by catchment flooding, until such time as flood studies are completed. Areas affected by coastal inundation outside of any existing Flood Planning Areas are considered to have a risk equivalent to the Low Flood Risk Precinct as defined in DCP Chapter E13 – Floodplain Management because raised water levels via an oceanic entrance will not have high current velocities, and so the inundation event is relatively passive.	All public assets (e.g. public buildings, recreational assets such as caravan parks), infrastructure (e.g. local roads, major roads, stormwater infrastructure) and private property (residential, industrial, renovations and extensions).	Current Actions 1. Designate all relevant areas within the Coastal Inundation Area but not within an existing Flood Planning area as a Low Flood Risk Precinct Flood Planning Area (see Chapter 6) 2. Implement the planning controls given for Low Flood Risk Precincts in DCP Chapter E13 – Floodplain Management, for future development or re-development.
GDCP	Update DCP Chapter E12 – Geotechnical Assessment (GDCP) to ensure actions of the sea (overtopping, sea level rise) are included in the assessment of geotechnical stability and apply GDCP to areas identified within the geotechnical hazard area	Accommodate	This option would update the existing GDCP to additionally include actions of the sea (overtopping, sea level rise) in geotechnical assessments, and then apply development controls according to the risk of geotechnical failure under existing risk assessment mechanisms. The DCP is applied on a case by case basis as property (private or public) is developed or re-developed.	The majority of properties identified as at risk from coastal influenced geotechnical hazards already exist in an area identified to be at risk from geotechnical failure. Properties within the coastal-influenced geotechnical hazard area have already been informed of their risk through notation of this hazard on their Section 149 certificates.		Current Action Update existing provisions within the DCP Chapter E12 - Geotechnical Assessment to: • Identify wave action, wave overtopping, sea level rise and increased rainfall intensities due to climate change as possible causes of geotechnical failure that should be assessed; and; • State the NSW Government’s Sea Level Rise planning benchmarks (i.e. 0.4 m above AHD by 2050 and 0.9 m above AHD by 2100) for use in geotechnical assessments.

5.4.5 "Do Nothing" (Accept Risk) Option

Option Symbol	Option Name	Option Type	Description	Cost-benefit considerations	Suitable Locations / Applicable Assets (refer to Beach Maps & Tables for further detail)	Proposed Actions or Trigger for Future Actions
DN	No limitations upon existing development or future development / re-development over planning timeframe	"Do nothing"	The "do nothing" option assumes all levels of risk are accepted. The "do nothing" scenario assumes that there is no change in existing planning controls, and no actions are implemented (i.e. no controls are implemented to treat known coastal risks). Private and public landholders are free to maximise their development rights as per current controls. This would allow further subdivision, increased development density and built area on land identified to be at risk now and to 2100. The "do nothing" scenario provides the basis for comparison of all other options.	The "do nothing" or accept option does not involve any new action. Where existing levels of risk are low, accepting the risk may be appropriate. However, the "do nothing" scenario may not be appropriate for high risk locations / assets. Under the "do nothing" scenario, the value of property at risk continues to increase over time as development is intensified (i.e. property continues to be developed, land subdivided and development density increased). The cost of "do nothing" may be substantially greater in the future than the current cost of implementing planning controls. This is because the value of land at risk continues to increase, as does the cost of mitigating recession impacts over time (such as retrofit, or even abandoning lost lands). Further, as the value of land at risk continues to increase over time, implementation of retreat options in the future, which provide for a sandy beach amenity for the broader community, become increasingly desirable while more difficult to implement. This approach is at odds with the NSW Coastal Policy and the stated objectives of the NSW Coastal Protection Act to manage the future development of coastal areas and minimise the risk from coastal hazards at present and into the future. This strategy also places the cost upon future generations to manage the impacts and damage from coastal risks and does not accord with the principles of ecologically sustainable development.	This option is assessed at all locations.	Implement Now

5.5 Rapid Analysis for Costs and Benefits of Options

A simple tool has been developed to assess the positive and negative costs and benefits of the various options, as given in Table 5-2. The criteria are based on a "traffic light" colour system to clearly display if an aspect of an option should be cause to "stop" and reconsider, "slow" to proceed with caution or "go" with few trade-offs expected.

The assessment has been conducted for each option specified at each beach, to account for the local variants between beaches that may make an option more or less beneficial. This aims to build upon the cost-benefit considerations given for the management options above.

The aim of the assessment is to provide a straightforward overview of the options at a particular beach. It is aimed at presenting quickly and clearly to community the benefits and trade-offs of a particular option, to assist in the selection of a preferred option

For the assessment tables for each beach, details regarding who may fund the option have also been indicated. For community to make an informed decision regarding a particular option, it will be important to understand not only the cost of the option, but who may need to fund the option, whether this be by current programs, new levies or increased rates through Council, State Government Grants, or private investment by affected landholders (as directed by Council or otherwise).

The capital cost and recurrent cost limit values are based upon an order of magnitude difference from "high" to "low". Typically, this order of magnitude expenditure would require investigations and approvals by Council before proceeding.

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

	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk
STOP & reassess	Very Expensive ($300K to millions)	Very Expensive ($300K to millions)	Will impact negatively on environment, community or beach amenity	Unlikely to be acceptable to community and politically unpalatable. Extensive community education, endorsement by Minister(s) and Council required.	Option is irreversible once implemented; option limits alternative options in future.	Option does not provide a long term solution, only effective over short term	Will require an EIS and/or Government approval to implement. There is a residual risk that approval will not be able to be obtained for the proposed works/strategy
SLOW	Moderately expensive (e.g. $30,000 - $300,000)	Moderately expensive (e.g. $30,000 - $300,000)	No net impact	Would be palatable to some, not to others (50/50 response). Briefing by Councillors, GM and community education required	Option is reversible or adaptable but at considerable cost / effort	Option is only a short term solution but has other benefits; or option requires further resources / changes to be effective over long term	Will require Government approvals to be implemented. Generally these approvals would likely to be granted assuming requirements are met
GO	Little to no cost (< $30,000)	Little to no cost (< $30,000)	Will benefit environment, community or beach amenity (e.g. improve beach access, recreation, habitats etc)	Is very politically palatable, acceptable to community. Minimal education required	Option can be easily adapted for future circumstances or should impacts not occur, option would not negatively impact future generations.	Option provides a long term solution	No or minimal government approvals required to implement

Note that the technical viability of the options has been assessed for specific assets / locations on a beach by beach basis. Refer to individual beach tables and maps (Chapter 6) for the technical assessment of options.

6 RISK LEVELS AND TREATMENT OPTIONS

This chapter provides a risk register for each beach detailing assets affected by erosion and recession or coastal inundation, with a risk level for the immediate, 2050 and 2100 time periods. Presented with the risk register are treatment options considered technically viable for each asset affected. Following on from the risk register, for each beach a map is presented that provides the immediate risk level for erosion and recession or coastal inundation, then a spatial representation of the management options. Linear assets such as stormwater pipelines and cycleways are also risk colour coded on these maps. It is also noted that the flood planning area is displayed upon the coastal inundation maps where one exists for each beach, presenting the existing controls for the backwater inundation hazard.

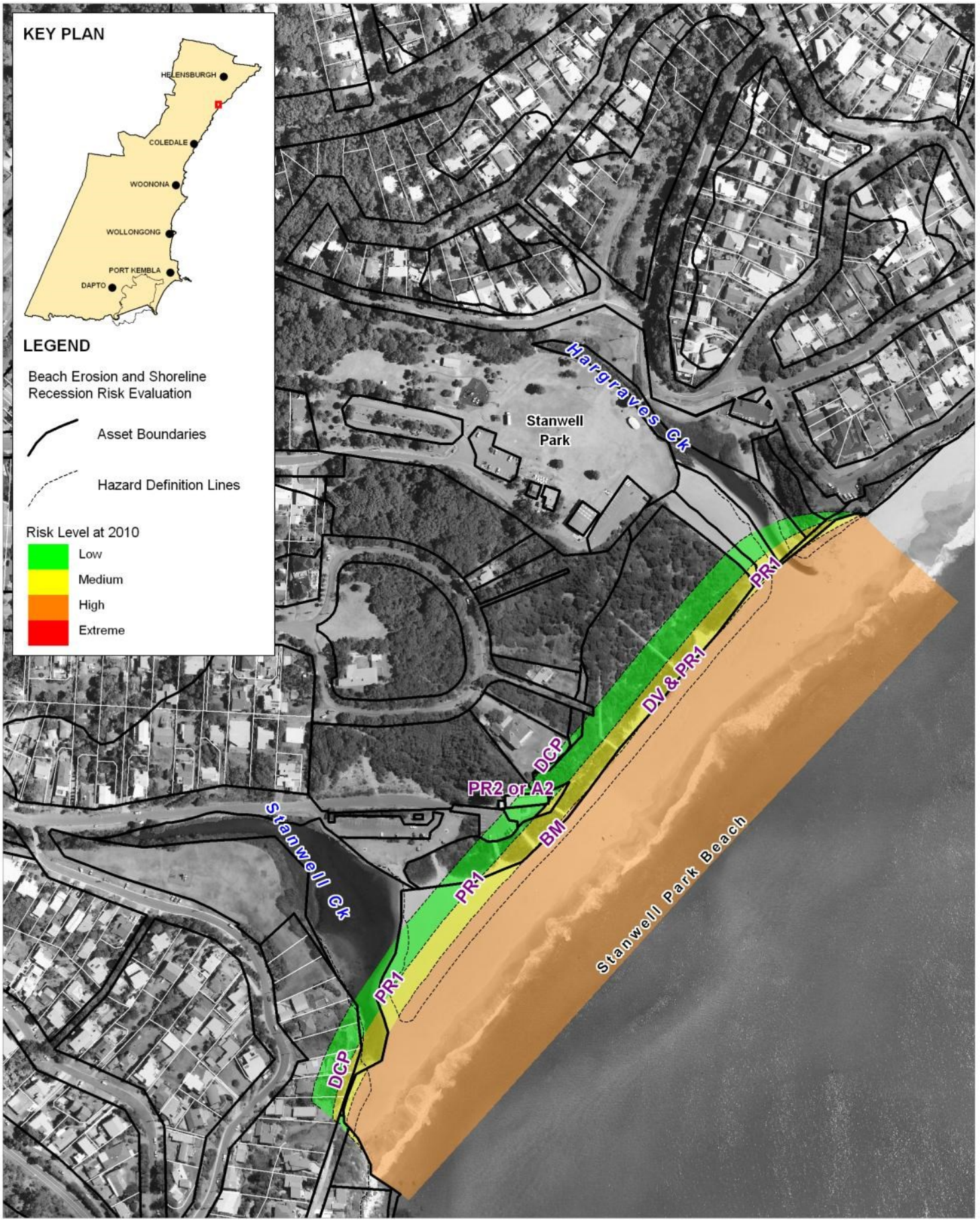
The risk level mapping for immediate, 2050 and 2100 for erosion and recession, coastal inundation and geotechnical hazards are presented in Appendix A.

6.1 Stanwell Park Beach

6.1.1 Erosion and Recession Risk Level and Treatment Options

Stanwell Park Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Stanwell Park Beach	High	Extreme	Extreme				✓✓		✓✓								NR14	
Stanwell Park Recreation Area Park, and Natural Area	Medium	Medium	High						✓✓									
Coastal Dune Systems	High	Extreme	Extreme				✓✓		✓✓									
Hargraves Creek	Medium	Medium	High						✓✓								NR11	
Stanwell Creek	Medium	High	High						✓✓								NR11	
Community Infrastructure																		
Helensburgh / Stanwell Park SLSC	Medium	High	Extreme					✓		✓✓				✓✓	✓	✓	NR3, NR14	●
Transport Infrastructure																		
Beach Access Car Park	Low	Low	Medium											✓✓			NR5	✓
Residential Development																		
Existing Residences (1 centre of beach)	Low	Medium	Medium											✓✓				
Existing Residences (4 ppty S end)	Medium	Medium	High											✓✓			NR14	●
Vacant Land (Future Development) (1 block at S end)	Low	Low	Medium											✓✓				

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
●	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Stanwell Park Beach

Drawing: 6-1

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

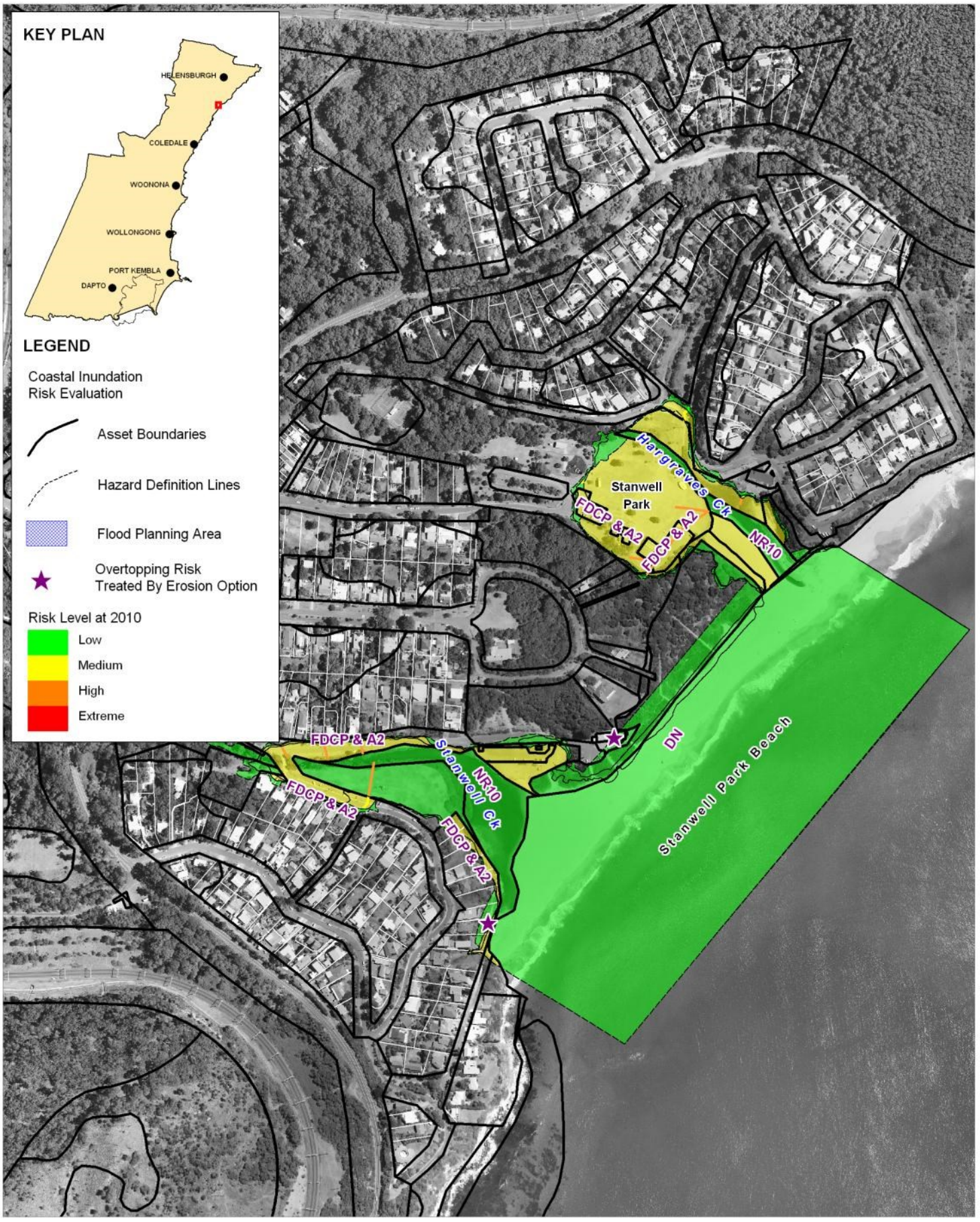
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_101_110427 Drawing 6-1.WOR

6.1.2 Coastal Inundation Risk Level and Treatment Options

Stanwell Park Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Stanwell Park Beach	Low	Low	Medium						✓
Stanwell Park Recreation Area Park, and Natural Area	Low	Medium	Medium						✓
Coastal Dune Systems	Low	Low	Medium						✓
Hargraves Creek	Medium	Medium	High					NR10, NR11	
Stanwell Creek	Medium	Medium	High					NR10, NR11	
Baird Park	Low	Low	Medium						✓
Community Infrastructure									
Helensburgh / Stanwell Park SLSC	Low	Medium	Medium	✓		✓✓	✓	NR10	
Stanwell Park Beach Toilets (South)	Low	Low	Medium			✓✓	✓	NR10	✓
Kiosk (in Stanwell Park Recreation Area)	Medium	High	Extreme			✓✓	✓	NR10, NR9	●
Stanwell Park Reserve Dwelling	Medium	High	Extreme			✓✓	✓	NR10, NR9	●
Stanwell Park Reserve Toilets	Medium	Medium	High			✓✓	✓	NR10	
Transport Infrastructure									
Local Roads, (including car parks)	Medium	High	Extreme			✓✓	✓	NR10	
Water and sewage infrastructure									
Stormwater outlets and pipes (servicing upper reaches surrounding Stanwell Ck)	High	Extreme	Extreme			✓	✓✓	NR7, NR10, NR14	●
Stormwater outlets and pipes (servicing across Stanwell Park adjacent to Kiosk and from N carpark to Hargraves Ck)	High	Extreme	Extreme			✓	✓✓	NR7, NR10, NR14	●
Residential Development									
Existing Residences (edge of 6 ppties at S end of beach next to Stanwell Ck)	Medium	High	Extreme	✓		✓✓	✓	NR10, NR9	●
Existing Residences (Edge of 13 ppties at upper reach of Stanwell Ck)	Medium	High	Extreme			✓✓	✓	NR10, NR9	●
Vacant Land (Future Development) (edge of 4 ppties at S end of beach next to Stanwell Ck)	Low	Medium	High			✓✓	✓	NR10, NR9	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
●	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Stanwell Park Beach

Drawing: 6-2

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_101_110427 Drawing 6-2.WOR

6.1.3 Assessment of Treatment Options

Stanwell Park Beach

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over long term	Legal / Approval Risk	Specific Cost Benefit Considerations for Stanwell Park Beach	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								Dune care programs must be considerate of sightline requirements for SLSC activities. *Refer to Protect Options Table for further cost benefit details of DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	×								This option involves scraping and contouring beach sands to accumulate in dunes in front of the surfclub structure. This aims to increase sand volumes in front of the structure to prolong its current location. *Refer to Protect Options Table for further cost benefit details for BM.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This is an excellent option for retaining the beach at Stanwell Park where there are wide dunes and reserve lands to enable natural retreat of the beach, and hence continued provision of a beach over the long term. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate SLSC outside of hazard zone	**Current Action:** NR3 **Trigger:** When SLSC needs to be refurbished OR erosion escarpment threatens building foundations.	✓	✓	×								There are likely to be site contstraints (Norfolk Is Pine) that limit relocating the surfclub. If this option is feasible (based on NR3) relocation of the surf club would provide a new club facility for community and the SLSC. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	×								Erosion and inundation impacts are likely to affect land within property boundaries, however the buildings are not likely to be affected for some time. Applying development controls when these residences are redeveloped would improve their structural stability and therefore the longevity of the developments. Management options to either retreat from or protect the residences can be revised in the future, as the estimates for hazard impact change or impacts become imminent. Development controls may include foundations piles down to bedrock, minimum floor levels, distance from boundary for structures etc. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs, increased rates and levies?) - cost to prepare DCP and implement at public assets ☑ Private landholders - cost to implement DCP	Recommended

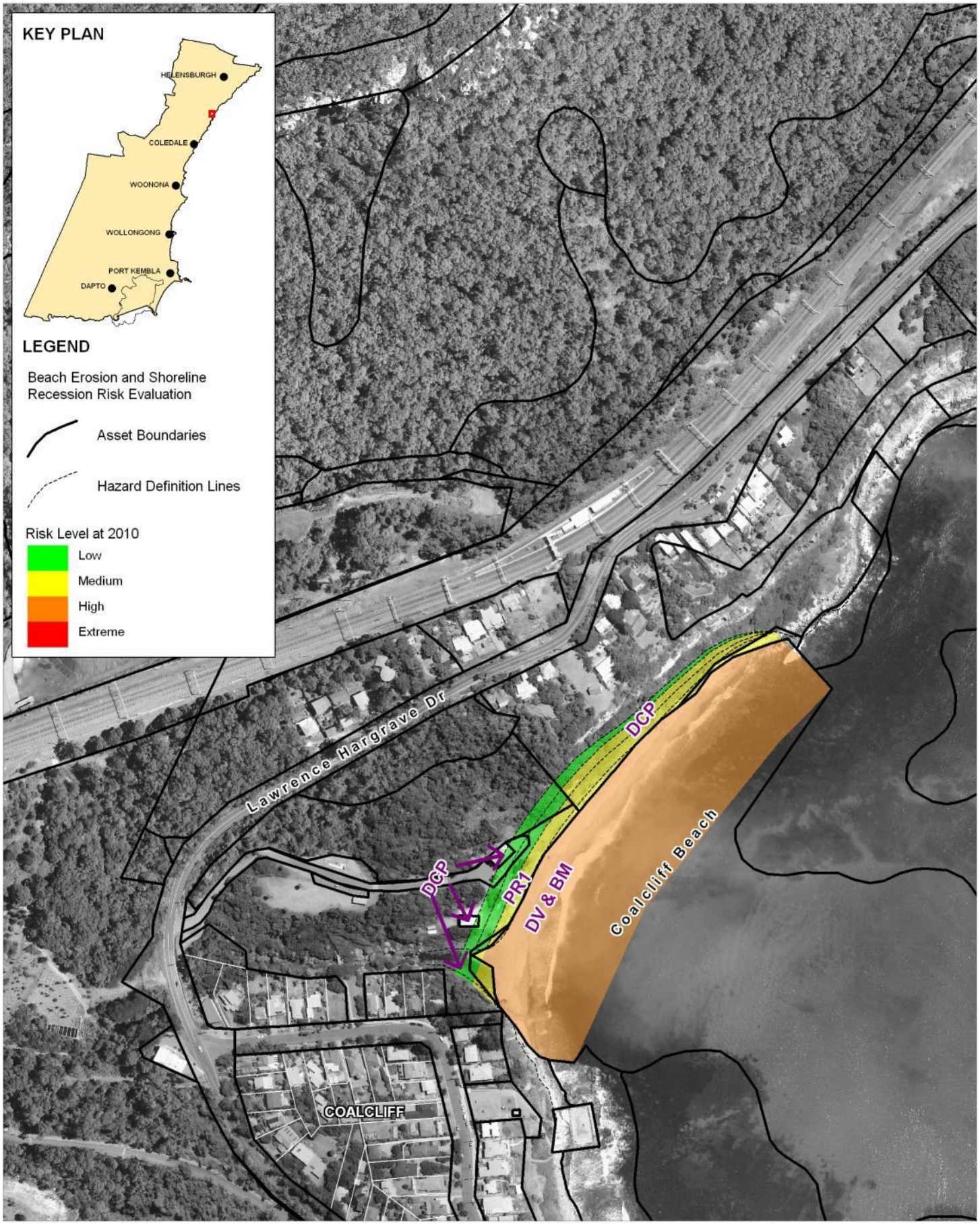
Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability***	Reversible / Adaptable in Future	Effectiveness over long term	Legal / Approval Risk	Specific Cost Benefit Considerations for DCP	Potential Funding Sources (Who may pay)	
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	**Current Action:** NR7 **Trigger:** When inundation frequency impedes effective conveyance of stormwater OR when asset replacement is required, whichever is sooner.	×	×	✓								Stormwater assets are shown to be affected by coastal inundation through Hargraves and Stanwell Creeks. The outcomes of NR7 shall guide suitable designs for ensuring conveyance of stormwater with more frequent inundation with sea level rise. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
A2	Redesign or retrofit SLSC in current location to withstand impacts.	**Current Action:** NR3 **Trigger:** When SLSC needs to be refurbished OR erosion escarpment threatens building foundations.	✓	✓	✓								Would require re-development of SLSC in current location, but with design to withstand erosion and wave overtopping. The viability of this option will depend on outcomes of NR3. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Marginal
A3	Replace existing SLSC with relocatable structure.	**Current Action:** NR3 **Trigger:** When SLSC needs to be refurbished OR erosion escarpment threatens building foundations.	✓	✓	✓								Depending upon site contraints, this option may be only viable way to retain structure in current location to withstand impacts. The viability of this option will depend on outcomes of NR3. *Refer to Accommodate Options Table for further cost benefit details for A3.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Marginal
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As residences redeveloped, new developments built	×	×	✓								This option involves applying the existing Flood DCP chapter to properties at risk of coastal inundation at the "low flood risk" level, until Flood Studies are conducted for the creeks (for combined catchment and ocean water level events, see NR10). *Refer to Accommodate Options Table for further cost benefit details for FDCP.*	*N/A* State Government (external funding unlikely to be needed) ☑ Council (Current Programs) ☑ Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								In general, Stanwell Park has relatively few assets at risk, so "do nothing" may not be as detrimental as elsewhere in Wollongong. However there would be a small number of private residences and public assets affected, making this an unacceptable option. Further, this option limits future management options, both where land value at risk is increased, or permanent loss of land/assets from erosion occurs prior to management action. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR3, NR5, NR7, NR9, NR10, NR11, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.2 Coalcliff Beach

6.2.1 Erosion and Recession Risk Level and Treatment Options

Coalcliff Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments															
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Coalcliff Beach	High	Extreme	Extreme				✓✓	✓✓	✓✓								NR14	
Coalcliff Beach Reserve Nature Area, Coalcliff Beach Reserve	Medium	Medium	High						✓✓									
Stoney Creek	Medium	Medium	High						✓✓								NR11	
Community Infrastructure																		
Coalcliff Surf Club	Low	Medium	Medium							✓				✓✓			NR3	✓
Coalcliff Boatshed	Low	Low	Medium											✓✓				✓
Coalcliff Tidal Rock Pool (S end)	Medium	High	High						✓						✓		NR4, NR14	
Transport Infrastructure																		
Beach access road and car park	Low	Medium	Medium											✓✓				✓
Water and sewage infrastructure																		
Stormwater outlet and pipe (S end of beach)	Low	Medium	High							✓✓				✓			NR7, NR14	
Residential Development																		
Existing Residences (10 ppties N end, but edge of ppty below cliff)	Medium	Medium	High											✓✓				

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Coalcliff Beach

Drawing: 6-3

Rev: A

N

0 75 150m

Approx. Scale

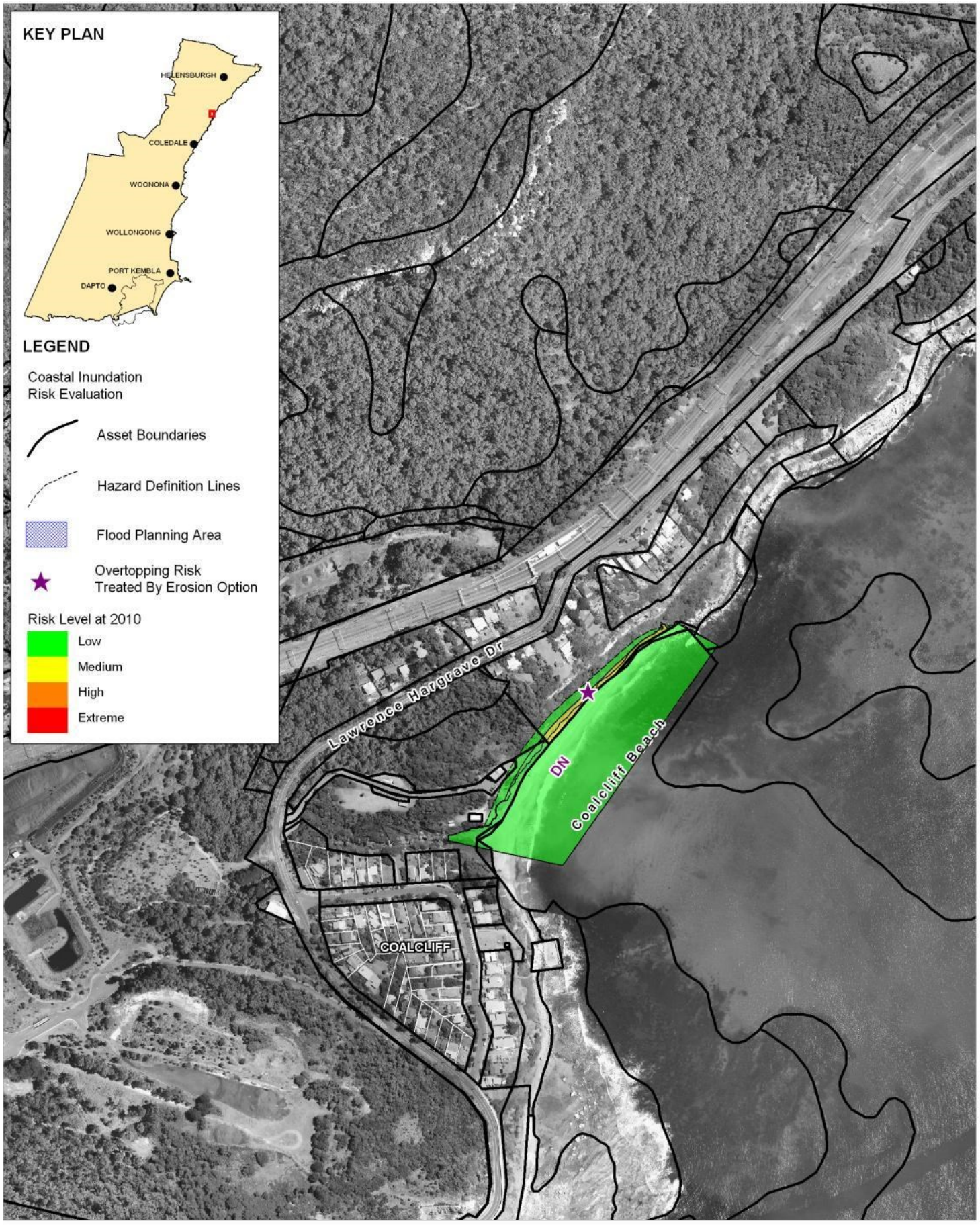
BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_102_110427 Drawing 6-3.WOR

6.2.2 Coastal Inundation Risk Level and Treatment Options

Coalcliff Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Coalcliff Beach	Low	Low	Medium						✓✓
Coalcliff Beach Reserve Nature Area, Coalcliff Beach Reserve	Low	Low	Medium						✓✓
Stoney Creek	Low	Low	Medium						✓✓
Community Infrastructure									
Coalcliff Tidal Rock Pool (S end)	Low	Medium	Medium						✓✓
Transport Infrastructure									
Beach access road and car park	Low	Low	Low						✓✓
Residential Development									
Existing Residences (10 ppties N end, but edge of ppty below cliff)	Medium	High	Extreme	✓✓					✓

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Coalcliff Beach

Drawing: 6-4

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_102_110427 Drawing 6-4.WOR

6.2.3 Assessment of Treatment Options

Coalcliff

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability***	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Coalcliff Beach	Potential Funding Sources (Who may pay)	Conclusion (provisional)
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	N/A								Dune care programs must be considerate of sightline requirements for SLSC activities. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	N/A								This option involves scraping and contouring beach sands to increase sand volumes held in dune storage for storm protection. *Refer to Protect Options Table for further cost benefit details for BM.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	N/A								This is an excellent option for retaining Coledale beach, by utilising public open space to enable natural retreat and thus continued provision of a beach over the long term. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate stormwater assets landward of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe.	✓	✓	N/A								Given the small piece of stormwater outlet and pipe shown to be at risk, it is likely that the outlet and pipe can be progressively removed landward as impacts occur.. The best option for these assets should be confirmed through NR7. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate Coalcliff SLSC landward of hazard zone	**Current Action:** NR3 **Trigger:** When asset requires major refurbishment or replacement	✓	✓	N/A								Coalcliff is highly constrained by bedrock, making the need for the SLSC to remain in current location unlikely, because of retreat of the shoreline. Relocation of the SLSC would require reconfiguring of the access road and carpark – this would be required with a retreated shoreline in any case. The best option for the SLSC should be confirmed through NR3. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended

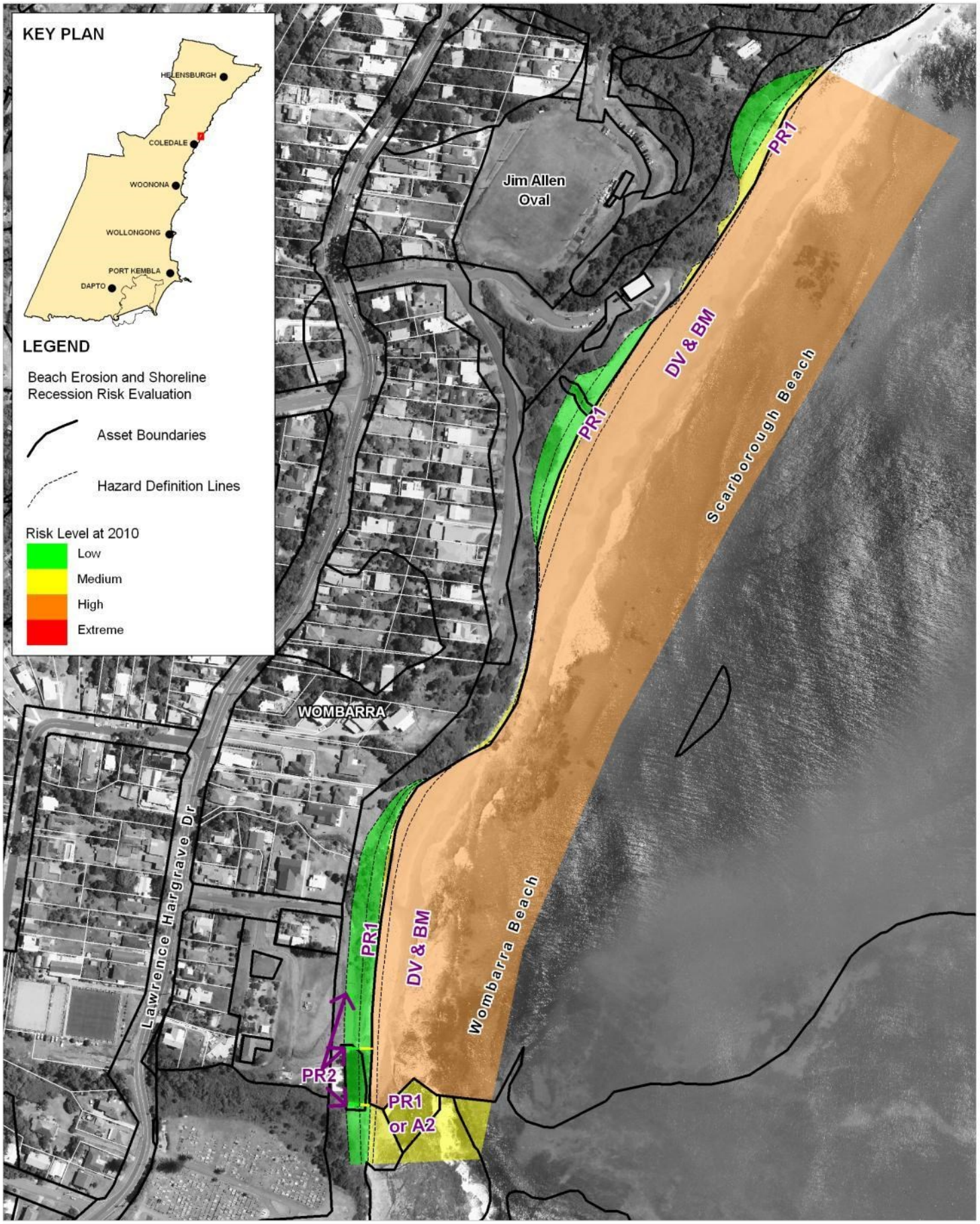
Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability***	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	N/A								*Private Properties* Erosion and overtopping impacts are shown to affect land within the property boundary, however the residences are situated far landward and higher than area identified at risk. Applying development controls to redevelopment ensures coastal erosion and overtopping are considered, but given the distance and building footprint, controls are unlikely to be extensive. *Public Assets: SLSC, Boatshed, carpark* These public assets are currently at low risk, so there is no immediate need for action. Investigations and action can be delayed until asset replacement is required. At that time, the DCP will trigger investigations that will govern whether the asset needs to be relocated (e.g. PR2), or redesigned to withstand impacts (A2 or A3). In the meantime, Council can prioritise efforts towards other locations presently at high risk. This is also more cost effective as actions are done in conjunction with the expected cost for asset maintenance & replacement. Inundation at Coalcliff is related to wave overtopping, rather than backwater inundation. This should be managed through Coastal DCP controls, as existing Flood DCP controls may not be	**?** State Government (Grant programs) ☑ Council (Current Programs, increased rates and levies?) - cost to prepare DCP and implement at public assets ☑ Private landholders - cost to implement DCP	Recommended
A2	Retrofit Coalcliff Pool in current location to withstand impacts.	**Current Action:** NR4 **Trigger:** When damage to pool shell occurs OR the pool is being inundated at water levels lower than MSL.	✓	✓	N/A								The decision to progressively retrofit Coalcliff Pool over time to withstand wave and sea level rise impacts shall depend upon the suitability of pool condition for this purpose, based upon NR4. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	✓	✓	N/A								There is generally a low risk or limited area at risk from erosion, recession and overtopping. This includes private property where the developments themselves are well outside of the hazard area. "Do nothing" is therefore largely an acceptable option as it enables Council to focus resources on other higher risk locations. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Marginal
NR	NR1, NR3, NR4, NR7, NR11, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.3 Scarborough and Wombarra Beaches

6.3.1 Erosion and Recession Risk Level and Treatment Options

Scarborough / Wombarra Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Scarborough Wombarra Beaches	High	Extreme	Extreme				✓✓	✓✓	✓✓								NR2, NR14	
Scarborough Recreation Reserve, Jim Allen Oval Natural Area	Low	Medium	Medium				✓✓		✓✓									✓
Small creek / drainage lines (S end and centre of Scarborough beach)	Low	Medium	Medium						✓✓								NR11	✓
Community Infrastructure																		
Wombarra Rock Pool	Medium	Medium	High						✓						✓		NR4, NR14	
Wombarra Rock Pool Amenities	Low	Low	Medium											✓✓				✓
Local roads (inc road access within William Sweeney Park area at Wombarra)	Low	Low	Medium											✓✓				✓
Water and sewage infrastructure																		
Stormwater outlets and pipes (3 at S end Wombarra Beach)	High	Extreme	Extreme							✓✓				✓✓	?		NR7, NR14	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Scarborough/Wombarra Beach

Drawing: 6-5

Rev: A

N

0 75 150m

Approx. Scale

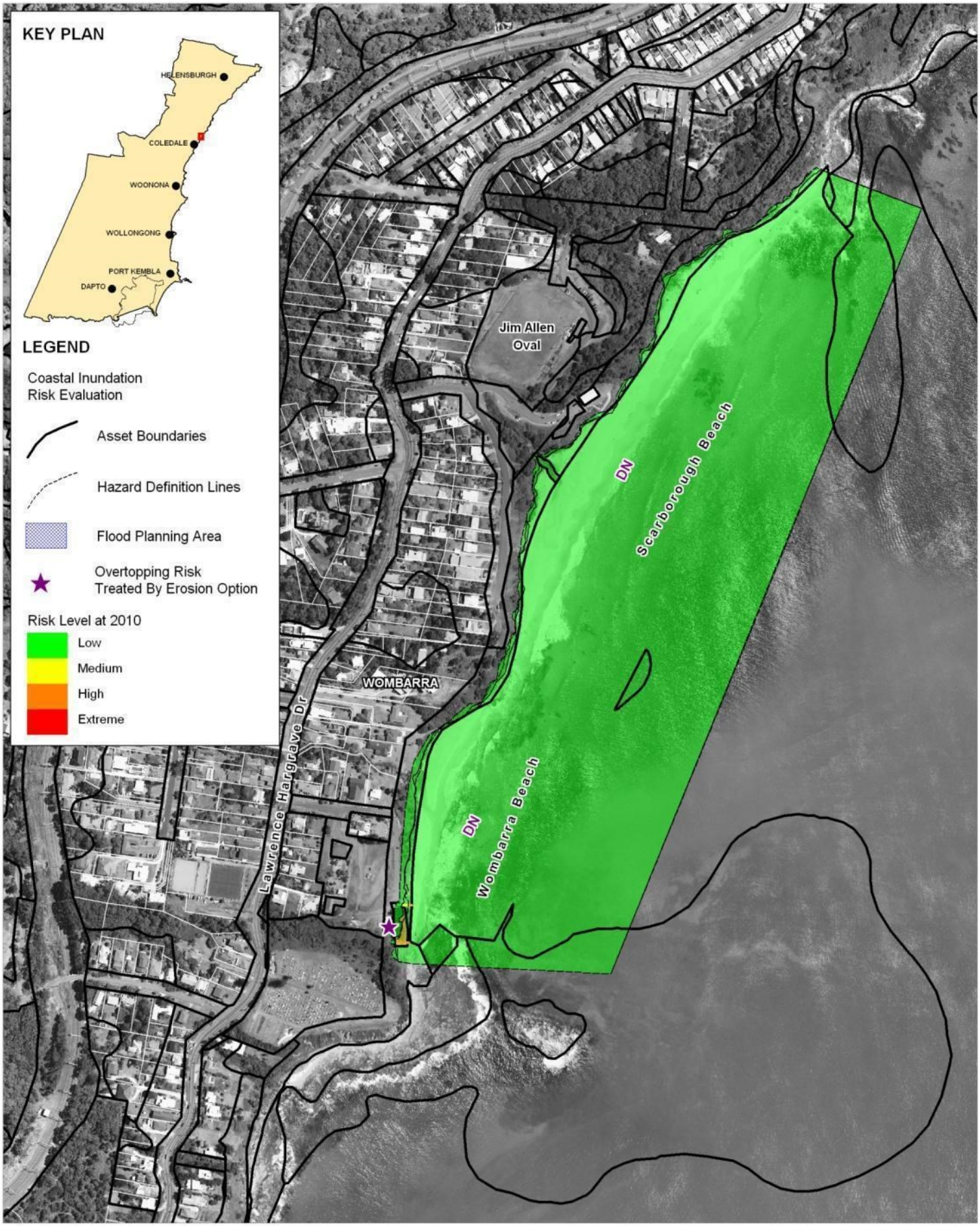
BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_103_110427 Drawing 6-5.WOR

6.3.2 Coastal Inundation Risk Level and Treatment Options

Scarborough / Wombarra Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Scarborough Wombarra Beaches	Low	Low	Medium						✓✓
Scarborough Recreation Reserve, Jim Allen Oval Natural Area	Low	Low	Medium						✓✓
Small creek / drainage lines (S end and centre of Scarborough beach)	Low	Low	Medium						✓✓
Community Infrastructure									
Wombarra Rock Pool	Low	Low	Medium						✓✓
Wombarra Rock Pool Amenities	Low	Low	Low						✓✓
Water and sewage infrastructure									
Stormwater outlets and pipes (3 at S end Wombarra Beach)	High	Extreme	Extreme	✓✓				NR7, NR14	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Scarborough/Wombarra Beach

Drawing:	Rev:
6-6	A

N

0 125 250m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_103_110427 Drawing 6-6.WOR

6.3.3 Assessment of Treatment Options

Scaborough and Wombarra Beaches

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Scaborough and Wombarra Beaches	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	N/A								Dune care programs must be considerate of sightline requirements for SLSC activities. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	N/A								This option involves scraping and contouring beach sands to accumulate in dunes along the beach. This aims to increase sand volumes held in dune storage for storm protection. *Refer to Protect Options Table for further cost benefit details for BM.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	N/A								This is an excellent option by utilising public open space to enable natural retreat to retain the beach. At Scarborough and Wombarra, erosion risk extents are limited suggesting there may not be extensive impacts to parkland, increasing the viability of this option. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate stormwater assets landward of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR the pipe requires replacement, whichever is sooner.	✓	✓	N/A								Erosion risk appears to affect the ends of a small number of stormwater assets. It is likely that the outlets and pipes can be progressively removed as erosion occurs. However, the outlets will also need to withstand inundation with sea level rise and wave overtopping. The best option for these assets should be confirmed through NR7. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended

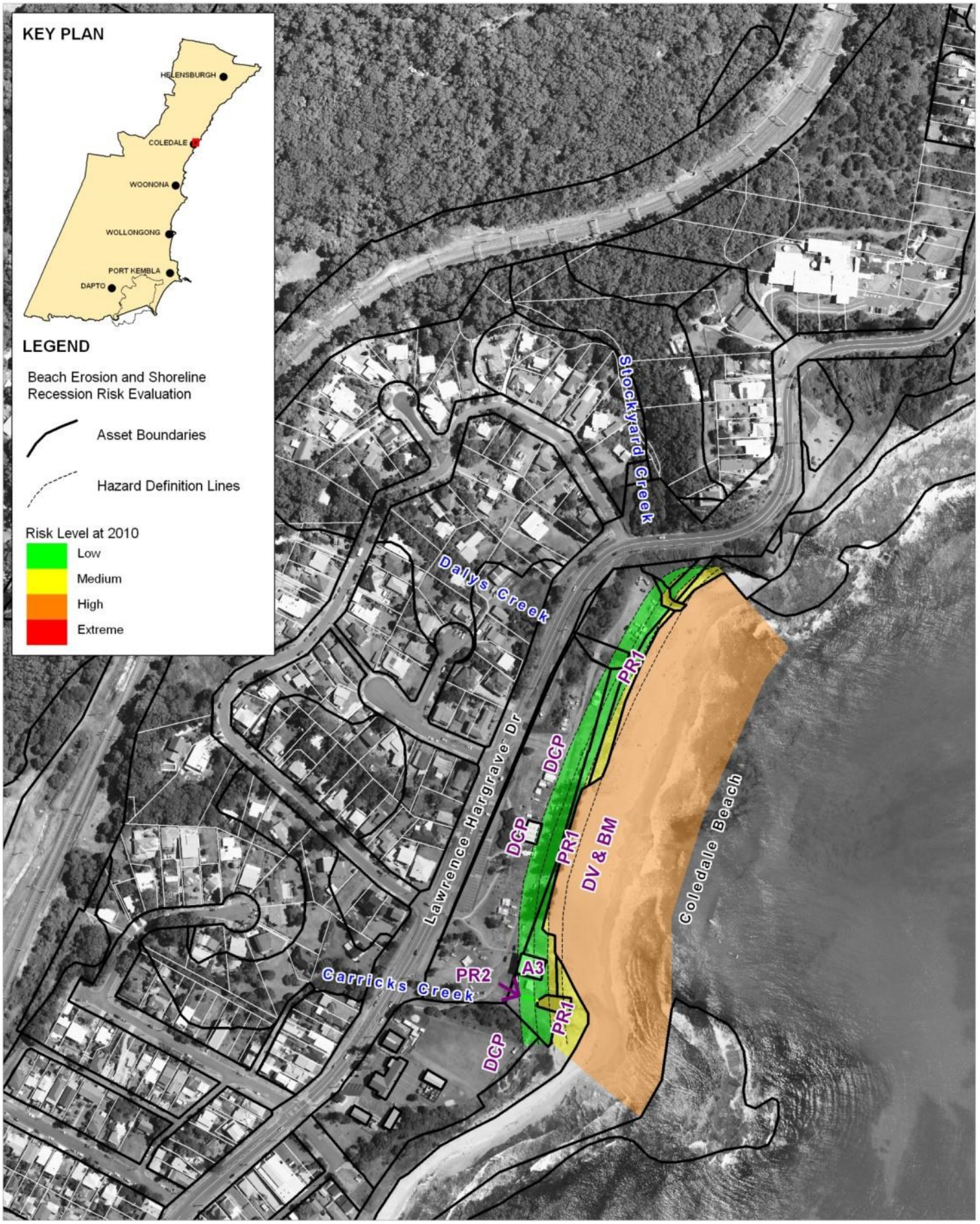
Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR2	Potential Funding Sources (Who may pay)	Conclusion
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	N/A								The Amenities building and local access road are currently at low risk, so there is no immediate need for action. Investigations and action can be delayed until asset replacement is required. This is also more cost effective as actions are done in conjunction with the expected cost for asset maintenance & replacement. At that time, the DCP will trigger investigations that will govern whether the assets need to be relocated (e.g. PR2), or redesigned to withstand impacts (A2, A3). This allows Council to prioritise efforts towards other locations presently at high risk. Inundation at Scarborough and Wombarra is related to wave overtopping, rather than backwater inundation. This should be managed through Coastal DCP controls rather than existing Flood DCP controls that may not be applicable to the overtopping risk. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement at public assets *N/A* Private landholders	**Recommended**
A2	Redesign or retrofit stormwater structures and Wombarra Pool in current location to withstand impacts.	**Current Action:** NR7; NR4 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner; When damage to pool shell occurs OR the pool is being inundated at water levels lower than MSL.	✓	✓	N/A								Based on outcomes of NR7, if it is not possible to relocate the stormwater assets (i.e. PR2), then they will need to be redesigned and replaced in the current location to withstand impacts. The decision to progressively retrofit Wombarra Rock Pool over time to withstand wave and sea level rise impacts shall depend upon the suitability of pool condition, based upon NR4. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	**Marginal**
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								There is generally a low risk or limited area at risk from erosion, recession and overtopping. "Do nothing" is therefore largely an acceptable option as it enables Council to focus resources on other higher risk locations. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	**Marginal**
NR	NR1, NR2, NR4, NR7, NR11, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	**Recommended**

6.4 Coledale Beach

6.4.1 Erosion and Recession Risk Level and Treatment Options

Coledale Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Coledale Beach	High	Extreme	Extreme				✓✓	✓✓	✓✓								NR14	
Coledale Beach Reserve	Medium	Medium	High						✓✓									
Carricks Creek	Medium	High	Extreme						✓✓								NR11	
Stockyard Creek	Medium	High	Extreme						✓✓								NR11	
Dalys Creek	Medium	Medium	High						✓✓								NR11	
EEC - Coastal Headland Banksia Scrub	Medium	Medium	High						✓✓								NR11	
Community Infrastructure																		
Coledale Surf Club	Low	Medium	Medium											✓✓		✓✓		✓
Coledale Beach Camping and Caravan Park	Medium	Medium	High						✓✓					✓				
Coledale Beach Camping Reserve - Amenities Building	Low	Medium	Medium											✓✓			NR3	✓
Heritage Site: Norfolk Island Pines	Medium	Medium	High						✓✓								NR12	✓
Coledale Rock Pool	High	Extreme	Extreme						✓						✓		NR4, NR14	
Transport Infrastructure																		
Local Beach Access Road and car parking	Low	Low	Medium											✓✓				✓
Water and sewage infrastructure																		
Stormwater outlet and pipe (1 at S end = Carricks CK)	Medium	High	Extreme							✓✓				✓			NR7, NR14	
Institutional Infrastructure																		
Coledale Public School - Grounds only	Low	Low	Medium											✓				✓

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Coledale Beach

Drawing: 6-7

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

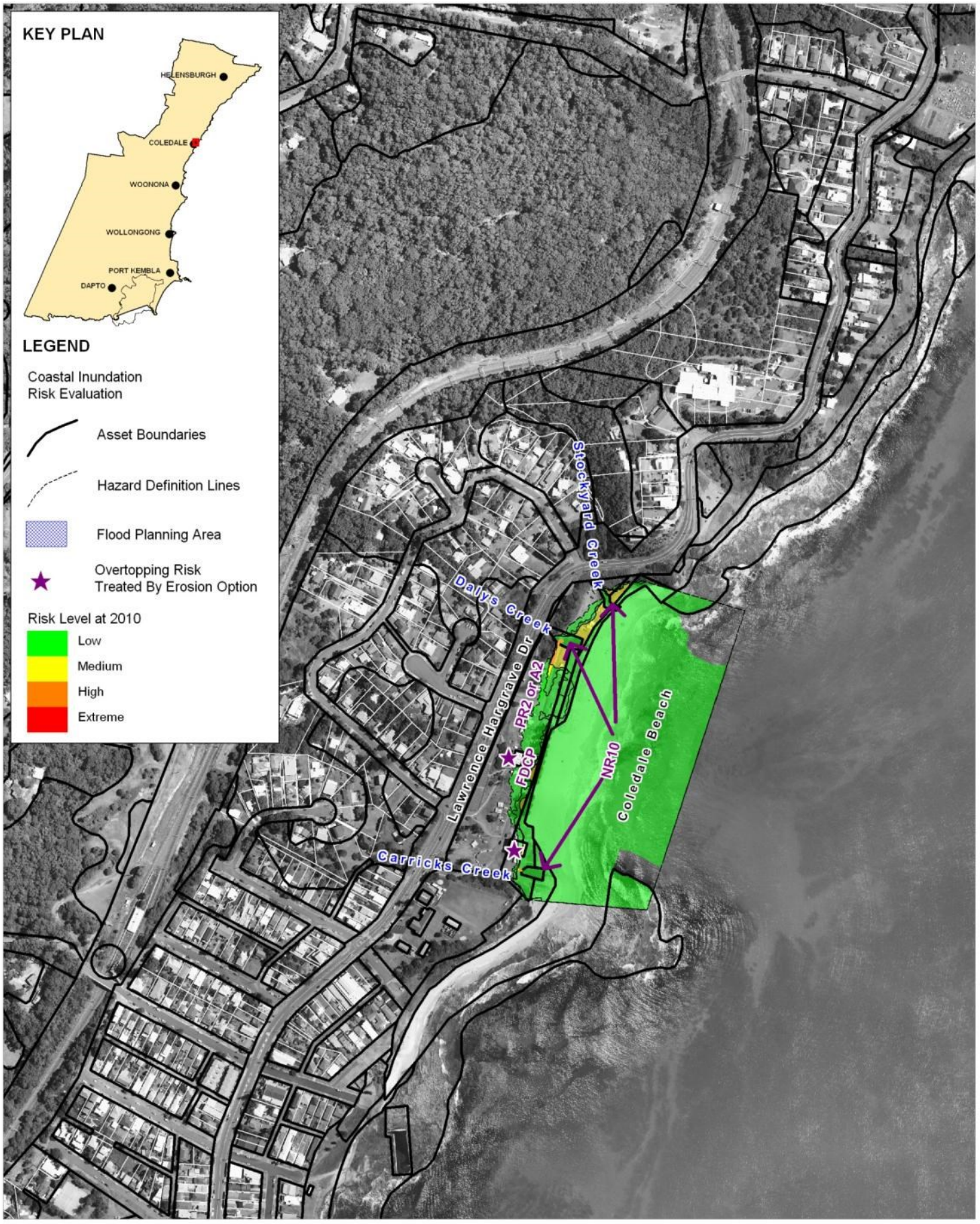
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_104_110427 Drawing 6-7.WOR

6.4.2 Coastal Inundation Risk Level and Treatment Options

Coledale Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Coledale Beach	Low	Low	Medium	✓					✓
Coledale Beach Reserve	Low	Low	Medium	✓					✓
Carricks Creek	Medium	Medium	High					NR10, NR14	✓
Stockyard Creek	Medium	Medium	High					NR10, NR14	✓
Dalys Creek	Medium	Medium	High					NR10, NR14	✓
EEC - Coastal Headland Banksia Scrub	Medium	Medium	High					NR11	✓
Community Infrastructure									
Coledale Surf Club	Medium	High	Extreme	✓		✓✓		NR10, NR14	
Coledale Beach Camping and Caravan Park	Medium	Medium	High			✓✓	✓	NR10	
Coledale Beach Camping Reserve - Amenities Building	Low	Medium	Medium	✓		✓✓		NR10	✓
Heritage Site: Norfolk Island Pines	Low	Low	Medium						✓
Coledale Rock Pool	Medium	Medium	High	✓					
Transport Infrastructure									
Local Beach Access Road and car parking	Low	Low	Medium						✓
Water and sewage infrastructure									
Stormwater outlets and pipes (1 at S end at Carrick Ck, 2 beach parallel at Dalys Ck)	High	Extreme	Extreme		✓	✓	✓✓	NR7, NR14	•
Institutional Infrastructure									
Coledale Public School - Grounds only	Low	Low	Medium	✓✓		✓			✓

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Coledale Beach

Drawing: 6-8

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_104_110427 Drawing 6-8.WOR

6.4.3 Assessment of Treatment Options

Coledale

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Coledale Beach	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								Dune care programs must be considerate of sightline requirements for SLSC activities. There are limited dunes here at present. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	×								This option involves scraping and contouring beach sands to accumulate in and increase sand volumes held in dune storage for storm protection. *Refer to Protect Options Table for further cost benefit details for BM.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This option enables the beach to be retained over time by allowing natural retreat through reserve and campground lands. These areas will still be usable even with erosion. Over time, existing Norfolk Pines can be replaced with new pines further landward, as the trees naturally perish. Based on NR4, if it is found that Coledale Pool cannot be progressively repaired to withstand wave and sea level rise impacts into the future (i.e. A2), the pool will need to be slowly removed as it fails over time. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate stormwater structures outside of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner.	✓	✓	×								Stormwater assets at Carricks Creek could be progressively removed and relocated landward. At Dalys Creek, parallel stormwater assets affected by inundation may not be able to be relocated, this would need to be confirmed through NR7. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Marginal
PR2	Relocate camp ground amenities and beach access road outside of hazard zone	When amenities needs to be replaced; when erosion impacts occur to roadway.	✓	✓	×								The Camp ground amenities is currently at low risk, so relocation needs only be timed to occur at the next refurbishment cycle. This makes relocation more cost effective as it is done in conjunction with the expected cost for asset maintenance & replacement. The local road access would not need to be relocated until impacts manifest, as it is currently at low risk. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
A3	Replace SLSC with relocatable structure.	Already in progress	✓	✓	✓								A proposal is already in progress to replace the Coledale SLSC with a relocatable structure, which is relatively inexpensive,will have power, water and wastewater and can be moved prior to a storm. *Refer to Accommodate Options Table for further cost benefit details for A3.*	**?** State Government (Grant Programs) ☑ Council (Current Program) *N/A* Private landholders who directly benefit from option	Recommended

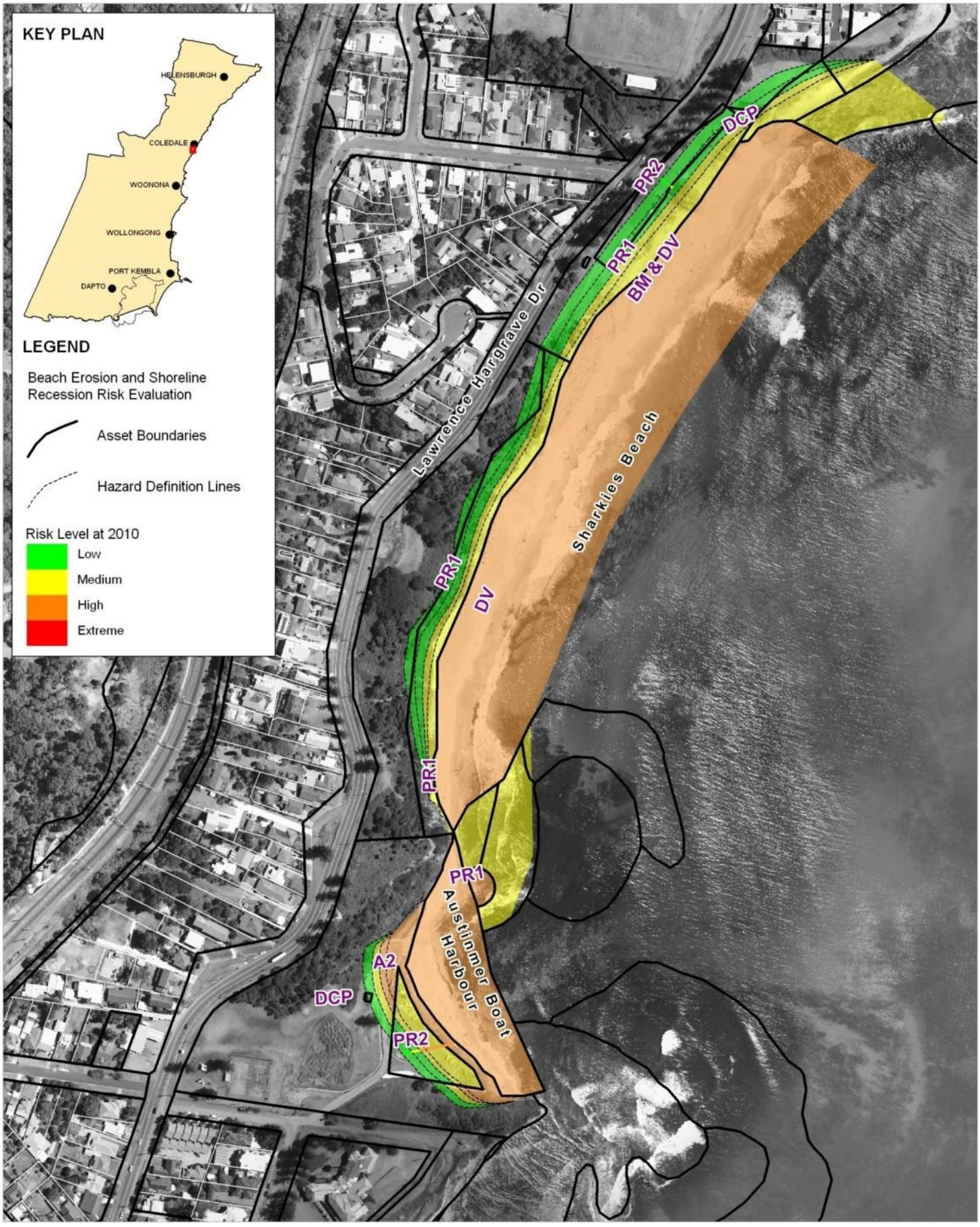
Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for DCP Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit stormwater structures and Coledale Pool in current location to withstand impacts.	**Current Action:** NR7; NR4 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner; When damage to pool shell occurs OR the pool is being inundated at water levels lower than MSL.	✓	✓	N/A								Based on outcomes of NR7, if it is not possible to relocate the stormwater assets (i.e. PR2), then they may need to be redesigned and replaced in the current location to withstand impacts. The decision to progressively retrofit Coledale Pool over time to withstand wave impacts and sea level rise shall depend upon the suitability of pool condition for this purpose, based upon NR4. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	✗								The amenities and roadway are currently at low risk, so there is no immediate need for action. At the time for asset replacement, the DCP will trigger investigations to govern whether the asset needs to be relocated (e.g. PR2), redesigned to withstand impacts (A2, A3). This allows Council to prioritise efforts towards other locations presently at high risk. This is also more cost effective as actions are done in conjunction with the expected cost for asset maintenance & replacement. The DCP controls will also manage wave overtopping. The risk to the school applies to the grounds only. Applying the DCP will flag investigations to ensure future re-developments/developments consider and mitigate erosion and overtopping risks if required for DCP. *Refer to Accommodate Options Table for further cost benefit details.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement at public assets *N/A* Private landholders	Recommended
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As property / assets redeveloped, new developments built	✗	✗	✓								This option involves applying the existing Flood DCP chapter to those areas identified at risk from coastal inundation, as an interim measure until such time as Flood Studies for Dalys, Stockyard and Carricks Creek are completed (refer NR10). The controls are applied at the "low risk" level. *Refer to Accommodate Options Table for further cost benefit details for FDCP.*	*N/A* State Government (external funding unlikely to be needed) ☑ Council (Current Programs) ☑ Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								There is generally a low risk or limited assets at risk from erosion, recession and overtopping. "Do nothing" is a partly acceptable option as it enables Council to focus resources on other higher risk locations. The key assets that may be affected are stormwater assets, and impacts may be costly if not managed. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Marginal
NR	NR1, NR3, NR4, NR7, NR10, NR11, NR12, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.5 Sharkys Beach

6.5.1 Erosion and Recession Risk Level and Treatment Options

Sharkys Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Sharkys Beach	High	Extreme	Extreme				✓✓	✓✓	✓✓								NR14	
Sharkys Beach Reserve	Medium	Medium	High						✓✓									
Community Infrastructure																		
Heritage Site: Norfolk Island Pines (backing entire beach)	Medium	Medium	High						✓✓								NR12	
Heritage Site: Site of Austinmer Jetty	High	Extreme	Extreme						✓✓	?							NR14	
Austinmer Boat Harbour toilets	Low	Low	Medium											✓✓			NR3	✓
Transport Infrastructure																		
Car park (behind Sharkys beach)	Low	Medium	Medium											✓				✓
Car park (At boat harbour)	Medium	Medium	High							✓✓				✓				
Sharkys / Austinmer Boat Harbour (Heritage listed)	High	Extreme	Extreme						✓						✓✓		NR14	•
Water and sewage infrastructure																		
Stormwater outlets and pipes	High	Extreme	Extreme							✓				✓	✓✓		NR7, NR14	•
Residential Development																		
Vacant Land (Shark Park, currently zoned residential)	Medium	Medium	High											✓✓			NR14	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Sharkies Beach

Drawing: 6-9

Rev: A

N

0 75 150m

Approx. Scale

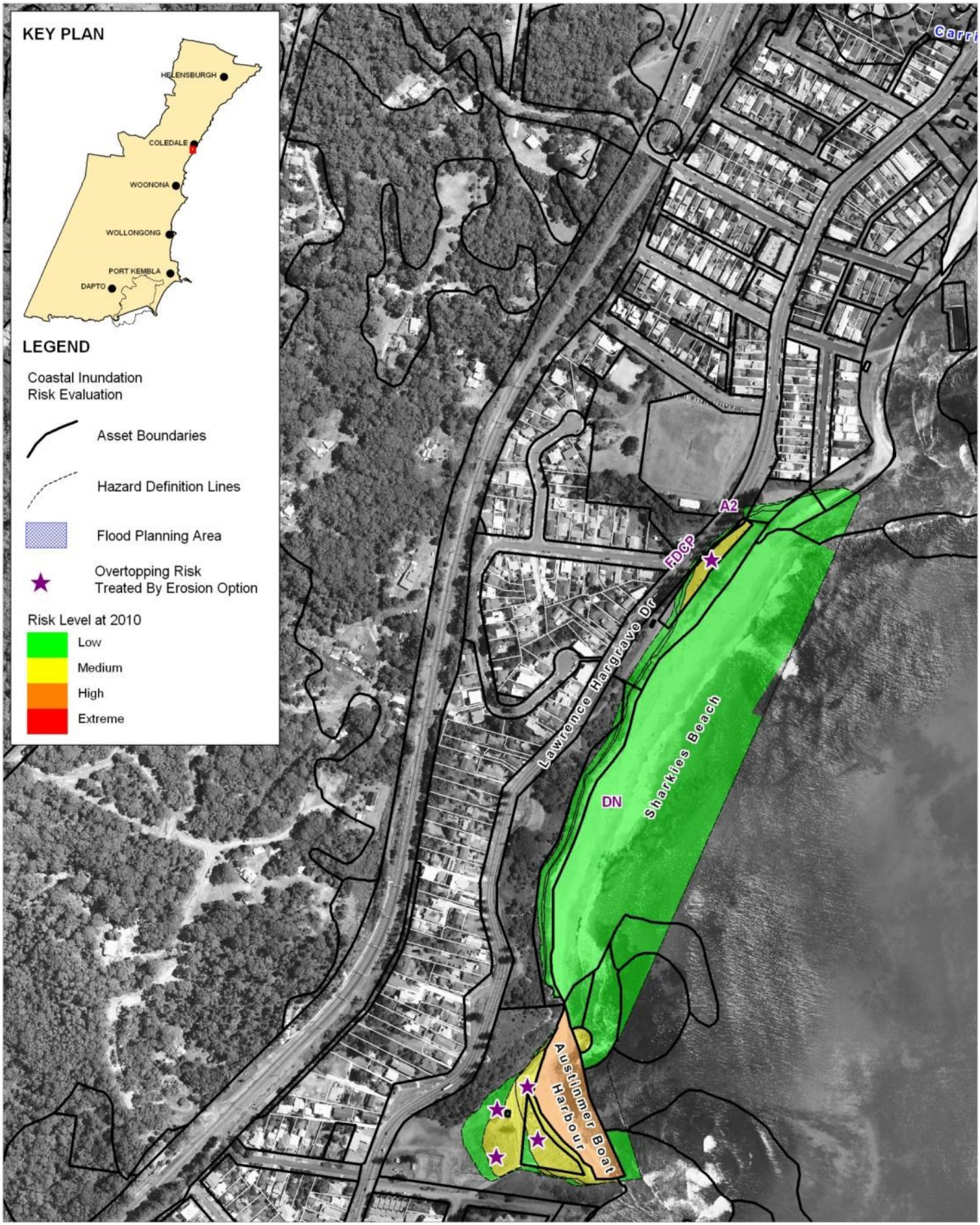
BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_105_110427 Drawing 6-9.WOR

6.5.2 Coastal Inundation Risk Level and Treatment Options

Sharkies Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Sharkys Beach	Low	Low	Medium						✓✓
Sharkys Beach Reserve	Low	Low	Medium						✓✓
Community Infrastructure									
Heritage Site: Norfolk Island Pines (backing entire beach)	Low	Low	Medium						✓✓
Heritage Site: Site of Austinmer Jetty	Medium	High	Extreme	✓✓					✓✓
Austinmer Boat Harbour toilets	Low	Medium	Medium	✓✓					✓
Transport Infrastructure									
Lawrence Hargrave Drive (Major Coastal Road)	Low	Medium	High			✓	✓		
Car park (behind Sharkys beach)	Medium	Medium	High	✓✓					
Car park (At boat harbour)	Medium	Medium	High	✓✓					
Sharkys / Austinmer Boat Harbour (Heritage listed)	High	Extreme	Extreme	✓✓					●
Water and sewage infrastructure									
Stormwater outlets and pipes	High	Extreme	Extreme	✓✓			✓	NR7, NR14	●
Residential Development									
Vacant Land (Shark Park)	Low	Low	Medium	✓✓					

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
●	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Sharkies Beach

Drawing: 6-10

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_105_110427 Drawing 6-10.WOR

6.5.3 Assessment of Treatment Options

Sharkys

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Sharkys Beach	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								Dune care programs must be considerate of sightline requirements for SLSC activities. There are currently limited dunes, this action would be supported by BM. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	×								This option involves scraping and contouring beach sands to accumulate in dunes along the beach, to increase sand volumes held in dune storage for storm protection. *Refer to Protect Options Table for further cost benefit details for BM.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								Similarly to Coalcliff, the extent of erosion is limited at Sharkys Beach, making this an excellent option for retaining the beach, by utilising public open space to enable natural retreat of the beach, and hence continued provision of a beach over the long term. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate stormwater structures outside of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner.	✓	✓	×								Erosion and overtopping risks affect the ends of two stormwater assets at the northern end of the beach. It is likely that the outlets and pipes can be progressively removed as erosion occurs. Overtopping risk appears more extensive for the stormwater pipeline at Austinmer Boat Harbour, and it may not be possible to relocate this structure further landward. The ability to relocate or redesign these pipes & outlets would need to be confirmed through NR7. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Marginal
PR2	Relocate Boat Harbour carpark landward of hazard zone	**Trigger:** When erosion or wave overtopping damages carpark such that it is not functional OR when Harbour is being redesigned	✓	✓	×								As part of retaining a functioning boat harbour for the community, car parking facilities for boat users needs to be retained. There is public open space landward of the current car park, relocation to this site would need to be determined in conjuction with remodelling the harbour to remain functional with sea level rise inundation impacts. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner.	✓	✓	✓								Particularly for the stormwater outlet at Austinmer Boat Harbour, the extent of inundation as well as erosion may not enable the structure to be located landward, and instead require redesign at the current location. This shall need to be confirmed based on outcomes of NR7. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit Austinmer Boat Harbour to withstand wave forces and inundation due to sea level rise.	**Current Action:** Investigate options, prepare approvals (as required) now **Trigger:** When wave overtopping and mean sea level inundation cause harbour to not be functional for the majority of sea conditions OR at major asset maintenance cycles, as required.	✓	✓	×								Austinmer Boat Harbour could feasibly be redesigned, such as boat ramp and breakwalls raised, to remain a functional regional recreational boat access point. Given there is a small patch of sandy beach below the ramp at present, the redesign will need to consider retaining the sandy strip with nourishment following storm events. The volumes are likely to be small. Alternative designs without sand that retain or improve current functioning may also be acceptable. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments	✓	✓	×								Vacant Land at Shark Park, Sharkys carpark and Austinmer Boat Harbour amenities building are currently at low risk, so there is no immediate need for action. Investigations and action can be delayed until asset replacement is required. At that time, the DCP will trigger investigations that will govern whether the asset needs to be relocated (e.g. PR2) or redesigned to withstand impacts (A2, A3) (which may be prohibitively expensive). Council can prioritise efforts towards other locations presently at high risk. The Coastal DCP shall manage both inundation related to wave overtopping as well as erosion and recession. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement at public assets *N/A* Private landholders	Recommended
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As property / assets redeveloped, new developments built	×	×	✓								This option involves applying the existing Flood DCP chapter to the small area of Lawrence Hargrave Drive affected by coastal inundation. The controls are applied at the "low risk" level, until more detailed studies as to flood levels are undertaken at this location. *Refer to Accommodate Options Table for further cost benefit details for FDCP.*	? State Government (Grant programs), cost to implement at RTA road ☑ Council (Current Programs, increased rates and levies?) - cost to prepare DCP *N/A* Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								There is generally a low risk or limited assets at risk from erosion, recession and overtopping. "Do nothing" is a somewhat acceptable option as it enables Council to focus resources on other higher risk locations. However, the key assets that may be affected are stormwater assets and the Austinmer Boat Harbour. Impacts are likely to be costly if not managed. Further, the harbour is one of few regional recreational boat access points for the community. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR3, NR7, NR11, NR12, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.6 Little Austinmer and Austinmer Beaches

6.6.1 Erosion and Recession Risk Level and Treatment Options – Little Austinmer

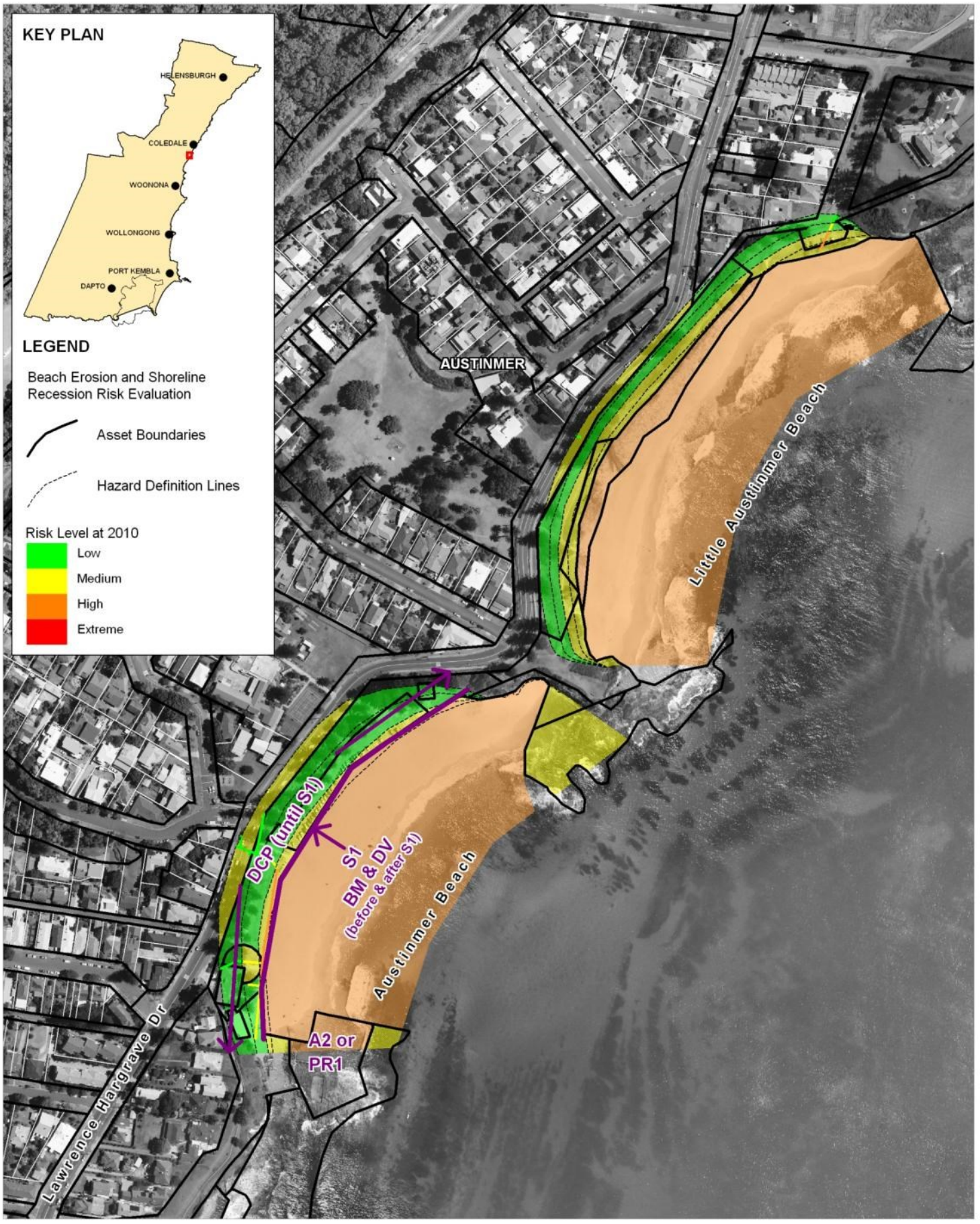
Little Austinmer Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments															
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Little Austinmer Beach	High	Extreme	Extreme				✓✓	✓✓	✓✓								NR14	
Little Austinmer Beach Reserve	Medium	Medium	High						✓✓									
Coastal Dune Systems	High	Extreme	Extreme				✓		✓✓									
Community Infrastructure																		
Heritage Site: Norfolk Island Pines (backing entire beach)	Medium	Medium	High						✓								NR12	
Tuckerman Park Toilet/Shed	Low	Medium	Medium											✓✓				
Transport Infrastructure																		
Lawrence Hargrave Drive (Major Coastal Road)	Medium	High	Extreme	?		?								✓✓	✓		NR5, NR14	•
Local roads and car park	Medium	Medium	High							✓✓				✓				
Water and sewage infrastructure																		
Stormwater outlets and pipes	High	Extreme	Extreme							✓✓				✓			NR7, NR14	
Residential Development																		
Existing Residences (1 at N end)	Low	Medium	Medium											✓✓				

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time

6.6.2 Erosion and Recession Risk Level and Treatment Options – Austinmer

Austinmer Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Austinmer Beach	High	Extreme	Extreme				✓	✓	✓								NR2, NR14	
Austinmer Beach Reserve and Tuckermans Park	Medium	Medium	High		✓				✓								NR2	
Community Infrastructure																		
Austinmer Surf Club	Medium	High	Extreme		✓					?				✓	✓		NR2, NR3, NR14	•
Heritage Site: Norfolk Island Pines (backing entire beach)	Medium	Medium	High		✓				✓								NR2	
Austinmer Rock Pool	High	Extreme	Extreme						✓						✓		NR4, NR14	
Austinmer changeroom & toilets	Low	Medium	Medium		✓									✓				
Austinmer Boatshed	Low	Low	Low		✓									✓				
War Memorial (Heritage Site)	High	Extreme	Extreme		✓					✓							NR2, NR14	
Transport Infrastructure																		
Lawrence Hargrave Drive (Major Coastal Road)	Medium	High	Extreme		✓									✓	✓		NR2, NR5, NR14	•
Beach access and car park	Medium	Medium	High		✓				✓								NR14	
Water and sewage infrastructure																		
Stormwater outlets and pipes	High	Extreme	Extreme		✓					✓				✓	✓		NR7, NR2, NR14	•

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Austinmer Beach - Seawall S1 Option

Drawing: 6-11

Rev: A

N

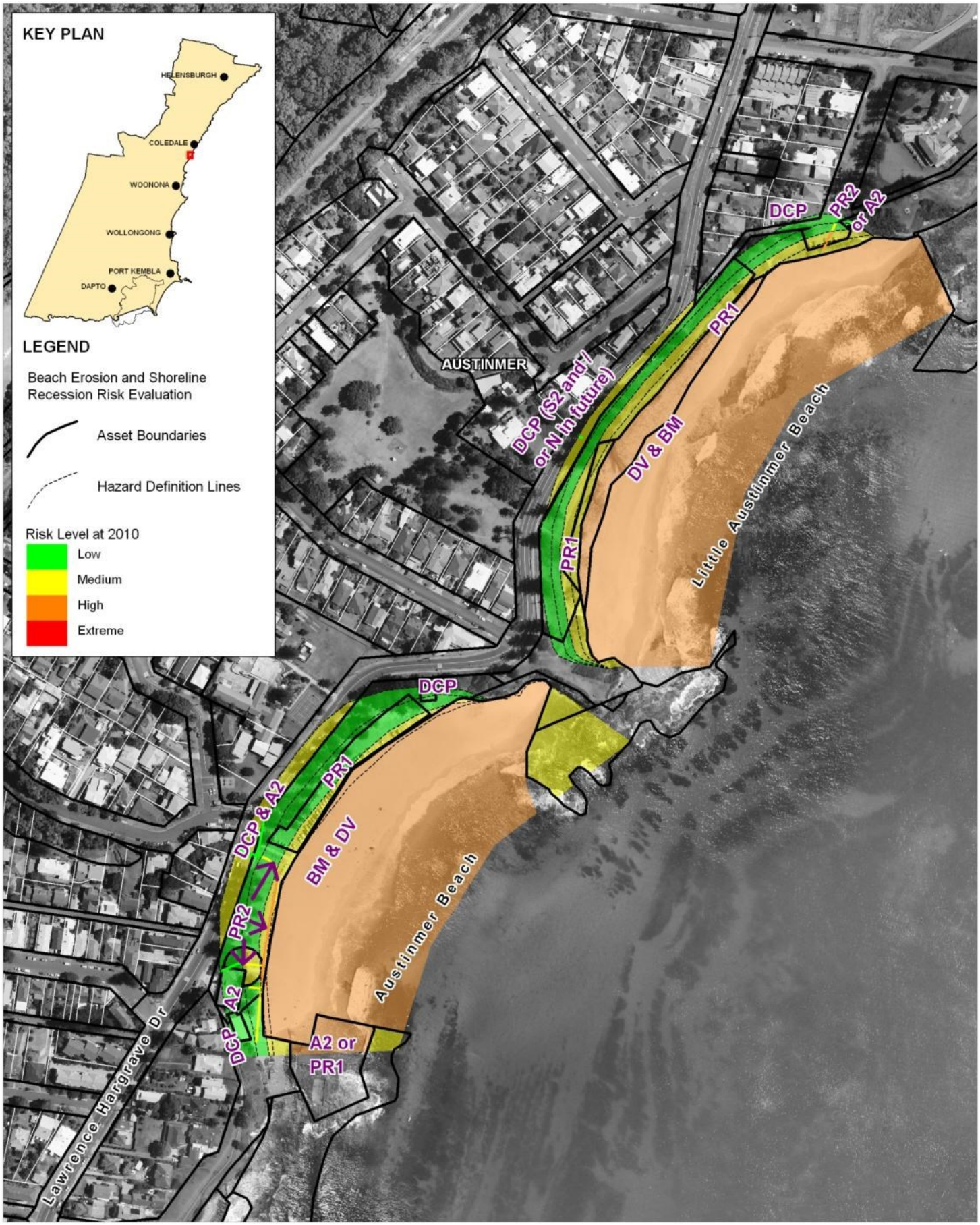
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_106_110427 Drawing 6-11.WOR



Title:

Immediate Erosion Risk Levels and Treatment Options Austinmer Beach & Little Austinmer Beach

Drawing: 6-12

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_106_110427 Drawing 6-12.WOR

6.6.3 Coastal Inundation Risk Level and Treatment Options – Little Austinmer

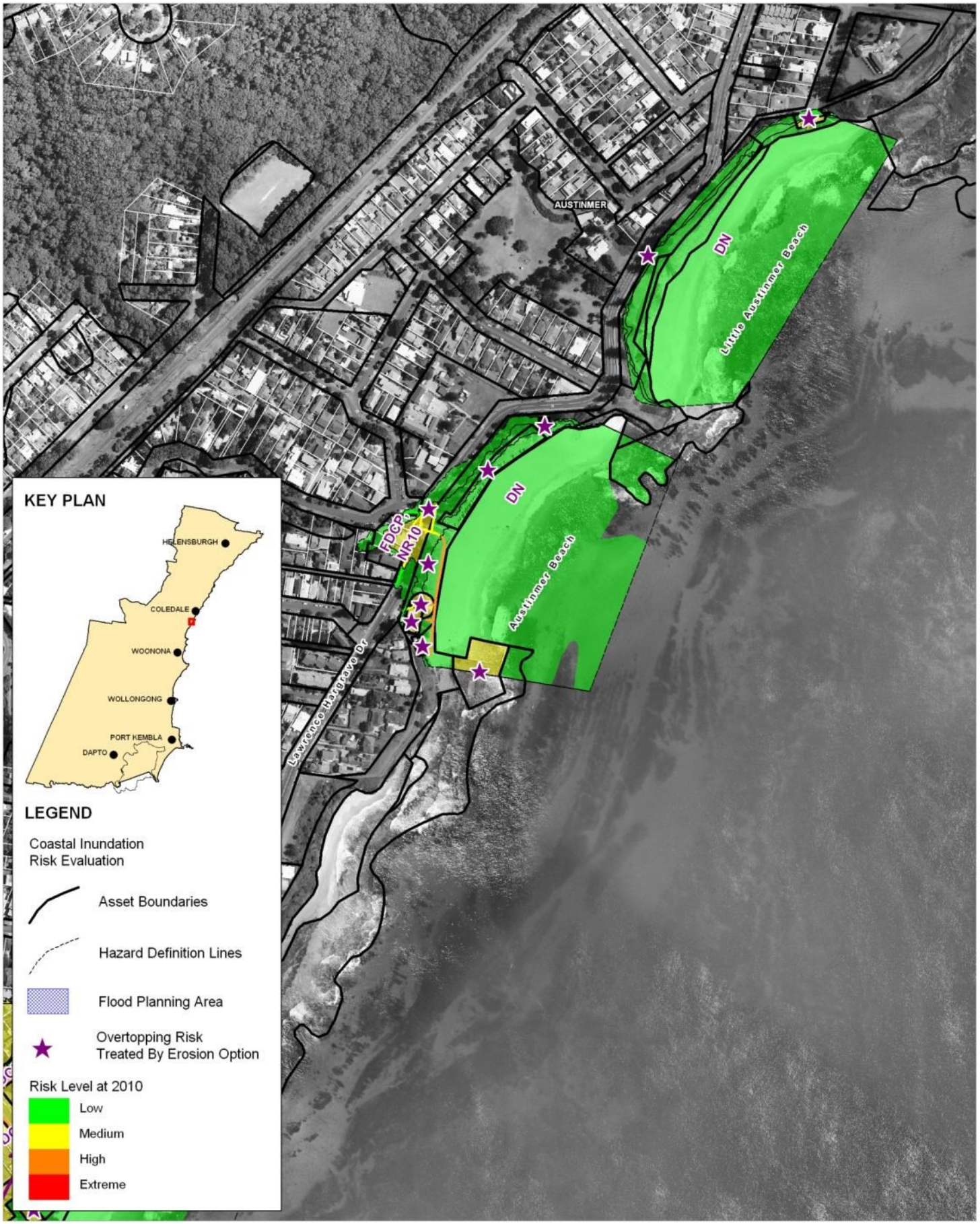
Little Austinmer Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Little Austinmer Beach	Low	Low	Medium						✓✓
Little Austinmer Beach Reserve	Low	Low	Medium						✓✓
Coastal Dune Systems	Low	Low	Medium						✓✓
Community Infrastructure									
Heritage Site: Norfolk Island Pines (backing entire beach)	Low	Low	Medium						✓✓
Tuckerman Park Toilet/Shed	Low	Low	Low						✓✓
Transport Infrastructure									
Lawrence Hargrave Drive (Major Coastal Road)	Medium	High	Extreme	✓✓					
Local roads and car park	Medium	Medium	High	✓✓					
Water and sewage infrastructure									
Stormwater outlets and pipes	High	Extreme	Extreme	✓✓					

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time

6.6.4 Coastal Inundation Risk Level and Treatment Options – Austinmer

Austinmer Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Austinmer Beach	Low	Low	Medium						✓
Austinmer Beach Reserve and Tuckermans Park	Low	Low	Medium						✓
Community Infrastructure									
Austinmer Surf Club	Medium	High	Extreme	✓					
Heritage Site: Norfolk Island Pines (backing entire beach)	Low	Low	Medium						✓
Geologic Site: Rock headland / platform	Low	Low	Medium						✓
Austinmer Rock Pool	Medium	Medium	High	✓					✓
Austinmer changeroom & toilets	Low	Low	Low						✓
Austinmer Boatshed	Medium	Medium	High	✓					
War Memorial (Heritage Site)	Medium	High	Extreme	✓					
Transport Infrastructure									
Lawrence Hargrave Drive (Major Coastal Road)	Medium	High	Extreme	✓		✓	✓	NR10, NR14	
Beach access and car park	Low	Low	Medium	✓					✓
Water and sewage infrastructure									
Stormwater outlets and pipes	High	Extreme	Extreme	✓				NR10, NR14	
Commercial and Industrial Development									
Neighbourhood Business Centre (local shops)	Medium	Medium	High			✓	✓	NR10, NR14	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Austinmer Beach & Little Austinmer Beach

Drawing: 6-13

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_106_110427 Drawing 6-13.WOR

6.6.5 Assessment of Treatment Options – Little Austinmer

Little Austinmer

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Little Austinmer Beach	Potential Funding Sources (Who may pay)	Conclusion
N	Beach nourishment	**Current Action:** NR5 **Trigger:** Implement when ZRFC measured from the erosion escarpment reaches the roadway.	✓	✓	×								Beach nourishment is not proposed for the entire beach. This option is suggested for protection of Lawrence Hargrave Drive only, at some point in future when roadway is impacted. Nourishment of relatively small volumes would be performed to protect this major local and regional traffic route. Typical costs for nourishment are $25/m3, with 200 m3/ m required to widen the beach by 20m. *Refer to Protect Options Table for further cost benefit details for N.*	**?** State Government - through RTA as major road asset protected by this option; Grant Programs ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Marginal
S2	Construct seawall (revetment) along specified alignment to protect specific asset(s)	**Current Action:** NR5 **Trigger:** Implement when ZRFC measured from the erosion escarpment reaches the roadway.	✓	✓	×								Lawrence Hargrave Drive is the major traffic pathway for the northern Wollongong LGA, and will need to be retaned in some form. The decision to protect the roadway using a section of seawall or accommodate impacts in some other form will need to be determined through NR5. This option suggests a short section of wall to protect the roadway (approx 200m). At a typical cost of $5,000 - $10,000 /m length of wall, this equates to between $1 -2 million, without ongoing maintenance or nourishment costs. Long sections of seawall will typically not be economically viable, however the needs to retain this traffic route will govern outcomes. The option has the additional benefit of protecting properties landward of the roadway, although the primary purpose remains for public benefit. *Refer to Protect Options Table for further cost benefit details for S2.*	**?** State Government - through RTA as major road asset protected by this option; Grant Programs ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Marginal
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								Dune coverage is limited at this location at present. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for BM Beach	Potential Funding Sources (Who may pay)	Conclusion
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	×								This option involves scraping and contouring beach sands to accumulate in dunes along the beach, to increase sand volumes held in dune storage for storm protection. *Refer to Protect Options Table for further cost benefit details for BM.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This is typically an excellent option for retaining the beach, by utilising public open space to enable natural retreat of the beach, however assets at risk such as Lawrence Hargrave Drive may be affected (refer S2, A2). *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Marginal
PR2	Relocate stormwater structures outside of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner.	✓	✓	×								Erosion and overtopping risks affects the stormwater asset at the northern end of the beach, and it is possible that the outlets and pipes can be progressively removed as erosion occurs. The ability to relocate or redesign the pipes & outlets would need to be confirmed through NR7. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	×								There is one private property proposed to have the Coastal DCP applied. The buildings on the property are at the edge of the risk zones and may not be affected for some time. Applying the DCP allows redesign of buildings upon the land when the building is redeveloped, improving longevity of the developments. Additional controls can be considered as needed in the future, should risk levels be revised or hazard impacts advance more quickly (see NR14). The DCP shall also be applied to public assets such as Lawrence Hargrave Drive, as well as the local carpark and amenities. Again, this will ensure that investigations that will govern the redesign or location of these assets are prepared, when the asset needs to be replaced (either through wear and tear or coastal damage). For Lawrence Hargrave Drive, this may trigger the need for seawall protection or other accomodating design. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement at public assets *N/A* Private landholders	Recommended

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner.	✓	✓	x								The extent of inundation as well as erosion may not enable the stormwater structure to be located landward, and instead require redesign at the current location. This shall need to be confirmed based on outcomes of NR7. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Marginal
A2	Redesign Lawrence Hargrave Drive in current location to withstand impacts.	**Current Action:** NR5 **Trigger:** When erosion or wave overtopping destabilises roadway	✓	✓	x								Based upon the outcomes of NR5, there will need to be clear decision regarding the approach to accommodating impacts to Lawrence Hargrave Drive, and which may include protection (see S2 and N above). Alternative measures to protect the roadway, such as raising the roadway as a bridge will need to be investigated. This decision can be delayed until impacts become imminent *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Marginal
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								For coastal inundation at Little Austinmer, the majority of assets are at low risk, and hence the risk can be accepted. However, there are significant assets at risk from erosion. "Do nothing" may result in unacceptable impacts, such as the destabilisation of the major roadway at Lawrence Hargrave Drive. Further, "Do nothing" may limit management options considered in the future, as either land and assets at risk have increased making more costly options inevitable, or irreversible erosion impacts impacts have already occurred. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR5, NR7, NR11, NR12, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.6.6 Assessment of Treatment Options – Austinmer

Austinmer

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Austinmer Beach	Potential Funding Sources (Who may pay)	Conclusion
S1	Replacce or repair seawall (revetment) along existing alignment covering entire beach length	**Current Action**: NR2, then detailed design and approvals to replace or repair existing wall as required **Trigger:** When upgrade / replacement required (based on Current Action) OR structure is damaged by storm event, whichever is sooner	✓	✓	×								There is an existing wall extending 350 m in length across the entire Austinmer Beach. The wall should be assessed (NR2) as it may already offer adequate protection. Further if this wall requires upgrade rather than construction of an entire new wall, this option may be more financially viable. The S1 option may require limited nourishment (N) in the future to retain a sandy beach with sea level rise (refer Protect Options Table for cost benefit details for N). S1 is aimed at protecting Lawrence Hargrave Drive. However, rather than allowing the other significant assets seaward of the roadway to be lost to erosion, it is sensible to retain these assets and keep a seawall along the current alignment. As this beach already has a seawall and promenade, this option is in keeping with the current character of the beach. Costs for a new wall at Austinmer based on $5,000 - $10,000 /m are $1.75 - 3.5 million, not including ongoing maintenance and nourishment costs. The seawall design will need to include measures to reduce the wave overtopping risk. The S1 option would not provide for reduced inundation at the stormwater outlet and pipeline, and consideration of wave overtopping risk to the SLSC that cannot be cost effectively managed within the seawall design. The costs of these factors will	**?** State Government - through RTA as major road asset protected by this option; Grant Programs ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								In this location, dune care programs would be associated with beach management activities, to stabilise re-contoured sands. The vegetation types should be low-lying and unobtrusive, in keeping with the character of this beach. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	×								Scraping and contouring beach sands to accumulate in the back beach area in front of the existing wall is proposed, to assist retaining sand volumes for storm protection. For either a "planned retreat" or "seawall" option, beach management should be undertaken to assist protection of the existing wall (i.e., until wall is replaced or removed, depending on decision to "retreat" or "repair the seawall") *Refer to Protect Options Table for further cost benefit details for BM.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for BM Beach	Potential Funding Sources (Who may pay)	Conclusion
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This option is an alternative to S1. This is typically an excellent option for retaining the beach, by utilising public open space to enable natural retreat of the beach and hence continued provision of a beach in the long term. However at Austinmer, there is an existing seawall, and allowing degradation and removal of this wall is not in keeping with the current promenade character of this beach. There are also extensive stormwater assets and the main traffic pathway of Lawrence Hargrave Drive located landward of public open space. These assets would need to be moved (see PR2) or redesigned (see A2). Given these factors, economic analysis of seawall options from Thirroul may not be relevant to this location. Based on NR4, if it is found that Austinmer Pool cannot be progressively repaired to withstand wave and sea level rise impacts into the future, the pool will need to be slowly removed as it fails over time. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	**Marginal**
PR2	Relocate structure / service outside of hazard zone: Stormwater assets; war memorial	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner; Relocate War Memorial when ZRFC measured from erosion escarpment encroaches foundations	✓	✓	×								This option is an alternative to S1. The stormwater assets at Austinmer Beach run parallel to the current seawall, and are at risk from erosion and inundation at present. It is likely to be a very costly exercise to relocate this extent of pipe. This would need to be compared with the cost of upgrading the existing seawall, or redesign of these assets to withstand impacts, based on NR7 and A2. Relocation of the War Memorial could be undertaken in the future. Relocation of the surf club structure or Lawrence Hargrave Drive are unlikely to be possible due to land constraints (this would need to be confirmed through NR3 and NR5). *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	**Marginal**
A2	Retrofit Austinmer Pool in current location to withstand impacts.	**Current Action:** NR4 **Trigger:** When damage to pool shell occurs OR the pool is being inundated at water levels lower than MSL.	✓	✓	N/A								The decision to progressively retrofit Austinmer Pool over time to withstand wave and sea level rise impacts shall depend upon the suitability of pool condition for this purpose, based upon NR4. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	**Recommended**

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit stormwater structures in current location to withstand impacts	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when inundation frequency impedes effective conveyance of stormwater OR when asset replacement is required, whichever is sooner.	✓	✓	✓								This option is an alternative to S1 for erosion only. Regardless of whether S1 is implemented, the outlet will still need to be redesigned to withstand inundation, and there may be impacts from inundation along the pipeline also. This will need to be considered in selecting an appropriate option for the entire beach (e.g. S1 or PR1 and 2). *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
A2	Redesign or retrofit SLSC in current location to withstand impacts	**Current Action:** NR3 **Trigger:** When ZRFC measured from erosion escarpment threatens building foundations OR building requires major refurbishment.	✓	✓	✓								This option is an alternative to S1 for erosion only. Wave overtopping may still require redesign of the SLSC, regardless of S1. Additionally designing for erosion impacts (e.g suitable foundation capacity) will be dependent upon the decision to implement S1. Given land constraints, it is unlikely to be possible to relocate the SLSC, and therefore the structure will need to be redesigned or retrofit in current location to withstand impacts. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	×								Planning controls shall apply to development in areas at risk regardless of which option is selected (i.e. S1 or PR1 & 2 and A2) to improve resilience of the structures. Public assets including Lawrence Hargrave Drive, SLSC, carpark, boatshed and amenities are at risk. The DCP will trigger investigations that will govern whether the asset needs to be relocated (e.g. PR2) or redesigned to withstand impacts (A2 or A3) either alone or prior to a seawall being implemented. Given risk is currently high at assets affected, the DCP controls may be done in conjunction with the expected cost and timeframe for asset maintenance & replacement or sooner should erosion and wave overtopping impacts threaten the development. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs), cost to implement at RTA road ☑ Council (Current Programs, increased rates and levies?) - cost to prepare and implement DCP *N/A* Private landholders - cost to implement DCP	Recommended

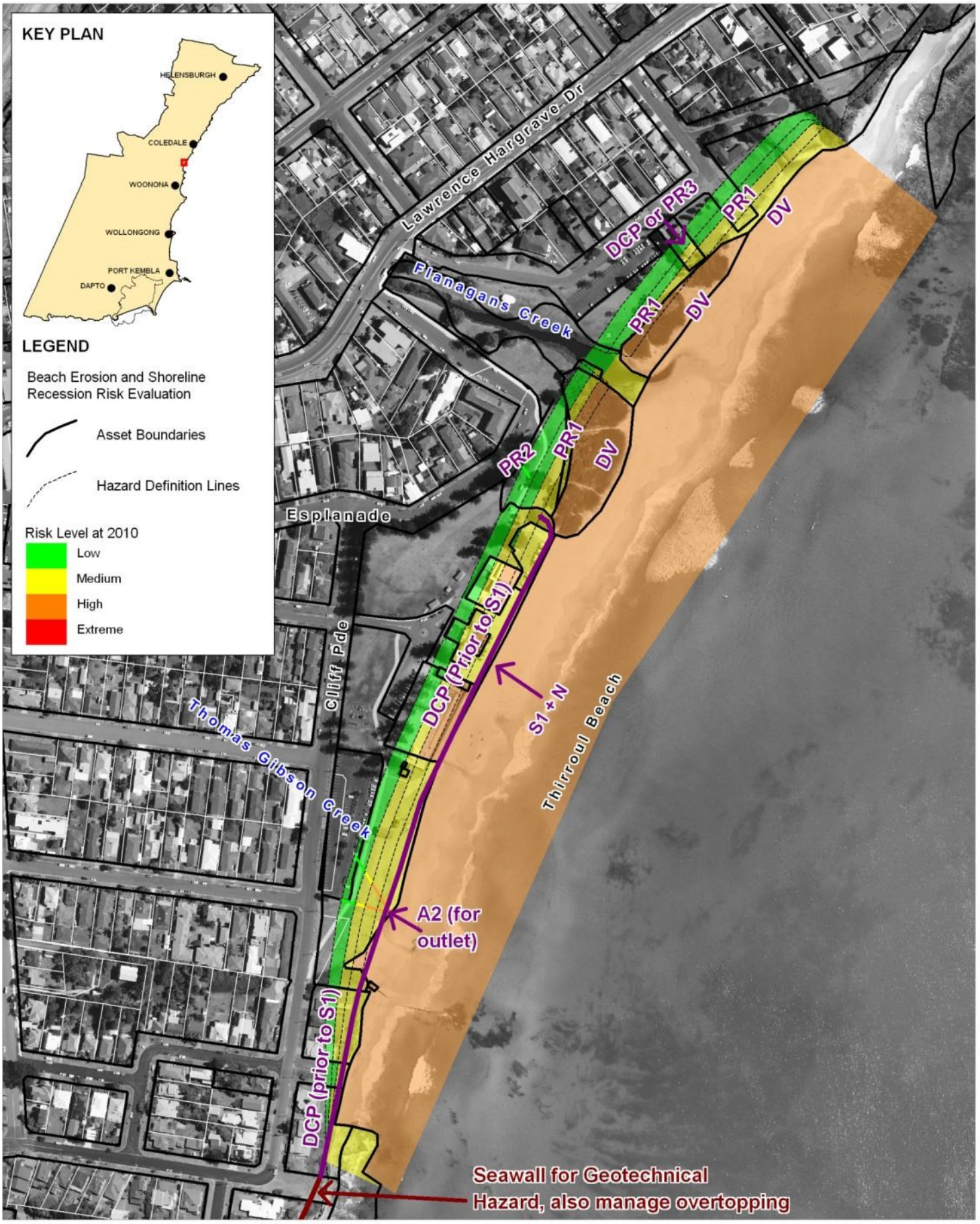
Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for A2 Beach	Potential Funding Sources (Who may pay)	Conclusion
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As property / assets redeveloped, new developments built	×	×	✓								While the majority of inundation at Austinmer appears related to wave overtopping and will be managed in combination with erosion controls, the backwater inundation risk to Lawrence Hargrave Drive and to stormwater assets should consider the combined catchment flood and ocean water level event (ie, NR10). In the interim, the existing Flood DCP chapter controls are applied at the "low risk" level, until such studies are conducted. *Refer to Accommodate Options Table for further cost benefit details for FDCP.*	? State Government (Grant programs), cost to implement at RTA road ☑ Council (Current Programs, increased rates and levies?) - cost to prepare and implement DCP ☑ Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								There is currently a large extent of assets that are both expensive and vital to community function at risk at Austinmer, so "Do nothing" is unlikely to be acceptable. Land and assets lost to erosion cannot be replaced, and particularly for Lawrence Hargrave Drive (and stormwater assets to a lesser degree) are likely to cause unacceptable disruption to the regional and local community should impacts occur. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR2, NR3, NR4, NR5, NR7, NR10, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.7 Thirroul Beach

6.7.1 Erosion and Recession Risk Level and Treatment Options

Thirroul Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Thirroul Beach	High	Extreme	Extreme	✓			✓✓		✓✓								NR14	●
Tingara Park	Medium	Medium	High				✓		✓✓									
Flanagans Creek	Medium	Medium	High						✓								NR11	
Coastal Dune System (small area adjacent to creek entrance)	High	Extreme	Extreme				✓		✓✓									●
Community Infrastructure																		
Thirroul Surf Club	High	Extreme	Extreme		✓	✓				✓				✓		✓	NR2, NR3, NR14	●
Thirroul Pool (also heritage site)	High	Extreme	Extreme		✓	✓				?				✓			NR2, NR4, NR14	●
Thirroul Pool office and amenities	High	Extreme	Extreme		✓	✓				?				✓			NR2, NR4	●
Thirroul Pool toilet	Medium	High	Extreme		✓	✓				?				✓			NR2, NR4	●
Thirroul Pool storage shed (large)	Medium	High	Extreme		✓	✓				?				✓			NR2, NR4	●
Thirroul Pool intake	High	Extreme	Extreme							✓				✓	✓		NR14	●
Heritage site: Thirroul Pavillion (being used as kiosk / restaurant) and residence	High	Extreme	Extreme		✓	✓				?							NR2, NR3, NR14	●
Heritage Site: Thirroul Beach Reserve (S of pool)	Medium	High	Extreme		✓				✓								NR2, NR3	
Heritage Site: Norfolk Island Pines	Low	Low	Medium						✓								NR2, NR12	✓
Transport Infrastructure																		
Local Roads (Bath St)	Low	Medium	Medium		✓	✓				✓				✓			NR2, NR5	
Beach access and car park (S end of Beach)	Low	Low	Medium		✓	✓				✓				✓			NR2, NR5	✓
Beach access and car park (N end of beach); Local Roads Henley St, Jones St, Mary St	Low	Low	Medium							✓				✓			NR2, NR5	✓
Water and sewage infrastructure																		
Stormwater outlet to Flanagans Creek	Medium	High	High		✓					✓				✓	✓		NR7, NR14	●
Thomas Gibson Creek - Major stormwater outlet	High	Extreme	Extreme		✓	✓				✓				✓	✓		NR7, NR14	●
Residential Development																		
Existing Residences: 1 ppty at centre of beach	Medium	High	Extreme			?			✓		✓	✓	?	✓			NR14	●
Existing Residences (8 ppty at S end of beach)	Medium	High	Extreme		✓	✓✓			✓			?	?	✓			NR14	●

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
●	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Erosion Risk Levels and Treatment Options
Thirroul Beach - Seawall S1 Option

Drawing: 6-14

Rev: A

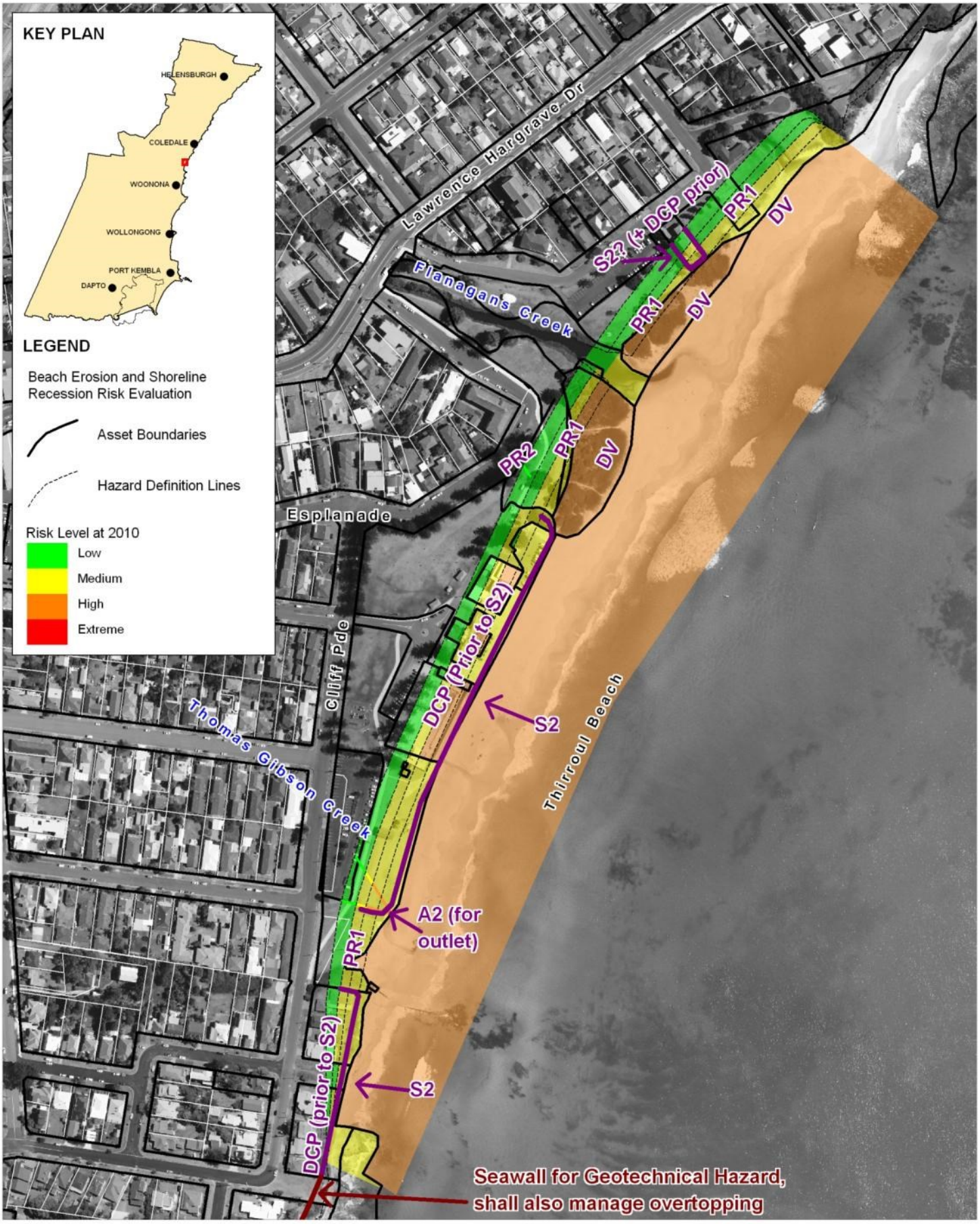
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_107_110427 Drawing 6-14.WOR



Title:

Erosion Risk Levels and Treatment Options
Thirroul Beach - Seawall S2 Option

Drawing: 6-15

Rev: A

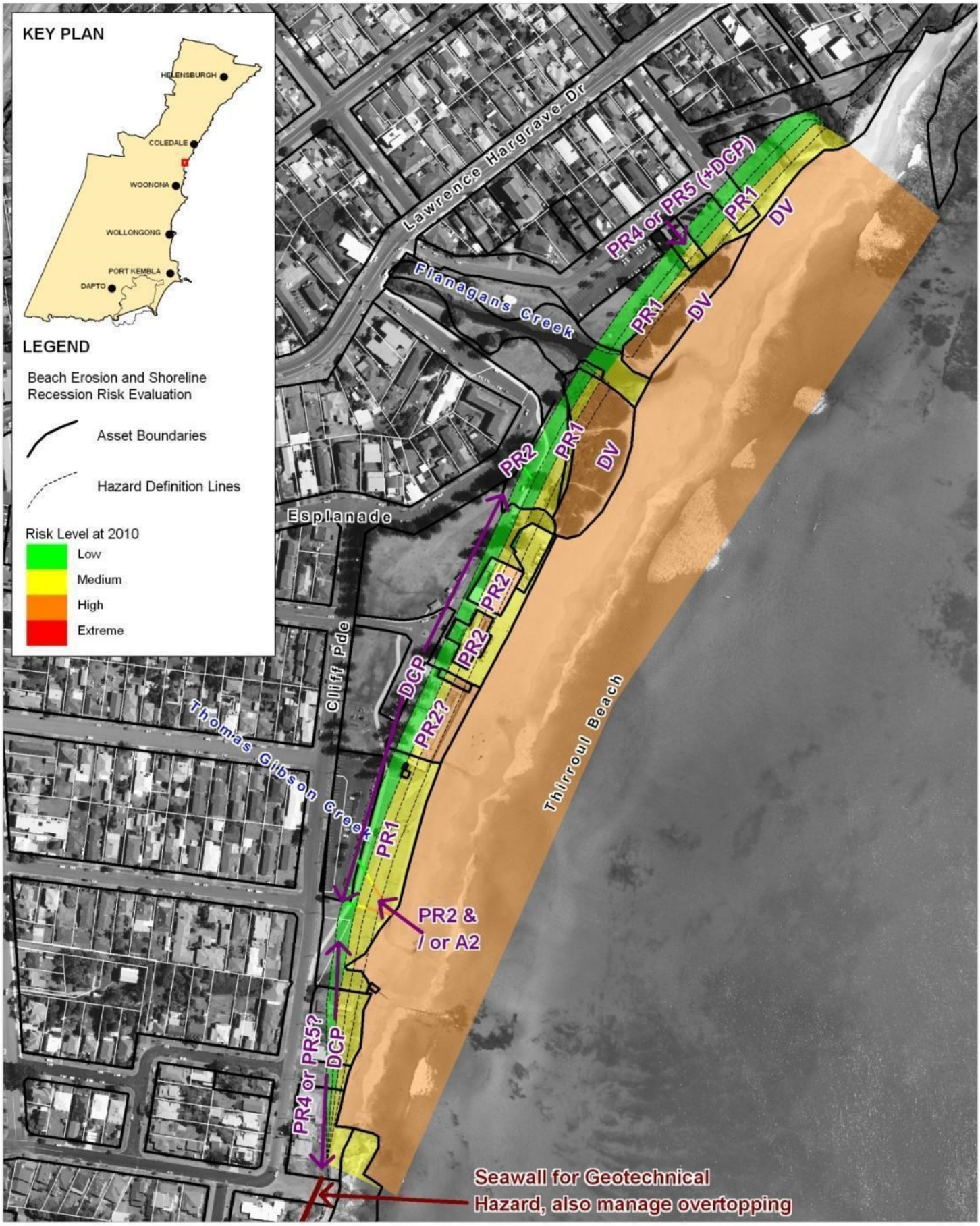
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_107_110427 Drawing 6-15.WOR



Title:

Erosion Risk Levels and Treatment Options
Thirroul Beach - Planned Retreat Option

Drawing: 6-16

Rev: A

N

0 75 150m

Approx. Scale

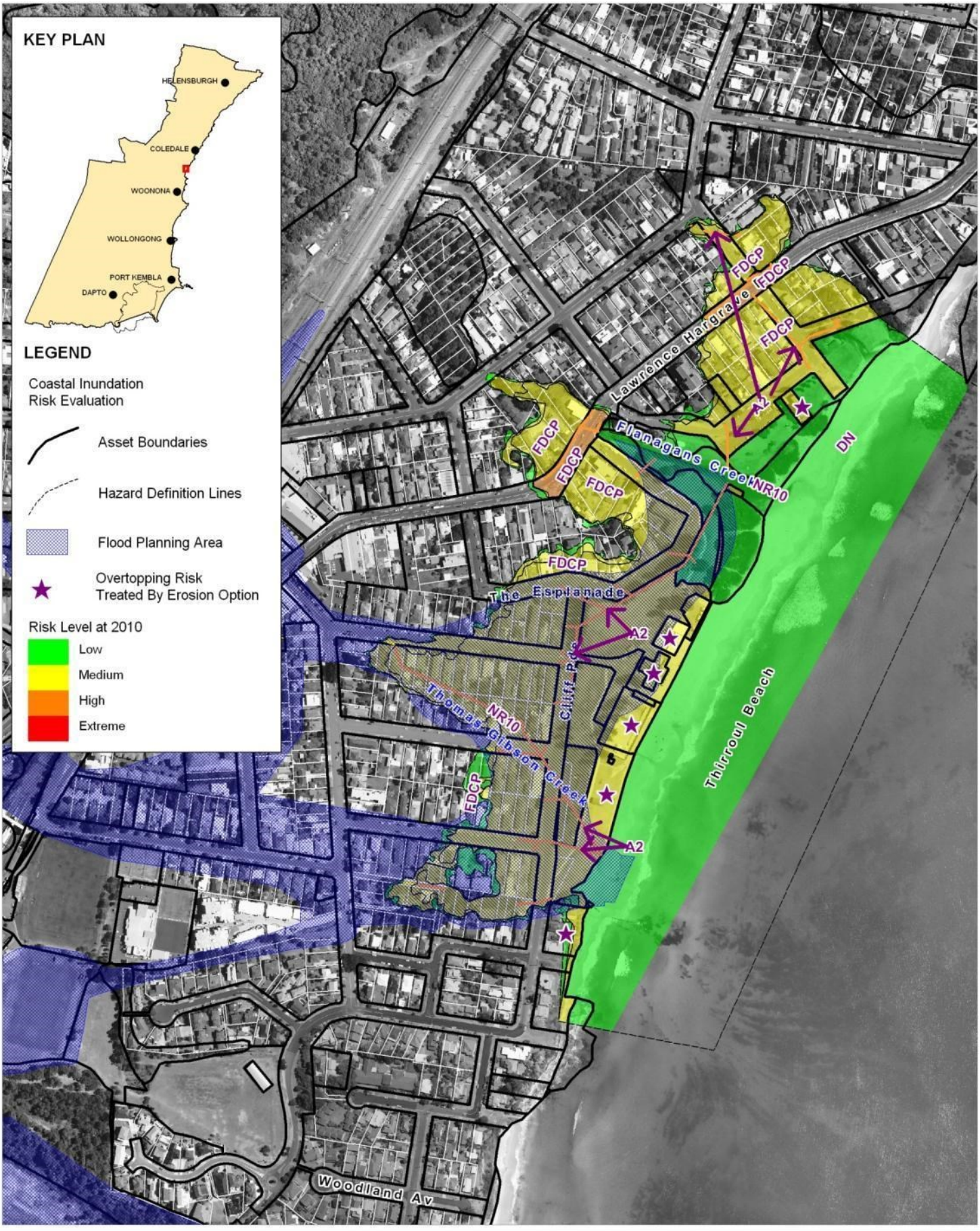
BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_107_110427 Drawing 6-16.WOR

6.7.2 Coastal Inundation Risk Level and Treatment Options

Thirroul Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Thirroul Beach	Low	Low	Medium						✓
Tingara Park	Low	Low	Medium						✓
Flanagans Creek	Low	Low	Medium					NR10, NR14	✓
Coastal Dune System (small area adjacent to creek outlet)	Low	Low	Medium						✓
Community Infrastructure									
Thirroul Surf Club	Medium	High	Extreme	✓		✓			●
Thirroul Pool (also heritage site)	Medium	High	Extreme	✓		✓			●
Thirroul Pool office and amenities	Medium	High	Extreme	✓		✓			●
Thirroul Pool toilet	Medium	High	Extreme	✓		✓			●
Thirroul Pool storage shed (large)	Medium	High	Extreme	✓		✓			●
Thirroul Pool intake	Medium	High	Extreme	✓		✓			●
Heritage site: Thirroul Pavillion (being used as kiosk / restaurant) and residence	Medium	High	Extreme	✓		✓			●
Heritage Site: Thirroul Beach Reserve	Low	Medium	Medium						✓
Heritage Site: Norfolk Island Pines	Low	Medium	Medium						✓
Heritage site: Former Quest House	Medium	High	Extreme			✓	✓		
Transport Infrastructure									
Major Roads (Lawrence Hargrave Drive)	High	Extreme	Extreme			✓		NR10, NR9, NR14	●
Local Roads (Bath St linking to the Esplanade, Henley St, Road reserve for Harbord & Ocean Sts)	Medium	High	Extreme			✓		NR10, NR9, NR14	●
Beach access and car park (N end of beach)	Low	Low	Low						✓
Beach access and car park (S end of beach)	Low	Low	Low						✓
Water and sewage infrastructure									
Stormwater outlets and pipes (upper Flanagans Ck catchment)	High	Extreme	Extreme			✓	✓	NR10, NR7, NR14	●
Thomas Gibson Creek - Stormwater outlet	High	Extreme	Extreme			✓	✓	NR10, NR7, NR14	●
Residential Development									
Existing Residences (151 cadastral parcels)	Medium	High	Extreme			✓	✓	NR10, NR9	●

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
●	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Thirroul Beach

Drawing: 6-17

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_107_110427 Drawing 6-17.WOR

6.7.3 Assessment of Treatment Options

Thirroul Beach						Rapid Cost Benefit Analysis (Traffic Light)									
Option Symbol	**Option**	**Trigger for implementation (following relevant planning, approvals, etc)**	**Erosion Option**	**Overtopping Option**	**Backwater Inundation Option**	**Capital Cost**	**Recurrent Costs**	**Environmental or Social Impact**	**Community Acceptability**	**Reversible / Adaptable in Future**	**Effectiveness over time**	**Legal / Approval Risk**	**Specific Cost Benefit Considerations for Thirroul Beach**	**Funding Sources / Who pays**	**Conclusion**
N	Beach nourishment	Immediately and whenever sand reserve is below the identified storm demand seaward of development being protected (following storms)	✓	✓	×								Suitable sand sources are not likely to be available for large scale beach nourishment in the local area. This significantly increases the cost of this option, or constrict the use of this option. However, nourishment is a necessity to retain a sandy beach in combination with Seawall S1 (see below). Thirroul Beach alone was valued at over $142 million over the next 100 years (see PR1 below, Gillespie Economics Appendix D). Nourishment costs have been estimated at $25/m3, with typical volumes of up to 200 m3/m length of beach required to widen the beach by 20 m. For a single nourishment event across half of Thirroul Beach this would equate to roughly 100,000 m3, costing $2.5 million. As sea level rises, the frequencey of nourishment events shall increase, resulting in increasing costs over time. *Refer to Protect Options Table for further cost benefit details for N.*	**?** State Government (Grant Programs) - unlikely to fund private property protection ☑ Council (new levies or increased rates) ☑ Private landholders who directly benefit from option (personal investment or directed by Council)	**Not Recommended**
S1	Construct seawall (revetment) along specified alignment covering majority to all of beach length	Prior to redevelopment /upgrading of any development identified as “at risk” (otherwise DCP shall apply).	✓	✓	×								This seawall option would need to be accompanied by ongoing beach nourishment if a sandy beach amenity is to be maintained over time as sea level rises. Issues associated with beach nourishment noted above are also applicable here. Seawall costs are of the order of $5,000 - $10,000 per m length of wall. For a 500 m wall along half of Thirroul Beach, this would equate to between $2.5 - $5 million, and doesn’t include the costs of nourishment (see above), ongoing maintenance and future upgrading. If the seawall is to be abandoned at some time in the future, the costs for removal and repair of the beach must also be included. At Thirroul Beach, assuming unlimited funds for all options, Gillespie Economics (Appendix D) found the S1 + N option to be economic as nourishment ensures the beach amenity and Thirroul Beach Reserve is retained. Beach use values were estimated at $142 million (see PR1 below). However, as funding is limited, Gillespie Economics found that compared with both S1 & N and S2 options, planned retreat (including relocating assets (PR2) and loss of park land (PR1)) has a substantially higher net present value (i.e. value of benefits less value of costs) per dollar invested. While S1 retains the use of	**?** State Government (Grant Programs) - unlikely to fund private property protection ☑ Council (new levies or increased rates) ☑ Private landholders who directly benefit from option (personal investment or directed by Council)	**Not Recommended**

Option Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for S2	Funding Sources / Who pays	Conclusion
S2	Construct seawall (revetment) along specified alignment to protect specific asset(s)	Prior to redevelopment /upgrading of any development identified as "at risk" or when the Immediate Impact Zone (including foundation stability allowance) intersects the development.	✓	✓	×								Seawall S2 option assumes shorter sections of seawall are installed without large scale nourishment (except to manage offsite impacts) and assuming it is accepted that sections between shall erode naturally to retain a limited sandy beach amenity (see map). Seawall costs are of the order of $5,000 - $10,000 per m length of wall. For sections of wall wall along Thirroul Beach, this would equate to between $2.25 - $4.5 million, and doesn't include the costs of ongoing management of offsite impacts (e.g.small scale nourishment) and future upgrading. Even if the $ value of the beach (estimated at $142 million, refer PR1) is reduced by 80 %, planned retreat remains the more economically viable option at Thirroul (Gillespie Economics, Appendix D), see PR1 below. It may be viable to allow a section of wall connecting with the geotechnical seawall option for properties affected at the southern end of the beach, but not other areas along the beach. In this case, such walls protecting private properties should be built on private land, and State Government legislation permits Council to require sections of wall protecting private property and ongoing maintenance to be funded by the private property owners. *Refer to Protect Options Table for further cost benefit details for*	**?** State Government (Grant Programs) - unlikely to fund private property protection ☑ Council (new levies or increased rates) ☑ Private landholders who directly benefit from option (personal investment or directed by Council)	**Marginal (Southern end of beach only)**
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This is an excellent option for retaining the beach, by utilising public open space to enable natural retreat of the beach, and hence continued provision of a beach over the long term Gillespie Economics found that the asset with the highest economic value is Thirroul Beach itself. Based on both resident and visitor use (domestic day visitors, overnight visitors and international visitors whose main activity is spending time at the beach, (TRA, 2007)), Thirroul Beach alone was valued at over $142 million over the next 100 years. Therefore, any option which retains this asset shall be preferred for economic reasons. This is in addition to the community and environmental values associated with the beach. At Thirroul Beach, compared with both S1 & N and S2 options, planned retreat (including relocating assets (PR2), loss of Thirroul Beach Reserve area (PR1) and planning controls on residences (DCP)) was found to have a substantially higher net present value (ie value of benefits less value of costs) per dollar invested. Particularly as funds are constrained, the option of planned retreat is far more viable than both "do nothing" and protect options such as S1 & N or S2, even if the $ value of the beach is reduced by 80%	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	**Recommended**
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								The continuation of dune care programs must be considerate of sightline requirements for SLSC activities. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	**Recommended**

Option Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR4	Funding Sources / Who pays	Conclusion
PR2	Relocate structure / service outside of hazard zone	Prior to redevelopment /upgrade OR when the Immediate Impact Zone (including foundation stability allowance) intersects the development, whichever is sooner	✓	✓	×								Further investigations are required to confirm that it is technically and financially viable to relocate Thirroul Pool or Thirroul Pavilion in a manner which retains their heritage character and value. Preliminary investigations suggest it is technically viable and may cost less (financially and environmentally) than implementation of a seawall to protect the structures (refer S1 and S2 above). The pool intake would have to be relocated to continue to service the pool well before impacts occur to the pool itself. Relocation of the surf club structure could provide a new club facility for community and the SLSC. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
PR3	Prohibit expansion of existing use rights	Now	✓	✓	×								This option is proposed for a single residential property that is located within adjacent park lands that are suitable for planned retreat to retain the sandy beach into the future. This option may limit the property value. Without repurchase of this land by the government (State, Federal, Local?), the land remains in private ownership. This may become a problem should planning controls change in the future. *Refer to Planned Retreat Options Table for further cost benefit details for PR3.*	☒ State Government ☒ Council (Current Programs) ☑ Private landholders	Not Recommended
PR4	Voluntary acquisition	**Current Action:** Apply for government funding. **Trigger:** Offer once funding becomes available.	✓	✓	✓								This option may be financially viable for a single property, but would not be financially possible for multiple properties without substantial government assistance, which is not currently available. Current funding mechanisms from State Government and Council are not sufficient to acquire multiple properties. *Refer to Planned Retreat Options Table for further cost benefit details for PR4.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) ☒ Private landholders who directly benefit from option	Recommended
PR5	Buy back – lease back	**Current Action:** Apply for mortgage now **Trigger:** Offer acquisition once funding becomes available. Demolish property when erosion impacts destabilise building foundations.	✓	✓	✓								This option involves Council applying for funding through typical mortgage arrangements to acquire affected property(s), on a voluntary basis. As the finanical viability of this option depends on leasing the property once purchased at market rates to assist mortgage repayments until the hazard impact is imminent, the repurchase offer to landholders will be discounted in accordance with likely time remaining before erosion impacts . The option then enables natural retreat of the beach and land available for use by the community as the development shall be demolished once impacts occur. This option ensures the land returns to public ownership once impacts are imminent (unlike PR3 above). Funding and financial risk for this option would fall solely with Council. This option is as yet untested. *Refer to Planned Retreat Options Table for further cost benefit details for PR5.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) ☒ Private landholders who directly benefit from option	Recommended

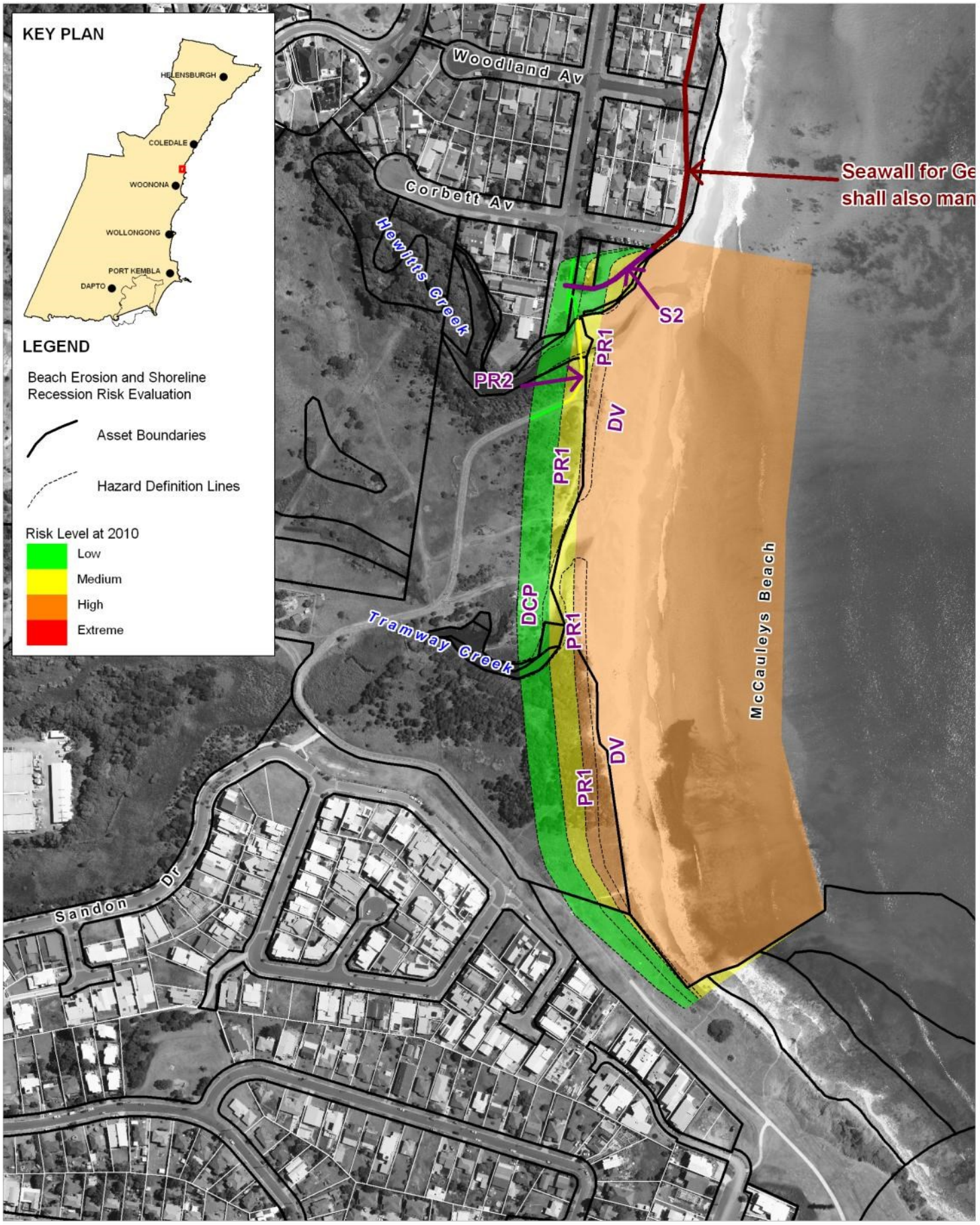
Option Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for FDCP	Funding Sources / Who pays	Conclusion
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property/ assets redeveloped, new developments built	✓	✓	x								This option shall apply planning controls to development that reflect the level of risk at the propertye and expected life of the development. DCP controls will apply to land prior to implementation of seawalls also, should this be selected. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement for public assets ☑ Private landholders - cost to implement DCP	Recommended
A2	Redesign or retrofit stormwater structures and Thirroul Pool intake in current location to withstand impacts	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when inundation frequency impedes effective conveyance of stormwater OR when asset replacement is required, whichever is sooner.	✓	✓	✓								Thomas Gibson Creek forms a significant section of stormwater infrastructure and will be affected by inundation due to sea level rise. Seawall (S1, S2) options, if implemented, will not reduce inundation impacts, and other mechanisms to accommodate this risk shall need to be considered. Thirroul Pool intake will similarly be affected by inundation with sea level rise, and this impact will need to be accommdated (for example, raising the pipe line) if the structure cannot be relocated and the Pool is to be protected or retained in a similar form to present. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
A3	Replace existing SLSC with relocatable structure.	**Current Action:** NR3 **Trigger:** When SLSC needs to be replaced OR erosion escarpment threatens building foundations.	✓	✓	✓								This would provide an alternative to relocating or protecting the surf club. The viability of this option will depend on outcomes of NR3. *Refer to Accommodate Options Table for further cost benefit details for A3.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Marginal
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and	As property/ assets redeveloped, new developments	x	x	✓								This option involves applying the existing Flood DCP chapter to those areas identified at risk from coastal inundation at the "low risk" level, until a Flood Study is completed and updated for Flanagans Creek and Thomas Gibson Creek respectively (refer NR10). The majority of properties affected by coastal inundation in the Thomas Gibson catchment are also within the existing Flood Planning Area, therefore this option would have no additional effect	*N/A* State Government (external funding unlikely to be needed) ☑ Council (Current Programs) ☑ Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								Given the extent, type and value of assets at risk from erosion and recession and inundation at Thirroul, the "do nothing" option is unacceptable. There would be damaging and irreversible impacts, and this may limit management options in the future as land is irreversibly lost or development has intensified, requiring more costly options to mitigate future risk. This option is not reversible in the future for development or land that is lost to erosion.	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR2, NR3, NR4, NR5, NR7, NR9, NR10, NR11, NR12, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.8 McCauleys Beach

6.8.1 Erosion and Recession Risk Level and Treatment Options

McCauleys Beach (not inc Sandon Pt)	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
McCauleys Beach	High	Extreme	Extreme				✓✓		✓✓								NR14	
Woodland Avenue Reserve, Corbett Ave Reserve, Sandon Point Reserve	Medium	Medium	High						✓✓									
McCauleys Beach Reserve	High	Extreme	Extreme						✓✓									
Hewitts Creek	Medium	Medium	High						✓✓								NR11	
Tramway Creek	Low	Medium	Medium						✓✓								NR11	
Coastal Dune Systems (S end)	High	Extreme	Extreme				✓✓		✓✓									
Community Infrastructure																		
Significant Aboriginal Site (Tent Embassy).	Medium	High	High							✓				✓✓			NR14	
Cycleway / Shared Pathway (Northern Coastal Cycleway)	Medium	Medium	High							✓✓				✓	✓		NR6, NR14	
Transport Infrastructure																		
Local Roads (inc Woodlands Ave, Corbett Ave)	Low	Medium	Medium			✓			✓									
Water and sewage infrastructure																		
Stormwater outlets and pipes (N end of beach)	Low	Medium	High			✓				✓				✓	✓		NR7	
Residential Development																		
Existing Residences (1 ppty at N end of beach)	Medium	Medium	High			✓					?	✓	✓	✓			NR14	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options
McCauley's Beach - Seawall S2 Option

Drawing: 6-18

Rev: A

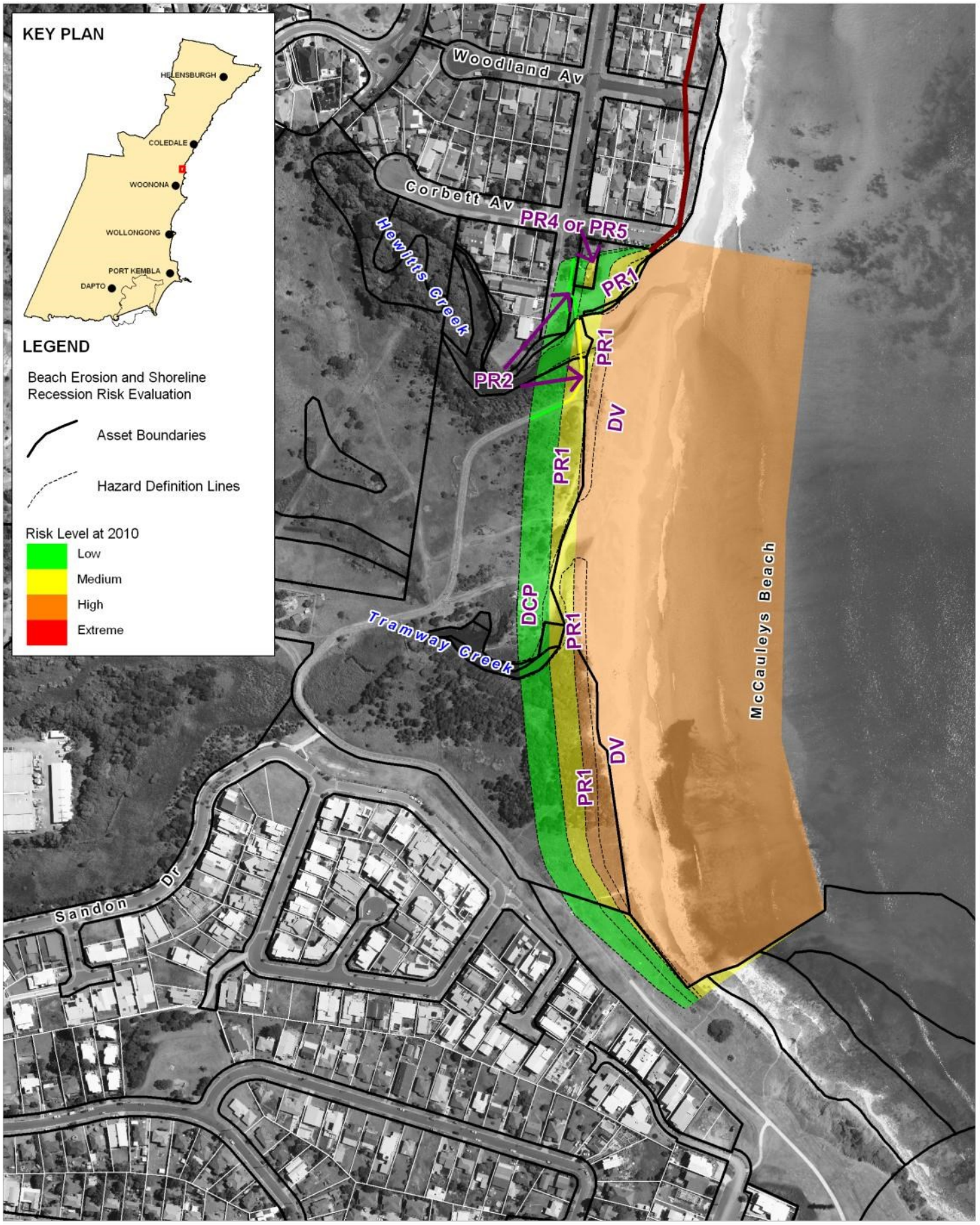
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_108_110427 Drawing 6-18.WOR



Title:

Immediate Erosion Risk Levels and Treatment Options McCauley's Beach - Planned Retreat Option

Drawing: 6-19

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

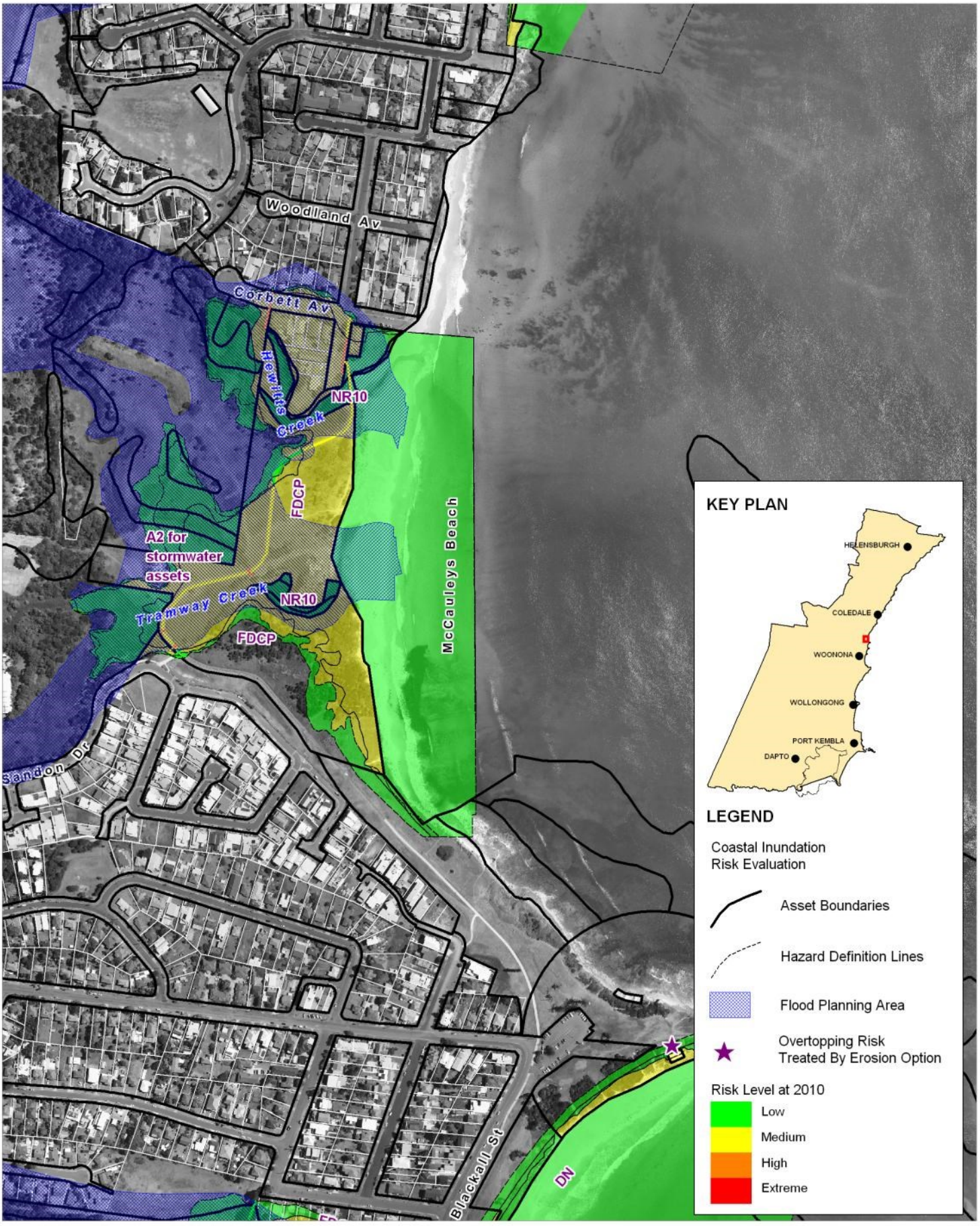
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_108_110427 Drawing 6-19.WOR

6.8.2 Coastal Inundation Risk Level and Treatment Options

McCauleys Beach (not inc Sandon Pt)	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
McCauleys Beach	Low	Low	Medium						✓
Woodland Avenue Reserve, Corbett Ave Reserve, Sandon Point Reserve (public open space)	Low	Low	Medium	✓					✓
McCauleys Beach Reserve (park & open space)	Medium	High	Extreme			✓✓		NR10	
Hewitts Creek	Medium	Medium	High					NR10, NR14	
Tramway Creek	Medium	Medium	High					NR10, NR14	
Coastal Dune Systems (S end)	Low	Low	Medium						✓
Community Infrastructure									
Significant Aboriginal Site (Tent Embassy).	High	Extreme	Extreme			✓✓	✓		
Cycleway / Shared Pathway (Northern Coastal Cycleway)	Medium	Medium	High		✓	✓✓	✓		
Transport Infrastructure									
Local Roads (inc Corbett Ave, Hamilton Rd)	Medium	High	Extreme			✓✓	✓	NR14	
Water and sewage infrastructure									
Stormwater outlets and pipes (N end of beach)	High	Extreme	Extreme			✓	✓✓	NR7, NR14	
Residential Development									
Existing Residences (1 ppty at N end of beach	Medium	High	Extreme	✓		✓		NR10	
Existing Residences (7 ppty at N end of beach, not inc ppty above)	Medium	High	Extreme			✓✓		NR10	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options McCauley's Beach

Drawing: 6-20

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_108_110427 Drawing 6-20.WOR

6.8.3 Assessment of Treatment Options

McCauleys

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for McCauleys Beach	Potential Funding Sources (Who may pay)	Conclusion
S2	Construct seawall (revetment) along specified alignment to protect specific asset(s)	Prior to redevelopment /upgrading of any development identified as "at risk" or when the Immediate Impact Zone (including foundation stability allowance) intersects the development.	✓	✓	×								This option proposes a small section of seawall connecting with Council and other landholder seawalls (see Thirroul geotechnical hazard) along the very northern end of the beach. This section of wall would extend for 70 m in length costing an estimated $350,000 - $700, 000 (based upon $5,000 - $10,000 m per length of seawall) not including ongoing maintenance costs. The wall would not significantly constrict natural retreat of the beach (PR1) as it is located along the northern headland of the beach. However, the wall would not be in keeping with the natural character of the beach, unless tied to adjacent walls along the headland. The majority of this land is publicly owned except for 1 residential property. The wall should be extended to protect the stormwater outlet at the N end of the beach from erosion also. *Refer to Protect Options Table for further cost benefit details fo S2.*	**?** State Government (Grant Programs) - unlikely to fund private property protection ☑ Council (new levies or increased rates) ☑ Private landholders who directly benefit from option (personal investment or directed by Council)	Marginal
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								Dune care programs would be suitable to enhance the existing dune vegetation on this largely natural beach. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This is an excellent option for retaining the beach at this location where natural retreat through reserve lands enables continued provision of a beach over the long term. The land at risk has heritage values. However protection options (e.g. seawall) are in no way financially or environmentally viable and would destroy the current natural amenity of this location. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate stormwater structures outside of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner.	✓	✓	×								The stormwater outlet at the N end of the beach could be progressively moved landward as impacts eventuate. This should be confirmed through NR7, as there are likely to also be inundation impacts to be managed. The Aboriginal Tent Embassy could viably be relocated landward, to avoid erosion impacts. Landward area is community land also. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR1 Beach	Potential Funding Sources (Who may pay)	Conclusion
PR3	Prohibit expansion of existing use rights	Now and continuing	✓	✓	x								This option is proposed for the single residential property located at the northern end of the beach adjacent to Woodland Ave reserve. This option limits the property value. The option offers no compensation (repurchase) of the property to the current landholder when impacts occur. Without repurchase of this land by the government (State, Federal, Local?), the land remains in private ownership. This may become a problem should planning controls change in the future. *Refer to Planned Retreat Options Table for further cost benefit details for PR3.*	☒ State Government ☒ Council (Current Programs) ☑ Private landholders	Not Recommended
PR4	Voluntary acquisition	**Current Action:** Apply for government funding. **Trigger:** Offer once funding becomes available.	✓	✓	x								This option may be financially viable for the single property at risk at the N end of the beach. Voluntary acquisition would be offered at market rates, although the rate shall be discounted substantially should the owners wait until erosion impacts occur before accepting the offer. This option enables the land to return to community ownership, ensuring a suitable use for the land in keeping with the erosion risk in the future, and allowing natural retreat of the beach. *Refer to Planned Retreat Options Table for further cost benefit details for PR4.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) ☒ Private landholders who directly benefit from option	Recommended
PR5	Buy back – lease back	**Current Action:** Apply for mortgage now **Trigger:** Offer acquisition once funding becomes available. Demolish property when erosion impacts destabilise building foundations.	✓	✓	✓								This option involves Council applying for funding through typical mortgage arrangements to acquire 1 property at the N end of the beach. The repurchase the property is offered voluntarily at market rates, however, the offer shall be discounted in accordance with the length of time remaining before the property becomes uninhabitable due to erosion. This is because this option is dependent upon Council leasing the property at market rates to assist mortgage repayments prior to erosion impacts to building foundations. At that time the development shall be demolished and returned to Community Land. This option, as above, provides fair compensation to landowners and return of at risk land to public ownership to permit natural retreat of the beach. This option is as yet untested. *Refer to Planned Retreat Options Table for further cost benefit details for PR5.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) ☒ Private landholders who directly benefit from option	Recommended
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	x								This option applies proposed Coastal DCP controls to any redevelopments in areas at risk. This includes the Aboriginal Tent Embassy and the property at the northern end of the beach. The DCP controls will reflect the level of risk and development lifespan. The DCP will trigger investigations as to foundation capacity (bedrock), alternative locations, distance to erosion escparments, permissible fixed structures etc that will govern the relocation (e.g. PR2) or suitable design for developments (e.g.A2, A3). *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs, increased rates and levies?) - cost to prepare DCP and implement at public assets ☑ Private landholders - cost to implement DCP	Recommended

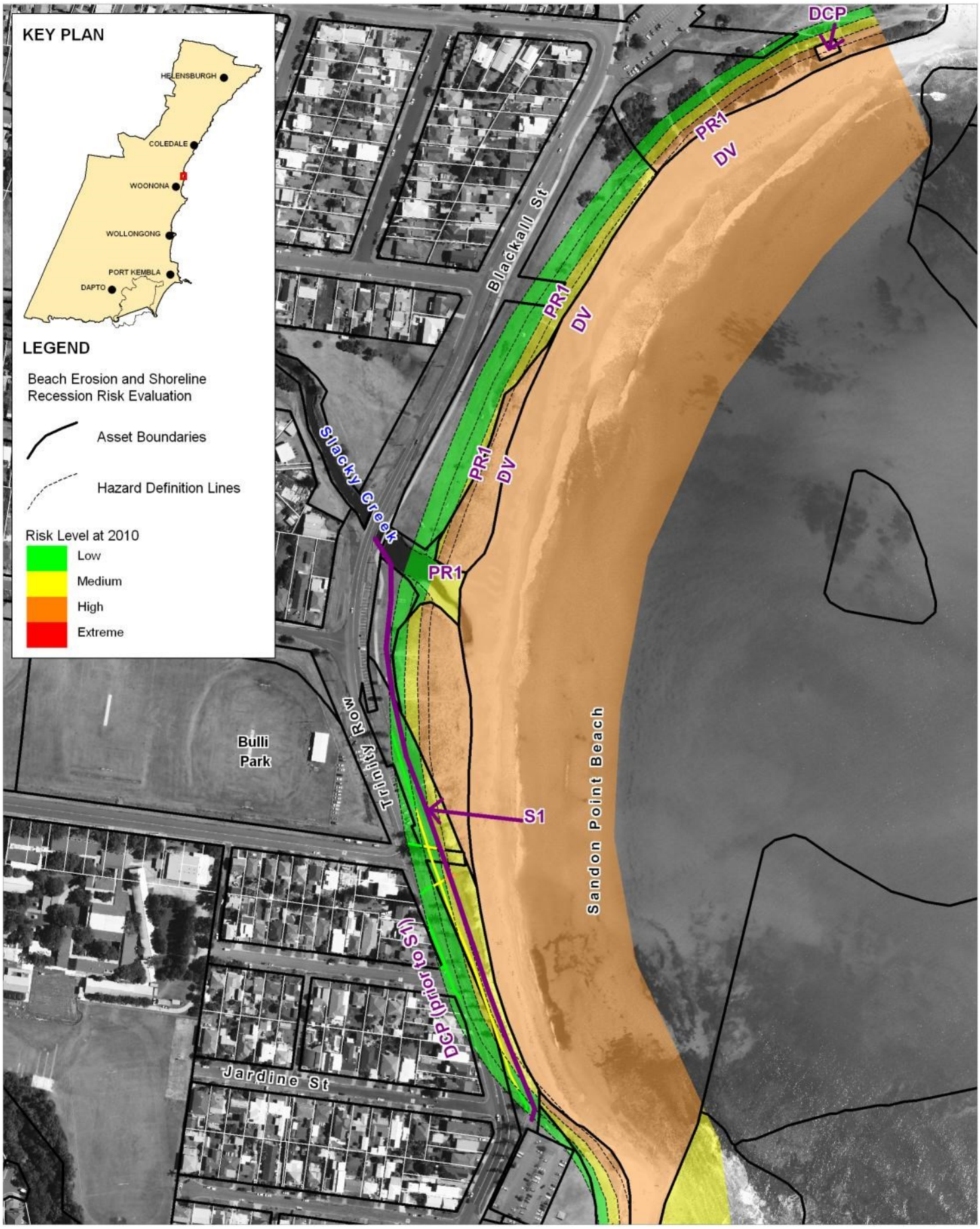
Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR5 Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when inundation no longer allows conveyance of stormwater OR when asset replacement is required, whichever is sooner.	✓	✓	✓								The stormwater assets affected by backwater inundation may require redesign and re-siting to enable conveyance of stormwater as sea levels rise. The stormwater asset at the N end of the beach may require design to withstand erosion, if it cannot be progressively relocated landward (i.e. PR2). Suitable design for replacement structures shall depend upon the outcomes of NR7. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As property / assets redeveloped, new developments built	x	x	✓								This option involves applying the existing Flood DCP chapter to those areas identified at risk from coastal inundation outside of the existing flood planning area at the "low flood risk" level prior to updated Flood Studies for Hewitts and Tramway Creeks (refer NR10). There are limited additional properties outside the flood planning area. The majority of properties affected by coastal inundation are also within the existing Flood Planning Area, therefore this option would have no additional effect on existing property value or development restrictions. *Refer to Accommodate Options Table for further cost benefit details for FDCP.*	*N/A* State Government (external funding unlikely to be needed) ☑ Council (Current Programs) ☑ Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								Assets at McCauleys are at risk from both erosion, overtopping and backwater inundation. The "do nothing" option would be acceptable within natural areas without development, however there are a number of private, community and cultural assets within this location, for which the outcomes of "do nothing" would have an unacceptable impact. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR6, NR7, NR10, NR11, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.9 Sandon Point Beach

6.9.1 Erosion and Recession Risk Level and Treatment Options

Sandon Point Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Sandon Point Beach	High	Extreme	Extreme				✓		✓								NR14	
Sandon Point Beach Reserve (not including Sandon Point Heritage area)	Medium	Medium	High						✓									
Slacky Creek	Medium	Medium	High						✓								NR11	
Coastal Dune Systems (N end of beach)	High	Extreme	Extreme				✓		✓									
Community Infrastructure																		
Sandon Point Surf Club	High	Extreme	Extreme											✓	✓		NR14	
Heritate Site: Sandon Point (also under NPW Act)	High	Extreme	Extreme						✓									
Heritage Site: Sandon Point Boat Sheds	Medium	High	High						✓									
Northern Cycleway / Shared Pathway (at S end of beach)	Medium	Medium	High		✓					✓							NR6, NR14	
Heritage Site: Norfolk Island Pines (S end of beach)	Medium	Medium	High						✓								NR12	
Transport Infrastructure																		
Local Roads: Blackall St, Ursula St, Alroy St)	Medium	Medium	High		✓		✓	✓		✓				✓			NR5, NR8, NR14	
Beach car parks (S end of Beach)	Low	Low	Medium		✓				✓									✓
Water and sewage infrastructure																		
Stormwater outlets and pipes (S end of beach)	High	Extreme	Extreme		✓					✓				✓			NR7, NR8, NR14	
Residential Development																		
Existing Residences (edge of 5 ppties at S end of beach)	Low	Medium	Medium		✓							✓	✓	✓			NR8	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options
Sandon Point Beach - Seawall S1 Option

Drawing: 6-21

Rev: A

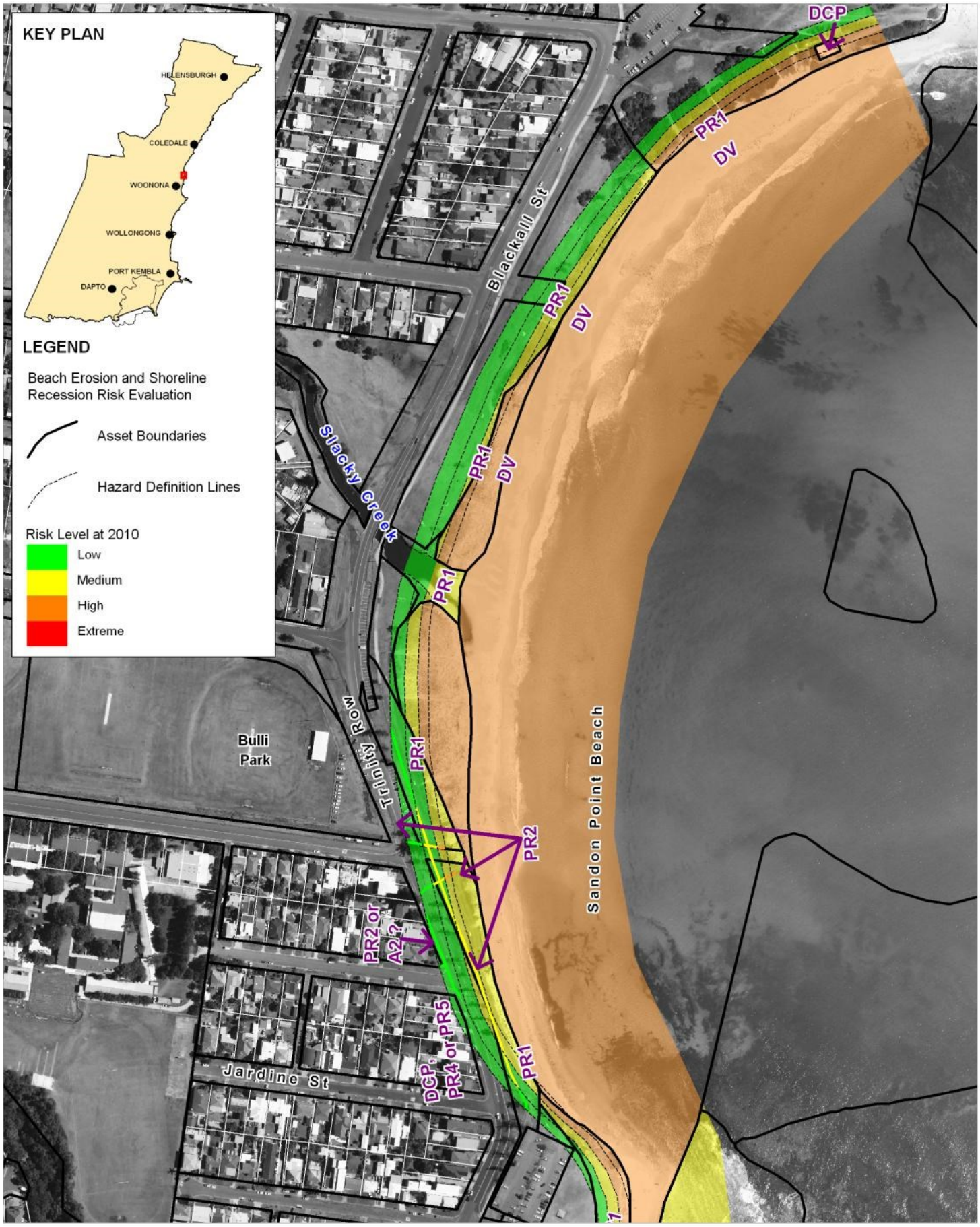
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_109_1104127 Drawing 6-21.WOR



Title:

Immediate Erosion Risk Levels and Treatment Options
Sandon Point Beach - Planned Retreat Option

Drawing: 6-22

Rev: A

N

0 75 150m

Approx. Scale

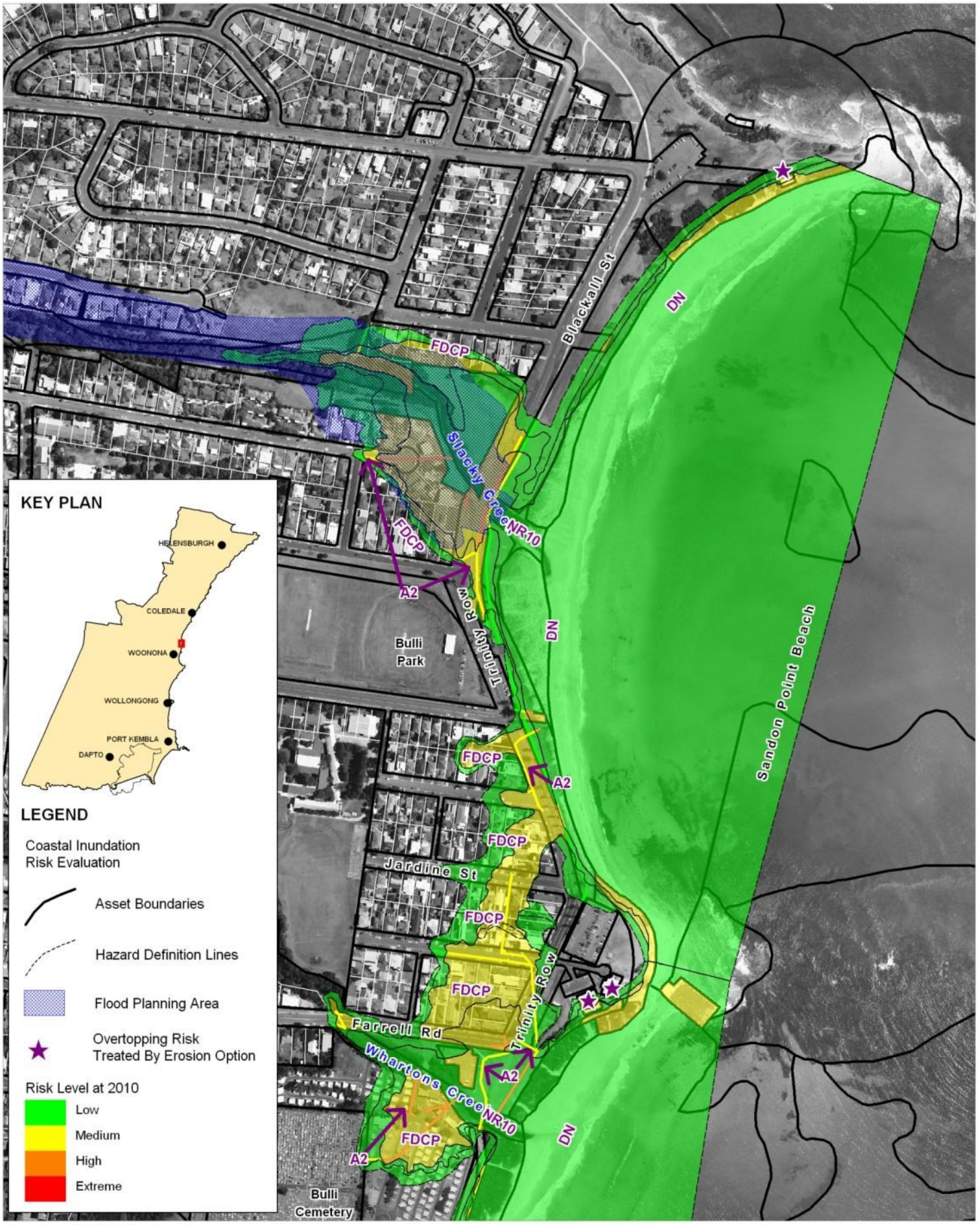
BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_109_1104127 Drawing 6-22.WOR

6.9.2 Coastal Inundation Risk Level and Treatment Options

Sandon Point Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Sandon Point Beach	Low	Low	Medium						✓
Sandon Point Beach Reserve (not including Sandon Point Heritage area)	Low	Low	Medium						✓
Slacky Creek	Medium	Medium	High					NR10, NR14	✓
Coastal Dune Systems (N end of beach)	Low	Low	Medium						✓
Community Infrastructure									
Sandon Point Surf Club	Medium	High	Extreme	✓		✓			
Heritate Site: Sandon Point (also under NPW Act)	Medium	Medium	High	✓					✓
Heritage Site: Sandon Point Boat Sheds	Medium	High	High	✓					✓
Northern Cycleway / Shared Pathway (Centre of Beach)	Medium	Medium	High			✓	✓	NR10	
Northern Cycleway / Shared Pathway (at S end of beach)	Medium	Medium	High	✓		✓			
Heritage Site: Norfolk Island Pines (S end of beach)	Low	Low	Medium						✓
Transport Infrastructure									
Local Roads: Blackall St adjacent to Slacky Creek)	Medium	High	Extreme			✓	✓	NR10, NR14	
Local Roads: Blackall St, Ursula St, Alroy St)	Medium	Medium	High	✓		✓	✓	NR10, NR14	
Water and sewage infrastructure									
Stormwater outlets and pipes (Centre of beach)	High	Extreme	Extreme			✓	✓	NR7, NR14	
Stormwater outlets and pipes (S end of beach)	High	Extreme	Extreme		✓	✓		NR7, NR14	
Residential Development									
Existing Residences (adjacent to Slacky Creek)	Medium	High	Extreme			✓	✓	NR10	
Existing Residences (S end off Blackall St)	Medium	Medium	High			✓	✓	NR10, NR9	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Sandon Point Beach

Drawing: 6-23

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_109_1104127 Drawing 6-23.WOR

6.9.3 Assessment of Treatment Options

Sandon Point

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Sandon Point Beach	Potential Funding Sources (Who may pay)	Conclusion
S1	Construct seawall (revetment) along specified alignment covering half of beach length	**Current Action:** Undertake concept design for entire length, plus approvals **Trigger:** implement progressively as erosion threatens cycleway	✓	✓	×								At this location, the erosion risk is higher at the south, progressively increasing towards the north over time. In this case, the proposed seawall could be built slowy in sections from south to north as the erosion impact occurs, managing the offsite impacts at the end of the wall progressively northwards also, ending at the creek mouth. The offsite impacts from the wall would require this full length to be implemented. This 600 m length of seawall would cost $ 3 - 6 million (based on estimate of $5,000 - $10,000 per m length of wall), not including management of offsite impacts and ongoing maintenance. Without nourishment the seawall would result in loss of the sandy beach amenity. The wall shall be designed to mitigate overtopping impacts also, and the wall can be progressively heightened over time as overtopping increases with sea level rise. However, this adds to costs of this option. Redesign of stormwater assets to accommodate inundation will be required even with a seawall, which must be included in costs. The wall would also protect residences that are currently at low risk behind the roadway and associated wastewater and water supply assets and which may add to the economic viability of this option.	**?** State Government (Grant Programs, Sydney water if assets are protected) ☑ Council (new levies or increased rates) ☑ Private landholders who directly benefit from option (personal investment or directed by Council)	Not Recommended
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								Dune care programs must be considerate of sightline requirements for SLSC activities. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This is an excellent option for retaining the beach, particularly along the northern half of the beach where public open space can be used to allow natural retreat of the beach, and hence continued provision of a beach over the long term (compared with seawall protection that would substantially reduce beach amenity in this location at a prohibitive financial cost to community). Retreat is also possible at the southern end of the beach provided assets are relocated or redesigned, and traffic redirected (refer PR2, A2). *Refer to Planned Retreat Options Table for further cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
PR2	Relocate cycleway and roadway outside of hazard zone	**Current Action:** NR6; NR5 **Trigger:** When erosion escarpment encroaches cycleway foundations OR when ZRFC from erosion escarpment encroaches upon Trinity Row.	✓	✓	×								The cycleway can be progressively relocated landward as erosion impacts occur, as an alternative to seawall protection. The ability to redirect traffic off Trinity Row will need to be confirmed through NR5. This option proposes allowing residential access only, and redirecting traffic along an alternate route. The current roadway would then be sacrificed to erosion, allowing the beach to naturally retreat, retaining the beach. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	**Recommended**
PR2	Relocate stormwater structures outside of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner.	✓	✓	×								For stormwater assets, the outcomes of NR7 shall determine where assets may be progressively relocated landward as impacts occur. This is most likely possible for the assets perpendicular to the beach, providing inundation aspects are also managed. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	**Recommended**
PR4	Voluntary acquisition	**Current Action:** Apply for government funding. **Trigger:** Offer once funding becomes available.	✓	✓	✓								This option is suggested for the four properties at the S end of the beach. The option is unlikely to be viable as there are typically insufficient government funds to apply this option to multiple properties. Voluntary acquisition would be offered at market rates. This includes discounting the rate substantially should the owners wait until erosion impacts occur before accepting the offer. This option enables the land to return to community ownership, ensuring a suitable use for the land in keeping with the erosion risk in the future, and allowing natural retreat of the beach. *Refer to Planned Retreat Options Table for further cost benefit details for PR4.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) ☒ Private landholders who directly benefit from option	**Marginal**
PR5	Buy back – lease back	**Current Action:** Apply for mortgage now **Trigger:** Offer acquisition once funding becomes available. Demolish property when erosion impacts destabilise building foundations.	✓	✓	✓								This option involves Council applying for funding through typical mortgage arrangements to acquire the four properties at the N end of the beach. The repurchase the property is offered voluntarily at market rates, then progressively discounted in accordance with the length of time remaining before the property becomes uninhabitable due to erosion, which Council will use to lease the property to assist mortgage repayments. This option, provides fair compensation to landowners and return of at risk land to public ownership to enable natural retreat of the beach. This option is as yet untested. *Refer to Planned Retreat Options Table for further cost benefit details for PR5.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) ☒ Private landholders who directly benefit from option	**Marginal**

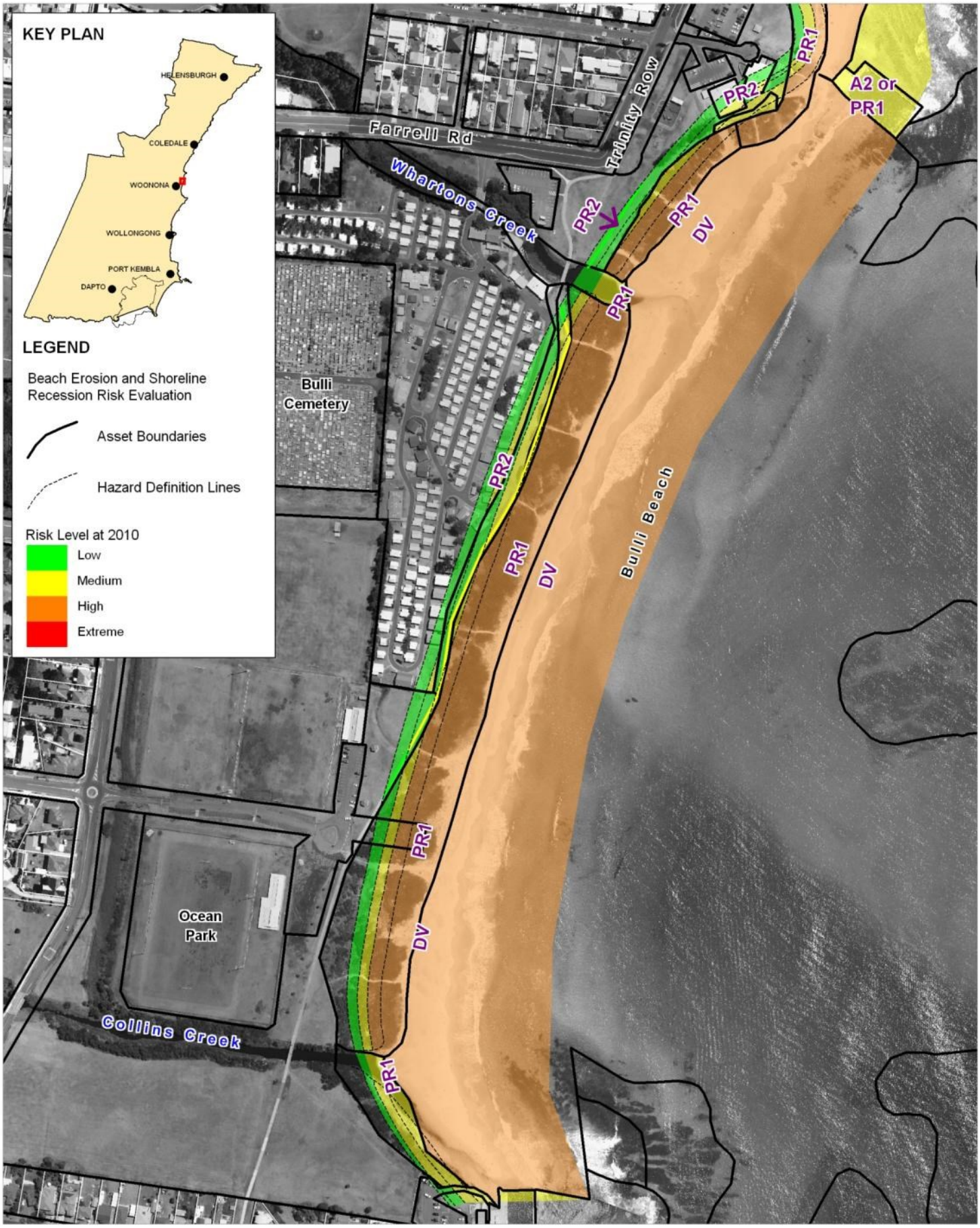
Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR5 Beach	Potential Funding Sources (Who may pay)	Conclusion
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	×								This option shall apply planning controls to 4 private propertys and some public assets currently in areas at risk, with less stringent controls applied to land at lower risk and / or land uses considered to have a shorter timeframe (design life), and vice versa. For the Sandon Point SLSC, a new development at the current site is already underway. Applying the DCP controls will ensure any future re-developments adequately consider alternative locations outside of the hazard zone. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs, increased rates and levies?) - cost to prepare DCP and implement at public assets ☑ Private landholders - cost to implement DCP	Recommended
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner	✓	✓	✓								Stormwater assets running parallel with Trinity Row may need to be redesigned in their current location particularly to enable conveyance of water with inundation. This option would be required in conjunction with S1 or PR options. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As property / assets redeveloped, new developments built	×	×	✓								This option involves applying the existing Flood DCP chapter to those areas identified at risk from coastal inundation outside of the existing flood planning area. This area is limited around Slacky Creek, with most properties already within the catchment flooding area. However, properties along Trinity Row are not currently within a flood planning area. The controls are applied at the "low flood risk" level, until A Flood Study at Whartons Creek is completed to provide better advice for flood planning (see NR10). *Refer to Accommodate Options Table for further cost benefit details for A2.*	*N/A* State Government (external funding unlikely to be needed) ☑ Council (Current Programs) ☑ Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								Particulalry at the S end of the beach, there are a number of private and public assets at risk. "Do nothing" is unacceptable, as there would be unacceptable disruption to the local community from the loss of those assets currently at risk. "Do Nothing" may limit management options considered in the future, as either land and assets at risk have increased making more costly options inevitable, or damaging impacts have already occurred, for example, irreversible erosion impacts. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR5, NR6, NR7, NR8, NR9, NR10, NR11, NR12, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.10 Bulli Beach

6.10.1 Erosion and Recession Risk Level and Treatment Options

Bulli Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Bulli Beach	High	Extreme	Extreme				✓✓		✓✓								NR14	
Bulli Beach Reserve	Medium	Medium	High						✓✓									
Ocean Park	Medium	Medium	High						✓✓									
Collins Park	Low	Medium	Medium						✓✓									
Whartons Creek	Medium	Medium	High						✓✓									
Collins Creek	Medium	High	Extreme						✓✓									
Coastal Dune Systems	High	Extreme	Extreme				✓		✓✓									
Waniora Point (Heritage site)	High	Extreme	Extreme						✓						✓✓		NR13	
Community Infrastructure																		
Bulli Surf Club	High	Extreme	Extreme							✓✓				✓	✓		NR3, NR14	
Bulli Kiosk and residence	Medium	Medium	High							✓✓				✓	✓		NR3, NR14	
Bulli Tourist Park (caravan park)	Medium	Medium	High							✓✓				✓				
Cycleway / Shared Pathway (extent between beach and tourist park)	Medium	High	Extreme							✓✓				✓			NR6, NR14	
Bulli Pool	Medium	High	Extreme						✓						✓		NR4, NR14	
Transport Infrastructure																		
Car parks (Bulli SLSC, Collins Pt reserve)	Low	Low	Medium							✓✓				✓				✓
Water and sewage infrastructure																		
Stormwater outlets and pipes	Low	Medium	High							✓				✓	✓		NR7	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Bulli Beach

Drawing: 6-24

Rev: A

N

0 75 150m

Approx. Scale

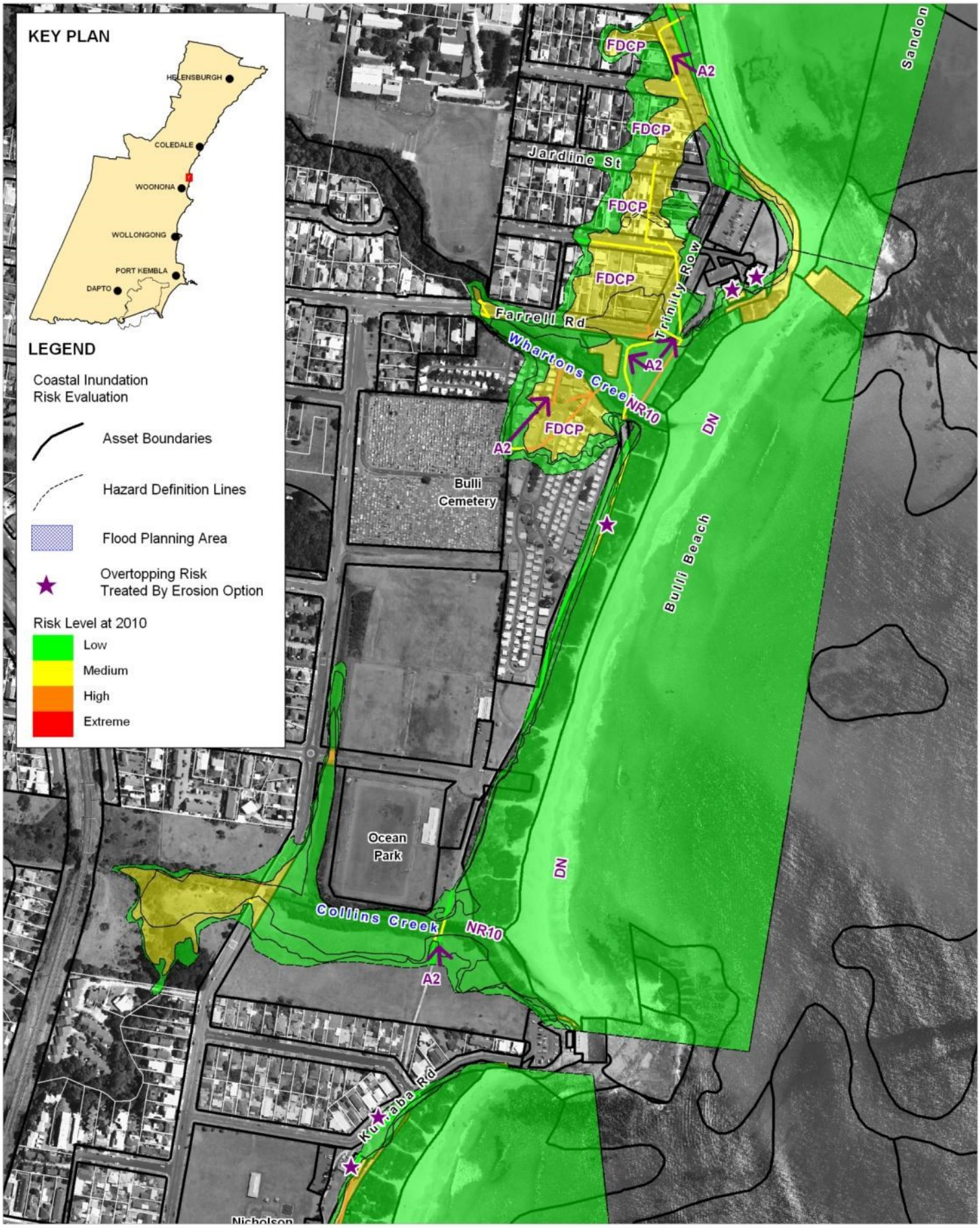
BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_110_110427 Drawing 6-24.WOR

6.10.2 Coastal Inundation Risk Level and Treatment Options

Bulli Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Bulli Beach	Low	Low	Medium						✓
Bulli Beach Reserve	Low	Low	Medium						✓
Ocean Park	Low	Medium	Medium						✓
Collins Park	Low	Low	Medium						✓
Whartons Creek	Low	Medium	Medium					NR10, NR14	
Collins Creek	Medium	Medium	High					NR10, NR14	
Coastal Dune Systems	Low	Low	Medium						✓
Waniora Point (Heritage site)	Medium	High	High	✓					
Community Infrastructure									
Bulli Surf Club	Medium	High	Extreme	✓					
Bulli Kiosk and residence	Low	Medium	Medium	✓					
Bulli Tourist Park (caravan park)	Medium	Medium	High			✓	✓		
Cycleway / Shared Pathway	Low	Medium	Medium	✓					
Bulli Pool	Medium	Medium	High	✓					
Heritage Site: Bulli Cemetary	Low	Medium	Medium						✓
Transport Infrastructure									
Car parks (Bulli SLSC, Collins Pt reserve)	Low	Low	Medium						✓
Local Roads (Farrell Rd, Trinity Row, Jardine St, Godolphin St affected by Whartons Ck)	Medium	High	Extreme			✓	✓	NR10, NR9, NR14	
Local Roads (Carrington St, Campbells St, affected by Collins Ck)	Medium	Medium	High			✓	✓	NR10, NR14	
Water and sewage infrastructure									
Stormwater outlets and pipes	High	Extreme	Extreme			✓	✓	NR7, NR10	
Residential Development									
Existing Residences (adjacent to Whartons creek & Stormwater System)	Medium	High	Extreme			✓	✓	NR10, NR9	
Institutional Infrastructure									
Bulli High School	Low	Medium	Medium			✓		NR10	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Bulli Beach

Drawing: 6-25

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_110_1104127 Drawing 6-25.WOR

6.10.3 Assessment of Treatment Options

Bulli

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Bulli Beach	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								Dune care programs must be considerate of sightline requirements for SLSC activities. This is particularly important at Bulli as existing dune vegetation in front of surf club already impedes sight to patrol area. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	**Recommended**
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This is an excellent option for retaining Bulli Beach, by utilising public open space and dunes to enable natural retreat of the beach, and hence continued provision of a beach over the long term. Based on NR4, if it is found that Bulli Pool cannot be progressively repaired to withstand wave and sea level rise impacts into the future, the pool will need to be slowly removed as it fails over time. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	**Recommended**
PR2	Relocate structures outside of hazard zone: Surf club and kiosk; tourist park cabins; cycleway	**Current Action:** NR3, NR6 **Trigger:** At scheduled time for asset maintenance OR when ZRFC measured from erosion escarpment encroaches onto building foundations, cabins or cycleway, whichever is sooner	✓	✓	×								Relocation of the surf club and kiosk structures would provide a new club facility for community and the SLSC. There is likely to be sufficient space nearby to relocate these structures, however this shall be based on NR3. If timed with asset maintenance this may reduce costs as they are combined with expected major maintenance costs. Tourist cabins are typically low key structures that will be easily relocatable. There is likely to be an alternative location to relocate the cycleway landward of the hazard zone. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	**Recommended**
PR2	Relocate stormwater assets landward of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR the pipe requires replacement, whichever is sooner.	✓	✓	×								The stormwater asset is likely to be able to be relocated, but this should depend on outcomes of NR7 and in combination with outcomes for the extended network affected by inundation (see also A2). *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	**Recommended**
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	×								Public assets at risk including the SLSC, kiosk, caravan park, cycleway and stormwater assets shall be subject to Coastal DCP Controls. The DCP will ensure that future upgrades/redevelopment involve assessments to determine whether the asset shall to be relocated (e.g. PR2) or redesigned to withstand impacts at the current location (A2 or A3). *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare and implement DCP *N/A* Private landholders	**Recommended**

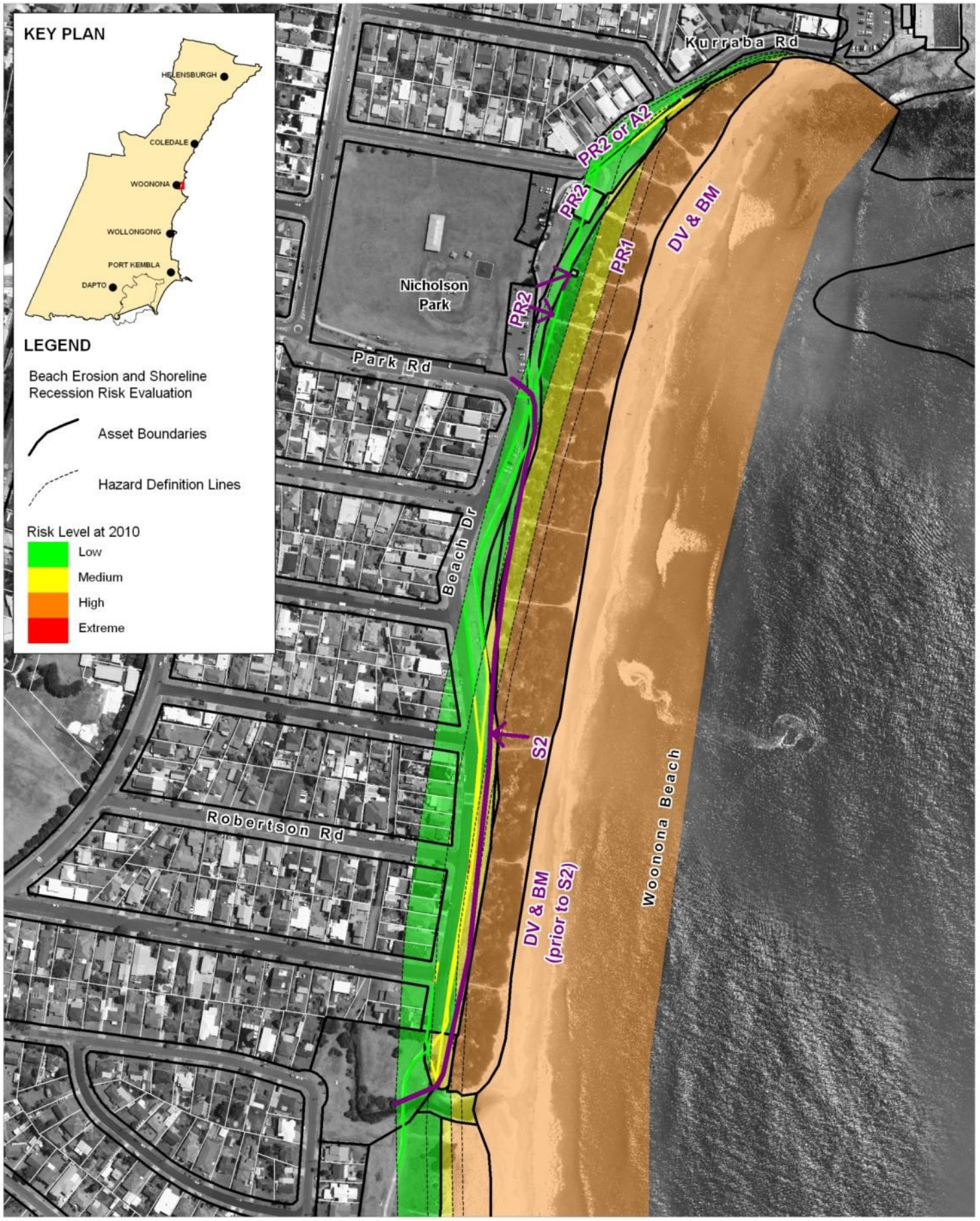
Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for DCP Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit surf club and kiosk structures in current location to withstand impacts.	**Current Action:** NR3 **Trigger:** At scheduled time for asset maintenance OR when ZRFC measured from erosion escarpment encroaches onto building foundations, whichever is sooner	✓	✓	N/A								Based on the outcomes of NR3, if alternative locations are not available for replacement structures, and there is foundation capacity and other controls for erosion and wave impacts can be affordably built, then the structures could be redeveloped or retrofit at the current location. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Marginal
A2	Redesign or retrofit stormwater structures and cycleway in current location to withstand impacts.	**Current Action:** NR7 **Trigger:** When inundation regularly impedes conveyance of stormwater OR when asset replacement is required, whichever is sooner	✓	✓	✓								There is a significant extent of stormwater pipes and structures that may be affected by coastal inundation that will require redesign to convey stormwater as effectively as possible with sea level rise. Designs shall be based on outcomes of NR7. *Refer to Accommodate Options Table for further cost benefit details for A2*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
A2	Retrofit Bulli Pool in current location to withstand impacts.	**Current Action:** NR4 **Trigger:** When damage to pool shell occurs OR the pool is being inundated at water levels lower than MSL.	✓	✓	N/A								The decision to progressively retrofit Bulli Pool over time to withstand wave impacts and remain a viable pool with sea level rise shall depend upon the suitability of pool condition for this purpose, based upon NR4. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As property / assets redeveloped, new developments built	×	×	✓								This option involves applying the existing Flood DCP chapter to those areas identified at risk from coastal inundation outside of an existing flood planning area at the "low flood risk" level, until a proper flood modelling study is conducted (refer NR10 for Whartons and Collins Ck). A flood study should be completed at Whartons Creek as a priority (see NR10), as many houses may be affected. *Refer to Accommodate Options Table for further cost benefit details for FDCP.*	*N/A* State Government (external funding unlikely to be needed) ☑ Council (Current Programs) ☑ Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								There are a number of private and public properties at high risk from erosion, overtopping and or backwater inundation at Bulli. "Do Nothing" is likely to be unacceptable due to damage causing increased social, environmental and financial costs over time, borne by future generations. "Do Nothing" may limit management options considered in the future, as either land and assets at risk have increased making more costly options inevitable, or irreversible erosion impacts have already occurred. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR3, NR4, NR6, NR7, NR9, NR10, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.11 Woonona Beach

6.11.1 Erosion and Recession Risk Level and Treatment Options

Woonona Beach (beach extends to creek at centre of beach)	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments															
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Woonona Beach	High	Extreme	Extreme				✓	✓	✓✓								NR14	
Collins Point Reserve, Woonona Beach Reserve, Beach Drive Park	Medium	Medium	High						✓✓									
Creek at Lighthorse Drive and adjacent habitat	Medium	Medium	High						✓✓								NR11	
Coastal Dune Systems	High	Extreme	Extreme				✓		✓✓									
Community Infrastructure																		
Woonona Surf Club	Low	Medium	High							✓✓				✓			NR3	
Lifeguard Tower	Low	Low	Medium							✓✓								✓
Woonona Ocean Pool (Collins Pt)	Medium	High	Extreme						✓						✓		NR4, NR14	
Cycleway / Shared Pathway	Medium	Medium	High			✓				✓✓				✓			NR6, NR14	
Transport Infrastructure																		
Beach access and car parks	Low	Low	Medium						✓✓									✓
Local Roads (Kurraba Rd)	Medium	Medium	High							✓				✓	✓		NR5, NR8, NR14	
Local Roads (Beach Drive, Liamina Ave, Robertson Rd, Dorrigo Ave)	Medium	Medium	High			✓				✓				✓			NR5, NR8, NR14	
Water and sewage infrastructure																		
Stormwater outlets and pipes (N end at Kurraba Rd)	High	Extreme	Extreme							✓				✓	✓		NR7, NR14	
Stormwater outlets and pipes (connecting line from Kurraba Rd to Beach Drive along beachfront)	High	Extreme	Extreme							✓				✓			NR7, NR14	
Stormwater outlets and pipes (along seaward edge of Beach Drive)	High	Extreme	Extreme			✓				✓				✓			NR7, NR14	
Residential Development																		
Existing Residences (19 at centre of beach)	Medium	Medium	High			✓			✓			?	?	✓			NR8, NR14	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Woonona Beach - Seawall S2 Option

Drawing: 6-26

Rev: A

N

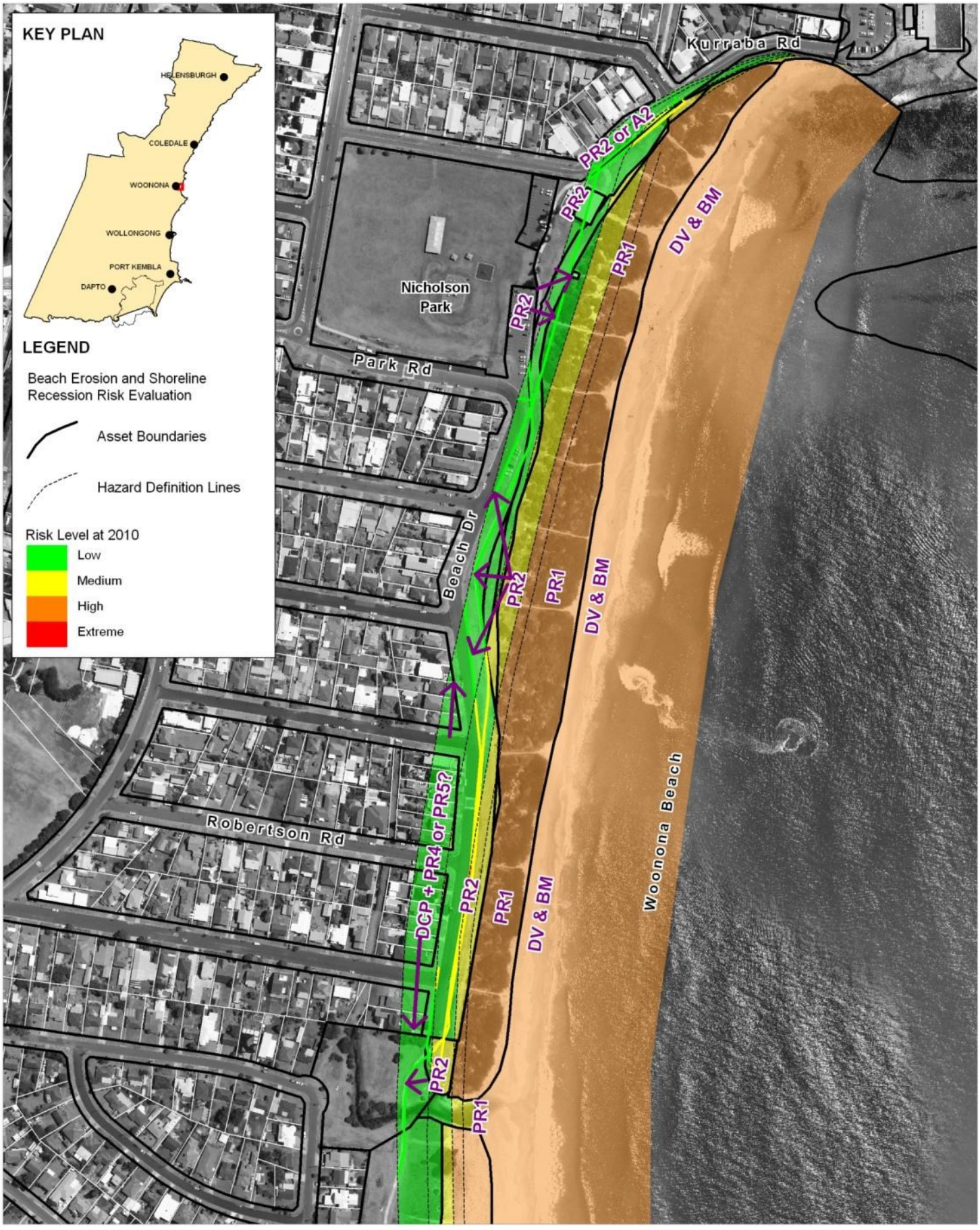
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_111_110427 Drawing 6-26.WOR



Title:

Immediate Erosion Risk Levels and Treatment Options
Woonona Beach - Planned Retreat Option

Drawing: 6-27

Rev: A

N

0 75 150m

Approx. Scale

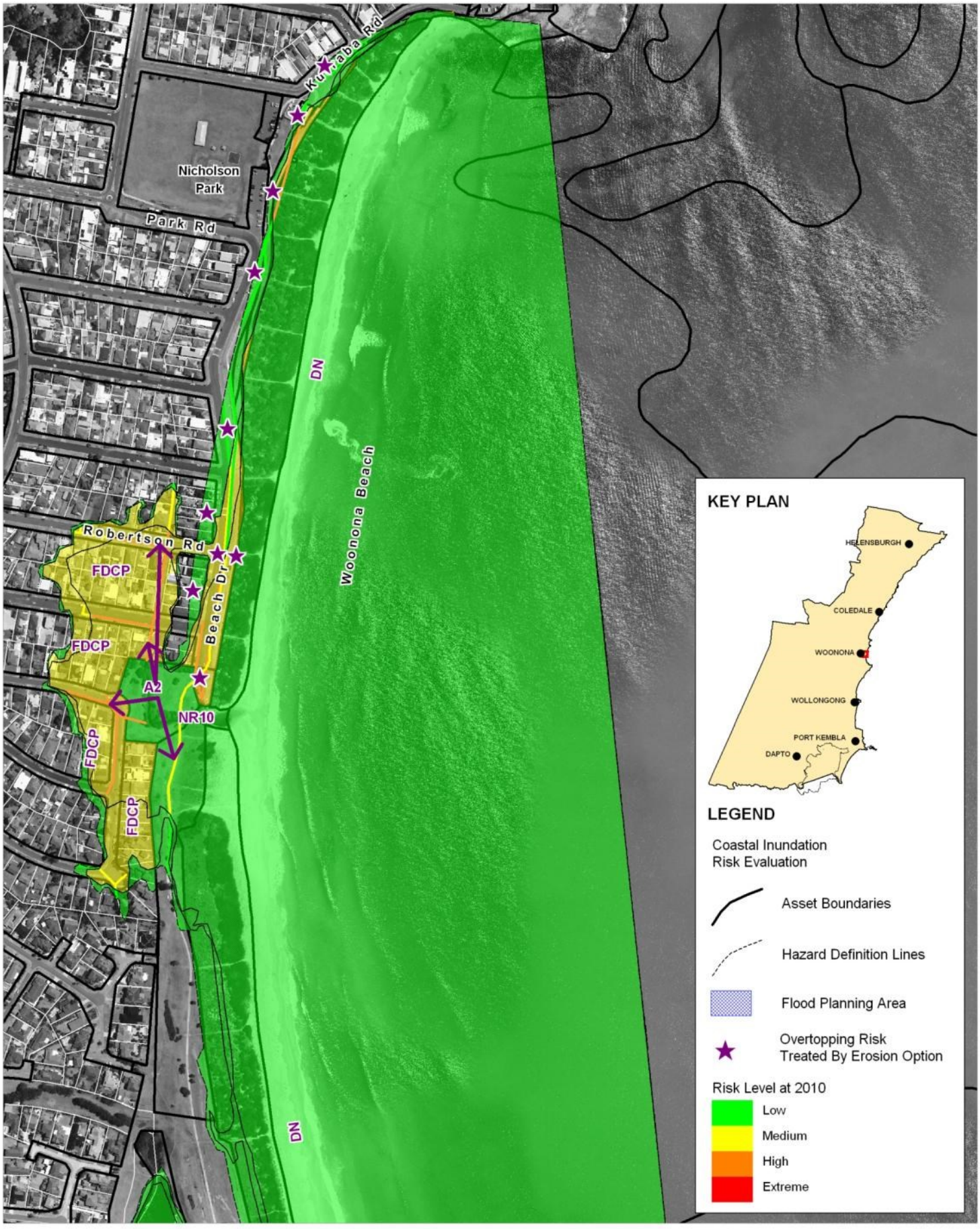
BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_111_110427 Drawing 6-27.WOR

6.11.2 Coastal Inundation Risk Level and Treatment Options

Woonona Beach (beach extends to creek at centre of beach)	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Woonona Beach	Low	Low	Medium						✓
Collins Point Reserve, Woonona Beach Reserve, Beach Drive Park	Low	Low	Medium						✓
Creek at Lighthorse Drive and adjacent habitat	Low	Low	Medium					NR10, NR14	✓
Coastal Dune Systems	Low	Low	Medium						✓
Community Infrastructure									
Woonona Surf Club	Medium	High	Extreme	✓		✓			
Lifeguard Tower	Low	Low	Medium			✓			✓
Woonona Ocean Pool (Collins Pt)	Low	Low	Medium	✓					
Cycleway / Shared Pathway	Low	Medium	Medium	✓		✓			✓
Transport Infrastructure									
Local Roads (Kurraba Rd)	Low	Medium	Medium	✓					
Local Roads (Beach Drive, Robertson Rd, Dorrigo Ave, Lighthorse Drive, Lassifer Ave, Pendlebury Pde)	Medium	High	Extreme	✓		✓		NR10, NR14	✓
Water and sewage infrastructure									
Stormwater outlets and pipes	High	Extreme	Extreme	✓		✓	✓	NR7, NR14	
Residential Development									
Existing Residences (19 at centre of beach)	Low	Medium	Medium	✓		✓			
Existing Residences (80 along creek & stormwater alignments, centre of beach)	Medium	High	Extreme			✓	✓	NR10, NR9	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Woonona Beach

Drawing: 6-28

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_111_1104127 Drawing 6-28.WOR

6.11.3 Assessment of Treatment Options

Woonona

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability***	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Woonona Beach	Potential Funding Sources (Who may pay)	Conclusion (provisional)
S2	Construct seawall (revetment) along specified alignment to protect specific asset(s)	**Current Action:** Detailed design and approvals **Trigger:** When ZRFC measured from erosion escarpment encroaches onto Beach Drive	✓	✓	×								A section of seawall is essentially proposed to protect the 18 residences along Beach Drive. If this is to be conducted, the roadway, underlying stormwater assets and potentially water supply and waste water assets are also needed to service the properties, and so must be protected by the seawall also, with the seawall installed on public land. Where seawalls shall protect private property, Council and State Government can require sections of wall protecting private property (and ongoing maintenance) to be funded by the private property owners. Given the natural beach shall be retained either side, the seawall could be constructed without large scale nourishment (except to manage offsite impacts). The erosion and recession risk is current, requiring a decision regarding S2 to be made presently. Based upon $5,000 - $10,000 per m length of wall, the proposed section of wall at Woonona Beach is estimated to cost $3 - $6 million, not including the costs of ongoing management of offsite impacts (e.g.small scale nourishment) and future upgrading. *Refer to Protect Options Table for further cost benefit details for S2.*	**?** State Government (Grant Programs) - unlikely to fund private property protection. May assist funding to protect water supply and waste water assets. ☑ Council (new levies or increased rates) ☑ Private landholders who directly benefit from option (personal investment or directed by Council)	**Marginal**
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								Dune care programs must be considerate of sightline requirements for SLSC activities, and beach amenity issues relating to prolific vegetation growth. Implementation of a dune care strategy enables Council to also manage prolific growth of plant species, and would not involve adding more vegetation to already well vegetated beaches but instead, ensuring weeds and vermin are not an issue on such beaches. Issues relating to growth of *Acacia sophorae* across incipient dunes are reported at Woonona, which limits beach usage at high tide. This is a short term (5 - 10 year) issue, as this area of the beach is the first to be impacted during storms. While there are community issues associated with this and height of dunes, the dunes are required as relatively cheap means of retaining beach sand to buffer from storm erosion. Over the long term, the incipient dunes and *Acacia sophorae* will become less common as the beach is impacted by storms and the dune is eroded periodically. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	**Recommended**
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	×								This option involves scraping and contouring beach sands to accumulate in dunes along the beach. This aims to increase sand volumes held in dune storage for storm protection. *Refer to Protect Options Table for further cost benefit details for BM.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	**Recommended**

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for BM Beach	Potential Funding Sources (Who may pay)	Conclusion
PR1	Accept loss of land following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	✗								This is an excellent option for retaining the beach by allowing natural retreat of dunes and reserve lands enabling continued provision of a beach over the long term. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss of Pool following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	✗								Woonona Pool is said to have higher walls and so is likely to withstand sea level rise impacts for longer. It is unlikely that the Pool will be managed to fail at this time, however this will depend upon assessment of its condition through NR4. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Marginal
PR2	Relocate structures outside of hazard zone: Surf club (and minor carparks)	**Current Action:** NR3 **Trigger:** At scheduled time for asset maintenance OR when ZRFC measured from erosion escarpment encroaches onto building foundations or cabins, whichever is sooner	✓	✓	✗								Relocation of the surf club would provide a new club facility for community and the SLSC. There is likely to be sufficient space nearby to relocate these structures, however this shall be based on NR3. If timed with scheduled major asset refurbishment, this may reduce costs as they are combined with expected major maintenance costs. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate stormwater assets landward of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR the pipe requires replacement, whichever is sooner.	✓	✓	✗								For stormwater assets, the outcomes of NR7 shall determine where assets may be progressively relocated landward as impacts occur. This is most likely possible for the assets perpendicular to the beach, providing inundation aspects are also managed. There is a significant extent of stormwater assets running parallel to the beach. This may make it a very costly exercise to relocate these assets, however this may be less than the cost of a seawall. Further, regardless of implementing S2, the assets must be redesign to accommodate inundation with sea level rise. This would need to be included in analysis of the benefit of a seawall (S2) or redesign of these assets to withstand impacts (see A2 and NR7). *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate Beach Drive, Kurraba Rd and cycleway landward of hazard zone	**Current Action:** NR5, NR6 **Trigger:** When ZRFC measured from erosion escarpment encroaches onto the cycleway and roadway.	✓	✓	✗								This option shall relocate Beach Drive, the cycleway and Kurraba Rd further landward when erosion impacts become imminent. At Kurraba Rd. This option is an alternative to S2 for the cycleway and Beach Drive. For Kurraba Road and Beach Drive, access to residential properties must be retained. The ability to redirect traffic on these roads will depend upon NR5. Relocating the cycleway is likely to be suitable and affordable, and could be conducted in sections as impacts manifest. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
PR4	Voluntary acquisition	**Current Action:** Apply for government funding. **Trigger:** Offer once funding becomes available.	✓	✓	✓								This option is not financially possible for multiple properties without substantial government assistance, which is not currently available. Given that impacts are not expected until 2050, it may be possible to flag this option now, with an assumption that government funding may change in the future. DCP controls until that time would limit intensification of risk until that time. Current funding mechanisms from State Government and Council are not sufficient to acquire multiple properties. *Refer to Planned Retreat Options Table for further cost benefit details for PR4.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) ☒ Private landholders who directly benefit from option	**Marginal**
PR5	Buy back – lease back	**Current Action:** Apply for mortgage now **Trigger:** Offer acquisition once funding becomes available. Demolish property when erosion impacts destabilise building foundations.	✓	✓	✓								This option involves Council applying for funding through typical mortgage arrangements to acquire 18 properties at the centre of the beach. The repurchase the property is offered voluntarily at market rates, but the rate is progressively discounted in accordance with the length of time remaining before the property becomes uninhabitable due to erosion. This is because this option is dependent upon Council leasing the property at market rates to assist mortgage repayments until the time the building is uninhabitable. At that time the property is demolished and land returned to community for natural beach retreat. The option provides fair compensation to landowners and ensures natural retreat to retain beach use values. This option is as yet untested. *Refer to Planned Retreat Options Table for further cost benefit details for PR5.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) ☒ Private landholders who directly benefit from option	**Marginal**
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	×								This option applies controls to redevelopment of existing 18 properties and public assets currently in areas at risk. Controls are applied such that less stringent controls apply to land at lower risk and / or land uses considered to have a shorter timeframe (design life), and vice versa. The DCP may require assessment of foundation capacity (bedrock), alternative locations, distance to erosion escparments, etc as relevant to the level of risk, to determine design controls for assets to remain in their current location (e.g. A2, A3) or require relocation of developments landward of hazard zones (e.g. PR2). Wave overtopping is also managed by the Coastal DCP, as existing Flood DCP controls may not be applicable to the overtopping risk. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement at public assets ☑ Private landholders - cost to implement DCP	**Recommended**

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for DCP Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign Kurraba Rd in current location to withstand impacts.	**Current Action:** NR5 **Trigger:** When ZRFC measured from erosion escarpment encroaches onto the roadway.	✓	✓	×								Based on the outcomes of NR5, if access to residential properties cannot be maintained on Kurraba Rd, methods to accommodate impacts at the current roadway may need to be investigated. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Marginal
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner;	✓	✓	✓								Ensuring function of stormwater assets with inundation due to sea level rise will be required regardless of whether S2 is or is not implemented. Particularly for stormwater assets surrouding Lighthorse Drive Creek, these services cannot be relocated and will require redesign at the current location to withstand inundation impacts. This shall need to be confirmed based on outcomes of NR7. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
A2	Retrofit Woonona Pool in current location to withstand impacts.	**Current Action:** NR4 **Trigger:** When damage to pool shell occurs OR the pool is being inundated at water levels lower than MSL.	✓	✓	×								The decision to progressively retrofit Woonona Pool over time to withstand wave impacts and remain a viable pool with sea level rise shall depend upon the suitability of pool condition for this purpose, based upon NR4. It is likely Woonona Pool is more suitable to being maintained as the pool walls are already higher, buffering from sea level rise. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As property / assets redeveloped, new developments built	×	×	✓								This option involves applying the existing Flood DCP chapter to all properties identified at risk from coastal inundation that are outside of an existing flood planning area applied at the "low flood risk". A Flood Study should be completed for the Creek at Lighthorse Driveas a priority, as many houses may be affected (refer NR10). *Refer to Accommodate Options Table for further cost benefit details for FDCP.*	*N/A* State Government (external funding unlikely to be needed) ☑ Council (Current Programs) ☑ Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								The "do nothing" scenario is not acceptable at this location as there are a large number of assets at risk currently. Failure to take action will either result in irreversible or very costly erosion impacts. Where development is intensified in the high risk zones this increases the cost to manage risks in the future also. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR3, NR4, NR5, NR6, NR7, NR8, NR9, NR10, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.12 Bellambi Beach, Boat Harbour, Bellambi Point Beach

6.12.1 Erosion and Recession Risk Level and Treatment Options – Bellambi Beach & Bellambi Boat Harbour

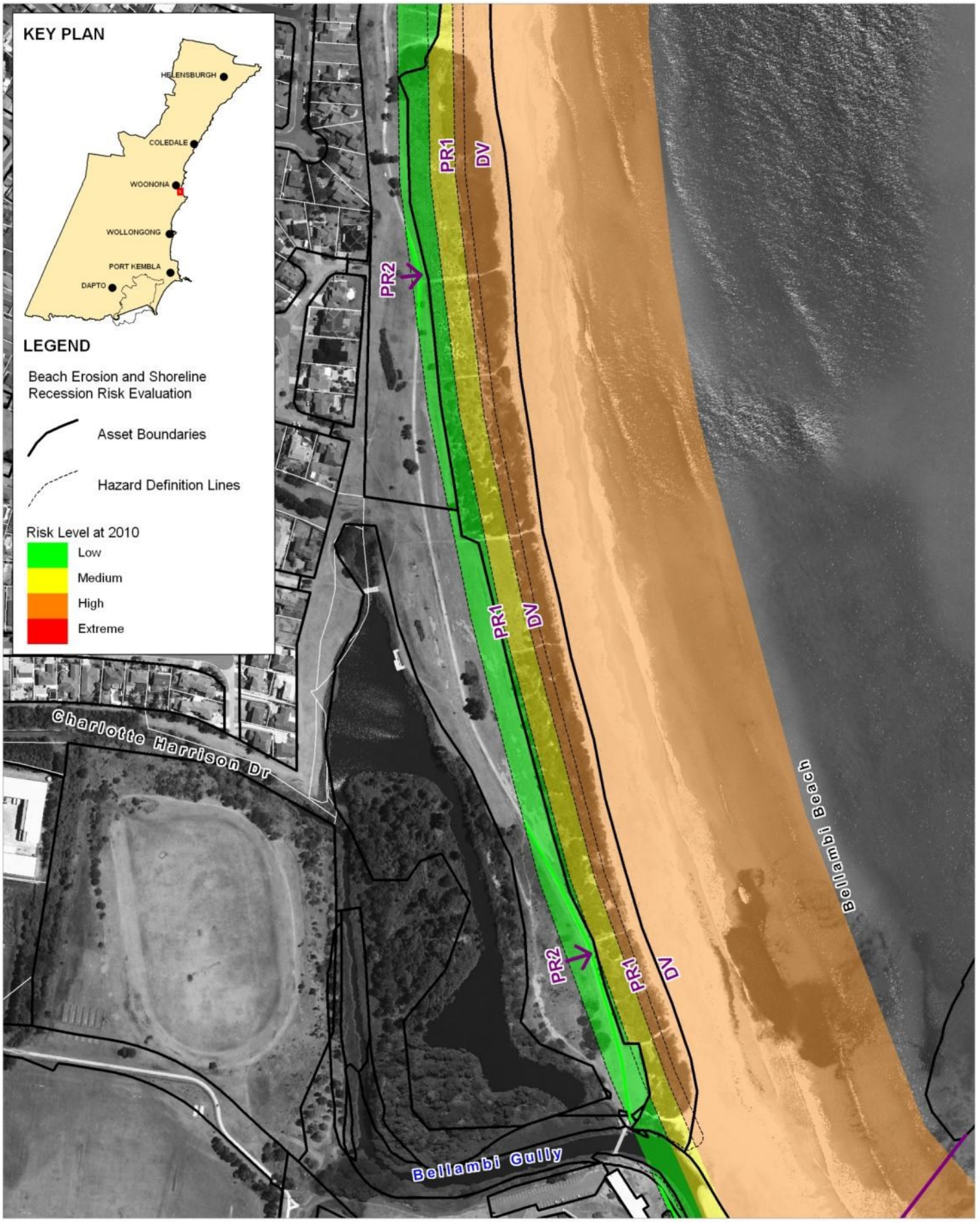
Bellambi Beach (Bellambi Pt in next table)	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Bellambi Beach	High	Extreme	Extreme				✓✓		✓✓								NR14	
Beach Drive Park, Bellambi Natural Area, Bellambi Point Reserve, Bellambi Pool Reserve	Medium	Medium	High						✓✓									
Coastal Dune Systems	High	Extreme	Extreme				✓✓		✓✓								NR11	
Bellambi Gully and adjacent habitat	Medium	High	Extreme						✓								NR11	
Bellambi Gully training walls	Low	Medium	High											✓	✓		NR2	
Community Infrastructure																		
Cycleway / Shared Pathway (N of Bellambi Gully entrance)	Low	Medium	Medium							✓✓				✓				
Cycleway / Shared Pathway (S of Bellambi Gully entrance)	Medium	Medium	High			✓								✓			NR2, NR6, NR14	
Bellambi Pool	High	Extreme	Extreme						✓						✓		NR2, NR4, NR14	
Bellambi Pool Toilet Block	Low	Medium	Medium			✓				✓				✓			NR2	✓
Transport Infrastructure																		
Bellambi Pool car park	Low	Medium	Medium			✓			✓					✓			NR2	✓
Bellambi Boat Harbour	High	Extreme	Extreme												✓		NR2, NR14	
Local access road along coastline to harbour (does not service houses)	Medium	High	Extreme							✓				✓			NR2, NR5	
Water and sewage infrastructure																		
Stormwater outlets and pipes (adjacent to Bellambi Pool carpark)	High	Extreme	Extreme							✓				✓			NR2, NR7, NR14	
Sewage Treatment Plant	High	Extreme	Extreme							✓				✓			NR2, NR8	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time

6.12.2 Erosion and Recession Risk Level and Treatment Options – Bellambi Point Beach

Bellambi Point Beach (Bellambi Point to Bellambi Lagoon)	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Bellambi Point Beach	High	Extreme	Extreme				✓✓		✓✓								NR14	
Coastal Dune Systems	High	Extreme	Extreme				✓✓		✓✓									
Heritage Site: Bellambi Lagoon and associated habitat	High	Extreme	Extreme						✓✓								NR11	
Community Infrastructure																		
Heritage Sites: Bellambi (Sandpit) Point	High	Extreme	Extreme			?	✓✓		✓✓								NR2	
Water and sewage infrastructure																		
Stormwater outlets and pipes (adjacent to STP)	High	Extreme	Extreme			✓				✓✓				✓			NR2, NR7, NR14	
Sewage Treatment Plant	High	Extreme	Extreme			✓				✓✓				✓			NR2, NR8, NR14	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Bellambi Beach

Drawing: 6-29

Rev: A

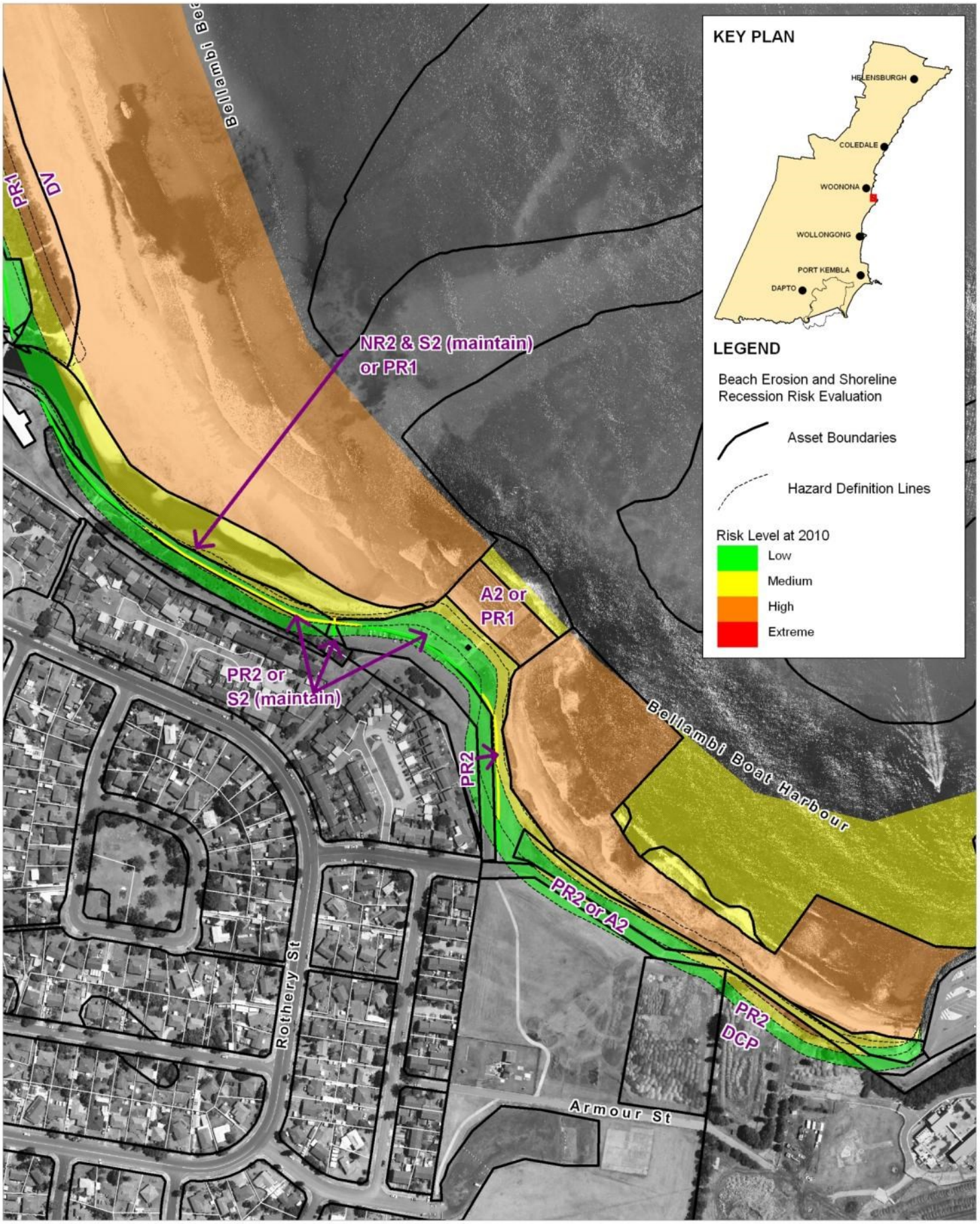
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_112_110428 Drawing 6-29.WOR



Title:

Immediate Erosion Risk Levels and Treatment Options Bellambi Boat Harbour

Drawing: 6-30

Rev: A

N

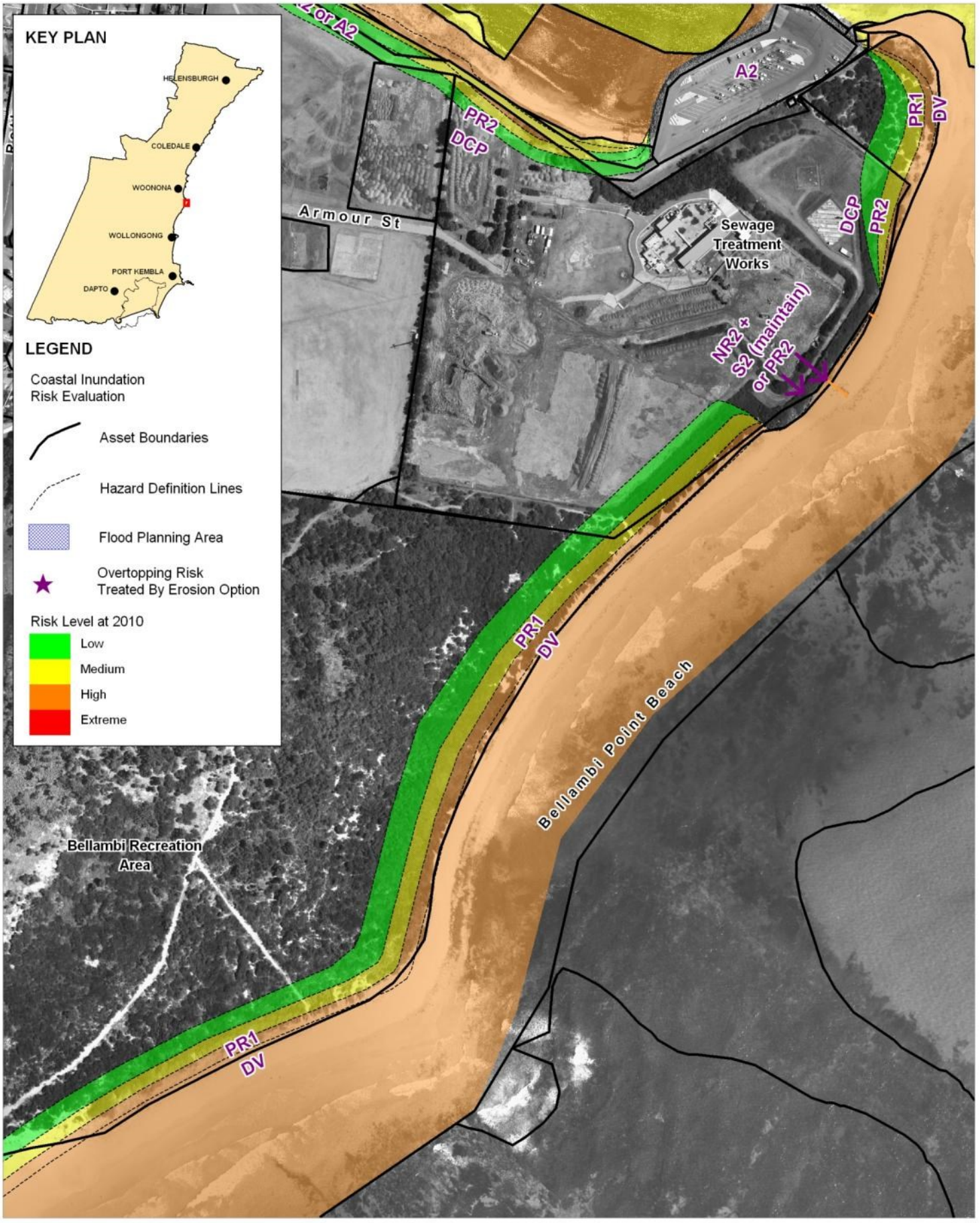
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_113_110428 Drawing 6-30.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Bellambi Point Beach

Drawing: 6-31

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_114_110428 Drawing 6-31.WOR

6.12.3 Coastal Inundation Risk Level and Treatment Options – Bellambi Beach & Bellambi Boat Harbour

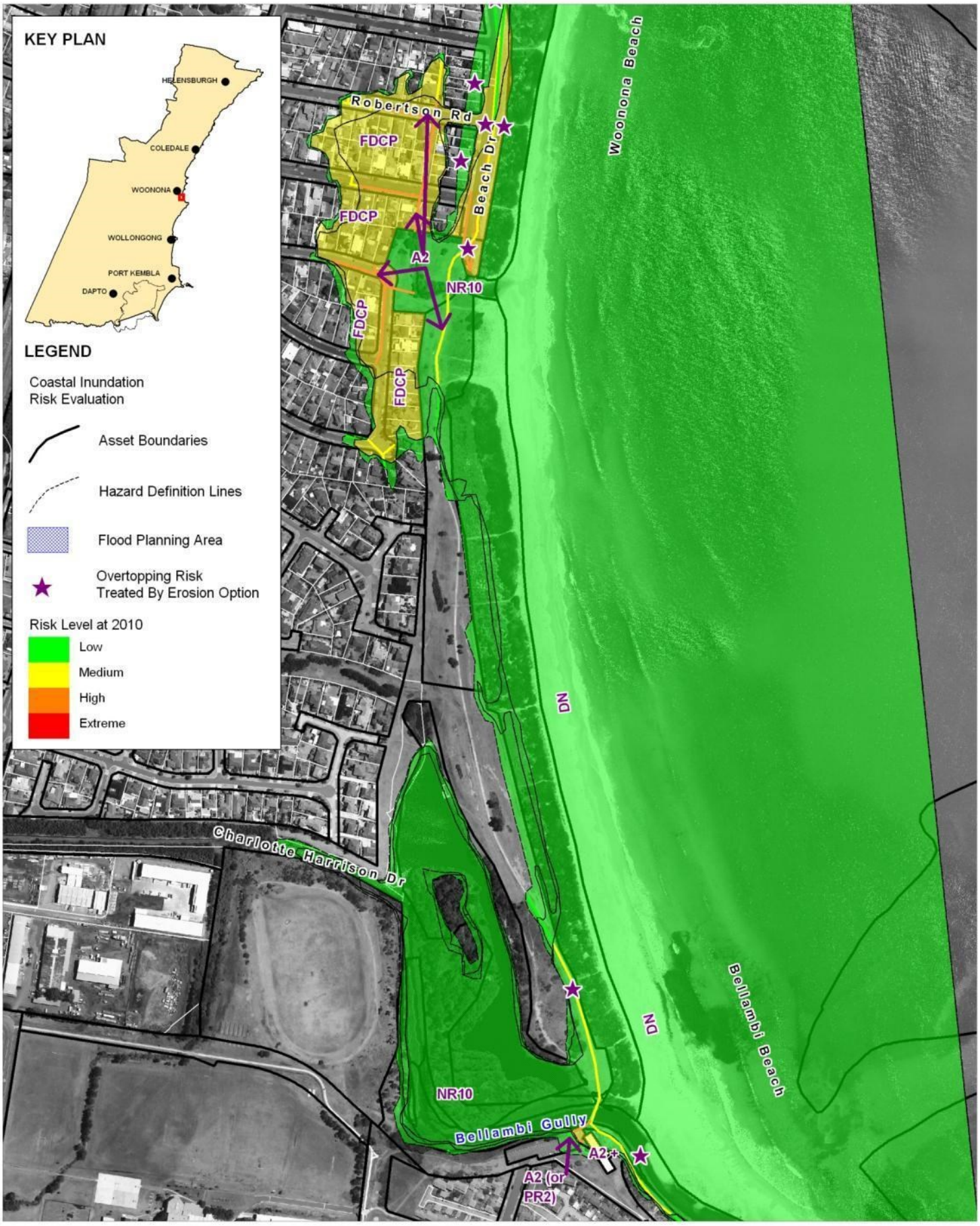
Bellambi Beach (Bellambi Pt in next table)	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Bellambi Beach	Low	Low	Medium						✓
Beach Drive Park, Bellambi natural Area, Bellambi Point Reserve, Bellambi Pool Reserve	Low	Low	Medium						✓
Bellambi Gully and adjacent habitat	Medium	High	Extreme					NR10, NR14	✓
Coastal Dune Systems	Low	Low	Medium						✓
Community Infrastructure									
Bellambi SLSC	Medium	High	Extreme			✓	✓✓	NR14	
Cycleway / Shared Pathway (N of Bellambi Gully entrance)	Medium	Medium	High	✓					
Cycleway / Shared Pathway (S of Bellambi Gully entrance)	Medium	Medium	High	✓					
Bellambi Pool	Medium	Medium	High	✓					
Bellambi Pool Toilet Block	Low	Low	Medium						✓
Transport Infrastructure									
Bellambi SLSC car park	Low	Medium	Medium			✓	✓✓		
Bellambi Pool car park	Low	Low	Medium	✓					✓
Bellambi Boat Harbour	Medium	Medium	High	✓					
Local access road along coastline to harbour (does not service houses)	Medium	Medium	High	✓					
Water and sewage infrastructure									
Stormwater outlets and pipes under Bellambi SLSC carpark	High	Extreme	Extreme		✓	✓	✓✓	NR7, NR14	
Stormwater outlets and pipes (adjacent to Bellambi Pool carpark)	High	Extreme	Extreme	✓				NR14	
Sewage Treatment Plant	High	Extreme	Extreme	✓				NR8	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time

6.12.4 Coastal Inundation Risk Level and Treatment Options – Bellambi Point Beach

Bellambi Point Beach (Bellambi Point to Bellambi Lagoon)	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Bellambi Point Beach	Low	Low	Medium						✓
Coastal Dune Systems	Low	Low	Medium						✓
Heritage Site: Bellambi Lagoon (Lake) and associated habitat	Medium	High	Extreme					NR10, NR14	✓
Bellambi Point Reserve, Happy Valley Reserve, Bellambi Lagoon Recreation Area	Low	Low	Medium						✓
Community Infrastructure									
Heritage Sites: Bellambi (Sandpit) Point	Medium	High	Extreme	✓					✓
Cycleway / Shared Pathway (W of Bellambi Lagoon, along Dobbie & Murray Ave)	Medium	Medium	High			✓✓	✓	NR14	
Transport Infrastructure									
Local roads (Dobbie Ave)	Medium	High	Extreme			✓✓		NR14	✓
Local car park at Lagoon entrance (off Murray Rd)	Medium	High	Extreme			✓✓		NR14	✓
Water and sewage infrastructure									
Stormwater outlets and pipes (adjacent to STP)	High	Extreme	Extreme	✓					
Stormwater outlets and pipes (flowing into Lagoon)	High	Extreme	Extreme			✓	✓✓	NR7, NR14	
Sewage Treatment Plant	High	Extreme	Extreme	✓					
Residential Development									
Existing Residences (10 adjacent to Bellambi Lagoon)	Medium	Medium	High			✓✓	✓	NR10	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Bellambi Beach

Drawing: 6-32

Rev: A

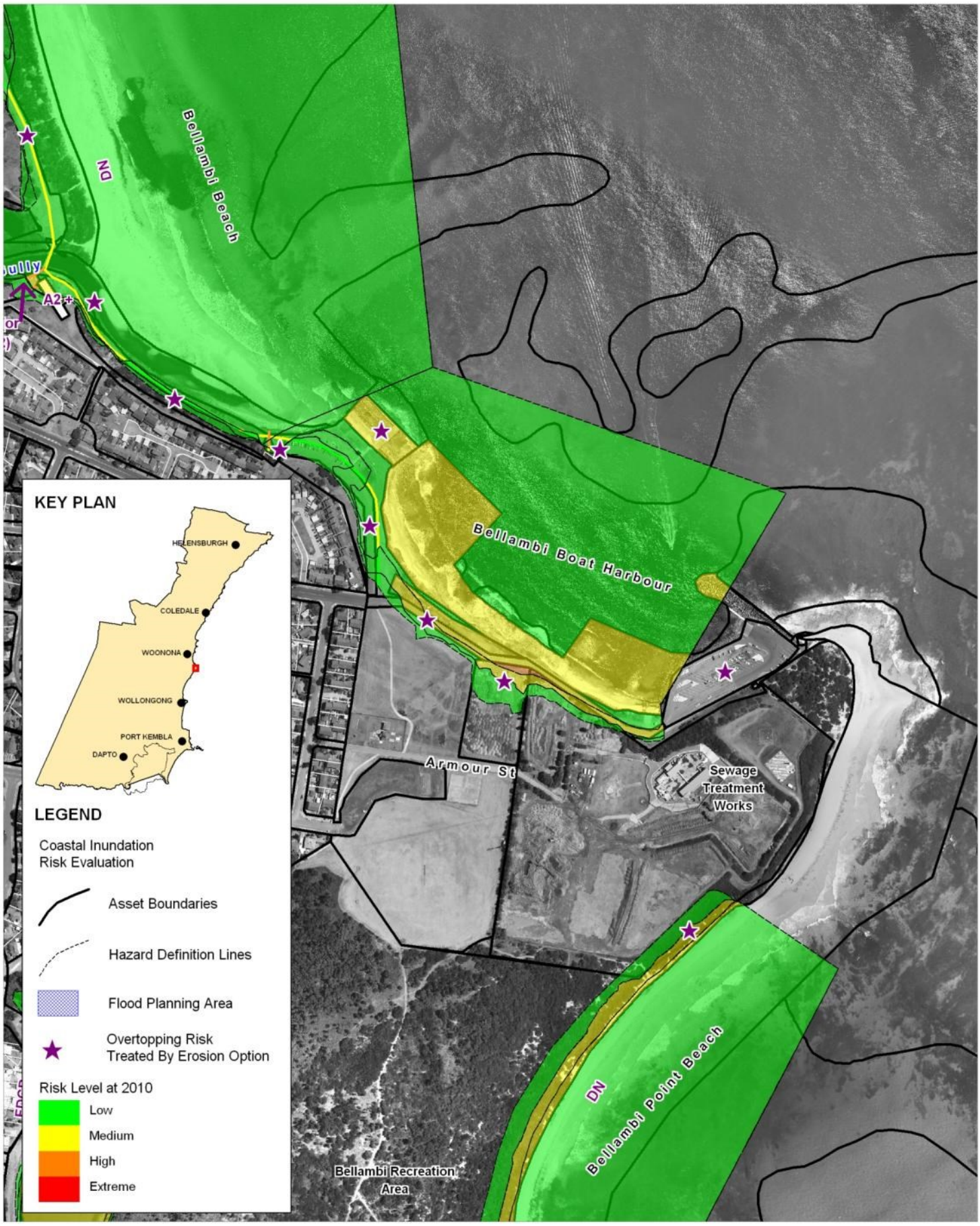
N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_112_1104127 Drawing 6-32.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Bellambi Boat Harbour

Drawing: 6-33

Rev: A

N

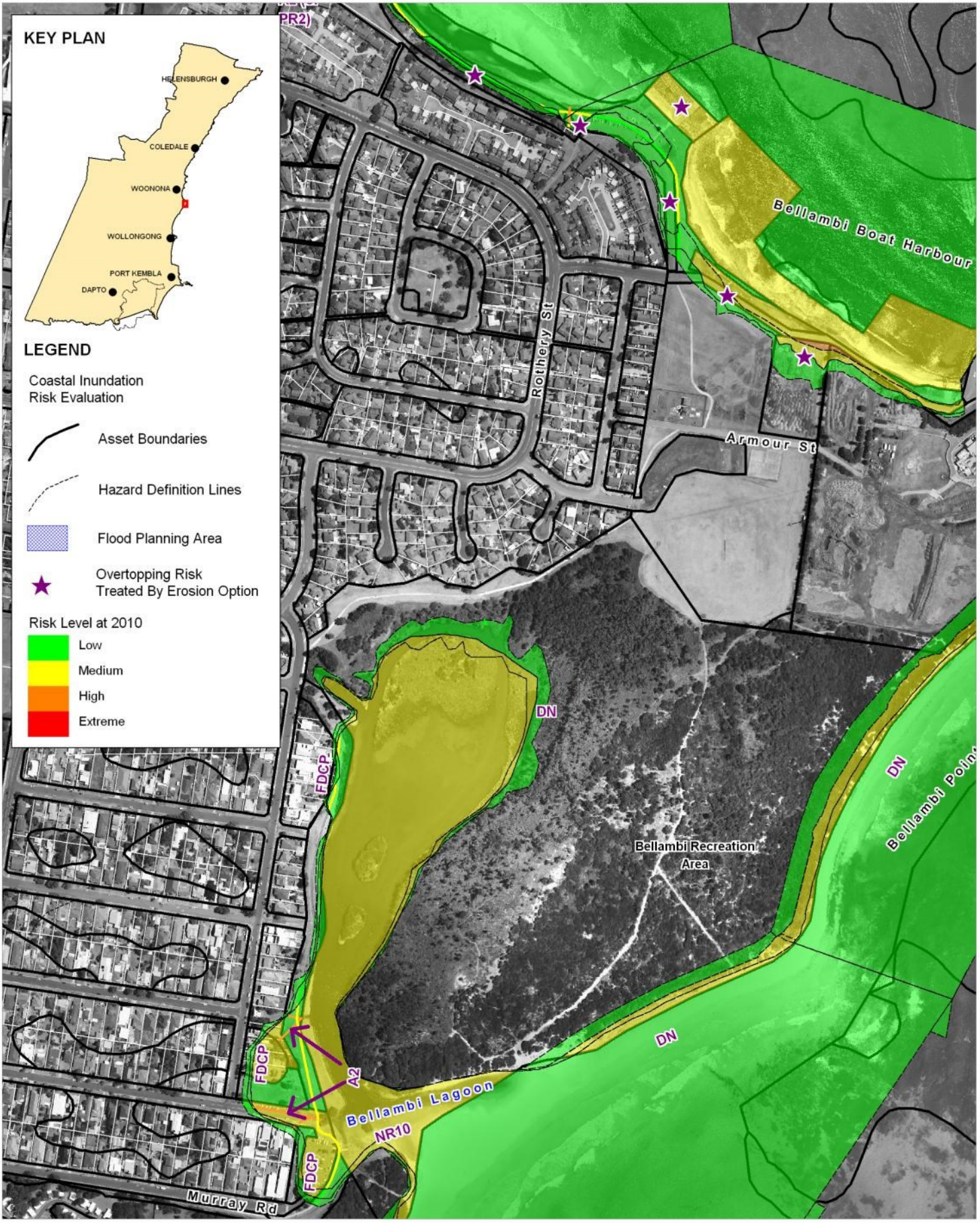
0 125 250m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_113_1104128 Drawing 6-33.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Bellambi Point Beach

Drawing: 6-34

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_114_1104128 Drawing 6-34.WOR

6.12.5 Assessment of Treatment Options – Bellambi Beach & Bellambi Boat Harbour

Bellambi

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Bellambi Beach	Potential Funding Sources (Who may pay)	Conclusion
S2	Maintain existing seawall along existing alignment	On as needs basis for asset maintenance or to repair storm damage.	✓	✓	×								This option involves maintaining the existing seawall / training wall from Bellambi Gully entrance to Bellambi Pool. The ability of the wall to provide protection or be upgraded will depend upon outcomes of NR2. The wall is likely to already provide some protection to land and pool assets, and could be progressively upgraded on an as needs basis overtime to continue to protect from erosion and wave overtopping (e.g. deflection or other barriers, changes to slope and armour stones). *Refer to Protect Options Table for further cost benefit details for S2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								Dune care programs must be considerate of sightline requirements for SLSC activities. The existing vegetation coverage should be maintained, particularly managing weed species (e.g. bitou). *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This is an excellent option at Bellambi Beach as there are extensive dunes and reserve lands to enable natural retreat of the beach, and hence continued provision of a beach over the long term. The outcomes of NR4 will determine the long term viability of Bellambi Pool. If pool condition is inadequate, the pool may have to be abandoned (progressively removed over time). *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate roadway, car park and adjacent sewage treatment plant assets landward of hazard zone	**Current Action:** NR5, NR8 **Trigger:** When ZRFC measured from erosion escarpment encroaches roadway	✓	✓	×								The roadway would need to be relocated onto land currently within the Sewage Treatment Plant boundary. This would require agreement and purchase of the land from Sydney Water. The Pool carpark could be relocated in conjunction with relocating the roaway. There appears to be sufficient vacant land within the Plant to relocate activities within the site to allow retreat or relocation of the roadway. The extent of rocky shore at this location suggests recession may be constrained by bedrock. Further investigations could better define the potential extent of recession, and relocation (or other) option requirements *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs), Sydney Water (at site) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Marginal

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
PR2	Relocate cycleway outside of hazard zone	**Current Action:** NR6 **Trigger:** When ZRFC measured from erosion escarpment encroaches cycleway	✓	✓	×								There is a low to medium risk at present, thus there is no immediate need for action. There appears to be sufficient land to relocate all of the at risk cycleway sections in the future when erosion impacts manifest. The cycleway section between Bellambi Gully and the pool may be protected by the existing seawall (see S2) if this structure is maintained. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	**Recommended**
PR2	Relocate stormwater assets landward of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe	✓	✓	×								Should the existing seawall not be maintained, the stormwater outlet adjacent to Bellambi Pool will need to be progressively moved landward and pipe shortened as erosion impacts manifest. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	**Marginal**
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	×								This option applies proposed Coastal DCP controls to any redevelopments on the Sewage Treatment Works site. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP ☑ Sydney Water - cost to implement DCP	**Recommended**
A2	Redesign roadway in current location to withstand impacts.	**Current Action:** NR3 **Trigger:** At scheduled time for asset maintenance OR when ZRFC measured from erosion escarpment encroaches onto building foundations, whichever is sooner	✓	✓	×								The roadway could be raised as a method of accommodating the erosion and wave overtopping threat. As noted for PR2 above, there is potentially bedrock below the site that could form suitable foundations to accommodate risks at the roadway. Actions to accommodate risks along the roadway would likewise offer protection to the Sewage Treatment Plant land behind. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs), Sydney Water (at site, may be benefit from action?) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	**Marginal**
A2	Upgrade Bellambi Boat Harbour in current location to withstand impacts.	**Trigger:** As asset maintenance to revetment and boat ramp is required over time, or following storm damage	✓	✓	×								The boatramp and associated carpark and revetment could be raised and upgraded over time, to ensure the structure remains viable for boat use with sea level rise and to continue to withstand wave overtopping and impacts during storms. Actions to preserve the Harbour additionally offer protection to the Sewage Treatment Plant behind *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	**Recommended**

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for A2 Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Retrofit Bellambi Pool in current location to withstand impacts.	**Current Action:** NR4 **Trigger:** When damage to pool shell occurs OR the pool is being inundated at water levels lower than MSL.	✓	✓	N/A								The decision to progressively retrofit Bellambi Pool over time to withstand wave impacts and remain a viable pool with sea level rise shall depend upon the suitability of pool condition for this purpose, based upon NR4. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
A2	Redesign or retrofit stormwater structures adjacent to surf club in current location to withstand impacts.	**Current Action:** NR7 **Trigger:** When inundation frequency impedes effective conveyance of stormwater OR as asset replacement is required, whichever is sooner;	×	×	✓								Stormwater assets may be increasingly impacted by inundation with sea level rise (this includes increased frequency of inundation events from storms). This option involves redesigning and / or re-siting the stormwater structures at their current location to withstand impacts. Designs will depend on outcomes of NR7. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
A2	Redesign or retrofit Surf Club in current location to withstand impacts.	**Current Action:** NR3 **Trigger:** When structure is refurbished or re-built.	×	×	✓								Development controls (see FDCP) would be utilised to redesign the Surf Club structure to accommodate inundation. This would be more affordably done at the next asset replacement cycle, particularly as the risk is medium at the present time. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As property / assets redeveloped, new developments built	×	×	✓								This option involves applying the existing Flood DCP chapter to the surf club at the "low flood risk" level, until a Flood Study for Bellambi Gully is conducted (refer NR10). *Refer to Accommodate Options Table for further cost benefit details for FDCP.*	*N/A* State Government (external funding unlikely to be needed) ☑ Council (Current Programs) *N/A* Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								There are many areas at low risk from inundation, to which 'do nothing' is an acceptable option, and allows Council to focus efforts on high risk areas. For areas at high risk, such as the Sewage Treatment Plant or Harbour, 'do nothing' may be acceptable now, but at some time in the future, impacts on these assets would not be tolerated by community and action will be required. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Marginal
NR	NR1, NR2, NR4, NR5, NR6, NR7, NR8, NR10, NR11, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.12.6 Assessment of Treatment Options – Bellambi Point Beach

Bellambi Point

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Bellambi Point Beach	Potential Funding Sources (Who may pay)	Conclusion
S2	Maintain seawall along existing alignment	On as needs basis for asset maintenance or to repair storm damage.	✓	✓	×								There is an existing seawall along the boundary of the Sewage Treatment Plant between Bellambi Lagoon and Bellambi Point. This option proposes ongoing maintenance of this wall to provide protection to the Sewage Treatment Plant. The wall should additionally be designed to ensure protection for the stormwater outlet at this location. Audit of the current wall (NR2) will need to investigate the combined impact from this existing seawall and Bellambi Boat Harbour on erosion rates on Bellambi Point. Given there may be heritage values at Bellambi Point, the need to and impacts of extending the wall around Bellambi Point should be considered. *Refer to Protect Options Table for further cost benefit details for S2.*	**?** State Government (Grant Programs) **?** Sydney Water - their site **?** Council (Current Programs, new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								The existing vegetation coverage should be maintained, particularly managing weed species (e.g. bitou). *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This option allows reserve or public open space to naturally recede, for continued provision of a beach over the long term. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate activities on Sewage Treatment Plant compound landward of hazard zone	**Trigger:** Move activities as erosion impacts manifest	✓	✓	×								There appears to be sufficient vacant land within the Plant to relocate activities within the site to allow retreat. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Sydney Water *N/A* Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate stormwater assets landward of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe	✓	✓	×								Should the existing seawall not be maintained, the stormwater outlet through the wall will need to be progressively moved landward and pipe shortened as erosion impacts manifest. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) **?** Sydney Water ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Marginal

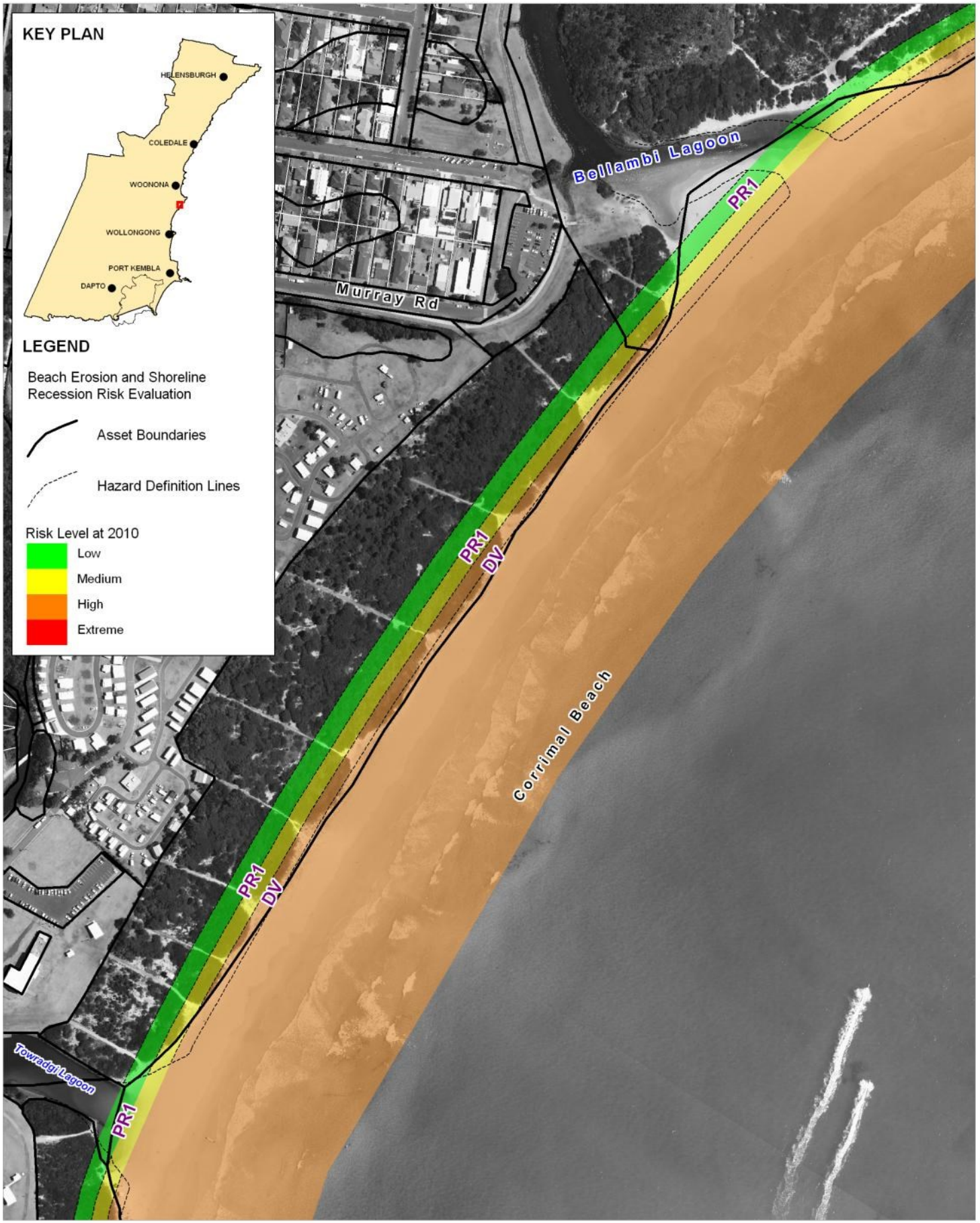
Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	x								This option applies proposed Coastal DCP controls to any redevelopments on the Sewage Treatment Works site. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP ☑ Sydney Water - cost to implement DCP	Recommended
A2	Redesign or retrofit stormwater structures W of Bellambi Lagoon in current location to withstand impacts.	**Current Action:** NR7 **Trigger:** When inundation frequency impedes effective conveyance of stormwater OR as asset replacement is required, whichever is sooner;	x	x	✓								Stormwater assets may be increasingly impacted by inundation with sea level rise (this includes increased frequency of inundation events from storms). This option involves redesigning and / or re-siting the stormwater structures at their current location to withstand impacts. Designs will depend on outcomes of NR7. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As property / assets redeveloped, new developments built	x	x	✓								This option involves applying the existing Flood DCP chapter to those areas identified at risk from coastal inundation at the "low risk" level, until a Flood Study for Bellambi Lagoon is conducted (refer NR10). *Refer to Accommodate Options Table for further cost benefit details for FDCP.*	*N/A* State Government (external funding unlikely to be needed) ☑ Council (Current Programs) ☑ Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								There are many assets at low or medium risk from inundation, which may be acceptable at the current time. For assets at high risk particularly from erosion, there will be unacceptable impacts should 'do nothing' be selected, particulary where community services are impacted. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR2, NR7, NR8, NR10, NR11, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.13 Corrimal Beach

6.13.1 Erosion and Recession Risk Level and Treatment Options

Corrimal Beach (from south of Bellambi Lagoon entrance)	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Corrimal Beach	High	Extreme	Extreme				✓✓		✓✓								NR14	
Coastal Dune Systems (Corrimal Beach Natural Area, Towradgi Park)	High	Extreme	Extreme				✓✓		✓✓									
Towradgi Lagoon and adjacent EEC Habitat	Low	Medium	Medium						✓✓								NR11	✓
Towradgi Park	Low	Medium	Medium						✓✓									✓
Community Infrastructure																		
Towradgi Rock Pool amenities mens	Low	Low	Medium											✓✓				✓
Towradgi Rock Pool amenities womens	Low	Low	Medium											✓✓				✓

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Corrimal Beach

Drawing: 6-35

Rev: A

N

0 75 150m

Approx. Scale

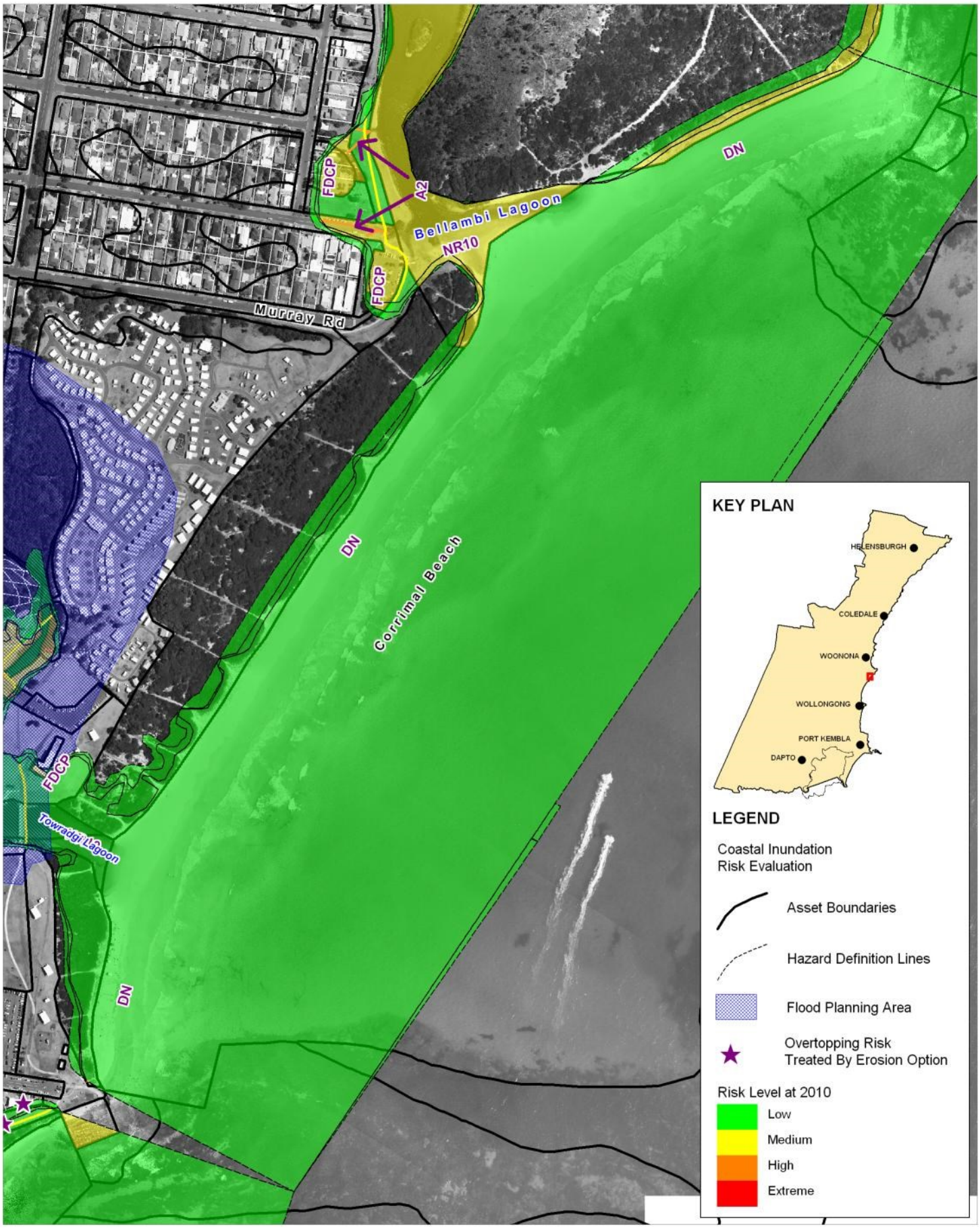
BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_115_110428 Drawing 6-35.WOR

6.13.2 Coastal Inundation Risk Level and Treatment Options

Corrimal Beach (from south of Bellambi Lagoon entrance)	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Corrimal Beach	Low	Low	Medium						✓
Coastal Dune Systems (Corrimal Beach Natural Area, Towradgi Park)	Low	Low	Medium						✓
Towradgi Lagoon and adjacent EEC Habitat	Medium	High	Extreme					NR10, NR14	✓
Corrimal Beach Reserve, Towradgi Creek Reserve	Low	Low	Medium						✓
Towradgi Park	Low	Low	Medium						✓
Community Infrastructure									
Corrimal Surf Club	Medium	Medium	High			✓✓	✓	NR10, NR14	
Towradgi Rock Pool amenities mens	Low	Low	Low			✓			✓
Cycleway (across & next to Towradgi Lagoon)	Medium	Medium	High			✓✓	✓	NR14	
Transport Infrastructure									
Local roads (Lake Pde)	Medium	High	Extreme			✓✓		NR14	✓
Water and sewage infrastructure									
Stormwater outlets and pipes	High	Extreme	Extreme			✓✓	✓✓	NR7, NR14	
Residential Development									
Existing Residences (37 adjacent to Towradgi Lagoon / Creek)	Medium	High	High			✓✓	✓	NR10	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Corrimal Beach

Drawing: 6-36

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_115_1104128 Drawing 6-36.WOR

6.13.3 Assessment of Treatment Options

Corrimal

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Corrimal Beach	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								The existing vegetation coverage should be maintained, particularly managing weed species (e.g. bitou). Dune care programs must be considerate of sightline requirements for SLSC activities. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This is an excellent option at Corrimal Beach as there are extensive dunes and reserve lands to enable natural retreat of the beach, and hence continued provision of a beach over the long term. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	×								Application of the Coastal DCP to minor public buildings, to ensure erosion and overtopping risks are adequately managed (including relocating the structures) in the future when the assets require redevelopment. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP ☑ Private landholders - cost to implement DCP	Recommended
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	**Current Action:** NR7 **Trigger:** When inundation frequency impedes effective conveyance of stormwater OR as asset replacement is required, whichever is sooner;	×	×	✓								Stormwater assets may be increasingly impacted by inundation with sea level rise (this includes increased frequency of inundation events from storms). This option involves redesigning and / or re-siting the stormwater structures at their current location to withstand impacts. Designs will depend on outcomes of NR7. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended

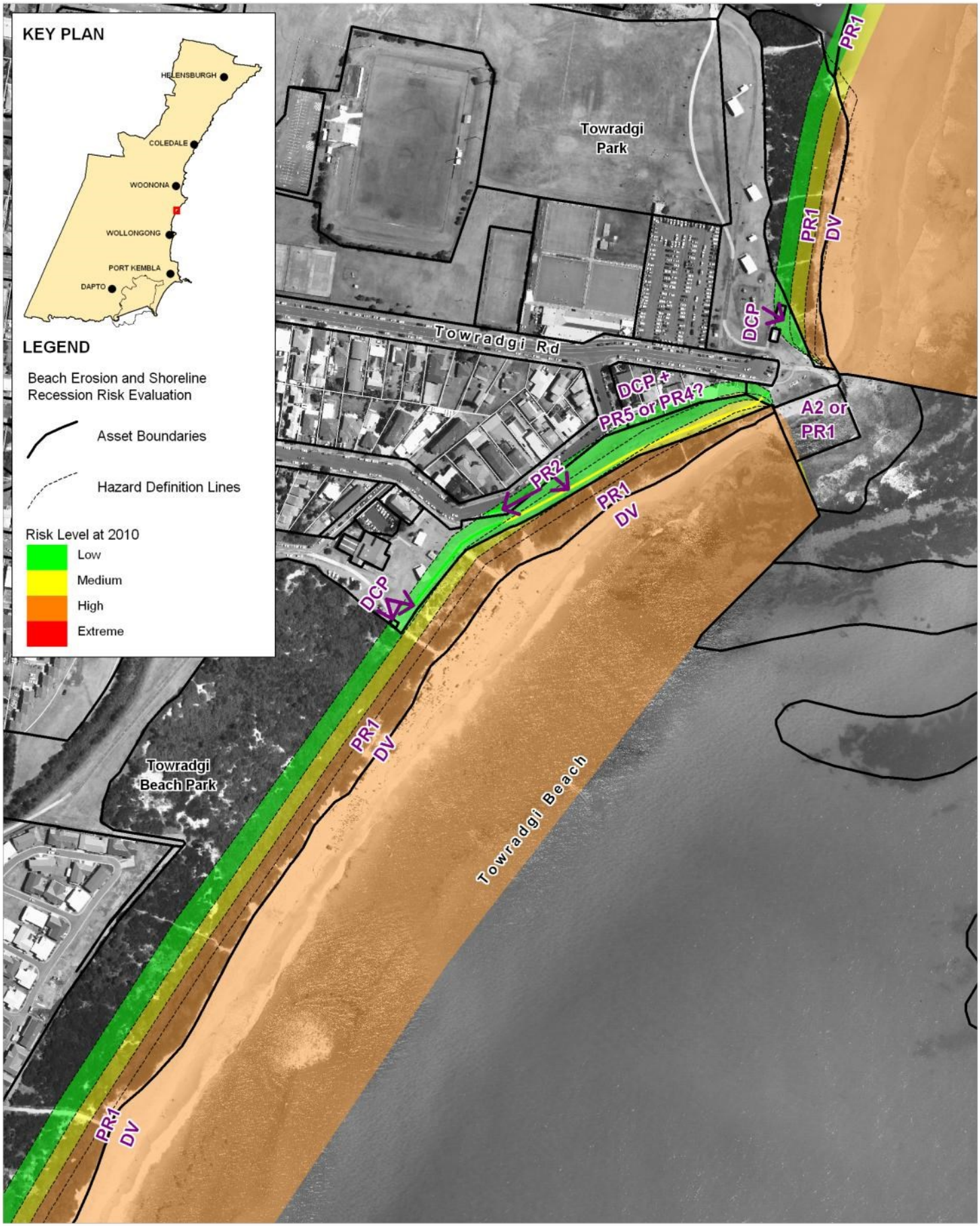
Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for A2 Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit Surf Club in current location to withstand impacts.	**Current Action:** NR3 **Trigger:** When structure is refurbished or re-built.	×	×	✓								Development controls (see FDCP) would be utilised to redesign the Surf Club structure to accommodate inundation. This would be more affordably done at the next asset replacement cycle, particularly as the risk is medium at the present time. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As property / assets redeveloped, new developments built	×	×	✓								The majority of land and assets within the coastal inundation area are within the Flood Planning Area for Towradgi Lagoon. These properties will aready have flood planning controls (FDCP), which should be applied also to managing the backwater inundation risk from coastal inundation. NR10 should be completed for Towradgi Lagoon to improve flood planning levels. *Refer to Accommodate Options Table for further cost benefit details for FDCP.*	*N/A* State Government (external funding unlikely to be needed) ☑ Council (Current Programs) ☑ Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								There is high risk from erosion and recession, but at little impact to developed assets. The "do nothing" option is acceptable to some degree where this allows for natural retreat of the shoreline. The majority of area affected by coastal inundation is already at risk from catchment flooding. Controls on catchment flooding will mitigate the coastal inundation risk under a "do nothing" scenario which is acceptable. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR3, NR5, NR7, NR9, NR10, NR11, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.14 Towradgi Beach

6.14.1 Erosion and Recession Risk Level and Treatment Options

Towradgi Beach (extending to just north of Fairy Meadow SLSC, at cadastral boundary of tourist park)	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Towradgi Beach	High	Extreme	Extreme				✓✓		✓✓								NR14	
Coastal Dune Systems	High	Extreme	Extreme				✓✓		✓✓									
Towradgi Beach Reserve	Low	Low	Medium				✓✓		✓✓									
Community Infrastructure																		
Cycleway / Shared Pathway	Medium	High	High							✓				✓			NR6, NR14	
Towradgi Pool	High	Extreme	Extreme						✓						✓		NR4, NR14	
Towradgi Beach Lifeguard Tower	Low	Low	Medium							✓				✓				✓
Transport Infrastructure																		
Local Roads: Marine Parade (N end of beach)	Low	Medium	Medium							✓				✓✓			NR5	
Water and sewage infrastructure																		
Stormwater outlet / pipe (N end)	Medium	High	High							✓✓				✓			NR7, NR14	
Residential Development																		
Existing Residences (3 at N end)	Low	Medium	Medium									✓	✓	✓✓			NR14	
Existing Residences (1 at N end)	Medium	Medium	High									✓	✓	✓✓			NR14	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Towradgi Beach

Drawing: 6-37

Rev: A

N

0 75 150m

Approx. Scale

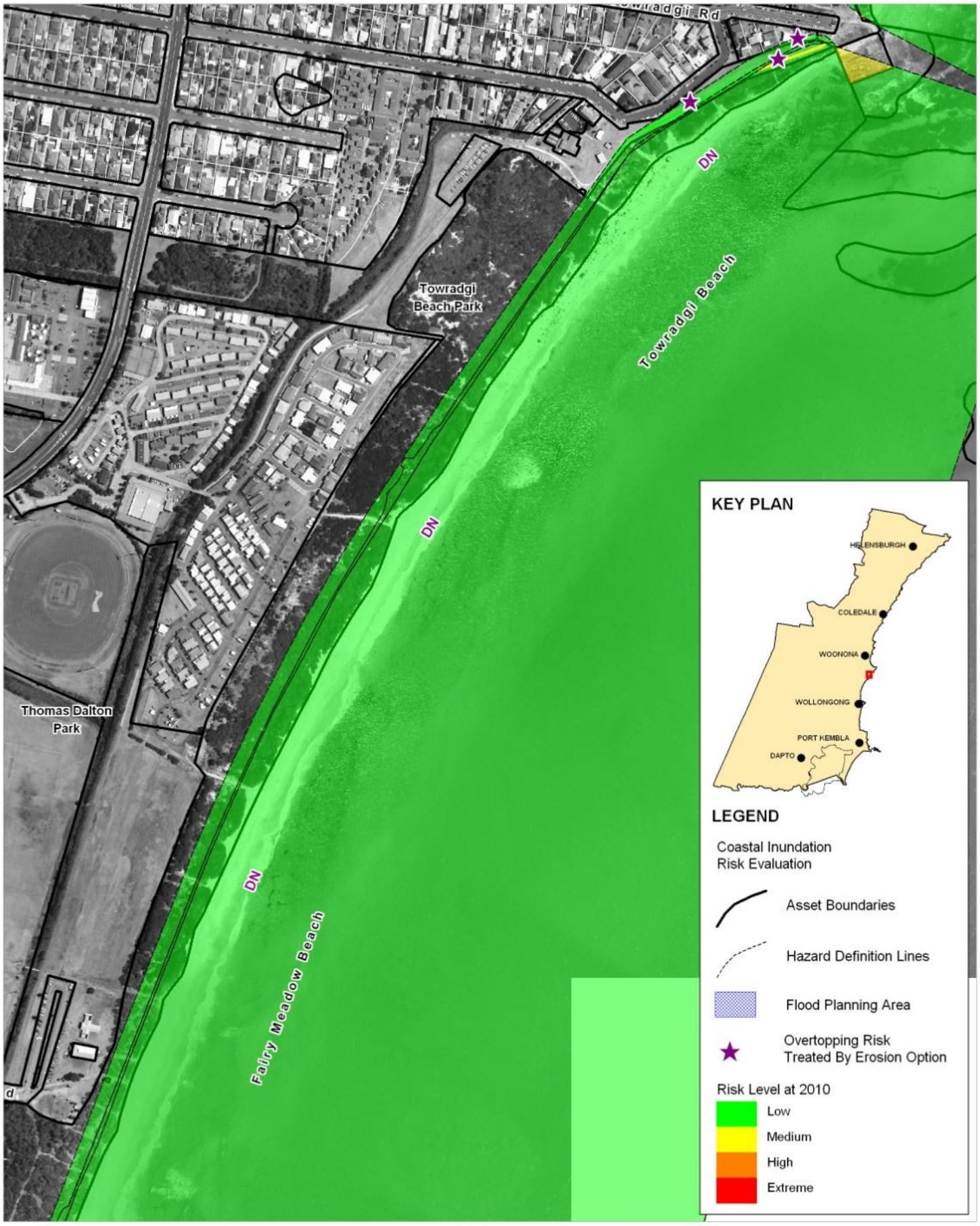
BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_116_110428 Drawing 6-37.WOR

6.14.2 Coastal Inundation Risk Level and Treatment Options

Towradgi Beach (extending to just north of Fairy Meadow SLSC, at cadastral boundary of tourist park)	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Towradgi Beach	Low	Low	Medium						✓
Coastal Dune Systems	Low	Low	Medium						✓
Community Infrastructure									
Cycleway / Shared Pathway	Medium	Medium	High	✓					
Towradgi Pool	Medium	Medium	High	✓					
Transport Infrastructure									
Local Roads: Towradgi Road, Marine Parade (N end of beach)	Low	Low	Low	✓					
Water and sewage infrastructure									
Stormwater outlet / pipe (N end)	High	Extreme	Extreme	✓					
Residential Development									
Existing Residences (3 at N end)	Low	Low	Low	✓					
Existing Residences (1 at N end)	Low	Medium	Medium	✓					

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Towradgi Beach

Drawing: 6-38

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_116_1104128 Drawing 6-38.WOR

6.14.3 Assessment of Treatment Options

Towradgi

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Towradgi Beach	Potential Funding Sources (Who may pay)	Conclusion (provisional)
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	x								Dune care programs must be considerate of sightline requirements for SLSC activities. There is generally good dune vegetation coverage, this needs to be maitained including to manage weeds (e.g. bitou). *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	x								This is an excellent option for retaining Towradgi Beach as there are generally wide dunes for the majority of beach length and reserve lands to enable natural retreat of the beach, and hence continued provision of a beach over the long term. Any decision to remove Towradgi Pool would be based on pool condition to withstand future impacts (see NR4). *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Redirect traffic from roadway outside of hazard zone, allowing retreat of road	**Current Action:** NR3 **Trigger:** At scheduled time for asset maintenance OR when ZRFC measured from erosion escarpment encroaches onto building foundations or cabins, whichever is sooner	✓	✓	x								Marine Drive is currently at low risk, with impacts not expected for many years. Initiating plans to redirect the roadway at the present time assists future traffic planning. Access to residential properties will need to be maintained if this option is selected. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate stormwater assets landward of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR the pipe requires replacement, whichever is sooner.	✓	✓	x								Assets adjacent to the roadway would need to be relocated to permit retreat at the northern end of the beach. The assets are at medium risk at the present, suggesting it is likely to be some time before impacts manifest *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate cycleway outside of hazard zone	**Current Action:** NR6 **Trigger:** When ZRFC measured from erosion escarpment encroaches cycleway	✓	✓	x								A long section of cycleway is at risk over time. To maintain the integrity of the cycleway, the path would need to be relocated at the same time. There are alternate routes to relocate the at risk sections of cycleway, at the time impacts become imminent. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
A2	Retrofit Towradgi Pool in current location to withstand impacts.	**Current Action:** NR4 **Trigger:** When damage to pool shell occurs OR the pool is being inundated at water levels lower than MSL.	✓	✓	N/A								The decision to retrofit Towradgi Pool over time to withstand wave and sea level rise impacts will depend on assessment of pool condition for this purpose (i.e. NR4). *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
PR4	Voluntary acquisition	**Current Action:** Apply for government funding. **Trigger:** Offer once funding becomes available.	✓	✓	×								This option may be financially viable for a single property, but would not be financially possible for multiple properties without substantial government assistance, which is not currently available. As noted for DCP option, the location of the properties suggest there may be stable foundation zone (bedrock) at close depth. In this case, private landowners may be able to accommodate the risk to their buildings and / or the hazard estimate for recession could be revised. This may negate the need for voluntary acquisition to retreat from these properties. *Refer to Planned Retreat Options Table for further cost benefit details for PR4.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) ☒ Private landholders who directly benefit from option	Marginal
PR5	Buy back – lease back	Buy and lease out property now. Demolish property when the Immediate Impact Zone (including foundation stability allowance) intersects the development.	✓	✓	✓								This option involves voluntary acquisition of at risk private property by Council funded by typical mortgage arrangements, with the properties leased at market rates until impacts become imminent. As noted for DCP option, the location of the properties suggest there may be stable foundation zone (bedrock) at close depth. In this case, private landowners may be able to accommodate the risk to their buildings and / or the hazard estimate for recession could be revised. This may negate the need to acquire and retreat from these properties. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) ☒ Private landholders who directly benefit from option	Marginal
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	×								This option shall apply Coastal DCP controls to redevelopments of at risk private property and public assets. The development controls will reflect the level of risk and lifespan of the (re-)development. The location of the private properties at the northern end of the beach suggests there may be stable foundation zone (bedrock) at close depth. In this case, private landowners may be able to accommodate the risk to their buildings and / or the hazard estimate for recession could be revised. The geotechnical investigation would be initiated through the Coastal DCP for any proposed re-developments. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement for public assets ☑ Private landholders - cost to implement DCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								The risk can be accepted at areas at low risk from inundation or erosion at the current time. However, impacts to community services (the roadway) or private property in the long term will not be acceptable,with impacts of 'do nothing' likely to be costly and possibly irreversible. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR4, NR5, NR6, NR7, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.15 Fairy Meadow Beach

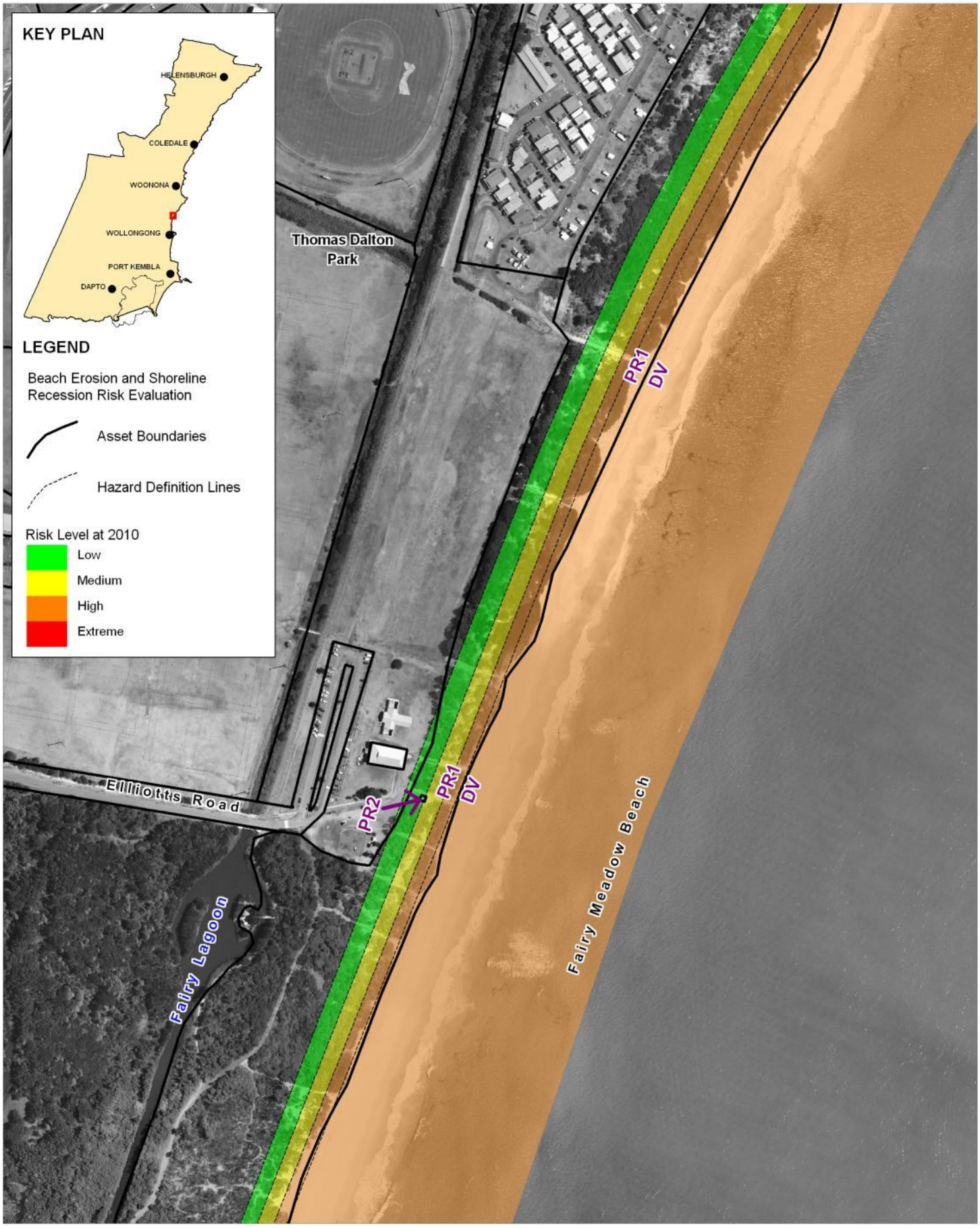
6.15.1 Erosion and Recession Risk Level and Treatment Options

Fairy Meadow Beach (extends to immediately north of Fairy Lagoon at boundary to Puckeys Estate)	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Fairy Meadow Beach	High	Extreme	Extreme				✓✓		✓✓								NR14	
Fairy Lagoon Habitat (part of Puckeys Estate lands)	Medium	High	High				✓✓		✓✓								NR11	
Coastal Dune Systems	High	Extreme	Extreme				✓✓		✓✓									
Community Infrastructure																		
Fairy Meadow SLSC Lifeguard Tower	Low	Medium	Medium							✓✓				✓				

6.15.1 Coastal Inundation Risk Level and Treatment Options

Fairy Meadow Beach (extends to immediately north of Fairy Lagoon at boundary to Puckeys Estate)	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Fairy Meadow Beach	Low	Low	Medium						✓
Fairy Lagoon and Habitat (part of Puckeys Estate lands)	Medium	High	Extreme	✓				NR11	✓
Coastal Dune Systems	Low	Low	Medium						✓
Community Infrastructure									
Fairy Meadow SLSC Lifeguard Tower	Low	Low	Low						✓

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Fairy Meadow Beach (north)

Drawing: 6-39

Rev: A

N

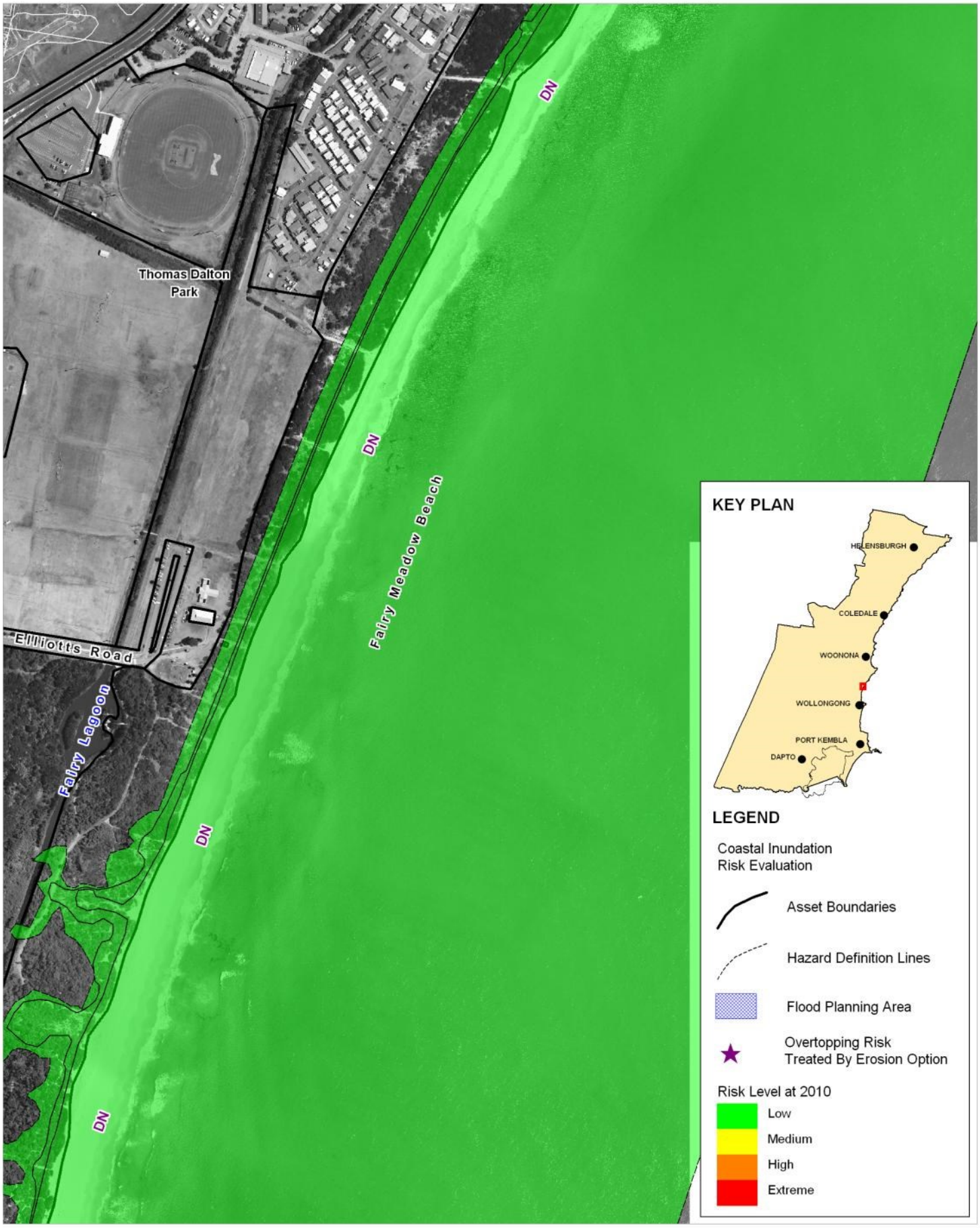
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_117_110429 Drawing 6-39.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Fairy Meadow Beach (north)

Drawing: 6-40

Rev: A

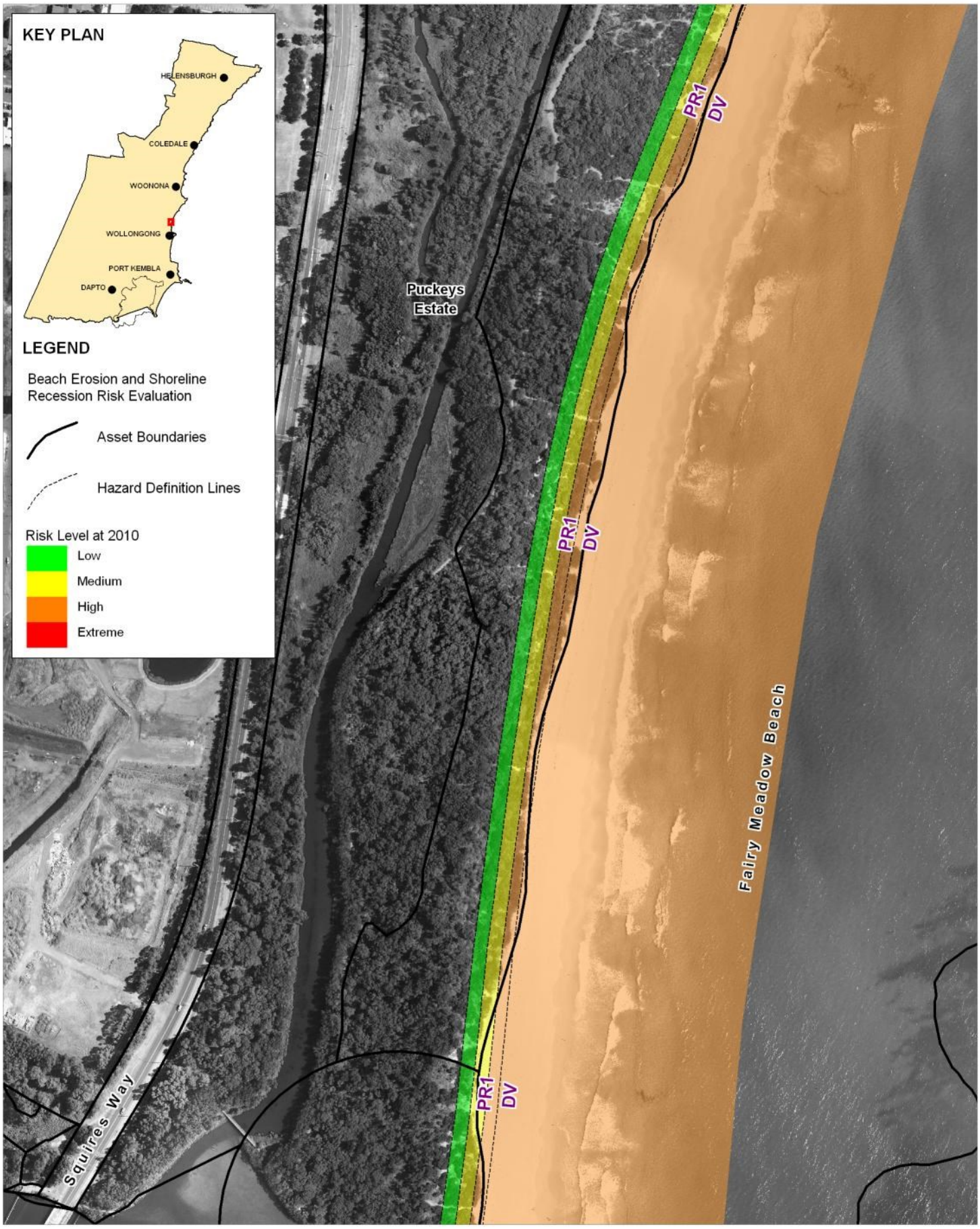
N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_117_1104129 Drawing 6-40.WOR



Title:

Immediate Erosion Risk Levels and Treatment Fairy Meadow Beach (south)

Drawing: 6-41

Rev: A

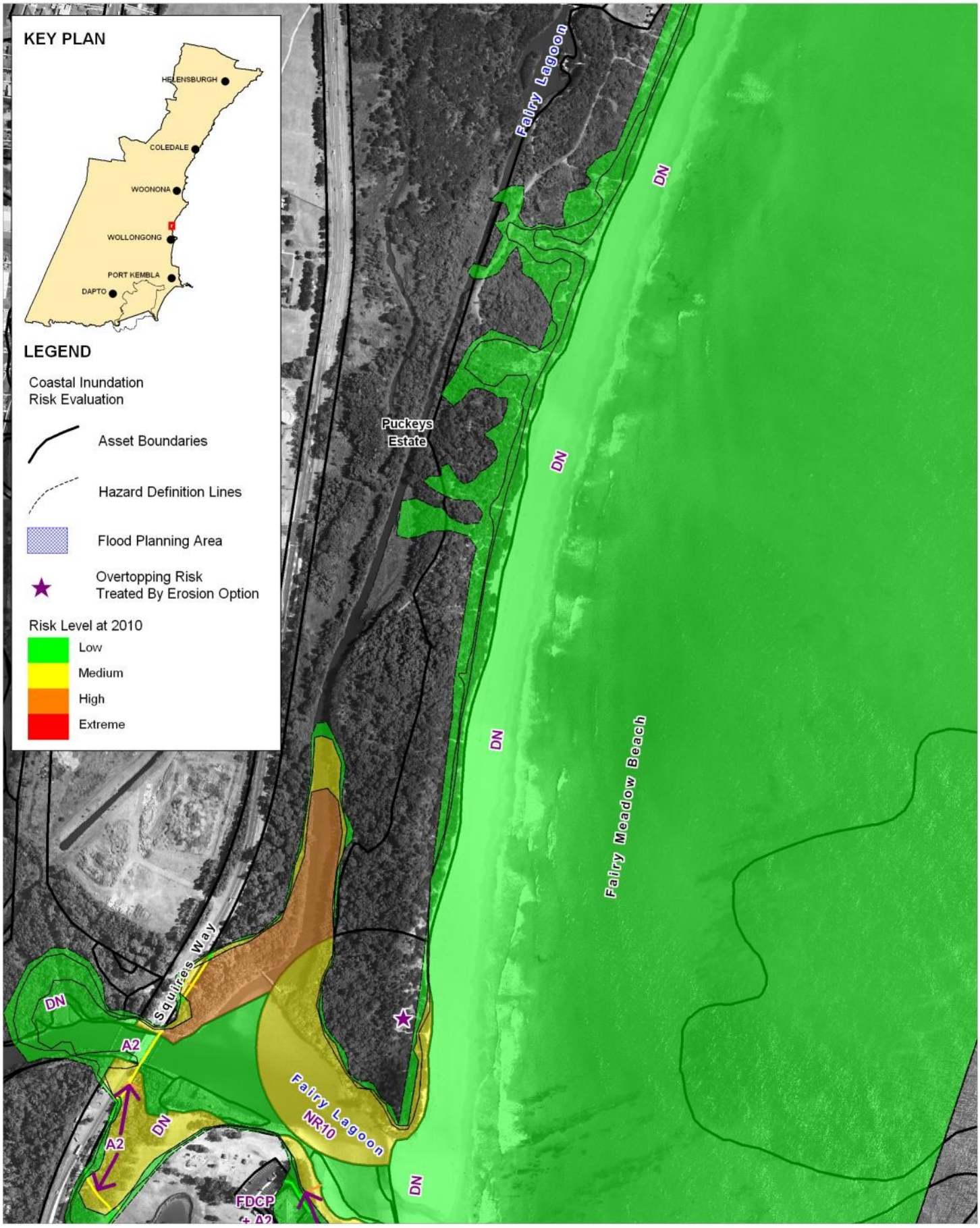
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_118_110429 Drawing A-41.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Fairy Meadow Beach (south)

Drawing: 6-42

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_118_1104129 Drawing 6-42.WOR

6.15.2 Assessment of Treatment Options

Fairy

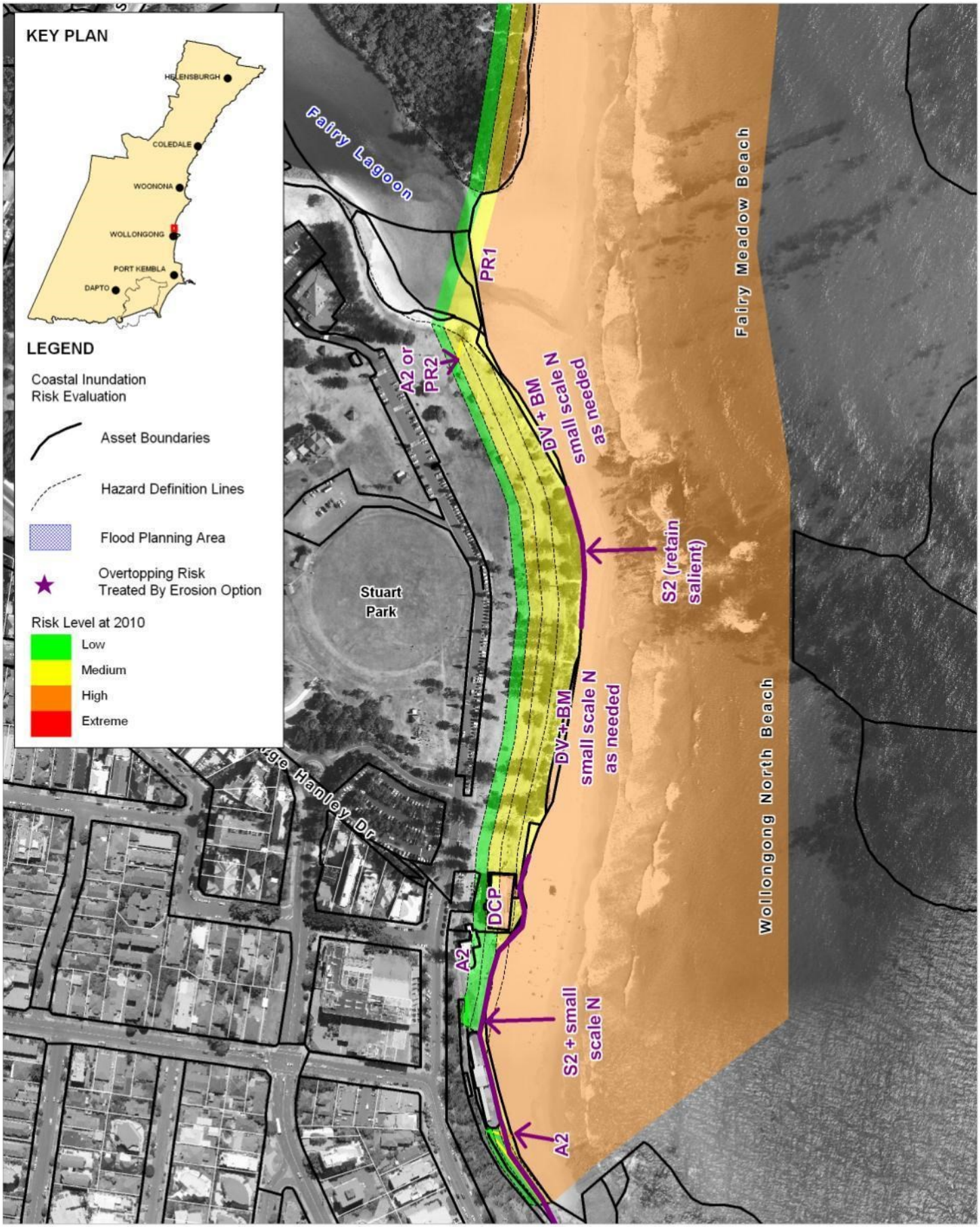
Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Fairy Beach	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								Dune care programs must be considerate of sightline requirements for SLSC activities. Existing vegetation coverage is good and should be maitained and managed for weeds (e.g. bitou bush). *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This is an excellent option for retaining Fairy Meadow Beach as there are generally wide dunes and reserve lands to enable natural retreat of the beach, and hence continued provision of a beach over the long term. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate lifeguard tower structure outside of hazard zone	**Trigger:** when ZRFC measured from erosion escarpment encroaches onto building foundations	✓	✓	×								The lifeguard tower is at low risk, there is no immediate need for action. When impacts become imminent, the tower is a low key structure that will be easily relocatable. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	×								Coastal DCP controls should apply to any future re-development of the lifeguard tower or other recreational facility. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement for public assets *N/A* Private landholders	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								Risk from inundation is low due to extensive dune protection and limited development and can be accepted. Likewise, while there are high erosion risks, 'do nothing' may be acceptable as there is limited development and the recession of dunes would enable the beach to be retained. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) *N/A* Private landholders in Future Generations	Recommended
NR	NR1, NR11, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.16 North Beach

6.16.1 Erosion and Recession Risk Level and Treatment Options

North Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
North Beach	High	Extreme	Extreme				✓	✓	✓								NR14	
Fairy Lagoon	Medium	High	Extreme						✓								NR11	
Stuart Park (on heritage list, local significance)	Medium	High	Extreme	✓		✓	✓	✓	✓									
Public open space adjacent to Pavillion, Kiosk	Low	Medium	Medium	✓		✓			✓								NR2	
Community Infrastructure																		
Puckeys Estate including Seafield House, Saltworks and gardens ruins	High	Extreme	Extreme						✓	?							NR14	
North Beach Surf Club	High	Extreme	Extreme	✓		✓				✓				✓			NR2, NR14	
Heritage Site: North Beach Kiosk	Low	Medium	High	✓		✓				?				✓	✓		NR3, NR2, NR14	
Heritage Site: North Beach Pavillion	Low	Medium	Medium											✓			NR14	✓
Heritage Site: Norfolk Island Pines	Medium	Medium	High						✓								NR12	
Cycleway / Shared Pathway (includes heritate railway cuttings and embankments)	Medium	High	Extreme	✓		✓				✓				✓	✓		NR6, NR14	
Water and sewage infrastructure																		
Stormwater outlets / pipes (at Lagoon entrance)	High	Extreme	Extreme							✓				✓	✓		NR7, NR14	
Stormwater outlets / pipes (adjacent to Pavilion)	High	Extreme	Extreme	✓		✓				✓				✓	✓		NR7, NR14	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Wollongong North Beach - Seawall S2 Option

Drawing: 6-43

Rev: A

N

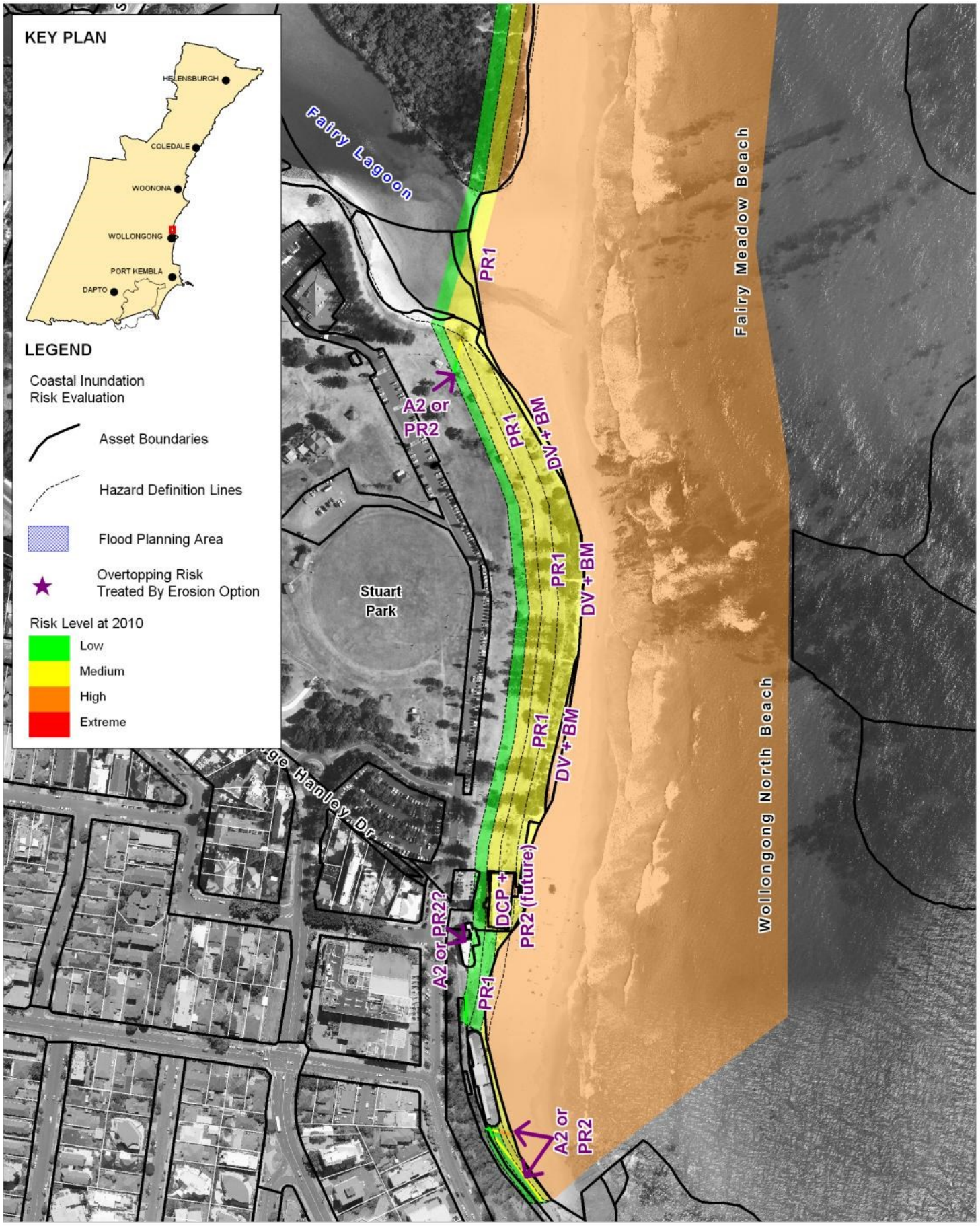
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_119_110429 Drawing 6-43.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Wollongong North Beach - Planned Retreat Option

Drawing: 6-44

Rev: A

N

0 75 150m

Approx. Scale

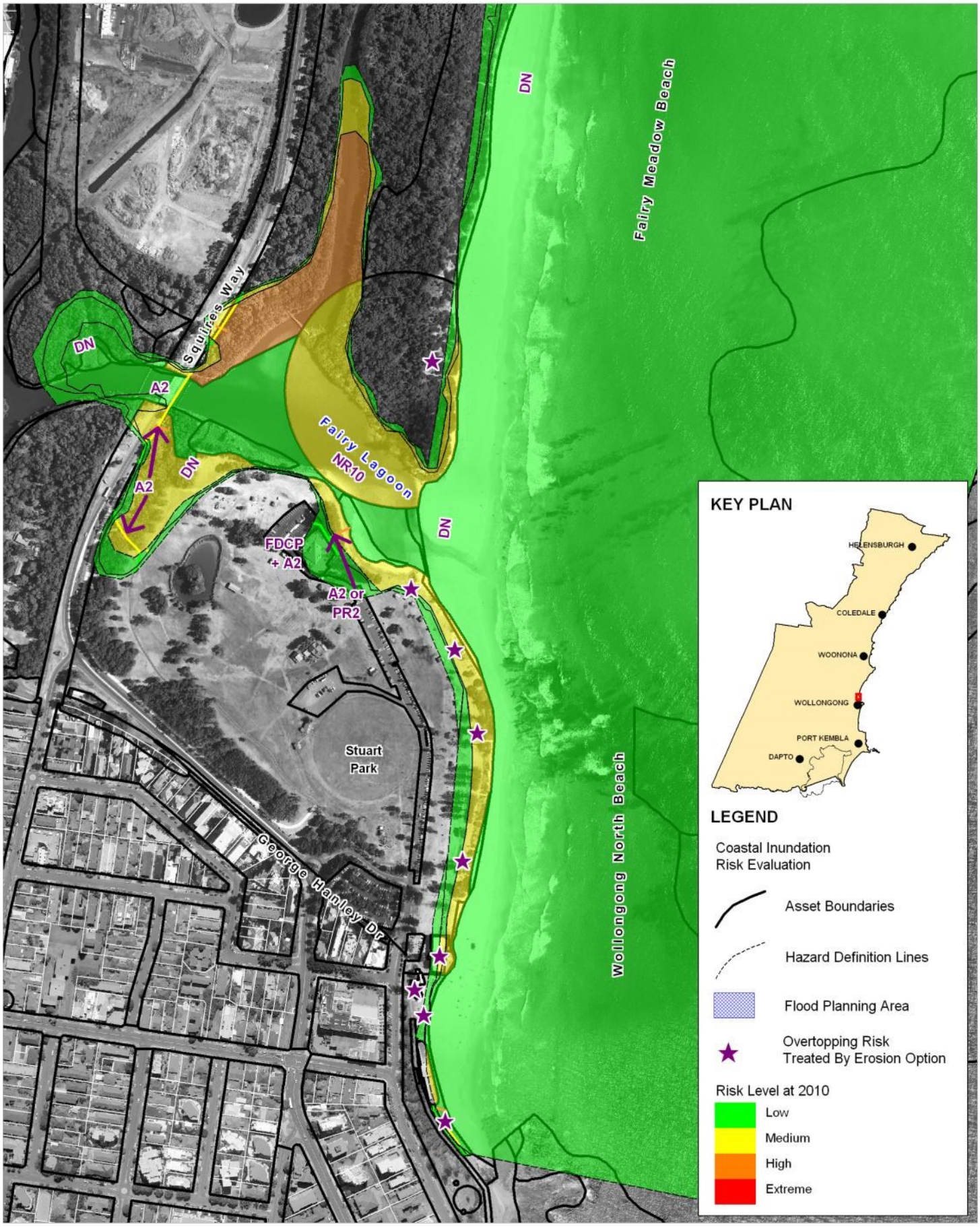
BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_119_110429 Drawing 6-44.WOR

6.16.2 Coastal Inundation Risk Level and Treatment Options

North Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
North Beach	Low	Low	Medium						✓
Fairy Lagoon	Medium	High	Extreme					NR10, NR14	
Stuart Park (Heritage listed of local significance)	Medium	Medium	High			✓			✓
Public open space adjacent to Pavillion, Kiosk	Low	Low	Low	✓					✓
Live Steamers Site, Public open space	Low	Low	Medium						✓
Community Infrastructure									
Puckeys Estate including Seafield House, Saltworks and gardens ruins	Low	Medium	High	✓					
Lagoon Kiosk/Restaurant	Low	Medium	Medium			✓	✓		✓
Stuart Park toilet block	Low	Low	Low			✓			✓
North Beach Surf Club	Medium	High	Extreme	✓					
Heritage Site: North Beach Pavillion	Medium	High	Extreme	✓					
Heritage Site: Norfolk Island Pines	Low	Low	Medium						✓
Cycleway / Shared Pathway (includes heritate railway cuttings and embankments)	Low	Low	Medium	✓					✓
Cycleway / Shared Pathway (adjacent to Squires Way)	Medium	Medium	High			✓		NR14	✓
Water and sewage infrastructure									
Stormwater outlets / pipes (at Lagoon Restuarant)	High	Extreme	Extreme			✓	✓	NR7, NR14	
Stormwater outlets / pipes (at Lagoon entrance)	High	Extreme	Extreme	✓		✓			
Stormwater outlets / pipes (adjacent to Pavilion)	High	Extreme	Extreme	✓		✓			
Transport Infrastructure									
Major roads (Pioneer Road)	Medium	High	High			✓	✓	NR14	
Local road (beach access into Lagoon restaurant and car park)	Low	Low	Medium			✓			✓

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Wollongong North Beach

Drawing: 6-45

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_119_1104129 Drawing 6-45.WOR

6.16.3 Assessment of Treatment Options

North Beach

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for North Beach Beach	Potential Funding Sources (Who may pay)	Conclusion
S2	Construct seawall along specified alignments to protect specific assets	**Current Action:** NR2, detailed designs and planning approvals **Trigger:** Implement at replacement of crib lock wall; Implement salient section following next major storm erosion event	✓	✓	×								Two sections of seawall are proposed. One section would continue along the cycleway to the planned wall at North Beach Pavillion to past the existing SLSC site. The existing crib lock wall is unlikely to provide erosion protection (to be confirmed through NR2). It is unlikely that the crib lock wall would be permitted to fail or removed and a replacement wall is in keeping with the current character of the beach. The replacement structure will need to include measures to manage overtopping (e.g. deflection barriers, slope and permeability / roughness), given the proximity of development (kiosk, proposed SLSC). A short section of wall is proposed to act as an artificial headland at the salient formed behind the extensive reef in the surf zone (see map), north of the SLSC at Stuart Park. The seawall is aimed to retain the current alignment of the beach and salient, and Stuart Park behind. If no protection is undertaken here, it is likely that as sea level rises and there is reduced dissipation across the surfzone reef, the salient will experience higher rates of recession and erode quickly, as the salient re-aligns with adjacent shorelines. This would result in extensive erosion of Stuart Park which is likely to be highly unacceptable to the local and regional community.	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Recommended
N	Beach nourishment	Current Action: Determine requirements in combinations with S2 (above) Trigger: following storms whenever sand reserve is below an identified storm demand seaward of seawalls.	✓	✓	×								There may be a need for small scale nourishment events following storms to assist protection of the beach and adjacent assets, once S2 seawalls have been implemented. Volumes and design profiles should be prepared in combination with designs for the seawall structures. *Refer to Protect Options Table for further cost benefit details for N.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Marginal
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								Dune care works would aim to support beach management activities, and retain windblown sands from nourishment episodes, where this is conducted. Dune care programs must be considerate of sightline requirements for SLSC activities. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	×								Beach management involving scraping and contouring beach sands to accumulate in dunes as storm protection aim to support dune revegetation works and nourishment or seawalls should they be implemented. *Refer to Protect Options Table for further cost benefit details for BM.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for BM Beach	Potential Funding Sources (Who may pay)	Conclusion
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								The loss of Stuart Park through planned retreat is unlikely to be acceptable given the high cultural and community values of the park. The Park is also part of extensive works completed in the area through the Blue Mile Masterplan. This option is suitable to retain the beach through natural retreat at Puckeys Estate and Fairy Lagoon sections of the beach. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Marginal
PR2	Relocate SLSC and kiosk structures and Seafield House (?) outside of hazard zone	**Current Action:** NR3, DCP **Trigger:** At scheduled time for asset maintenance OR when ZRFC measured from erosion escarpment encroaches onto building foundations, whichever is sooner	✓	✓	×								Plans to redevelop North Beach SLSC are already underway, however the proposed site remains within the erosion and recession risk area. The next scheduled refurbishment should consider the need to relocate the structure again, particularly if a seawall is not installed (see S2). Relocation of the heritage kiosk structure may be required shouls a seawall not be implemented. Further investigations would be needed to determine if this is possible in a manner which preserves the heritage character. It is unlikely that the ruins of Seafield House should or can be moved from their current location. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Marginal
PR2	Relocate stormwater assets landward of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe	✓	✓	×								The stormwater outlet adjacent to Fairy Lagoon will need to be moved landward over time. Stormwater assets at North Beach Pavillion will also need to be progressively removed should seawall S2 option not be implemented at this location. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate cycleway outside of hazard zone	**Current Action:** NR6 **Trigger:** When ZRFC measured from erosion escarpment encroaches cycleway	✓	✓	×								The cycleway sections between North Beach and Wollongong Harbour may need to be relocated or raised (see A2), if a seawall is not installed next to the Pavillion. The original rail embankment heritage features would not be able to relocated with the path. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Marginal
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	×								Coastal DCP controls should apply to any proposed redevelopment of existing assets (SLSC, Kiosk, Pavillion, cycleway) in addition to other options, including seawall options, to improve resilience of future structures to coastal risks. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement for public assets *N/A* Private landholders	Recommended
A2	Redesign or retrofit cycleway in current location to withstand impacts.	**Current Action:** NR6 **Trigger:** When ZRFC measured from erosion escarpment encroaches cycleway	✓	✓	×								If a seawall is not implemented, there may be scope to progressively raise the cycleway to withstand impacts. However, this is likely to require some form of revetment. It may provide a more robust outcome to formally implement a seawall (S2) instead. Accommodating impacts to the cycleway additionally allows continued access to heritage rail embankment workings. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (new levies or increased rates) *N/A* Private landholders who directly benefit from option	Marginal

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for DCP Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit kiosk structure and Lagoon Kiosk in current location to withstand impacts.	**Current Action:** NR3 **Trigger:** At scheduled time for asset maintenance OR when ZRFC measured from erosion escarpment encroaches onto building foundations, whichever is sooner	✓	✓	✓								The Kiosk structure could be retrofit during asset maintenance to better withstand erosion or overtopping impacts. If a seawall is built, there will still be a need for some actions (presumably less extensive), as the seawall may not feasibly mitigate all overtopping impacts. Should a seawall not be built, retrofit of the Kiosk may be an alternative to relocating the structure, providing there is adequate foundation capacity at the current site. The Lagoon Kiosk Restaurant should be retrofit to manage inundation impacts from Fairy Lagoon. A Flood Study for Fairy Lagoon should be conducted to better define flood levels at this location (NR10). *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner;	✓	✓	✓								Stormwater assets may be increasingly impacted by inundation with sea level rise (this includes increased frequency of inundation events from storms). Accommodating inundation will need consideration for stormwater assets at North Beach Pavillion, regardless of installation of a seawall. At Fairy Lagoon entrance, depending upon the timeframe of erosion impacts, further upgrades for inundation may or may not be required. The remaining stormwater structures (e.g. Lagoon Kiosk Restaurant, Squires Way) are not affected by erosion but will require upgrade to manage inundation. Designs will depend on outcomes of NR7. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As property / assets redeveloped, new developments built	✗	✗	✓								The existing Flood DCP chapter shall be applied to assets (e.g. Lagoon Kiosk) at risk from coastal inundation at the "low risk" level, until a Fairy Lagoon Flood Study is completed (refer NR10). *Refer to Accommodate Options Table for further cost benefit details for FDCP.*	*N/A* State Government (external funding unlikely to be needed) ☑ Council (Current Programs) ☑ Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								Given the number of socially and economically important assets at North Beach, 'do nothing' is not an acceptable option. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR2, NR3, NR6, NR7, NR10, NR11, NR12, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.17 Wollongong Harbour Belmore Basin

6.17.1 Erosion and Recession Risk Level and Treatment Options

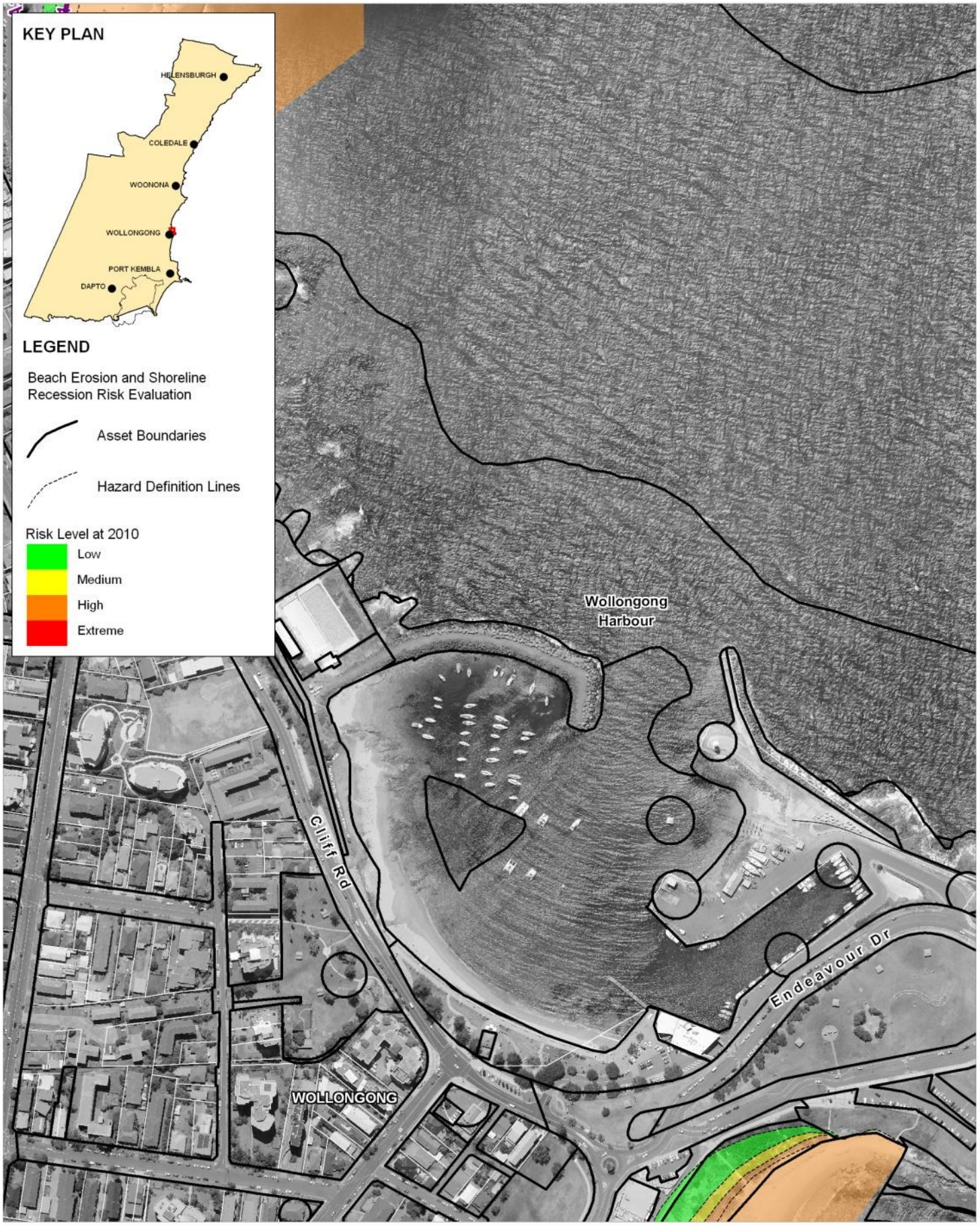
There is an existing Coastal Zone Management Plan for Wollongong Harbour and Belmore Basin. Actions such as replacement of the seawall at Belmore Basin which shall protect from erosion has already been constructed, and other improvement works in association with the Blue Mile Masterplan have also commenced.

A complete risk assessment was not possible at this location as hazards have not been mapped at this location. It is considered that existing actions has mitigated the immediate erosion hazard in this location.

The existing seawall will require upgrade again in the future to mitigate sea level rise impacts. There will be loss of a sandy beach in this location over the long term, particularly as large scale nourishment is currently not a feasible option at this time.

6.17.2 Coastal Inundation Risk Level and Treatment Options

The harbour is a state significant heritage precinct with a number of important features. Permanent inundation and enhanced wave overtopping with sea level rise are likely to impact upon assets in this area. Suitable options to manage the heritage items, for example “burial” with seawater or alternatively, raising the heritage assets, should be investigated at the present time, such as through Option NR13. Immediate action to manage the assets is not required, however Option NR13 would provide a plan for impacts as they manifest in the future.



Title:

Immediate Erosion Risk Levels and Treatment Options
Immediate Planning Horizon - Wollongong Boat Harbour

Drawing: 6-46

Rev: A

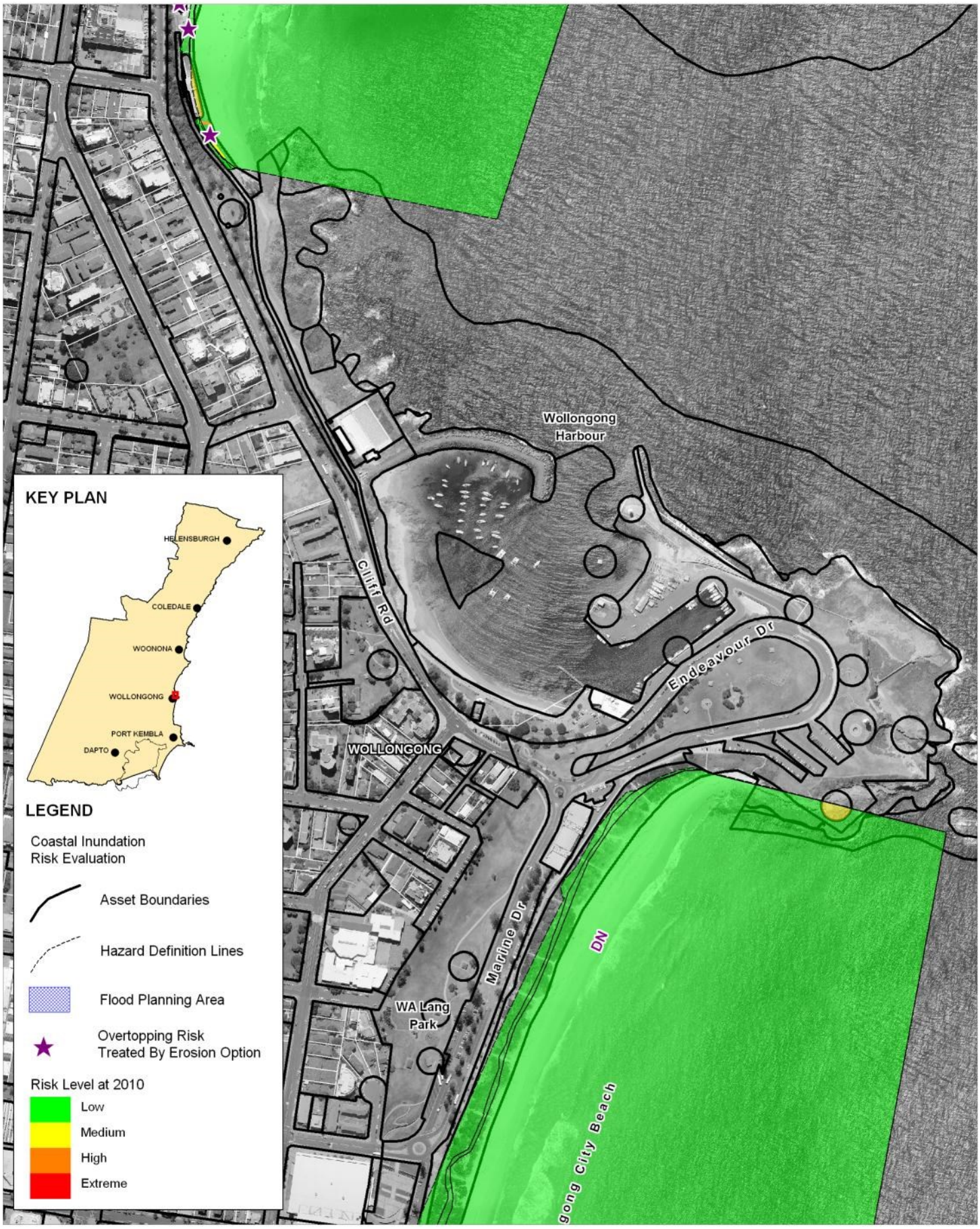
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_120_110429 Drawing 6-46.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Wollongong Harbour

Drawing: 6-47

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

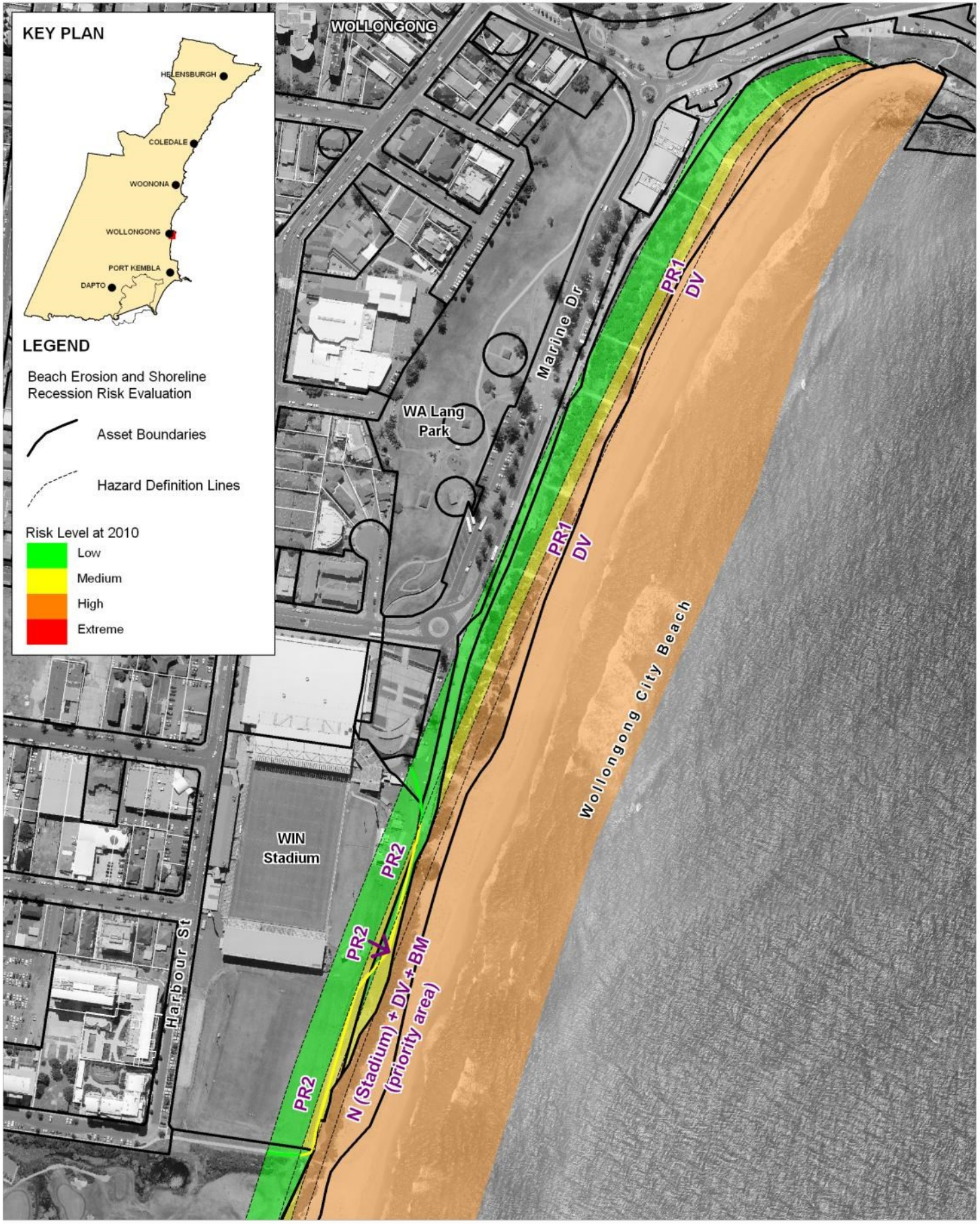
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_120_1104129 Drawing 6-47.WOR

6.18 City Beach

6.18.1 Erosion and Recession Risk Level and Treatment Options

City Beach (extending to northern boundary of golf course)	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
City Beach	High	Extreme	Extreme				✓✓		✓✓								NR14	
Open space, parks including City Beach Foreshore	Medium	Medium	High				✓✓		✓✓									
Football Ground (WIN Stadium) and Showground	High	Extreme	Extreme	✓			✓✓	✓✓		✓				✓✓			NR14	
Coastal Dune Systems	High	Extreme	Extreme				✓✓		✓✓									
Community Infrastructure																		
Cycleway / Shared Pathway	Medium	High	Extreme							✓✓				✓			NR6, NR14	
Transport Infrastructure																		
Local Roads: Beach access car parks	Low	Low	Medium						✓✓									✓

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Wollongong City Beach

Drawing: 6-48

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

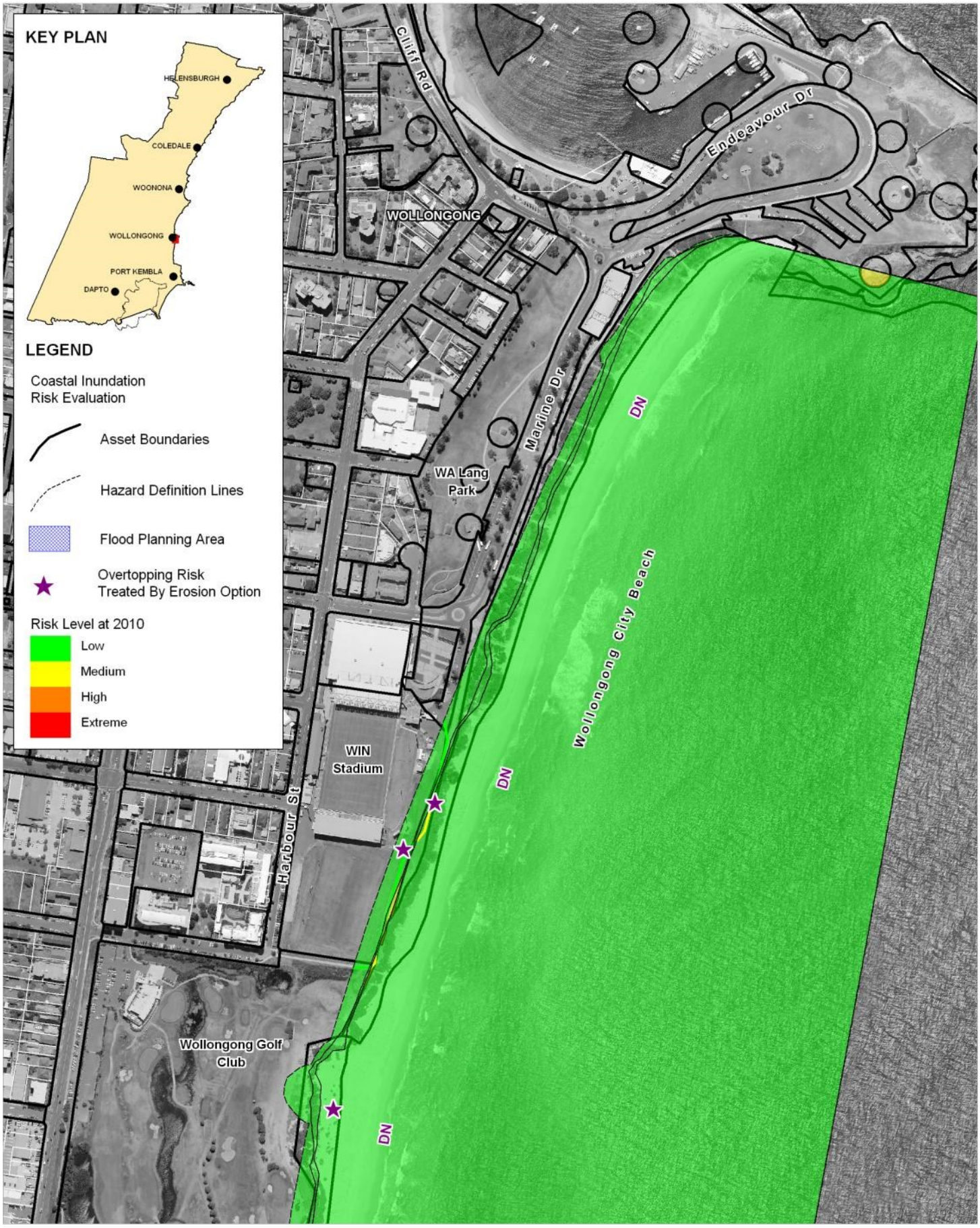
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_121_110429 Drawing 6-48.WOR

6.18.2 Coastal Inundation Risk Level and Treatment Options

City Beach (extending to northern boundary of golf course)	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
City Beach	Low	Low	Medium						✓
Open space, parks including City Beach Foreshore	Low	Low	Medium						✓
Football Ground (WIN Stadium) and Showground	Medium	Medium	High	✓					
Coastal Dune Systems	Low	Low	Medium						✓
Community Infrastructure									
Cycleway / Shared Pathway	Medium	Medium	High	✓					
Transport Infrastructure									
Local Roads: Beach access car parks	Low	Low	Low						✓
Commercial and Industrial Development									
NB: Nuns Pools and Ladies Pool at rock platform off Flagstafff Hill	Low	Low	Low						✓

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Wollongong City Beach

Drawing: 6-49

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_121_1104129 Drawing 6-49.WOR

6.18.3 Assessment of Treatment Options

City

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for City Beach	Potential Funding Sources (Who may pay)	Conclusion
N	Beach nourishment	Immediately and whenever sand reserve is below the identified storm demand seaward of development being protected (following storms)	✓	✓	×								This would involve a targeted nourishment program specifically for protection of the WIN Stadium. Siting and design for the program are thus aimed at a smaller scale, and should be done in combination with dune vegetation programs to build up dune storage in front of the stadium. Placement of sand should consider the typical net northward sediment transport, for example, placing part of the nourishment slightly south of the site. Dunes from the WIN Stadium to the south are limited, requiring work (see Coniston Beach). *Refer to Protect Options Table for further cost benefit details for N.*	**?** State Government (Grant Programs) - unlikely to fund private property protection ☑ Council (new levies or increased rates) ☑ Private landholders who directly benefit from option (personal investment or directed by Council)	**Marginal**
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								Particularly from the Stadium toward the south, dune vegetation, width and height are limited. Further north, the programs have had excellent success, and should be continued (with consideration of sightline requirements for SLSC activities). The program should progress southwards from the Stadium, to take advantage of the typical northward transport of sediment. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) **?** Private landholders who directly benefit from option	**Recommended**
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	×								This option would aim to support dune restoration activities from the Stadium south. This involves scraping and contouring beach sands (in combination with dune revegetation) to increase sand volumes held in dune storage for storm protection. *Refer to Protect Options Table for further cost benefit details for BM.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) **?** Private landholders who directly benefit from option	**Recommended**
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								The extensive dunes at the northern end of the beach support this as an excellent option for retaining the beach, by utilising dunes and reserve lands to enable natural retreat of the beach. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	**Recommended**

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for BM Beach	Potential Funding Sources (Who may pay)	Conclusion
PR2	Relocate cycleway outside of hazard zone	**Current Action:** NR6 **Trigger:** When ZRFC measured from erosion escarpment encroaches cycleway	✓	✓	✗								The cycleway could feasibly be relocated along the street landward of WIN Stadium to rejoin the existing cycleway at Wollongong Golf Course, in the future when erosion impacts manifest. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
PR2	Relocate stadium parking and ancillary buildings and minor football ground outside of hazard zone	**Trigger:** When erosion escarpment encroaches on the assets.	✓	✓	✗								There is potential to reconfigure the football ground landward to avoid hazards impacts, likewise, the actual WIN Stadium is currently at very low risk but parking and other small buildings adjacent would need to be relocated. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) **?** Council (new levies or increased rates) *þ Private landholders who directly benefit from option (personal investment or directed by Council)*	Recommended
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	✗								This option shall apply planning controls to re-development of the Stadium and associated grounds to minimise future risk from hazards. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement for public assets ☑ Private landholders - cost to implement DCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								For inundation the "do nothing" option is acceptable as risk is generally low. Likewise for managing erosion, however impacts at the Stadium site would not be accepted by community, in which case "do nothing" is not tenable. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR3, NR5, NR7, NR9, NR10, NR11, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.19 Coniston Beach

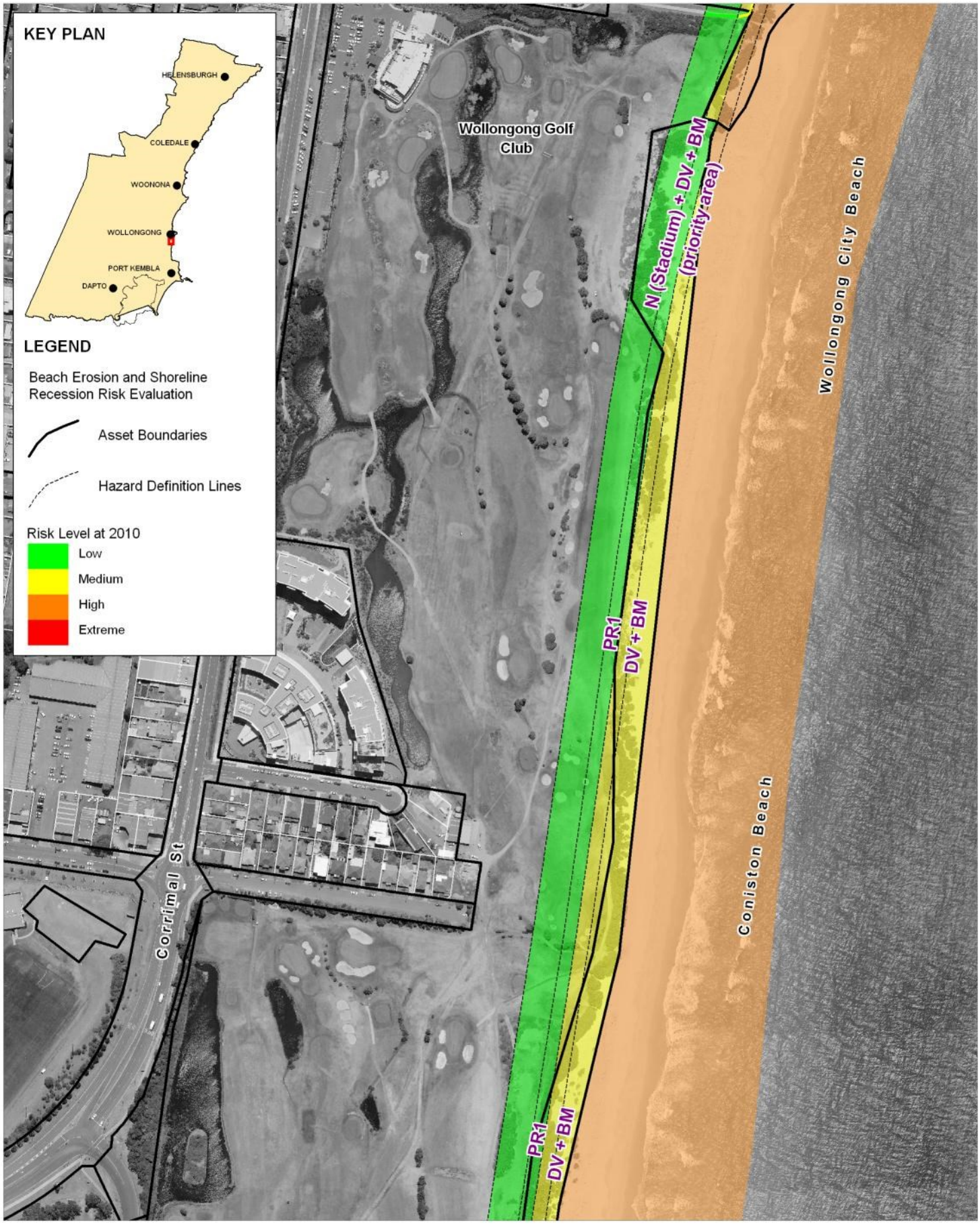
6.19.1 Erosion and Recession Risk Level and Treatment Options

Coniston Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Coniston Beach	High	Extreme	Extreme				✓✓	✓✓	✓✓								NR14	
Wollongong Golf Course ** for inundation, this is only a very small section at far south end.	Medium	Medium	High				✓✓	✓✓	✓✓					✓				
Coastal Dune Systems	High	Extreme	Extreme				✓✓	✓✓	✓✓									

6.19.1 Coastal Inundation Risk Level and Treatment Options

Coniston Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Coniston Beach	Low	Low	Medium						✓
Wollongong Golf Course ** for inundation, this is only a very small section at far south end.	Medium	Medium	High	✓					✓
Coastal Dune Systems	Low	Low	Medium						✓

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Coniston Beach (north)

Drawing: 6-50

Rev: A

N

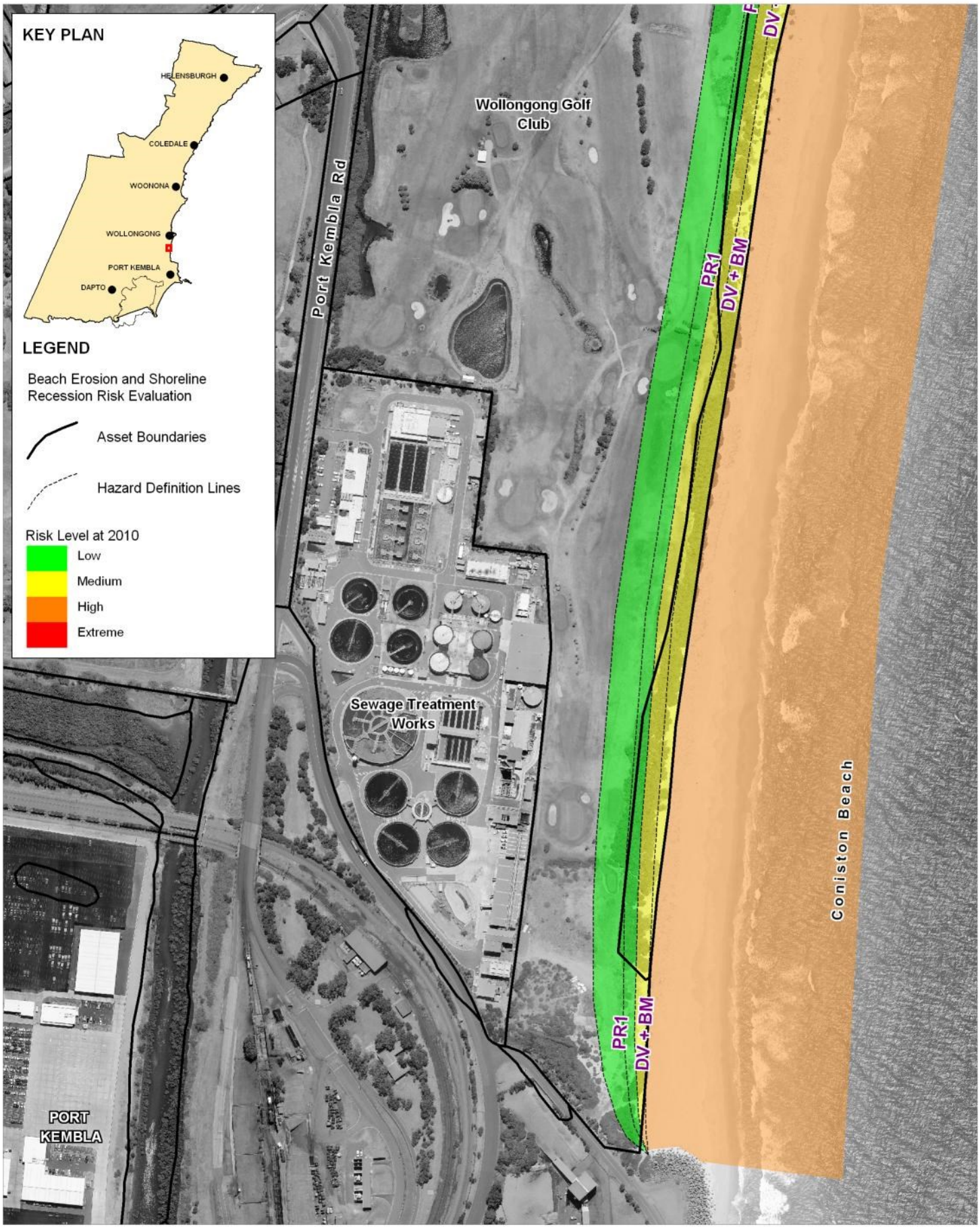
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_122_110429 Drawing 6-50.WOR



Title:

Immediate Erosion Risk Levels and Treatment Coniston Beach (south)

Drawing: 6-51

Rev: A

N

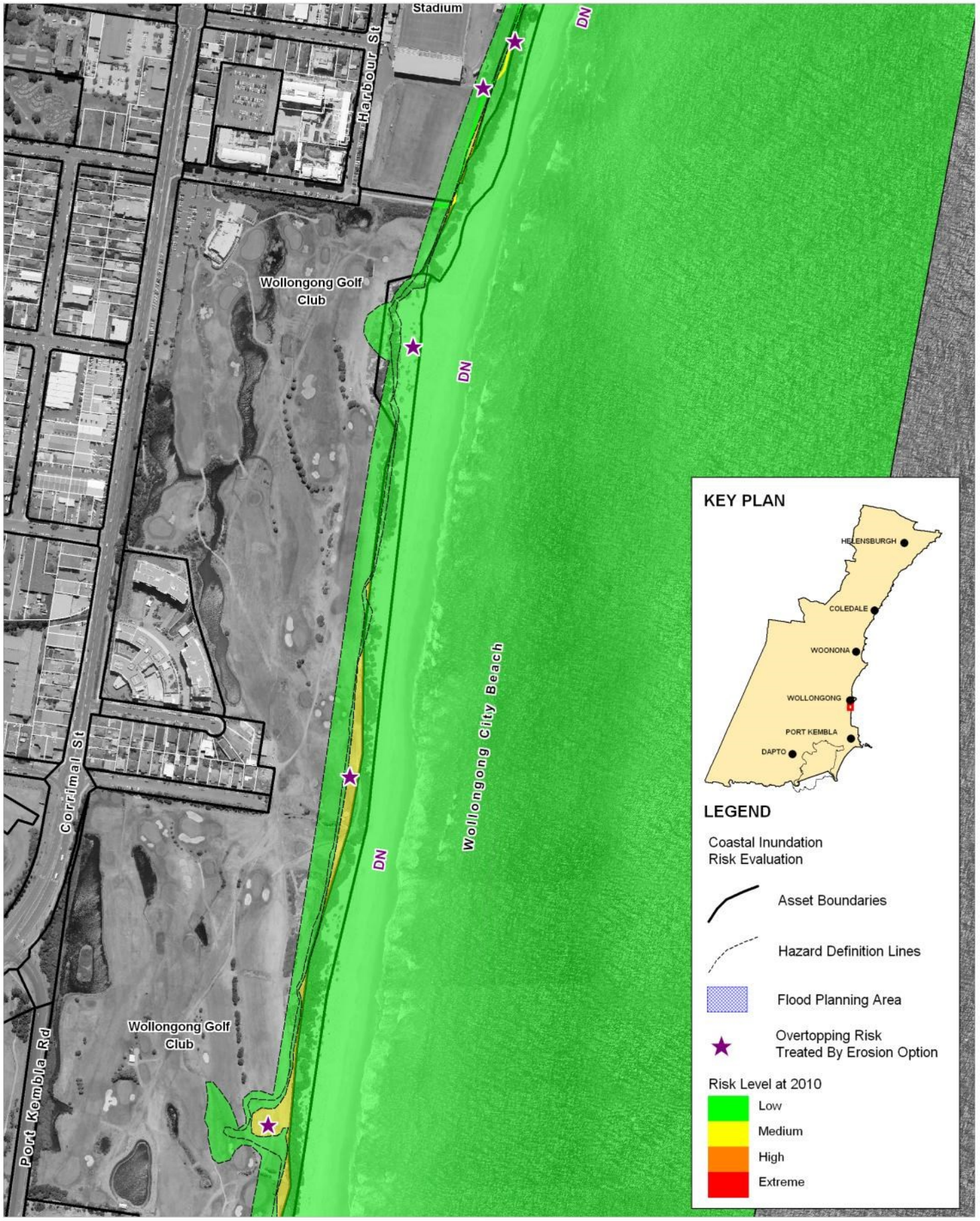
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_123_110429 Drawing 6-51.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Coniston Beach (north)

Drawing: 6-52

Rev: A

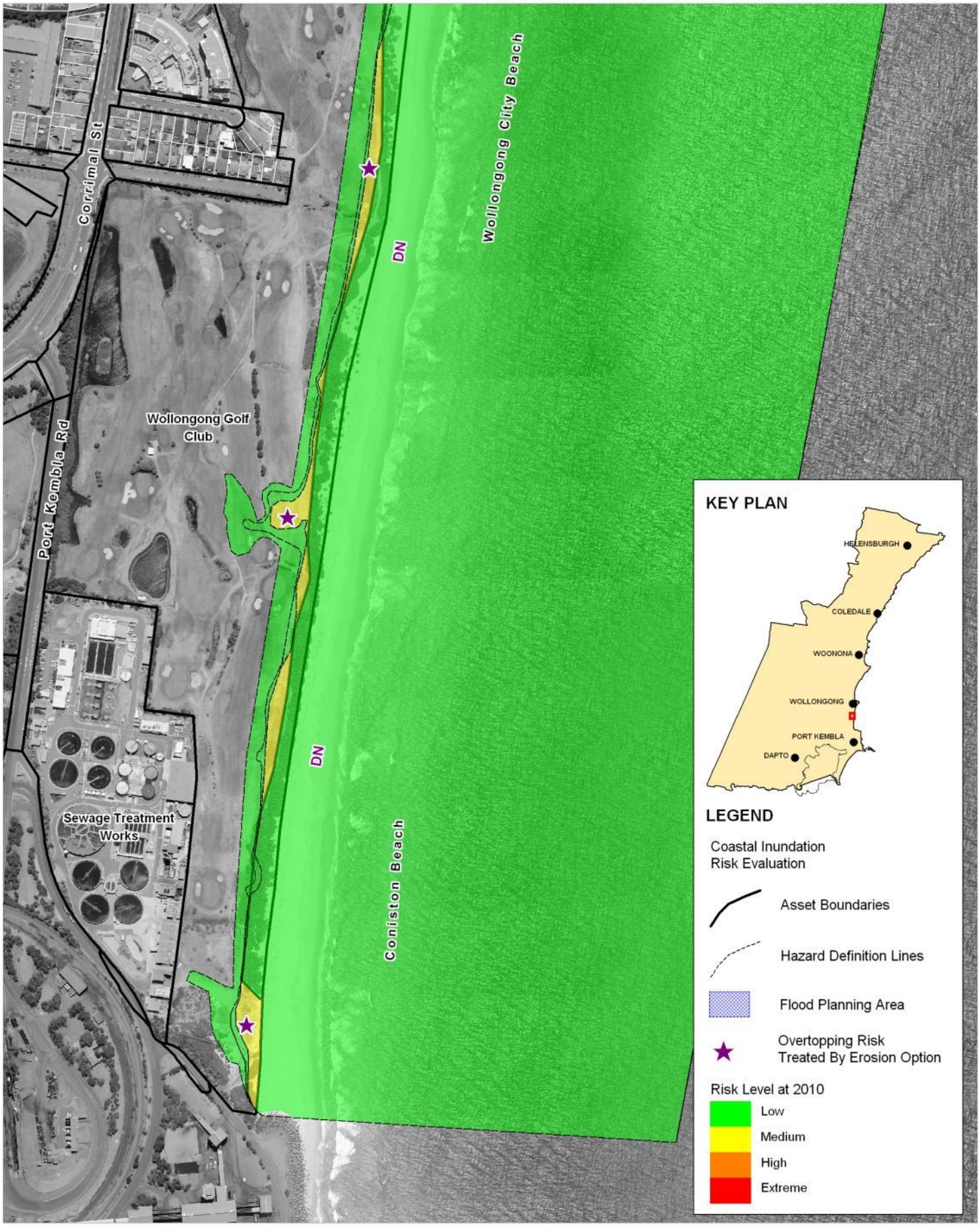
N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_122_1104129 Drawing 6-52.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Coniston Beach (south)

Drawing: 6-53

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_123_1104129 Drawing 6-53.WOR

6.19.2 Assessment of Treatment Options

Coniston

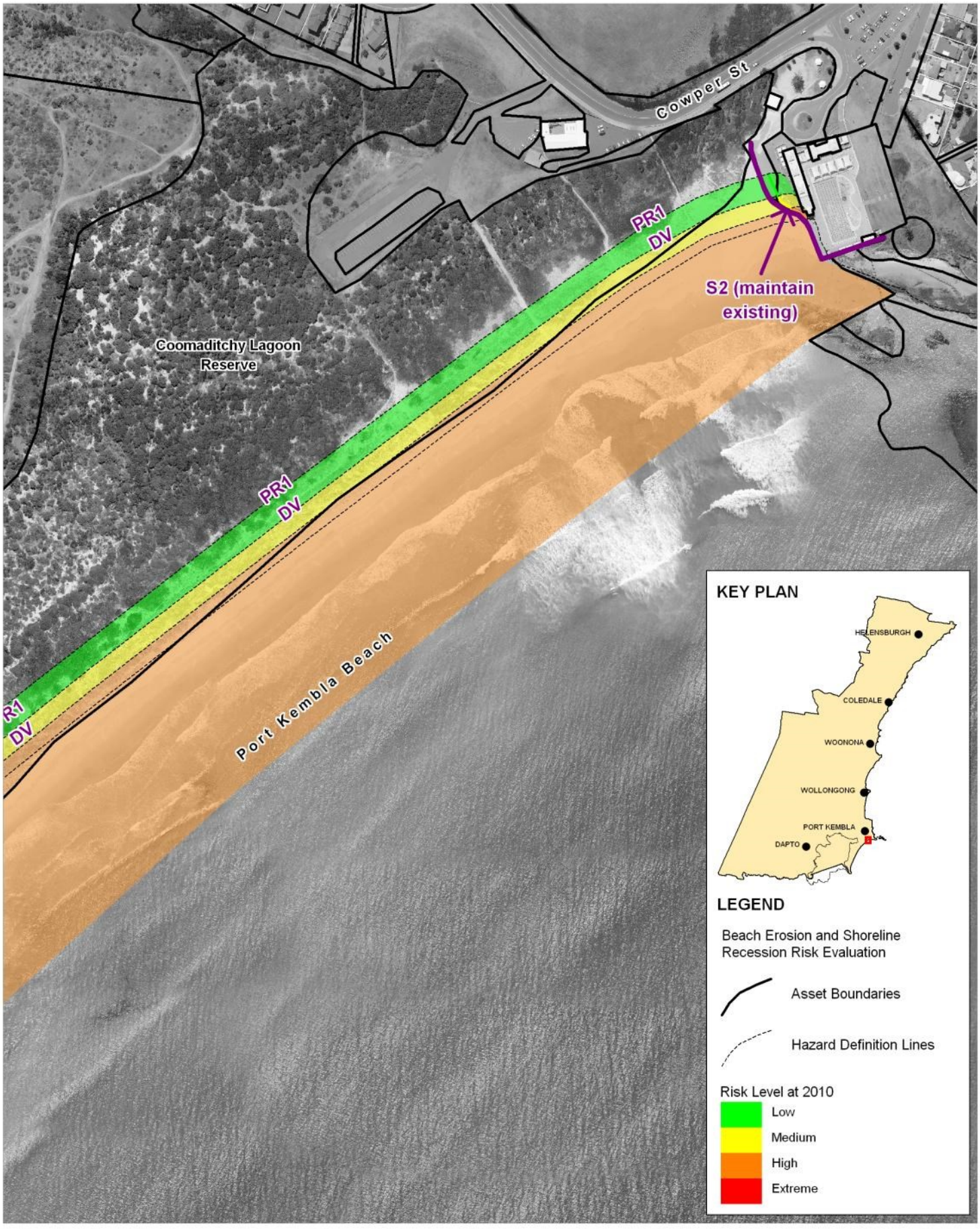
Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Coniston Beach	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	×								This is a priorty for the beach from WIN Stadium toward the south, as dune vegetation, width and height are limited. The program should progress southwards from the WIN Stadium, to take advantage of the typical northward transport of sediment. Enhanced dune vegetation will also improve protection from wave overtopping which poses a risk along Wollongong Golf Course boundary. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) **?** Private landholders who directly benefit from option	Recommended
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	×								This option would aim to support dune restoration activities from WIN Stadium south. This involves scraping and contouring beach sands (in combination with dune revegetation) to increase sand volumes held in dune storage for storm protection. *Refer to Protect Options Table for further cost benefit details for BM.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) **?** Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	×								This is an excellent option for retaining the beach. The golf course will remain a viable land use even if after erosion iimpacts. Dune vegetation works aim to slow the progression of erosion, at least over the short term. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	×								Coastal DCP development controls shall be applied to Wollongong Golf Course lands, in the case of redevelopments on the site. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement for public assets ☑ Private landholders - cost to implement DCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								This is largely an acceptable option with major assets typically at low risk at present. This option is not reversible in the future for development or land that is lost to erosion. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Marginal

6.20 Perkins Beach

6.20.1 Erosion and Recession Risk Level and Treatment Options

Perkins Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
Fishermans Beach & MM Beach	High	Extreme	Extreme				✓✓		✓✓								NR14	
Heritage listed: Hill 60 Nature Reserve	Low	Medium	Medium						✓✓									✓
Port Kembla - Perkins Beach - Windang Beach	High	Extreme	Extreme				✓✓		✓✓								NR14	
Coastal Dune Systems: Pork Kembla Beach, Perkins Beach Reserve	High	Extreme	Extreme				✓✓		✓✓									
Griffith Street Reserve, Port Kembla Beach Reserve, Windang Beach Reserve, Public Open Space	Low	Medium	Medium						✓✓									✓
Community Infrastructure																		
Port Kembla Olympic Pool	High	Extreme	Extreme			✓✓				✓				✓			NR4, NR2, NR14	
Port Kembla Pool - Amenities/Kiosk/Lifeguard Tower	High	Extreme	Extreme			✓✓				✓				✓			NR2	
Windang Surf Club	Low	Low	Low											✓✓				
Windang Beach Dressing rooms / toilets	Low	Low	Low											✓✓				
Transport Infrastructure																		
Lake Illawarra Training Walls	High	Extreme	Extreme												✓		NR14	
Water and sewage infrastructure																		
Stormwater outlets & pipes (one adjacent to Port Kembla Pool)	High	Extreme	Extreme			✓✓				✓				✓			NR7, NR2, NR14	

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Erosion Risk Levels and Treatment Options Port Kembla Beach - Seawall S2 Option

Drawing: 6-54

Rev: A

N

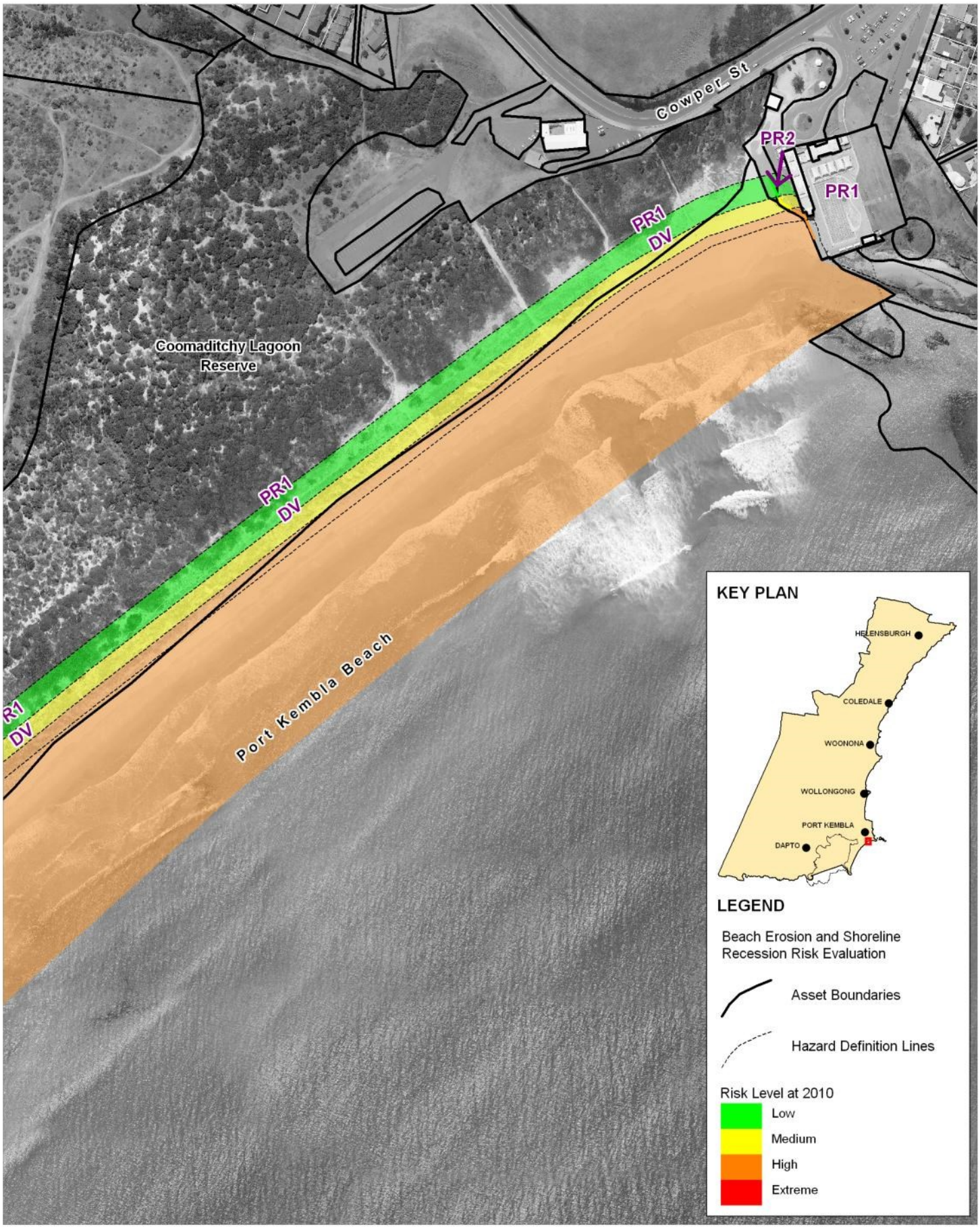
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_124_110429 Drawing 6-54.WOR



Title:

Immediate Erosion Risk Levels and Treatment Options
Port Kembla Beach - Planned Retreat Option

Drawing: 6-55

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM

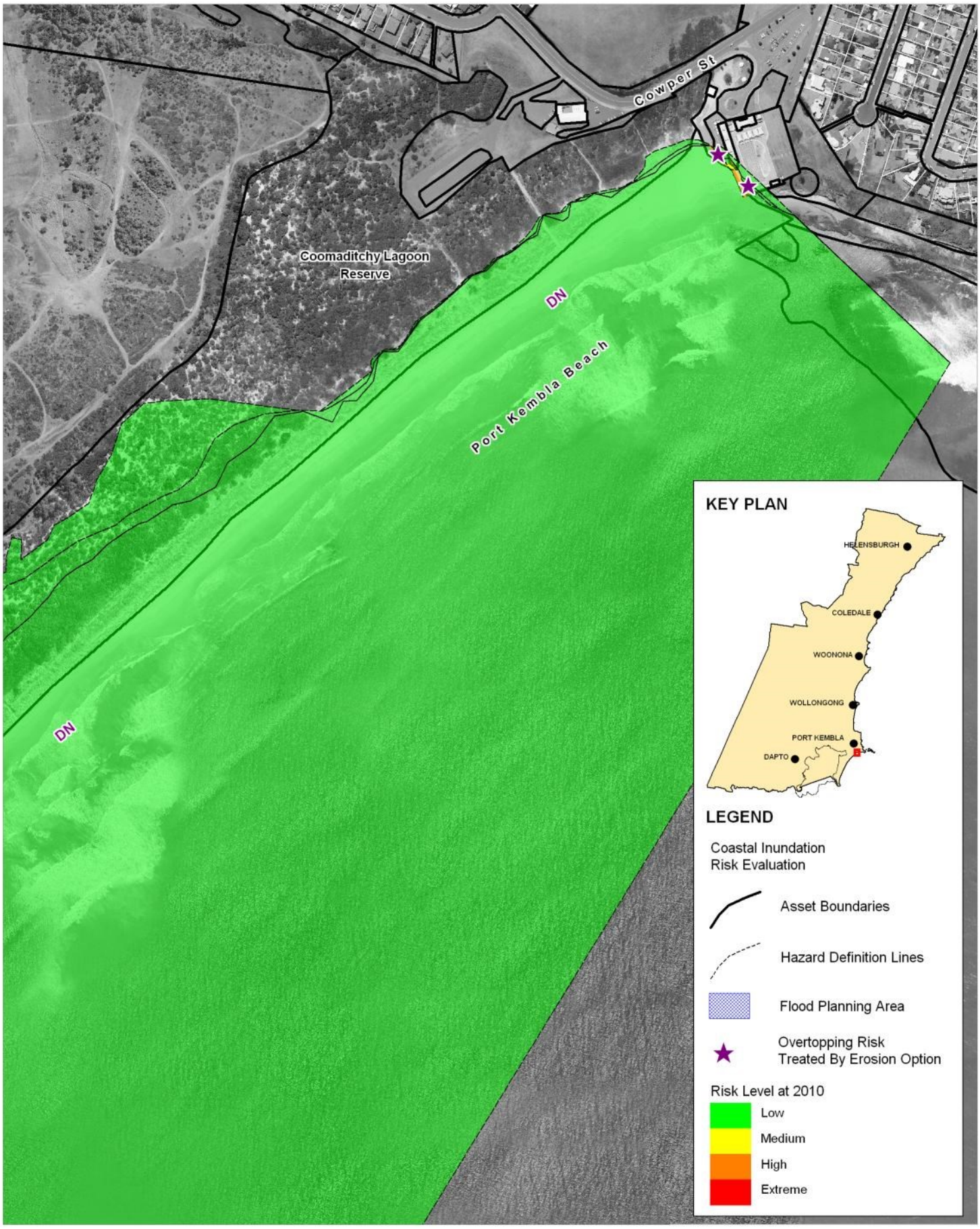
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_124_110429 Drawing 6-55.WOR

6.20.2 Coastal Inundation Risk Level and Treatment Options

Perkins Beach	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Fishermans Beach & MM Beach	Low	Low	Medium						✓
Heritage listed: Hill 60 Nature Reserve	Low	Low	Medium						✓
Port Kembla - Perkins Beach - Windang Beach	Low	Low	Medium						✓
Coastal Dune Systems: Pork Kembla Beach, Perkins Beach Reserve	Low	Low	Medium						✓
Griffith Street Reserve, Port Kembla Beach Reserve, Windang Beach Reserve, Public Open Space	Low	Low	Medium						✓
Community Infrastructure									
Port Kembla Olympic Pool	Medium	Medium	High	✓					
Port Kembla Pool - Amenities/Kiosk/Lifeguard Tower	Medium	Medium	High	✓					
Windang Surf Club	Medium	Medium	High	✓			✓		
Windang Beach Dressing rooms / toilets	Low	Low	Low	✓					✓
Transport Infrastructure									
Local Roads	Low	Medium	Medium						✓
Lake Illawarra Training Walls	Low	Low	Medium						✓
Water and sewage infrastructure									
Stormwater outlets & pipes (one adjacent to Port Kembla Pool)	High	Extreme	Extreme	✓					

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Port Kembla Beach

Drawing: 6-56

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM

www.wbmpl.com.au

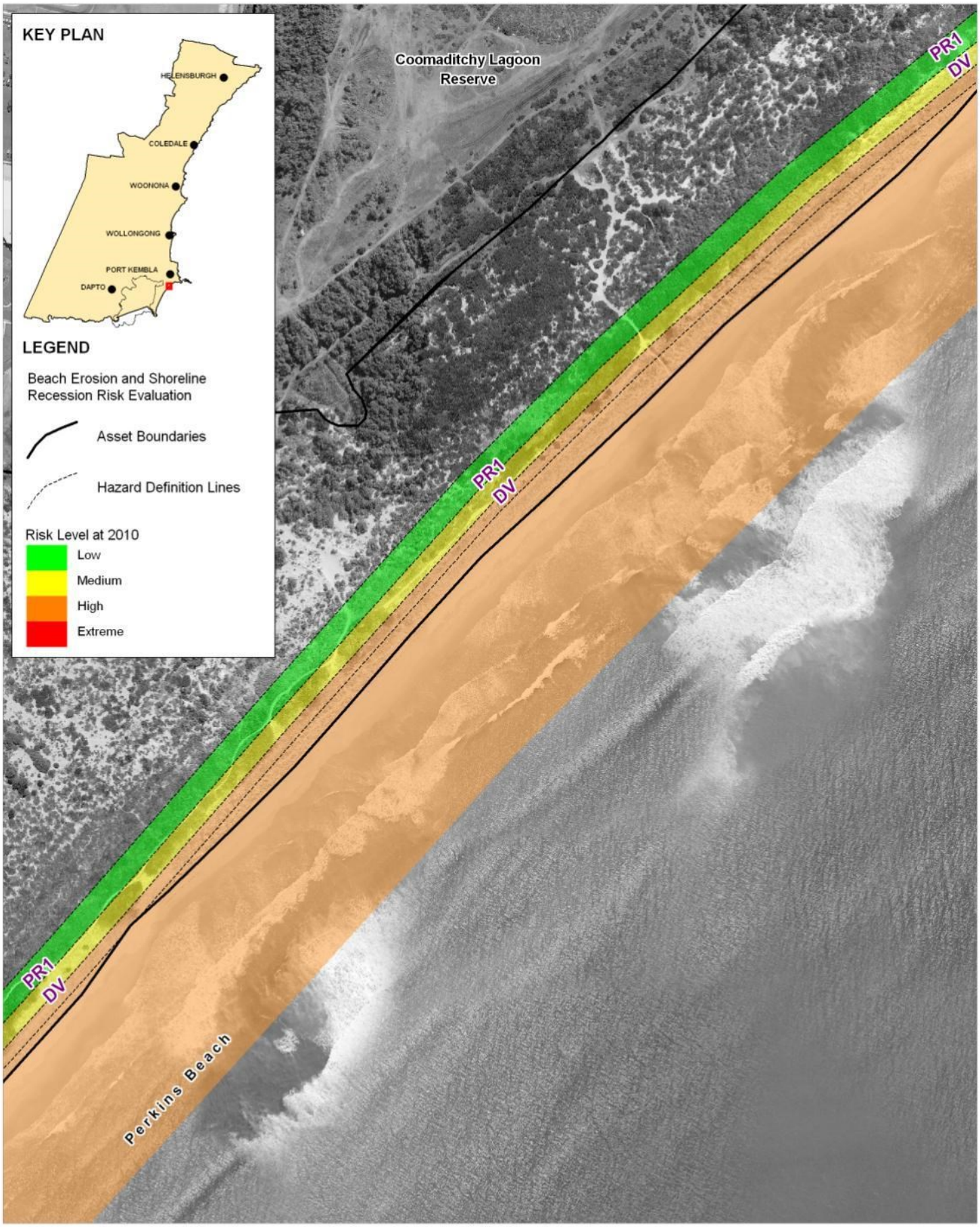
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_124_1104129 Drawing 6-56.WOR

6.20.3 Assessment of Treatment Options

Perkins

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Perkins Beach	Potential Funding Sources (Who may pay)	Conclusion
S2	Maintain existing seawall along existing alignment	On as needs basis for asset maintenance or to repair storm damage.	✓	✓	x								This option involves maintaining the existing seawall running adjacent to Port Kembla Olympic Pool. The ability of the wall to provide protection or be upgraded will depend upon outcomes of NR2. It is expected the wall already provides protection to land and pool assets, and could be progressively upgraded on an as needs basis overtime to continue to protect from erosion and wave overtopping (e.g. deflection or other barriers, changes to slope and armour stones). The wall would additionally protect the stormwater asset located beside the Pool. *Refer to Protect Options Table for further cost benefit details for S2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	x								Perkins Beach already has extensive dunes, and is a high priority area for rehabilitation in the Illawarra Biodiversity Strategy. *Refer to Protect Options Table for further cost benefit details for DV.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	x								This is an excellent option for retaining the beach at Port Kembla/Perkins to Windang, as there are extensive dunes and back beach reserve that are suitable to provide a buffer for natural retreat of the beach, and hence continued provision of a beach over the long term. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended
PR1	Accept loss following hazard event. Implement repairs to maintain public safety as impact occurs.	Repair damages to maintain public safety as impacts occur	✓	✓	x								If it is not possible to retain the seawall S2 along the Pool boundary, the long term result would be retreat from the Pool, with the structure slowly removed as impacts occurred. This is likely to be at a much later time than the suggested erosion impacts, as the existing wall is likely to provide protection even if it was decided not to maintain the wall. *Refer to Planned Retreat Options Table for further cost benefit details for PR1.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Not Recommended

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for PR1 Beach	Potential Funding Sources (Who may pay)	Conclusion
PR2	Relocate stormwater assets landward of hazard zone	**Current Action:** NR7 **Trigger:** When erosion or wave overtopping destabilises outlet or pipe OR the pipe requires replacement, whichever is sooner.	✓	✓	✗								As an alternative to upgrading the existing seawall, the stormwater asset located beneath the seawall adjacent to the pool would have to be progressively moved landward as the existing wall was impacted by erosion. *Refer to Planned Retreat Options Table for further cost benefit details for PR2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Not Recommended
DCP	Prepare a Coastal Management Development Control Plan (DCP) chapter, to implement controls upon future development and re-development (including minor and major alterations) to manage erosion, recession and wave overtopping risks.	As property / assets redeveloped, new developments built	✓	✓	✗								Coastal DCP controls shall apply to redevelopment of Windang SLSC and amenities buildings to manage wave overtopping and additionally erosion at Port Kembla Pool in conjunction with seawall options S2. *Refer to Accommodate Options Table for further cost benefit details for DCP.*	**?** State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement for public assets *N/A* Private landholders - cost to implement DCP	Recommended
A2	Redesign or retrofit Lake Illawarra Training Walls in current location to withstand impacts.	**Current Action:** None **Trigger:** When wave breaking destabilises armour stone and when frequency of overtopping is noted to impair boat passage through the entrance channel.	✓	✓	✓								With sea level rise, the Training walls are likely to experience increased wave impacts (breaking) and overtopping over time. There will be a need to maintain the walls, such as through increasing their height and replacing or enhancing armour stone to ensure the training walls remain intact overtime. *Refer to Accommodate Options Table for further cost benefit details for A2.*	☑ Lake Illawarra Authority (State Government) **?** Council (Current programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								For the majority of the beach length where there is no development directly affected, the risk can be accepted, particularly for inundation. Risks to assets at the far south and north end could also be accepted, provided the negative impacts can also be accepted. However, proposed actions to treat these risks are minimal compared with the benefit from retaining the assets. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) *N/A* Private landholders in Future Generations	Not Recommended
NR	NR1, NR2, NR4, NR7, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended



Title:

Immediate Erosion Risk Levels and Treatment Perkins Beach (1)

Drawing: 6-57

Rev: A

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

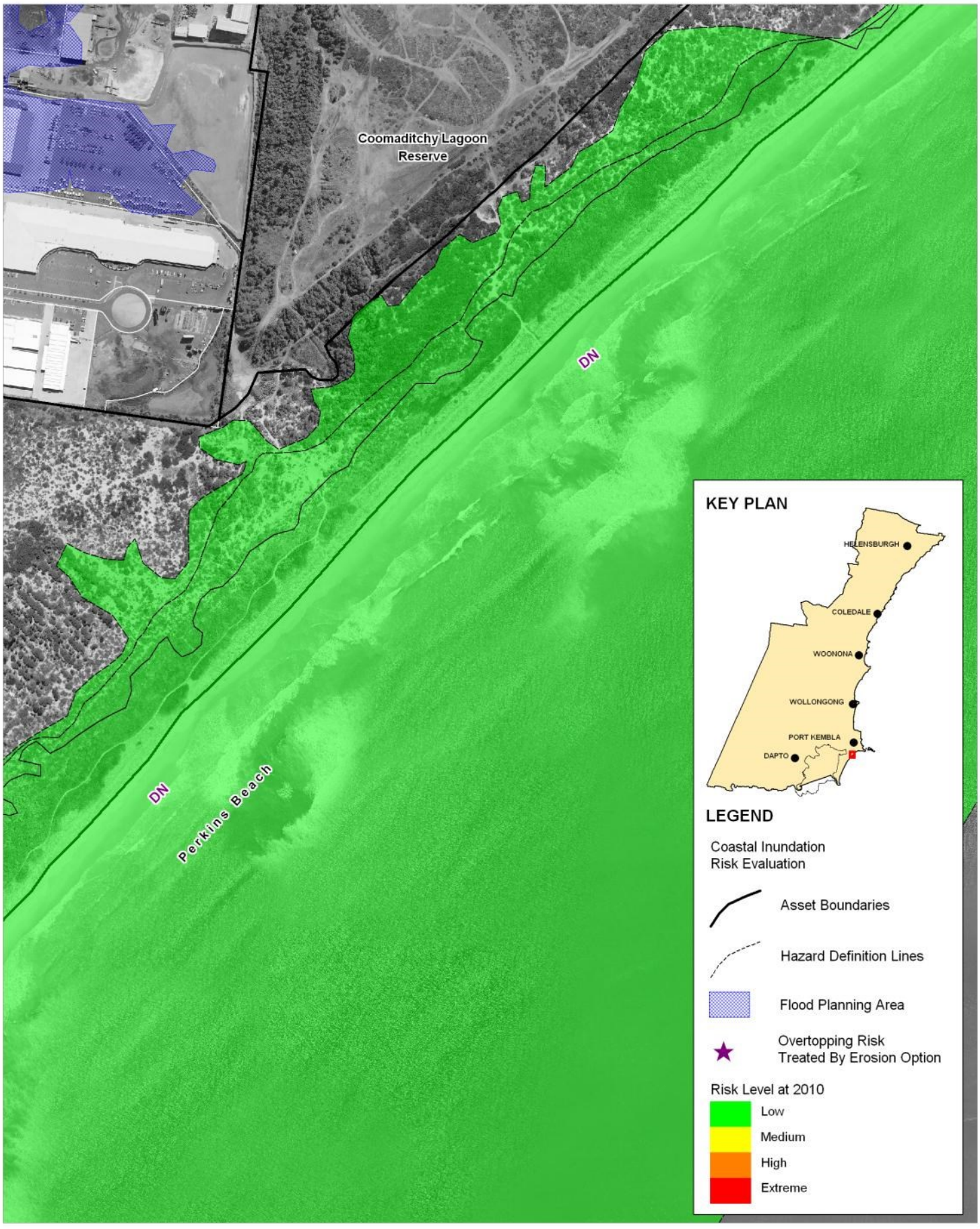
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_125_110429 Drawing 6-57.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Perkins Beach (1)

Drawing: 6-58

Rev: A

N

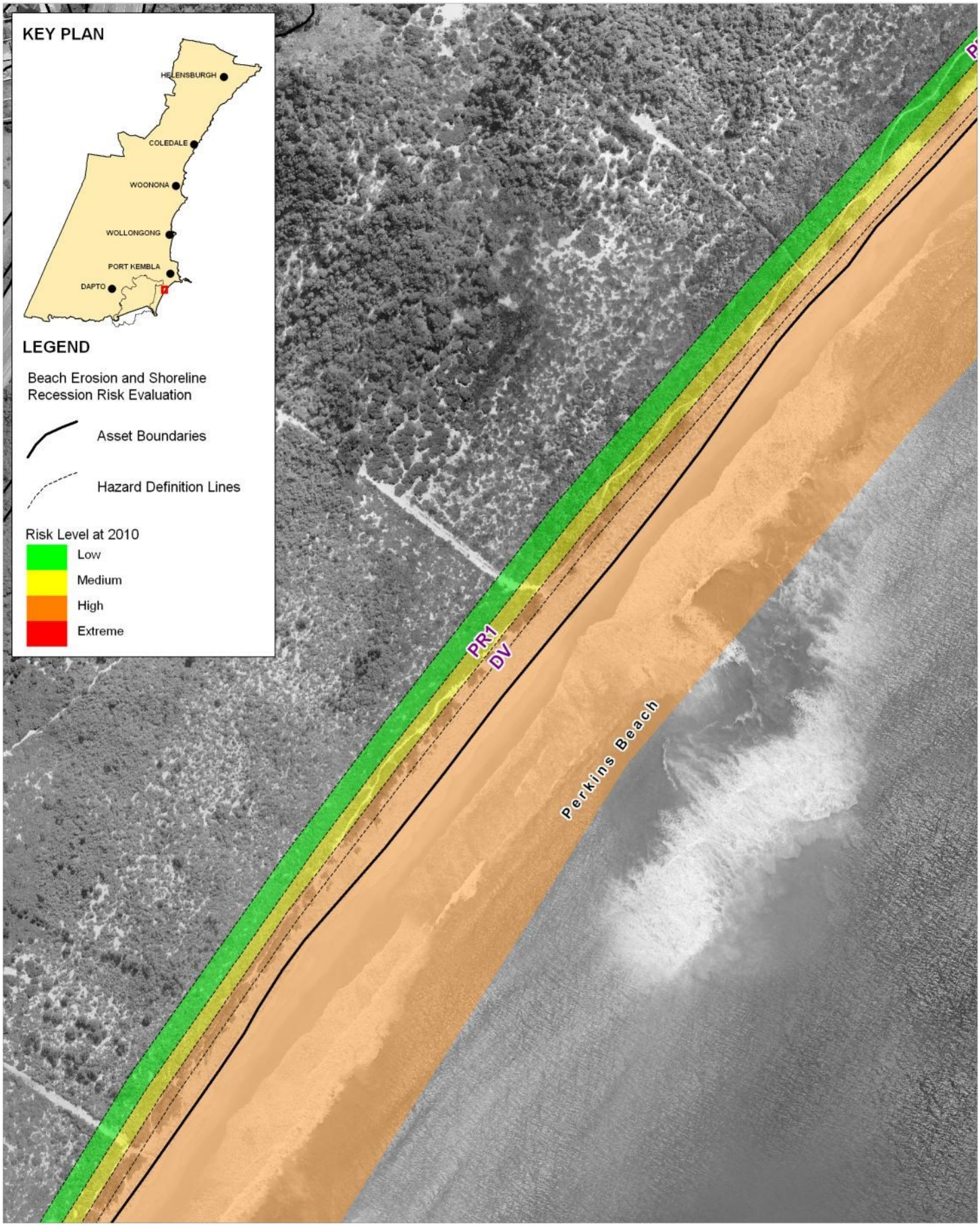
0 125 250m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_125_1104129 Drawing 6-58.WOR



Title:

Immediate Erosion Risk Levels and Treatment Perkins Beach (2)

Drawing: 6-59

Rev: A

N

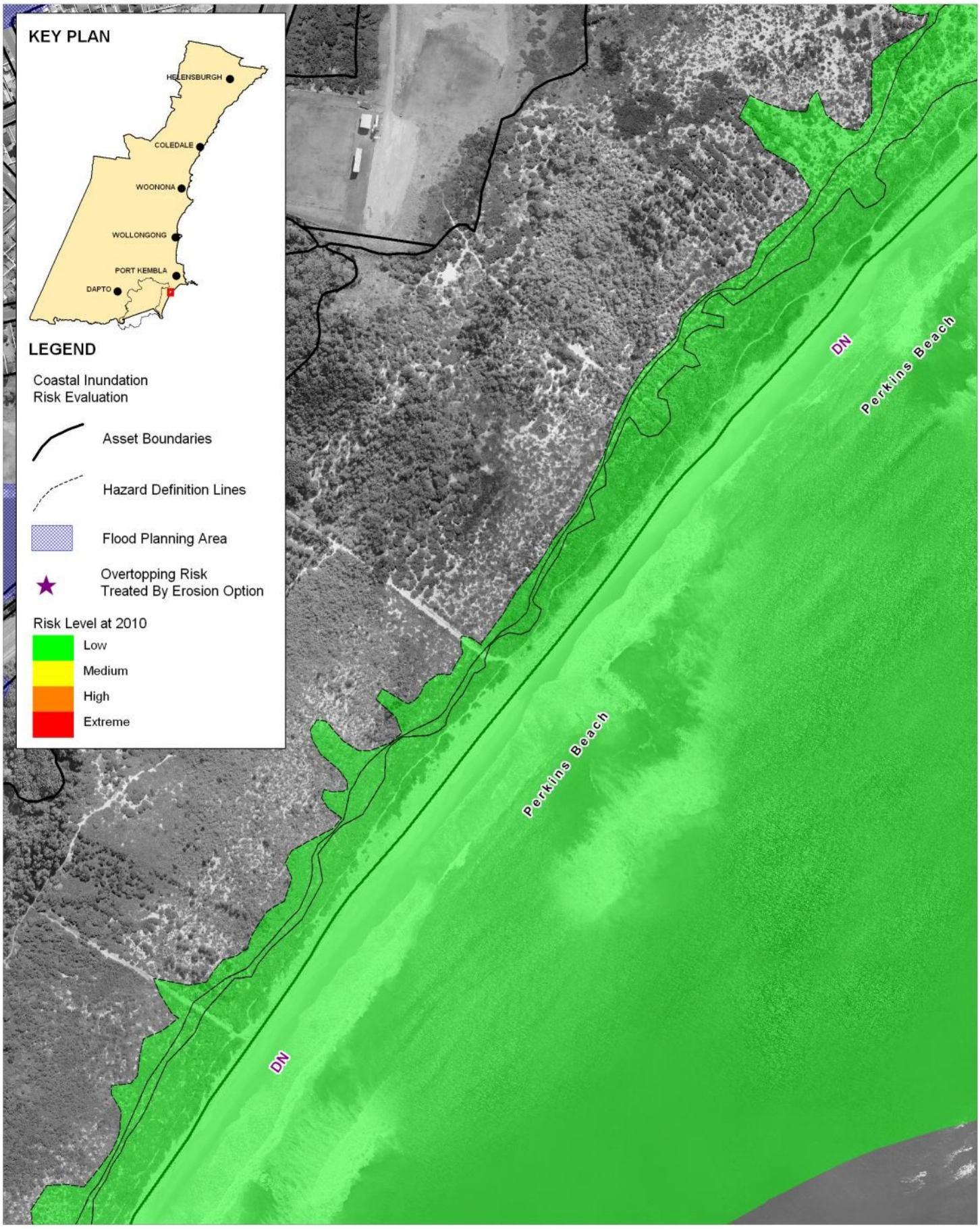
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_126_110429 Drawing 6-59.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Perkins Beach (2)

Drawing: 6-60

Rev: A

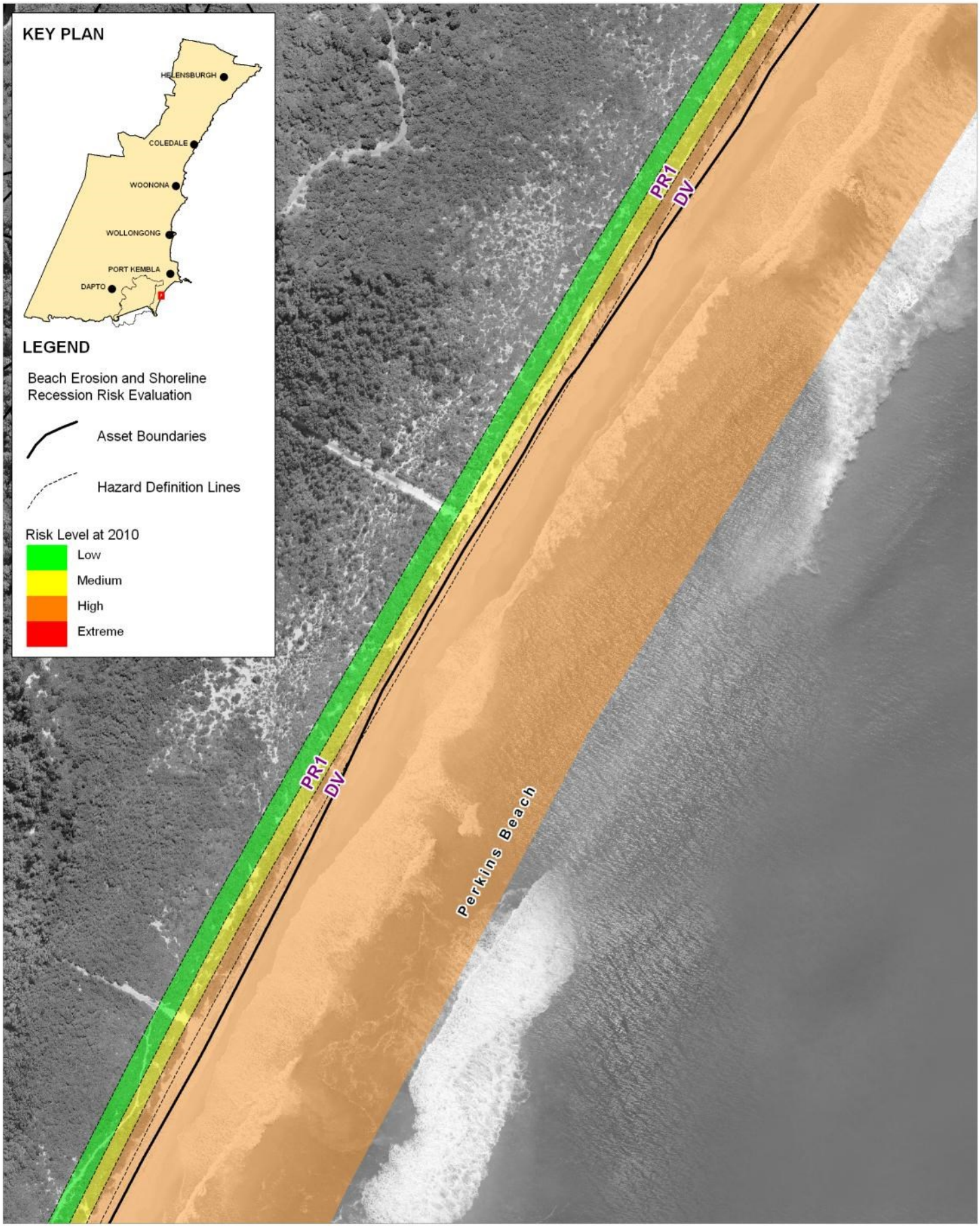
N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_126_1104129 Drawing 6-60.WOR



Title:

Immediate Erosion Risk Levels and Treatment Perkins Beach (3)

Drawing: 6-61

Rev: A

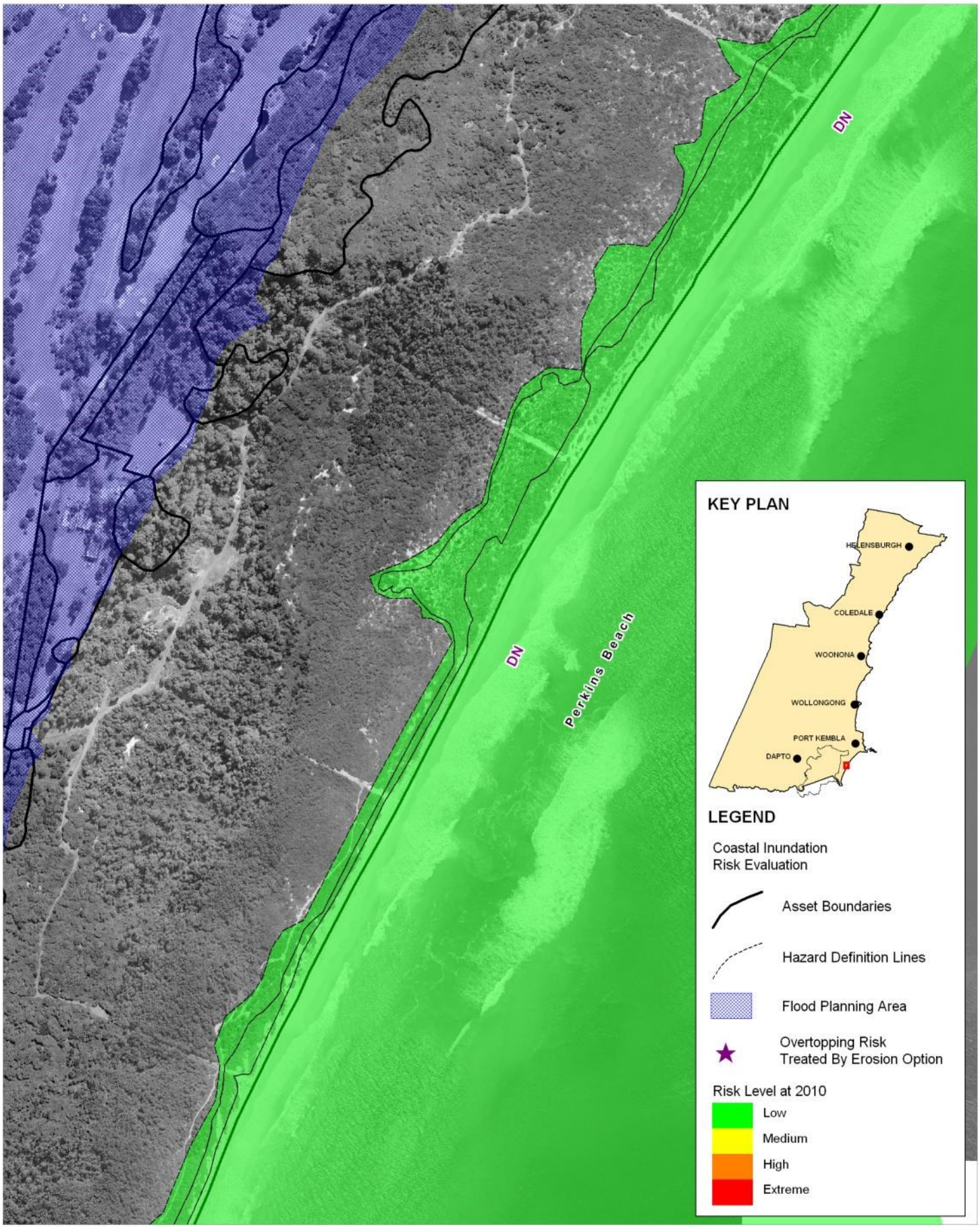
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_127_110429 Drawing 6-61.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Perkins Beach (3)

Drawing: 6-62

Rev: A

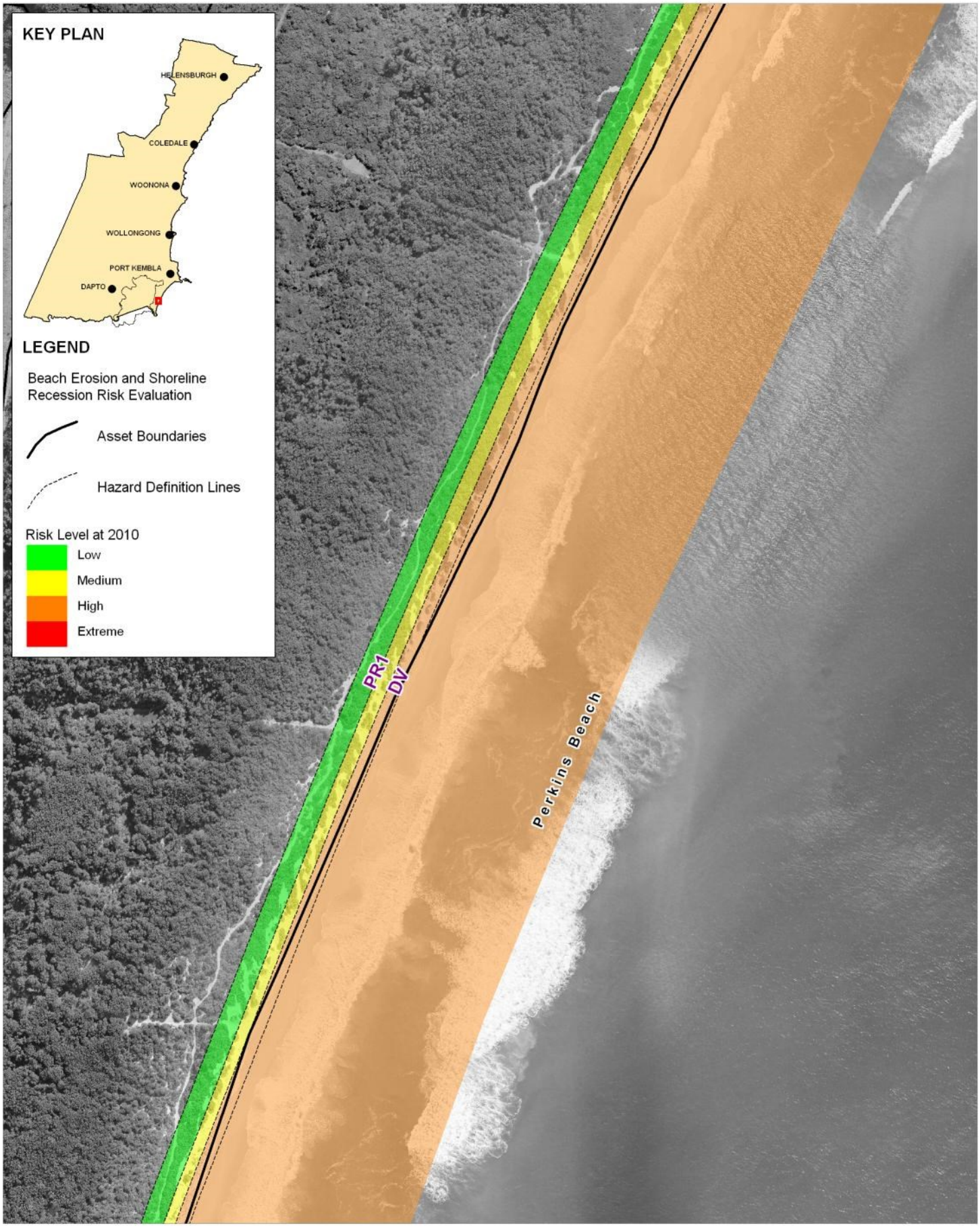
N

0 125 250m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_127_1104129 Drawing 6-62.WOR



Title:

Immediate Erosion Risk Levels and Treatment Perkins Beach (4)

Drawing: 6-63

Rev: A

N

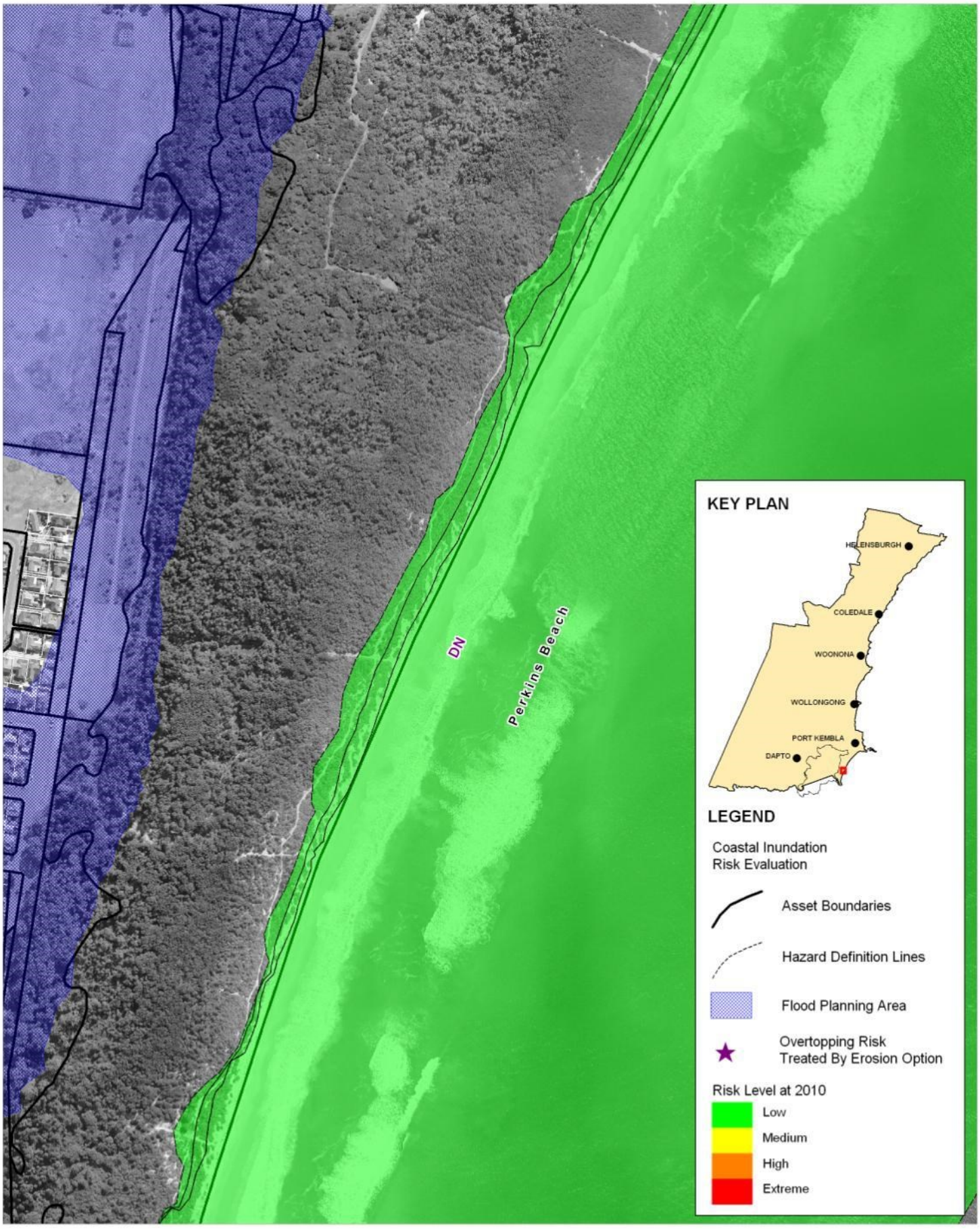
0 75 150m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_128_110429 Drawing 6-63.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Perkins Beach (4)

Drawing: 6-64

Rev: A

N

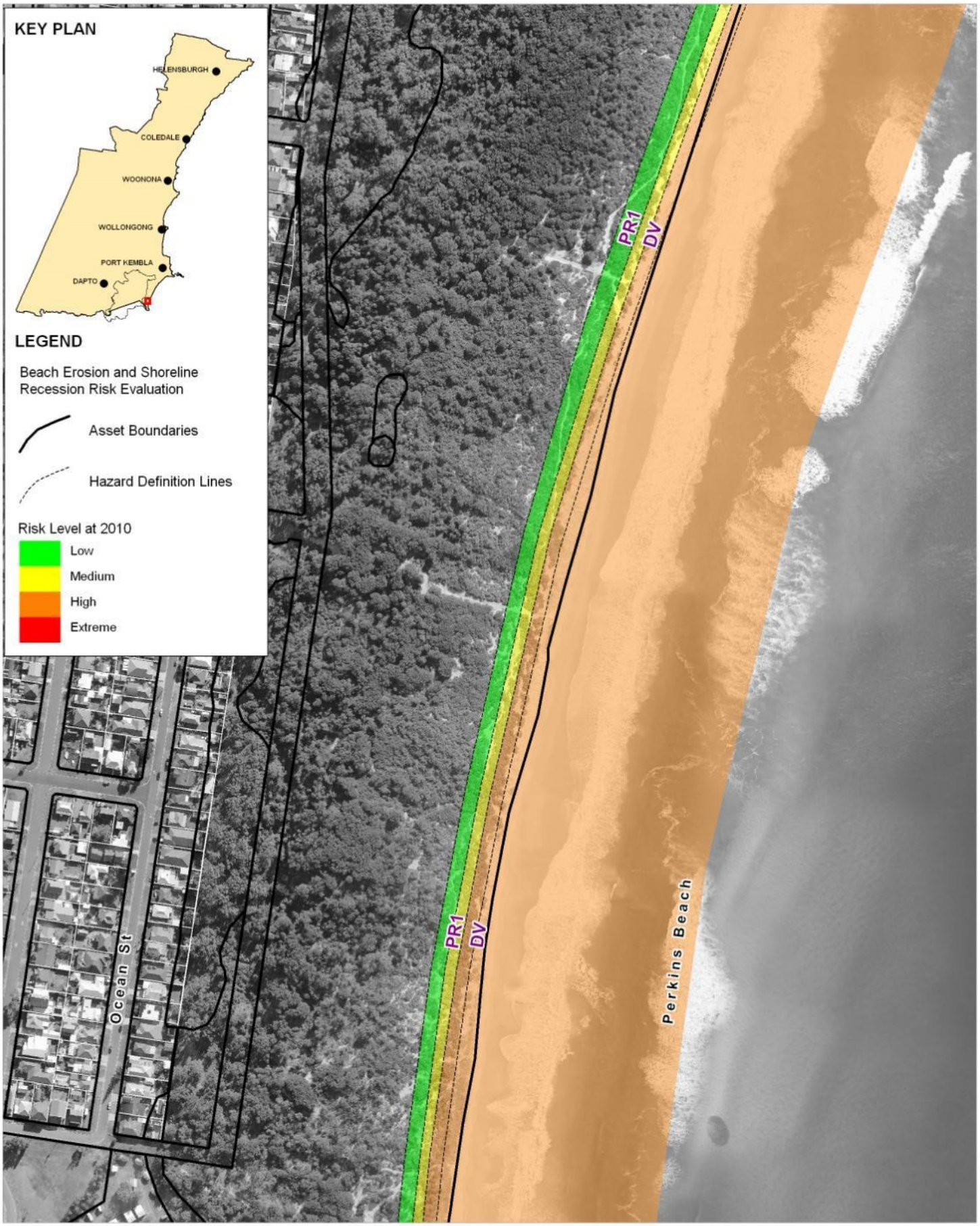
0 125 250m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_128_1104129 Drawing 6-64.WOR



Title:

Immediate Erosion Risk Levels and Treatment Perkins Beach (5)

Drawing: 6-65

Rev: A

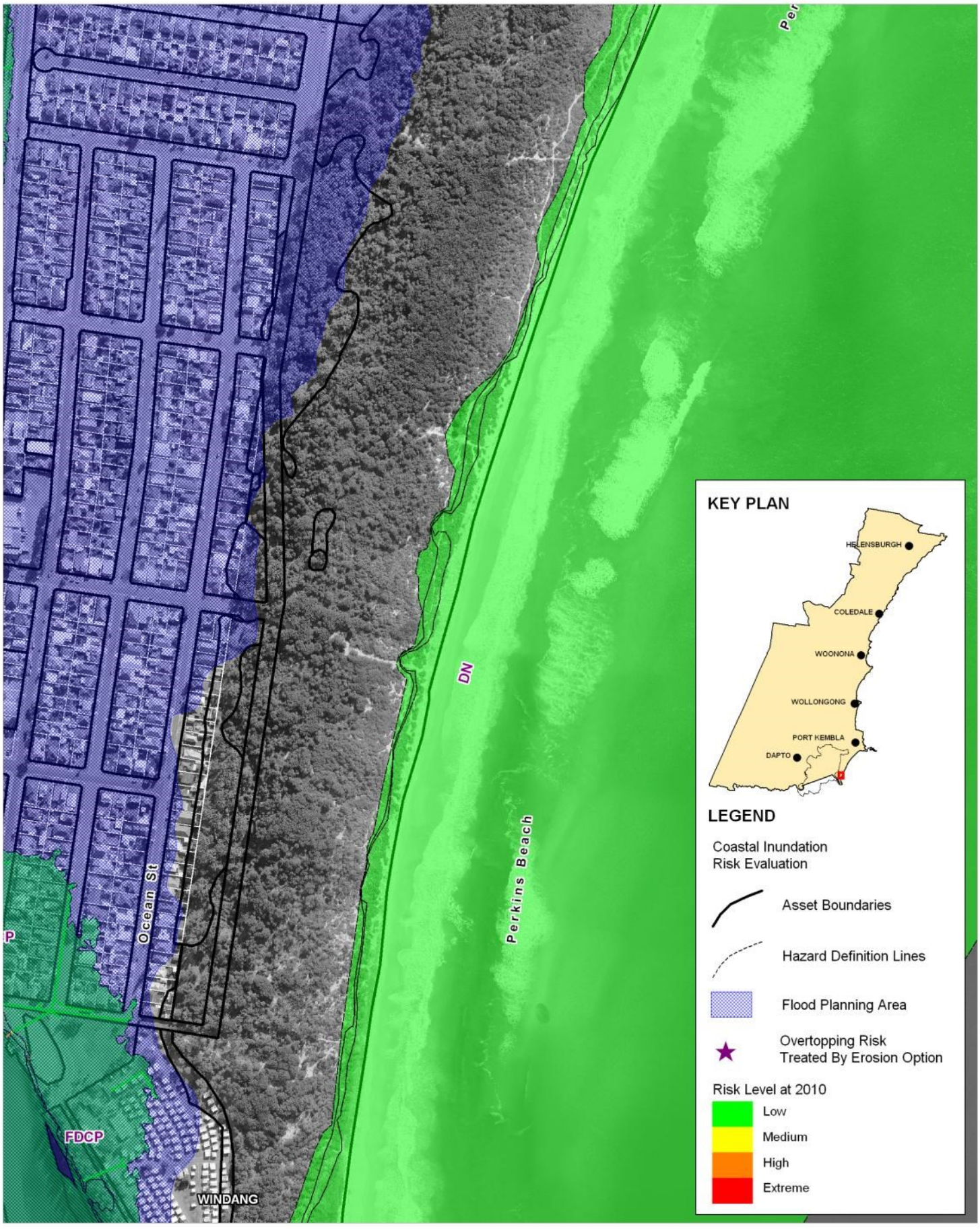
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_129_110429 Drawing 6-65.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Perkins Beach (5)

Drawing: 6-66

Rev: A

N

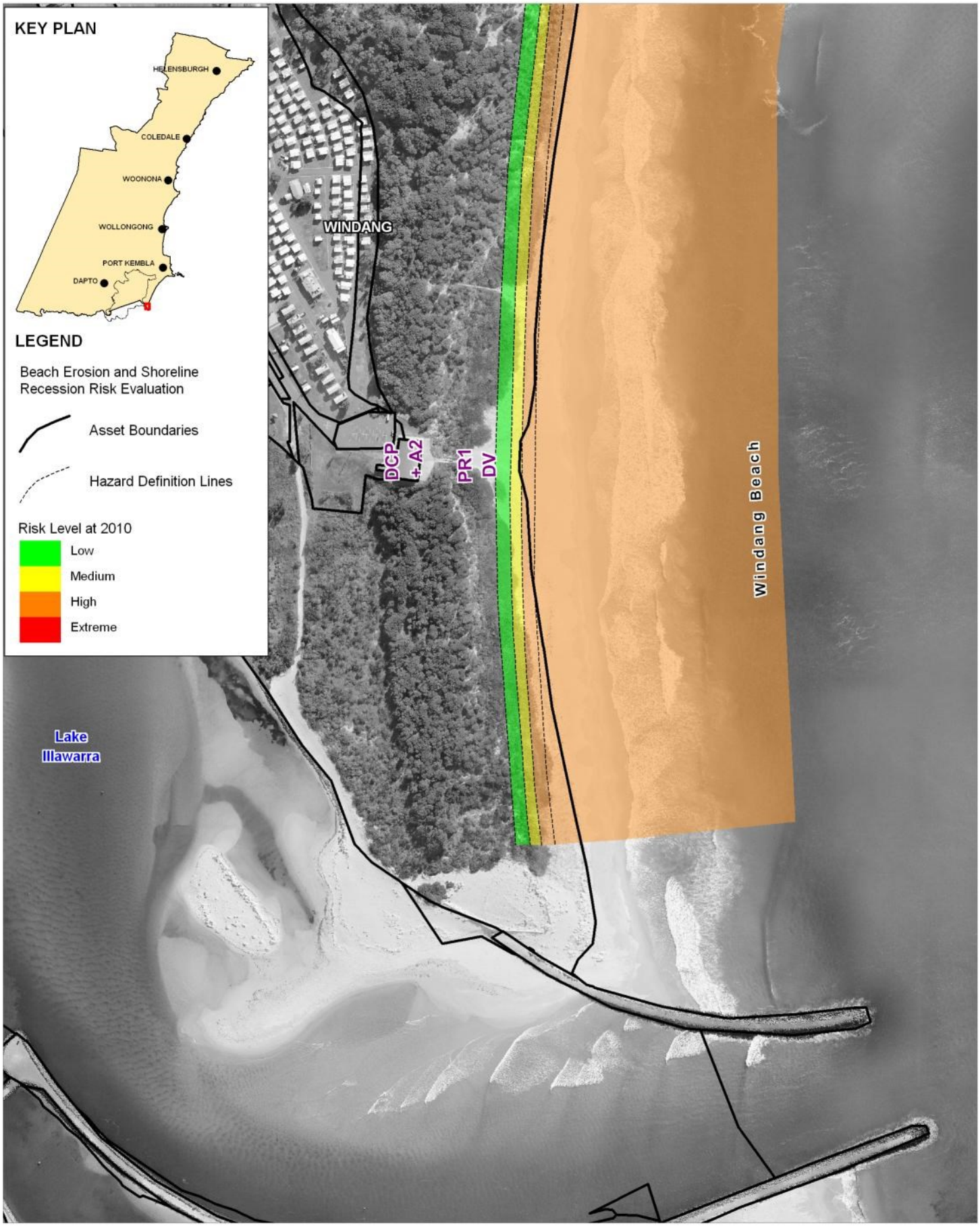
0 125 250m

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_129_1104129 Drawing 6-66.WOR



Title:

Immediate Erosion Risk Levels and Treatment Windang Beach

Drawing: 6-67

Rev: A

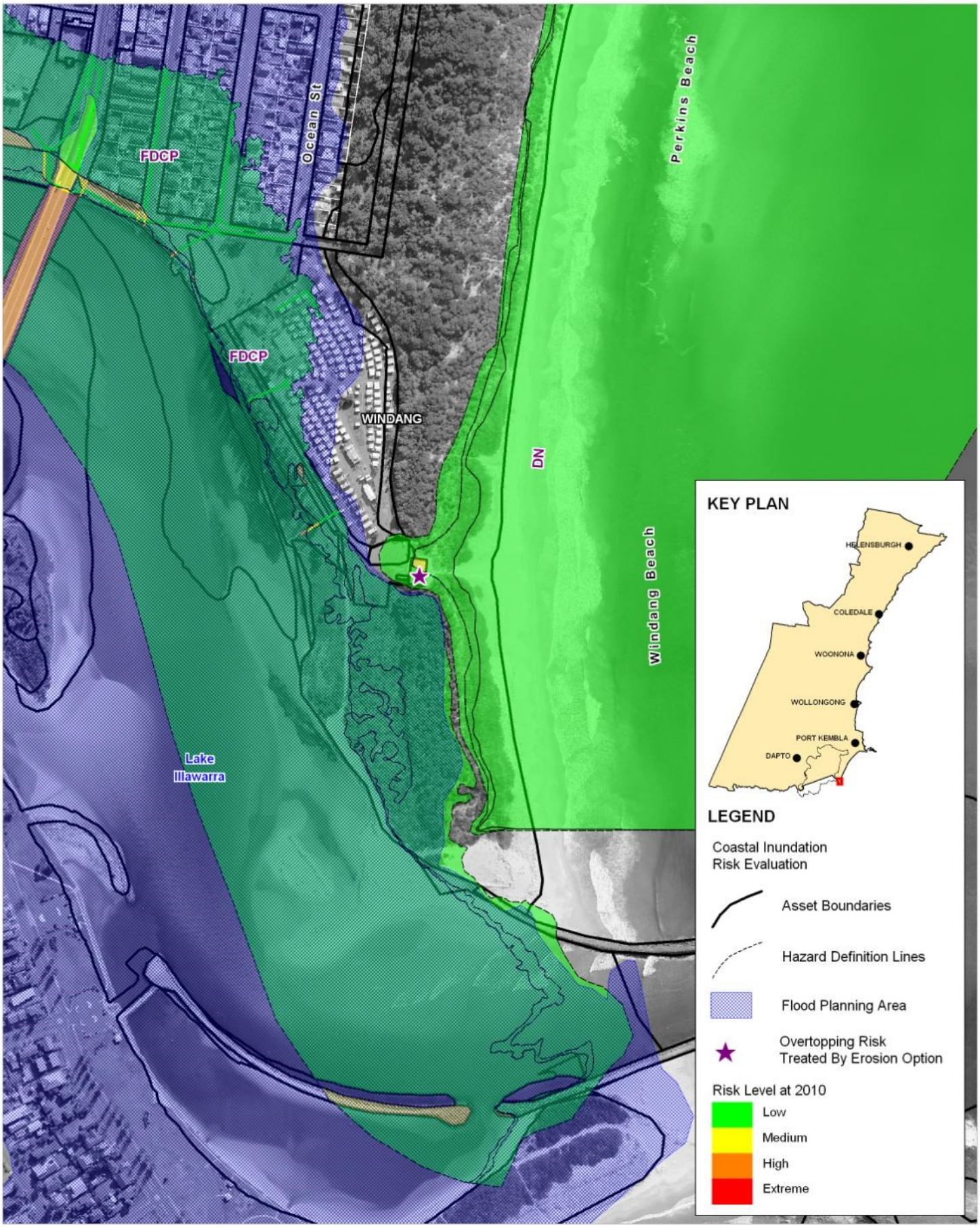
N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_130_110429 Drawing 6-67.WOR



Title:

Immediate Inundation Risk Levels and Treatment Options Windang Beach

Drawing: 6-68

Rev: A

N

0 125 250m

Approx. Scale

BMT WBM

www.wbmpl.com.au

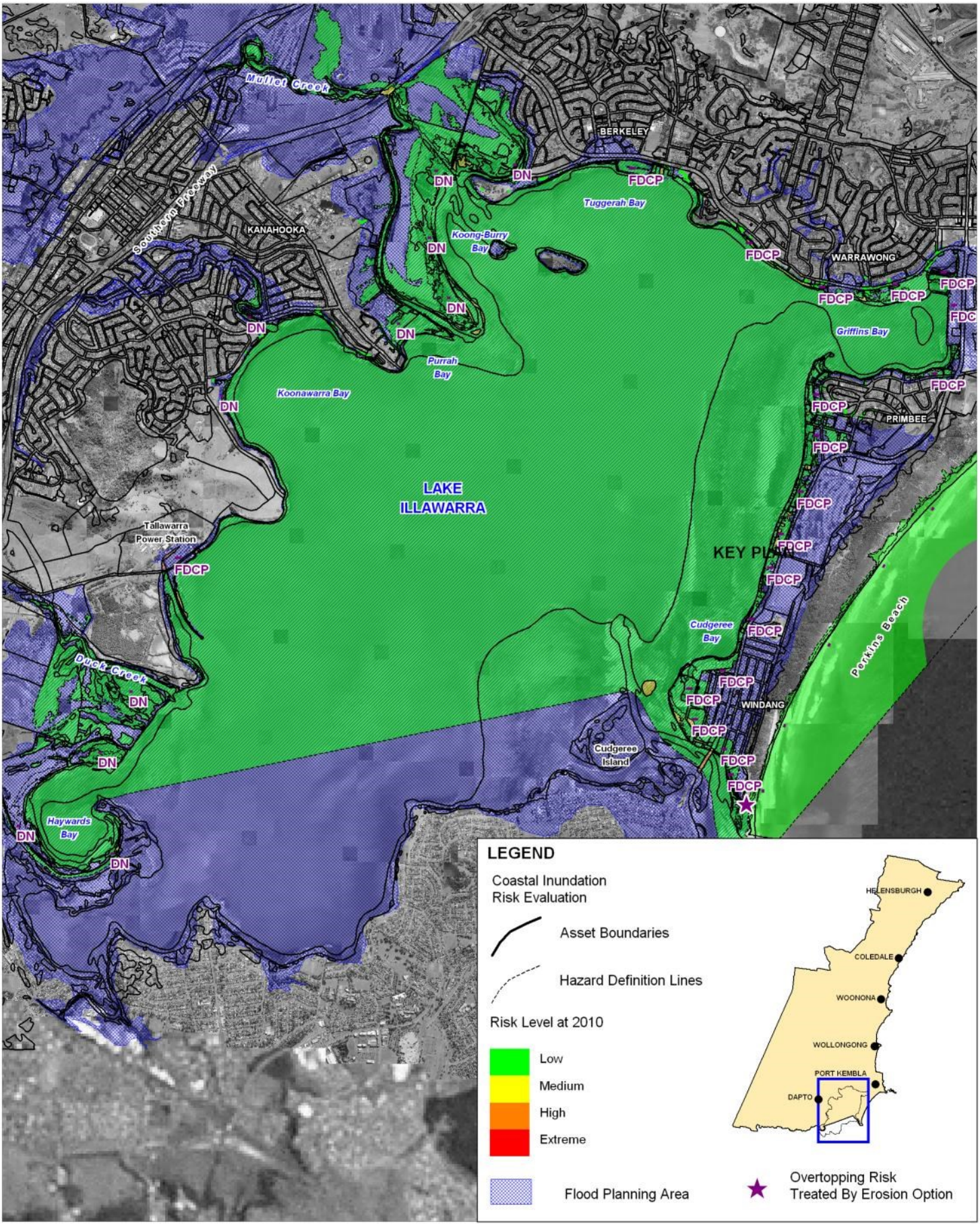
Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_130_1104129 Drawing 6-68.WOR

6.21 Lake Illawarra

6.21.1 Coastal Inundation Risk Level and Treatment Options

Lake Illawarra Foreshores	Inundation Risk Level			Inundation Risk Treatments					
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Treated by erosion option**	Planned Retreat	Accomm-odate		No Regrets	"Do Nothing" (Accept Risk)
Parks, Beaches and open space					PR2	FDCP	A2	Investigate*	DN
Lake Illawarra Foreshore	Low	Low	Low						✓
Windang Foreshore Park	Low	Low	Low						✓
Boronia Park / Oval	Low	Low	Low						✓
Kully Bay Park	Low	Low	Low						✓
Hooka Point Park	Low	Low	Medium						✓
Fred Finch Park Natural Area	Low	Low	Low						✓
Purrah Bay Reserve	Low	Low	Low						✓
Koonawarra Bay reserve / park	Low	Low	Medium						✓
Lakeside Drive Reserve	Low	Low	Medium						✓
Holbom Park Sailing Club	Medium	Medium	High			✓		NR14	
Windang Bowls Club (private recreation)	Low	Medium	Medium			✓			✓
Illawarra Yacht Club (private recreation)	Low	Low	Medium			✓			✓
EEC Swamp Oak Floodplain Forest	Medium	Medium	High					NR11	
EEC Coastal Swamp Oak Forest	Low	Medium	Medium					NR11	✓
Community Infrastructure									
Windang Tourist Park	Low	Medium	Medium			✓			✓
Other caravan parks	Low	Medium	Medium			✓			✓
Lake Illawarra Cycleway / Shared Pathway	Low	Medium	Medium						✓
Windang Memorial Park - Toilets	Low	Low	Medium			✓			✓
Windang Memorial Park - Tennis Clubhouse (leased)	Low	Low	Low			✓			✓
Boronia Park Dressing Sheds / toilets / gardeners	Low	Low	Medium			✓			✓
Boronia Park Kiosk	Low	Low	Medium			✓			✓
Boronia Park Pigeon Clubroom	Low	Low	Medium			✓			✓
Boronia Park Scout Hall	Low	Low	Medium			✓			✓
Fred Finch Park Baseball Kiosk	Low	Low	Low			✓			✓
Fred Finch Park Pony Clubhouse	Low	Low	Low			✓			✓
Fred Finch Park - Berkeley Basketball Stadium	Low	Medium	Medium			✓			✓
Willam Beach Park Exeloo, Brownsville	Low	Low	Medium			✓			✓
Transport Infrastructure									
Major roads, bridges: Windang Rd and Bridge	High	Extreme	Extreme			✓		NR14	
Local Roads, car parks	Low	Medium	Medium						✓
Port Kembla Sailing Club Boat ramp and harbour	Medium	Medium	High			✓			
Water and sewage infrastructure									
Stormwater outlets / pipes	Medium	High	High			✓	✓	NR7, NR14	
Residential Development									
Existing Residences (numerous)	Medium	Medium	High			✓			
Vacant Land (Future Development: Tourist zone at Kully Bay)	Low	Low	Low			✓			✓
Vacant Land (3 residential zoned blocks at Purrah Bay)	Medium	Medium	Medium			✓			
Note: 674 land parcels affected									
Commercial and Industrial Development									
Oasis Resort and Caravan Park	Low	Low	Medium			✓			✓
Tru Energy Gas Powered Station	High	Extreme	Extreme			✓		NR14	
Institutional Infrastructure									
Windang Public School	Medium	High	High			✓			

Sym-bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future dev't and re-dev't)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future dev't and re-dev't)
NR1	Update Asset Register for Hazards
NR2	Audit existing seawalls
NR3	Assess Public Buildings for "accommodate" or "relocate"
NR4	Audit Ocean Pool condition
NR5	Assess Roads for "accommodate" or "relocate"
NR6	Assess Cycleways for "accommodate" or "relocate"
NR7	Design criteria for Stormwater Assets
NR8	Design criteria for Waste water, water supply and electricity assets
NR9	Develop evacuation plans
NR10	Conduct Flood Study including ocean water levels
NR11	Audit EECs and habitats for priority conservation
NR12	Use Norfolk Island Pines in new plantings
NR13	Manage Aboriginal Heritage Items
NR14	Monitor erosion & inundation events
DN	"Do Nothing" (Accept Risk)
✓✓	Substantial risk reduction and / or highly effective in managing risk
✓	Good risk reduction and / or effective in managing risk
?	Technical feasibility of applying the option is questionable
•	"Do Nothing" option is likely to have detrimental effect OR result in increased risk over time



Title:

Immediate Inundation Risk Levels and Treatment Options Lake Illawarra

Drawing: 6-69

Rev: A

N

0 1 2km

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_257_110429 Drawing 6-69.WOR

6.21.2 Assessment of Treatment Options

Lake Illawarra

Sym-bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for Lake Illawarra	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	**Current Action:** NR7 **Trigger:** When inundation frequency impedes effective conveyance of stormwater OR as asset replacement is required, whichever is sooner;	×	×	✓								Stormwater assets may be increasingly impacted by inundation with sea level rise (this includes increased frequency of inundation events from storms). This option involves redesigning and / or re-siting the stormwater structures at their current location to withstand impacts. Designs will depend on outcomes of NR7. *Refer to Accommodate Options Table for further cost benefit details for A2.*	**?** State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) *N/A* Private landholders who directly benefit from option	Recommended
FDCP	Update DCP Chapter E13 – Floodplain Management to include areas affected by Coastal Inundation as Low Risk Flood Precincts, and implement DCP to manage inundation impacts as properties are redeveloped and assets replaced.	As property / assets redeveloped, new developments built	×	×	✓								Given that the existing Flood Planning Area extends over and beyond the coastal inundation area at Lake Illawarra, all affected properties will already be subject to FDCP. This option re-iterates the use of the FDCP controls, with the flood planning levels from the Flood Study to override levels given for coastal inundation alone. A recent Flood Study was conducted using a combined ocean water level and catchment flood event, providing a current and applicable flood level calculaton for use in planning. *Refer to Accommodate Options Table for further cost benefit details for FDCP.*	*N/A* State Government (external funding unlikely to be needed) ☑ Council (Current Programs) ☑ Private landholders - cost to implement FDCP	Recommended
DN	No limitations upon existing development or future development / re-development over planning timeframe	Now	N/A	N/A	N/A								The majority of assets affected are considered to be at low risk, which can be accepted. However stormwater is a key local infrastructure. The effect of sea level rise on inundation of stormwater outlets is unlikely to be acceptable as it may increase the frequency and disruption from inundation events. *Refer to "Do Nothing" Option Table for further cost benefit details.*	**?** State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Recommended
NR	NR1, NR7, NR11, NR13, NR14	Now	✓	✓	✓								*Refer to "No Regrets" Options Table for cost benefit details.*	**?** State Government (Grant Programs) ☑ Council (Current Programs) *N/A* Private landholders who directly benefit from option	Recommended

6.22 Geotechnical Risk Levels and Treatment Options

The majority of areas and assets are at low risk from coastal influenced geotechnical hazards, as demonstrated in the Geotechnical Risk Evaluation Maps in Appendix A. There are some assets at medium or high risk, and this relates to the asset type (e.g. major roads, railway, important public buildings, etc) rather than the likelihood of geotechnical hazard, which is considered 'rare'.

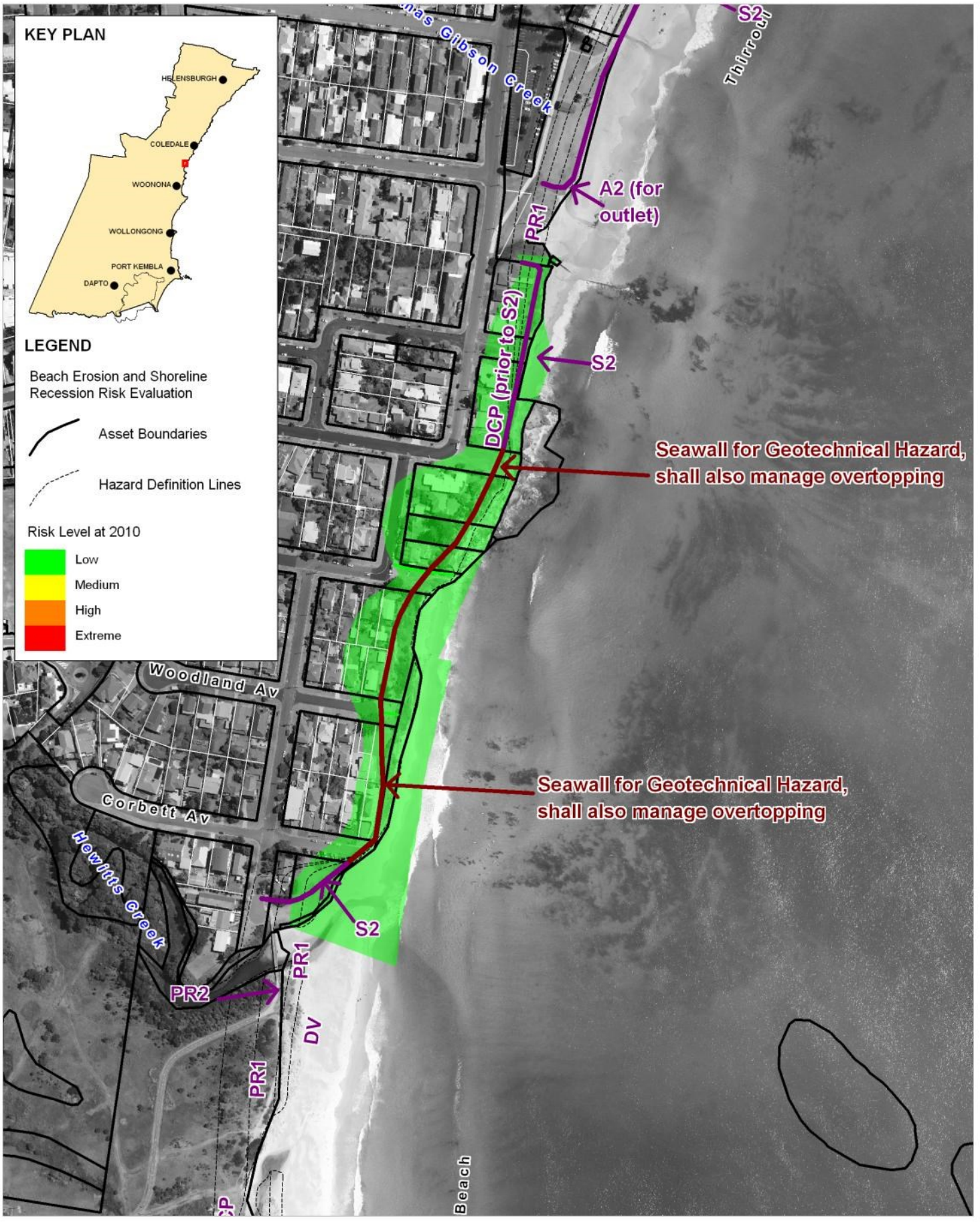
There are very few areas within the Coastal Influenced Geotechnical Hazard Area that are not already within a landslip geotechnical hazard zone, which already have Section 149 notifications provided to landholders by Council. Further, as noted in Section 4.4, there is already a sound process for managing geotechnical risk in the LGA, being Wollongong DCP Chapter E12 – Geotechnical Assessment.

Therefore, it is proposed to apply Accommodate Management Option GDCP (refer Section 5.4.4) to all land within the Coastal Influenced Geotechnical Hazard area. This will provide for assessment of wave action and sea level rise as part of the geotechnical assessment undertaken as properties are re-developed and assets repaired or replaced in the future. It is considered sufficient to manage existing assets and land through future re-development, because the risk of Coastal Influenced Geotechnical Hazard is considered rare.

In addition, the headland area between Thirroul and McCauleys Beaches is known to have high rates of cliff retreat, relating to the softness of bedrock in this location. At present, there are applications by landholders to construct protective revetments (seawalls) to manage cliff retreat. Further, Council is also undertaking construction of a seawall at Corbetts Avenue to manage this hazard at the present time.

Therefore, a seawall alignment along the headland section between Thirroul Beach and McCauleys Beach is proposed, as shown in Figure 6-70. The seawall alignment has been drawn within existing private property boundaries. It is intended that such revetments to manage cliff retreat would be designed, constructed and maintained (including offsite impacts) and development applications prepared and lodged at the individual landholders' expense (as is done along this section at present). The alignment is provided such that Council can manage the location of the walls, to ensure they are constructed upon private property and not public land. Further, under recent changes to the Coastal Protection Act (refer Section 2.2.1.1) Council may consider a levy (coastal protection service charge) on private property owners who construct the walls to fund ongoing maintenance and offsite impacts.

The option at Thirroul / McCauleys should be considered in conjunction with Seawall options S1 and S2 proposed for erosion risk at these beaches, refer Sections 6.7.1 and 6.8.1. That is, the selection of this option at the headland may affect the selection of erosion seawall options at adjacent locations.



Title:

Geotechnical Risk Levels and Treatment Options Thirroul to McCauleys Revetment Option

Drawing: 6-70

Rev: A

N

0 75 150m

Approx. Scale

BMT WBM
www.wbmpl.com.au

Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_107_110427 Drawing 6-14.WOR

7 RECOMMENDED MANAGEMENT OPTIONS

The assessment of treatment options for individual beaches, as presented in the previous chapter, outlines those options considered to be most suitable for addressing the various risks at each beach. The assessment considered capital and recurrent costs, environmental and social impacts, community acceptance, the reversibility or adaptability of the option, its effectiveness over time, and all legal and approval barriers and risks associated with implementation of the option.

When determining which options should be carried out as a priority in the future, consideration has been given to 1) the highest priority risks (ie the intolerable risks) as discussed in Section 4.6, and 2) the most effective options in treating those high priority risks (as presented in the previous chapter).

Recommended management options have been developed for each beach, as presented in the previous beach by beach assessment. Presented below in Table 7-1 and Table 7-2, is a summary of the recommended management options applicable to each beach along the Wollongong coastline.

Within Table 7-1 and Table 7-2, recommended options to treat the specifically identified 'high' or 'extreme' risks at the current timeframe are indicated by two ticks (✓✓), while recommendations to address the highest risks to 2050 and 2100 are given by one tick (✓).

Implementation of this list of recommended management options will ensure that all high and extreme risks up to 2100 (i.e. those considered to be intolerable risks) can be managed, with priority for implementation given to addressing the intolerable risks at the current timeframe.

These recommended options have subsequently been developed into an Implementation Action Plan for the Wollongong Coastal Zone, which accompanies this document.

Table 7-1 Recommended Management Options to Address Intolerable Risks to 2100 (Stanwell Park to Bulli)

	Stanwell Pk	Coalcliff	Scarb/Wom	Coledale	Sharkies	Little Austin.	Austinmer	Thirroul	McCauleys	Sandon Pt	Bulli
DV	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
BM	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓				
PR1	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓		✓✓	✓✓	✓✓	✓✓
PR2											
- SLSC & public bldgs	✓							✓✓			✓✓
- Stormwater		✓	✓✓			✓✓			✓	✓✓	✓
- Recreational fac.				✓							
- Carpark					✓						
- Cycleways										✓	
- Roadways										✓	
- Assets											
PR4								✓	✓		
PR5								✓	✓		
A2											
- stormwater	✓✓			✓✓	✓✓		✓	✓✓	✓✓	✓✓	✓✓
- ocean pool		✓		✓✓			✓✓				✓
- boatharbour					✓✓						
- SLSC & public bldgs							✓				
- Training walls											
A3				✓							
S1							✓✓				
S2											
- Maintain existing											
- Construct new wall											
DCP	✓	✓	✓✓	✓	✓	✓✓	✓	✓✓	✓	✓✓	✓✓
FDCP	✓✓			✓✓	✓		✓	✓✓	✓✓	✓✓	✓✓
DN											
NR1: notation for assets	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NR2: seawalls assess.							✓✓	✓✓			
NR3: SLSC assess.	✓			✓		✓	✓	✓✓		✓	✓✓
NR4: ocean pool assess.		✓	✓	✓✓			✓✓	✓✓			✓
NR5: roads assess.	✓					✓	✓	✓		✓	
NR6: cycleway assess.									✓	✓	✓
NR7: stormwater assess.	✓✓	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
NR8: services assess.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓✓	✓
NR9: evac. Planning								✓✓		✓	✓
NR10: flood studies	✓✓						✓✓	✓✓			✓✓
NR11: vegetation assess.	✓	✓	✓	✓		✓		✓	✓	✓	✓
NR12: Norfolk Is. Pines				✓	✓	✓		✓		✓	
NR13: Heritage framewk.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓✓
NR14: Monitoring	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓

Legend

✓✓	Treats identified 'high' or 'extreme' risks at the immediate timeframe
✓	Treats identified 'high' or 'extreme' risks at 2050 or 2100 timeframes

Table 7-2 Recommended Management Options to Address Intolerable Risks to 2100 (Woonona to Lake Illawarra)

	Woonona	Bellambi	Bellambi Pt	Corrimal	Towradgi	Fairy Mdw	North	City	Coniston	Perkins	Lake Illaw.
DV	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	
BM	✓✓						✓✓	✓✓	✓✓		
PR1	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓		✓✓	✓✓	✓✓	
PR2											
- SLSC & public bldgs	✓										
- Stormwater	✓✓				✓		✓✓				
- Recreational fac.											
- Carpark		✓						✓			
- Cycleways	✓				✓			✓			
- Roadways	✓				✓						
- Assets			✓✓			✓					
PR4											
PR5											
A2											
- stormwater	✓✓	✓✓	✓✓	✓✓			✓✓				✓
- ocean pool	✓	✓✓			✓✓						
- boatharbour		✓✓									
- SLSC & public bldgs		✓		✓			✓				
- Training walls										✓✓	
A3											
S1											
S2											
- Maintain existing		✓	✓✓							✓✓	
- Construct new wall							✓✓				
DCP	✓✓	✓✓	✓✓	✓	✓	✓	✓✓	✓	✓	✓✓	
FDCP	✓	✓✓	✓✓	✓✓			✓✓				✓✓
DN						✓					✓
NR1: notation for assets	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NR2: seawalls assess.		✓✓	✓✓				✓✓			✓✓	✓
NR3: SLSC assess.	✓	✓		✓	✓		✓✓				
NR4: ocean pool assess.	✓	✓✓			✓✓						
NR5: roads assess.	✓	✓			✓						
NR6: cycleway assess.	✓	✓			✓		✓	✓			
NR7: stormwater assess.	✓✓	✓✓	✓✓	✓✓	✓	✓	✓✓	✓	✓	✓✓	✓
NR8: services assess.	✓	✓✓	✓✓	✓	✓	✓	✓	✓	✓	✓	✓
NR9: evac. Planning	✓	✓									
NR10: flood studies	✓	✓					✓				
NR11: vegetation assess.	✓	✓	✓✓		✓		✓		✓	✓	✓
NR12: Norfolk Is. Pines							✓				
NR13: Heritage framewk.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NR14: Monitoring	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓

Legend

✓✓	Treats identified 'high' or 'extreme' risks at the immediate timeframe
✓	Treats identified 'high' or 'extreme' risks at 2050 or 2100 timeframes

8 REFERENCES

Bewsher Consulting (2003), *Towradgi Creek, Wollongong Floodplain Risk Management Study and Plan Final Report*, prepared for Wollongong City Council, June 2003.

Bruun, P., (1962). Sea-level rise as a cause of shore erosion, *Journal of Waterways and Harbors Division*, American Society of Civil Engineers, **88**, 117-130.

Cardno (2010), *Wollongong City Council Coastal Zone Study*, prepared for Wollongong City Council by Cardno Lawson Treloar, June 2010.

Cardno (2007a), *Towradgi Lagoon Entrance Management Policy*, prepared for Wollongong City Council by Cardno Lawson Treloar, April 2007.

Cardno (2007b), *Fairy Lagoon Entrance Management Policy*, prepared for Wollongong City Council by Cardno Lawson Treloar, April 2007.

Cardno (2007c), *Revised Wollongong Harbour Coastal Processes and Hazard Study*, prepared for Wollongong City Council by by Cardno Lawson Treloar, May, 2007.

Cardno (2007d), *Wollongong Harbour (Including Belmore Basin and Brighton Lawn Reserve) Coastal Zone Management Plan*, prepared for Wollongong City Council by by Cardno Lawson Treloar, October, 2007.

Carley, J. T., and Cox, R. J. (2003), A Methodology for Using Time-Dependent Beach Erosion Models for Design Events, *Proceedings of Coasts and Ports Australasian Conference 2003* Auckland.

Cowell, P.J., Thom, B.G., Jones, R.A., Everts, C.H., and Simanovic, D., (2006). Management of Uncertainty in Predicting Climate-Change Impacts on Beaches, *Journal of Coastal Research*, **22**, 232-245.

CSIRO (2007). *Climate Change in Australia Technical Report 2007*. CSIRO Marine and Atmospheric Research and Bureau of Meteorology, Melbourne, VIC, Australia.

DCC (2009), Climate Changes Risks to Australia's Coast: A First Pass National Assessment, Commonwealth of Australia.

DECC (2008), *Bellambi Lagoon Entrance Channel Northern Dune Erosion – Preliminary Technical Study*, prepared for Wollongong City Council by the Estuaries Unit, Coastal and Floodplain Programs Section, Department of Environment and Climate Change (DECC), April 2008.

DECCW (2009a), NSW Sea Level Rise Policy Statement, October 2009.

DECCW (2009b), Derivation of the NSW Government's sea level rise planning benchmarks, Technical Note, October 2009.

GHD (2007a), *Estuary Management Plan for Several Wollongong Creeks and Lagoons: Estuary Processes Study*, prepared for Wollongong City Council, December 2007.

GHD (2007b), *Estuary Management Plan for Several Wollongong Creeks and Lagoons: Estuary Management Study and Plan*, prepared for Wollongong City Council, December 2007.

GHD (2010), *Report on Wollongong Coastal Study Geotechnical Assessment*, Final Report, prepared for Cardno Lawson Treloar, June 2010.

IPCC (2007), *Climate Change 2007: Synthesis Report*, Intergovernmental Panel on Climate Change key findings and uncertainties contained in the Working Group contributions to the Fourth Assessment Report.

McInnes, K. L., Abbs, D.J., O'Farrell, S.P., Macadam, I., O'Grady, J. and R. Ranasinghe, (2007). *Projected Changes in Climatalogical Forcing for Coastal Erosion in NSW*, prepared by CSIRO for the Department of Environment and Climate Change [DECC].

Nielson, A.F., Lord, D.B., and H.G. Poulos, (1992). *Dune Stability Considerations for Building Foundations* , Institution of Engineers, Civil Engineering Transactions Vol CE34, No.2, June 1992, pp. 167-173.

NSW Government (1990). *Coastline Management Manual*, prepared September 1990.

OEH (2013) Guidelines for Preparing Coastal Zone Management Plans, July 2013.

PIANC (1992), Guidelines for the Design and Construction of Flexible Revetments Incorporating Geotextiles in Marine Environment.

Ranasinghe, R., Watson, P., Lord, D., Hanslow, D. and P.Cowell, (2007). *Sea Level Rise, Coastal Recession and the Bruun Rule*, Proceedings of the Coasts and Ports Conference '07, Engineers Australia

Short, A. D. and N. L. Trenaman, (1992). Wave Climate of the Sydney Region, an Energetic and Highly Variable Ocean Wave Regime, *Australian Journal of Marine and Freshwater Research*, **43**, 765-91.

Short, A.D., (2007). Beaches of the New South Wales Coast A guide to their nature, characteristics, surf and safety, 2nd Edition, February, 398p.

Suter & Associates (2006), *Wollongong Planning People Places Final Report*, prepared for Wollongong City Council by Suter & Associates Leisure & Tourism Planners, April 2006.

TRA (2007) Tourism Profiles for Local Government Areas in Regional Australia New South Wales City of Wollongong, accessed 5th April 2011 from www.tra.australia.com

Verdon, D.C., Wyatt, A.M., Kiem, A.S. and Franks, S.W., (2004). Multidecadal variability of rainfall and streamflow: Eastern Australia, Water Resources Reseach, **40**, W10201.

Wollongong Development Control Plan (DCP) 2009, prepared by Wollongong City Council (specifically chapters B1, E12 and E13).

Wollongong Local Environment Plan 2009, under the *Environmental Planning and Assessment Act, 1979*.

WCC (2004), *Plan of Management for Coledale Beach Reserve*, prepared by Wollongong City Council, June 2004.

WCC (2007a), *Wollongong City Council Social Plan 2001-11*, prepared by Wollongong City Council.

WCC (2007b) *Draft Beach Sightline Strategy*, prepared by Wollongong City Council, June 2007.

WCC (2007c), *the Blue Mile Masterplan, Revitalising Wollongong City Centre*, prepared by Wollongong City Council, November 2007.

WCC (?), *Hewitts Creek Incorporating Slacky, Tramway, Woodlands & Thomas Gibson Creeks Floodplain Risk Management Plan*.

WCC (2008a), *Wollongong City Foreshore Plan of Management*, prepared by Wollongong City Council, January 2008.

WCC (2008b), *Plan of Management for Judbooley Parade, Windang*, prepared by Wollongong City Council.

WCC (2009), *Plan of Management Stanwell Park Reserve and Bald Hill Lookout*, prepared for Wollongong City Council and Land and Property Management Authority, August 2009.

WCC (2010a), Draft *Illawarra Biodiversity Strategy*, prepared for Wollongong City Council, Shellharbour City Council and Kiama Municipal Council, 2010.

WCC (2010b), *Generic Plan of Management for the Community Land of Wollongong City Council*, prepared by Wollongong City Council, April 2010.

WCC (2010c), *Wollongong City Council Stormwater Infrastructure Valuation Methodology*, August 2010.

BMT WBM Bangalow
6/20 Byron Street, Bangalow 2479
Tel +61 2 6687 0466 Fax +61 2 66870422
Email bmtwbm@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Brisbane
Level 8, 200 Creek Street, Brisbane 4000
PO Box 203, Spring Hill QLD 4004
Tel +61 7 3831 6744 Fax +61 7 3832 3627
Email bmtwbm@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Denver
8200 S. Akron Street, #B120
Centennial, Denver Colorado 80112 USA
Tel +1 303 792 9814 Fax +1 303 792 9742
Email denver@bmtwbm.com
Web www.bmtwbm.com

BMT WBM London
International House, 1st Floor
St Katharine's Way, London E1W 1AY
Email london@bmtwbm.co.uk
Web www.bmtwbm.com

BMT WBM Mackay
PO Box 4447, Mackay QLD 4740
Tel +61 7 4953 5144 Fax +61 7 4953 5132
Email mackay@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Melbourne
Level 5, 99 King Street, Melbourne 3000
PO Box 604, Collins Street West VIC 8007
Tel +61 3 8620 6100 Fax +61 3 8620 6105
Email melbourne@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Newcastle
126 Belford Street, Broadmeadow 2292
PO Box 266, Broadmeadow NSW 2292
Tel +61 2 4940 8882 Fax +61 2 4940 8887
Email newcastle@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Perth
Level 3, 20 Parkland Road, Osborne, WA 6017
PO Box 1027, Innaloo WA 6918
Tel +61 8 9328 2029 Fax +61 8 9486 7588
Email perth@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Sydney
Suite G2, 13-15 Smail Street, Ultimo, Sydney 2007
Tel +61 2 8960 7755 Fax +61 2 8960 7745
Email sydney@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Vancouver
Suite 401, 611 Alexander Street
Vancouver British Columbia V6A 1E1 Canada
Tel +1 604 683 5777 Fax +1 604 608 3232
Email vancouver@bmtwbm.com
Web www.bmtwbm.com