

# *Government Gazette*

of the State of

New South Wales

**Number 25**

**Friday, 9 March 2018**

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## COUNCIL NOTICES

### COASTAL PROTECTION ACT 1979

#### Section 55H

#### Gazettal and Commencement of a Coastal Zone Management Plan

Wollongong City Council has prepared and adopted the Wollongong Coastal Zone Management Plan in accordance with Part 4A of the *Coastal Protection Act 1979*. The Plan was duly certified by the Chief Executive of the Office of Environment and Heritage, under delegation from the Minister for the Environment, The Honourable Gabrielle Upton, on 20 December 2017.

The Wollongong Coastal Zone Management Plan will help guide the management of the natural and built assets along the Wollongong coastline. The Plan will remain in force until such time as it is revised or repealed.

The Plan and its supporting documents may be viewed on Council's website at [www.wollongong.nsw.gov.au](http://www.wollongong.nsw.gov.au). A hardcopy may be viewed at the Council office.

DAVID FARMER, General Manager, Wollongong City Council, Locked Bag 8821, Wollongong DC NSW 2500

“Where will our knowledge take you?”

# Wollongong Coastal Zone Management Plan: Implementation Action Plan

Final Report September 2017





The Coomaditchie United Aboriginal Corporation is an Aboriginal organisation dedicated to raising the esteem, pride and dignity of young Aboriginal people in their Aboriginal culture and heritage. The Coomaditchie Artists' Cooperative is a vital organisation.

In addition to the Artists' Cooperative, as custodians of the Coomaditchie Lagoon and surrounding area, the Corporation provides employment and training for local community members. The Corporation is also committed to the regeneration and care of the land around the Coomaditchie Lagoon. Each time a product is purchased from the Coomaditchie United Aboriginal Corporation, a significant contribution towards these objectives is made.

Front Cover Design 'Let's Stop Coastal Destruction' by Lorraine Brown and Narelle Thomas, Coomaditchie United Aboriginal Corporation.

The artwork shows waves at the bottom, then the middens, the people, the rivers, the helping hand, gathering places and meeting circles and plant life.

	<p><b>Lorraine Brown</b> is the premier artist of the Coomaditchie United Aboriginal Corporation. Lorraine is a Jerrinjah woman born in Bega, one of 7 children. Lorraine views her ability to paint as a gift. She uses bold colours that reflect her coastal upbringing. "We're East Coast Saltwater People", Lorraine says. "My colours symbolise my life. I had a great childhood, great parents and family and extended family".</p> <p><b>Narelle Thomas</b> is one of Lorraine's sisters and they paint together. Lorraine does the fine work and Narelle fills in the details. Lorraine and Narelle work like professional dancers, one leads and the other follows and no-one steps on any toes. It is clear they have been working together for many, many years.</p>
<p><i>Lorraine Brown</i> <i>Narelle Thomas</i></p>	

# Wollongong Coastal Zone Management Plan: Implementation Action Plan

## DOCUMENT CONTROL SHEET

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<b>Title :</b>	Wollongong Coastal Zone Management Plan: Implementation Plan
<b>Author :</b>	Dr Philip Haines
<b>Synopsis :</b>	This is the action plan for implementing strategies to address coastal risks along the Wollongong Coastline. It is supported by the Coastal Zone Management Study, which identifies the main coastal risks, and then details and assesses options for addressing these risks. Document updated by WCC in September 2017.

### REVISION/CHECKING HISTORY

REVISION NUMBER	DATE OF ISSUE	CHECKED BY	ISSUED BY
0	Nov 2011	PEH	PEH
1	Jan 2012	PEH	VPR
2	June 2012	PEH	VPR
3	Dec 2016	PMD	MF
4	Sep 2017	WCC	WCC

### DISTRIBUTION

DESTINATION	REVISION				
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WCC	1	1	2 + 1e	1e	1
BMT WBM File	1	1	1	1	
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Prepared By: BMT WBM Pty Ltd (Member of the BMT group of companies)

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# 1 INTRODUCTION & BACKGROUND

## 1.1 Purpose

The Wollongong Coastal Zone Management Plan (CZMP) has been prepared to direct management of risks from coastal hazards along the Wollongong LGA coastline (see study area map in Section 18). The CZMP covers lands currently affected and potentially affected by coastal hazards up to the year 2100. The Wollongong CZMP comprises this Implementation Action Plan and the companion Management Study [CZM Study].

Coastal hazards have been quantified through the Wollongong City Council Coastal Zone Study (Cardno, 2010), while risks associated with these hazards have been identified and evaluated as part of the Wollongong Coastal Zone Management Plan: Management Study (BMT WBM, 2016). This document (the CZMP: Implementation Action Plan) presents the strategies and actions required to manage and mitigate the risks to existing and future development and community assets and values in Wollongong associated with coastal hazards, both now and in the future.

The Wollongong CZMP has been prepared in accordance with the *NSW Coastal Protection Act 1979*, the *NSW Coastal Policy* and the *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013), as well as other legislation applicable to managing the coastal zone (refer Chapter 2 of the CZM Study for details).

An Australian Standards Risk Management Framework (ISO 31000: 2009 *Risk Management Principles and Guidelines*) has been applied in identifying, evaluating and treating risks associated with coastal hazards (refer Figure 1). The risk assessment has considered impacts of coastal hazards on public and private properties, infrastructure and uses of coastal land. Risks were classed as 'low', 'medium', 'high' and 'extreme' for the immediate, 2050 and 2100 timeframes. Differences between risks today and those in the future relate primarily to the predicted response of the Wollongong coastline to future climate change, and sea level rise in particular. Generally, 'high' and 'extreme' risks were considered to be intolerable, 'medium' risks were seen to be tolerable, and 'low' risks were seen to be acceptable. Management of 'high' and 'extreme' risks present at the current timeframe is considered to be the highest priority.

The objectives of the CZMP therefore are to reduce or mitigate the risks associated with coastal hazards, focusing on the 'extreme' and 'high' risks at the current timeframe as a priority. This CZMP Implementation Action Plan also guides management of future intolerable risks (i.e., 'high' and 'extreme' risks at 2050 and 2100), in the instance where such risk manifest earlier than projected.

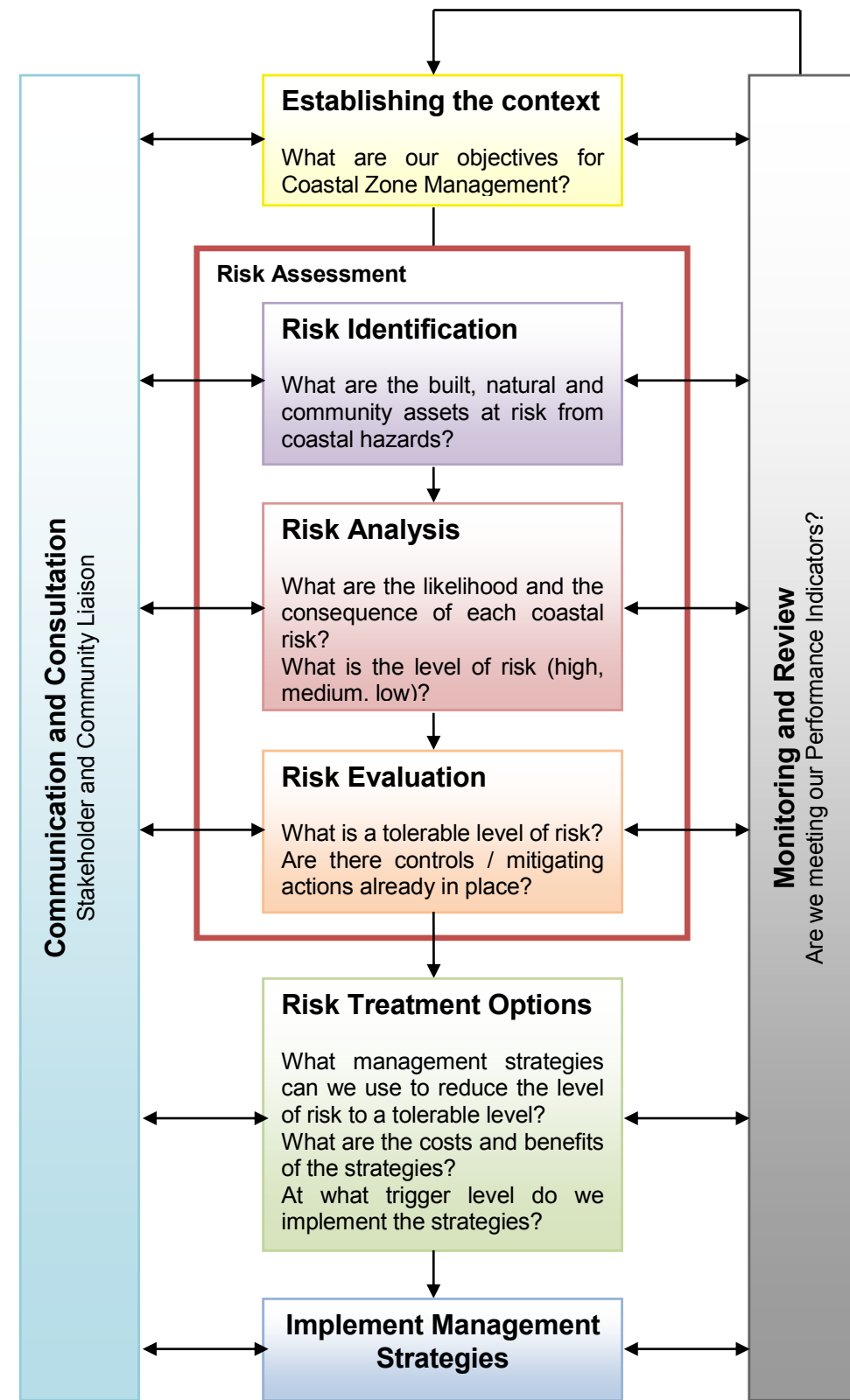


Figure 1 Risk Management Framework used to identify, assess and manage risks to the Wollongong Coastline, adapted from ISO 31000: 2009

## 1.2 Coastal Hazards

Natural coastal processes create hazards when they interact and conflict with current uses and assets located within the coastal zone. A summary of coastal processes and coastal values at Wollongong is given in Sections 1.3 and 1.4. The main coastal hazards affecting Wollongong's coast are:

- **Beach erosion** (during a short term storm event or series of events in close succession) and resulting dune slope instability. Erosion of beaches is typically balanced by accretion during non-storm periods, as the sand eroded is temporarily stored as nearshore storm bars, which are moved onshore under normal wave conditions;
- **Shoreline recession**, where there is a net long term migration of the shoreline in a landward direction. Shoreline recession typically occurs in response to man-made coastal structures, an increase in mean sea level or permanent changes to typical wave climate (wave height and/or direction);
- **Coastal inundation** (during high tides combined with storms and sea level rise) can occur as both wave overtopping of beaches and dunes or inundation of land behind the open coastline via coastal creeks, estuaries or stormwater systems connecting to the ocean (note that the level of coastal inundation within Lake Illawarra is much lower than the 1 in 100yr flood level from catchment rainfall);
- **Cliff instability and geotechnical hazards**, which may be exacerbated by higher sea levels and therefore greater wave attack at the base of coastal cliffs. A Coastal-Influenced Geotechnical Hazard Zone has been defined (GHD, 2010) representing the areas along the Wollongong Coastline where coastal processes (including climate change) will directly affect geotechnical hazards;
- **Coastal entrance instability** (notably at creeks and lagoons that have a variable entrance condition, such as Bellambi and Fairy Lagoons);
- Erosion of beaches at **stormwater outlets / drainage lines** (although this is very localised to the proximity of the stormwater outlet and would not have an influence on overall beach conditions);
- **Sand drift**, which apart from Windang and Port Kembla, has practically been eliminated due to extensive dune rehabilitation works along Wollongong's beaches.

All of the above hazards were assessed by Cardno (2010) for the current year (2010), 2050 and 2100 timeframes taking into account climate change, specifically sea level rise, with hazard mapping provided for the beach erosion and shoreline recession, coastal inundation and geotechnical hazards for the current, 2050 and 2100 timeframes.

## 1.3 Summary of Coastal Processes and Interactions at Wollongong

### 1.3.1 Geomorphology

The beaches of Wollongong's coastline range from long, south-easterly facing sandy beaches (such as Perkins and City Beaches), to highly embayed pocket beaches (such as Austinmer and Stanwell Park) towards the northern end of the LGA coastline. The coastal ranges comprising the Illawarra Escarpment are located along the shoreline at the northern end of the LGA, and the higher backing cliffs and shoreline rock platforms tend to form short embayed (or closed) beach units. As the Escarpment trends away from the shoreline, the beach embayments become longer, with outcropping of rocks forming smaller headlands and rock platforms, such as Sandon Point and Bellambi Head. Further south, the beach units tend to become longer and continuous, with Wollongong Harbour / Flagstaff Hill and Port Kembla forming larger headland features to separate the longer embayments. The shoreline generally is oriented towards the south east, with City Beach, Bellambi Beach, Woonona and Bulli facing slightly more east, and Perkins beach facing slightly more south compared to the other embayments.



### 1.3.2 Wave Climate

The Wollongong coastal zone is exposed to waves from the north east to south east sectors. Waves dominantly arrive from the south to south east sector throughout the year at Wollongong, with easterly and north easterly waves occurring in the wave record over the summer to autumn months. Typical for most NSW locations, the largest waves typically arrive from the south-east to south sector.

Over all months, south easterly swell waves and storm waves can arrive at Wollongong generated by storms in the Southern Ocean and Tasman Sea travelling northwards to NSW. During winter, south east is the dominant wave direction. The storm systems in the Tasman Sea and Southern Ocean form closer to the NSW coast during winter, generating storm waves at the coastline. During the summer months, strong afternoon sea breezes from the north east can generate short period wind swell from the north east to east, although south east sector waves remain the dominant wave direction. During late summer to autumn, tropical cyclones off the Queensland coast can send storm waves propagating southwards into the Wollongong area, however this is rare as such waves are usually dissipated before reaching the Wollongong coastal zone. During autumn, east coast low cyclones may form off the NSW coast, and can generate large storm waves arriving from the east to south east at Wollongong, in addition to the southerly storm systems which continue through autumn. East coast low cyclones are said to be the most damaging storm system for the NSW coast forming close to the shoreline (Short, 2007). The low pressure of east coast low storm systems also generate high water levels (due to barometric pressure set up), and as the high water levels coincide with high waves, this enhances the erosion potential of these storms.

While the dominant storm wave direction at Wollongong is south east, the nearshore wave modelling has indicated that east-south-east (ESE) is the critical offshore wave direction for Wollongong, as this direction produces the largest nearshore wave heights for a specified offshore wave height (Cardno, 2010). That is, for the same offshore wave height from all directions, wave heights are largest at the shoreline from the ESE direction. East coast low cyclones are typically associated with ESE wave directions, as these storm cells form at easterly locations off the NSW coast.

The greatest erosion extents on record in the NSW coast are associated with the series of storms during 1974, particularly the storms of May to June of that year. These storms generated extensive erosion on many beaches in NSW, including Wollongong. The May-June storms were also associated with unusually high water levels, which significantly enhanced the erosion. The storms of 1974 occurred during the highly stormy decade of the 1970s, during which there were a series of erosive coastal storms. After the 1970s until recently (~2007), the wave record has been relatively calmer, although isolated large storms have still occurred. Since 2007, there have been a number of notable storms occurring along the NSW coast, including at Newcastle and south east Queensland in 2007 and sequential storms in 2009 that have caused extensive recession on the mid north NSW coast.

Wollongong's beaches are highly embayed by headlands, rock platforms and rocky reefs. The larger headland features and reefs, such as Flagstaff Hill, Port Kembla and the Five Islands immediately offshore and Bellambi Point, will refract incoming waves from the south to south east direction,

and shorelines in the lee of these larger headlands and reefs are more protected from incoming waves. However, the majority of beach length in Wollongong is highly exposed to wave impacts.

Inside Lake Illawarra, the wave climate is comprised of locally generated wind waves, as there is no penetration of offshore swell energy into the lake. Given the limited fetch within the Lake to generate waves, the wind waves are typically short period, steep and small.

### 1.3.3 Sediment Transport

Sediment transport on beaches is typically generated by waves that induce currents in the surf zone. Sediment may be transported onshore, offshore and / or alongshore, causing the beach to undergo erosion and accretion cycles over periods of time ranging from days to decades (NSW Government, 1990).

Longshore sediment transport refers to the movement of sand parallel to the shoreline, and this is typically driven by waves arriving at an angle to the shoreline. Cross shore sediment transport refers to sand moving both onshore or offshore perpendicular to the shoreline. Cross-shore transport is driven by breaking waves and currents, including rip currents, which form perpendicular to the shoreline. Under low swell wave conditions, transport is directed onshore to assist accretion of sand onto the beach face (and associated movement of sand bars in the surfzone in a landward direction). Under storm wave conditions, the breaking waves generate offshore transport, and the higher waves breaking at the shoreline will erode the beach face. Rip currents form under low and high waves, however the strength and width of the current is greater during high waves, and these currents allow for significant transport of sediment offshore from the beach during a storm.

Embayed beaches, as are typical of Wollongong's coastline, are assumed to experience longshore and cross shore sediment transport that is retained within the embayment. The dominant south easterly swell arriving at the longer, south easterly sandy embayments in Wollongong (such as Perkins, City and Fairy Meadow Beaches) will generate longshore sediment transport towards the north. This will allow for movement of beach sand from south to north, which is retained within the closed embayments. At the more easterly facing beaches, south easterly swell is likely to generate a smaller rate of northerly transport within the embayment. Under north easterly waves (such as may occur in summer), the sediment transport may be directed towards the south. However, the net transport will be towards the north under dominant south easterly waves. The processes of sediment shifting from south to north to south again is often termed 'beach rotation'.

Within embayed beaches, the offshore sediment transport generated under storm wave conditions is retained within the embayment, and will be

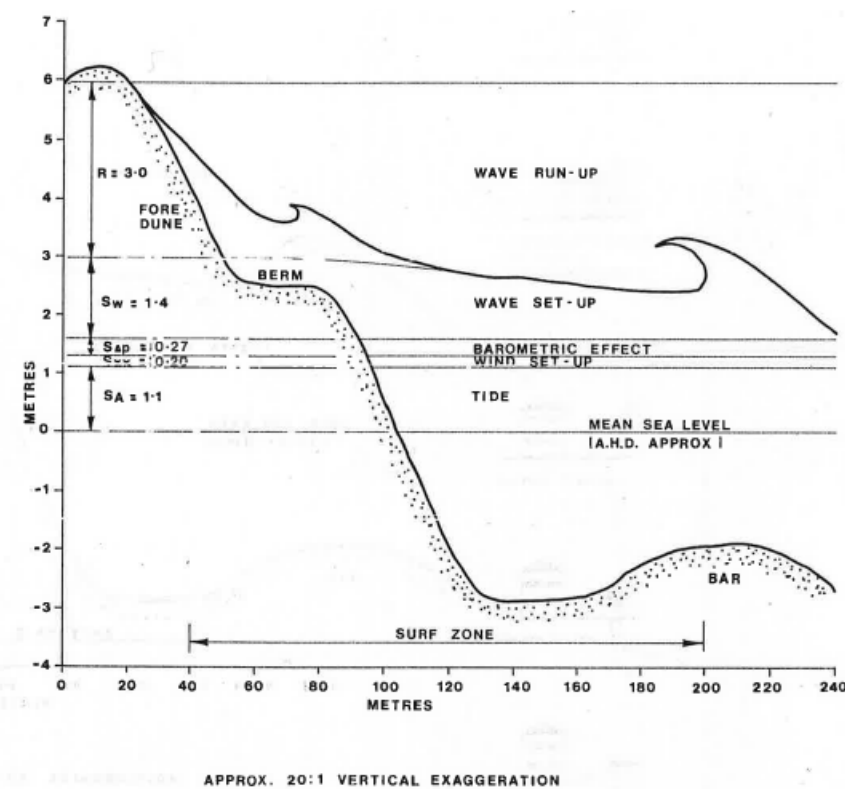


returned to beach face under regular swell waves. While the storm erosion may occur quickly (hours, days) the recovery period occurs more slowly (months to years). Cumulative storms may have a severe impact upon beaches, as there is insufficient time to allow the beach to recover before the next storm arrives.

Rip currents are generated in most wave conditions as a mechanism for water arriving at shore under breaking waves to flow back offshore. During storm conditions, rip currents tend to be more widely spaced, however the current itself is much wider and stronger. The landward end of these currents typically generates an eroded scarp and under storm conditions, the erosion formed at the landward end of rip currents can be significant, in fact greater than the erosion generated elsewhere along the beach under breaking waves.

### 1.3.4 Water Levels

Another important component of erosion during storms is water level. The low pressure of storm systems causes the water level to increase (called barometric set up), onshore winds during a storm can cause water to pile up on the shoreline and further increase the water level (wind set up), and the high waves also increase the water level through the release of energy during wave breaking (wave set up). When storm water levels are additionally combined with a high tide, the high water levels enable the breaking waves to reach higher on the beach face and cause erosion at the sand dunes behind the beach.



The high water levels during storms (combined with high tide) can also penetrate into coastal creek and lagoon entrances and stormwater systems, and this can cause inundation of low lying land behind the beach.

The tidal range at Wollongong is  $\sim 1.8$  m, with the highest astronomical tide (HAT) up to 1.13 m above AHD (Cardno, 2010). Extreme water levels (that is barometric set up with some wind set up, but excluding wave set up and wave run up) from Fort Denison were adopted for Wollongong. The 100 year Average Recurrence Interval (ARI) Still Water Level at Fort Denison that was adopted at Wollongong is 1.44 m AHD (which includes high tide). The use of Fort Denison statistics has been recommended by OEH (DECCW, 2009c), as there is little difference in tidal range for open coastal regions of the NSW Coast and the Fort Denison data set provides a far longer record from which to derive reliable extreme value analysis. The contribution of wave set up to water levels is typically 10 – 20% of the breaking wave height. 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.

In addition to changes in water levels during storms, there may also be variability in the sea level relating to climatic processes such as the El Nino Southern Oscillation (ENSO), which can vary sea levels by  $\sim 0.1$  m, and coastal trapped waves that can vary sea levels by up to 0.2 m (Cardno, 2010).

Wave run up is important in causing overtopping of dunes behind the beach during a storm. Wave run up is defined as the maximum vertical height that a breaking wave reaches on the shoreline. Modelling to investigate wave run up was conducted at Wollongong. Wave run-up includes water levels discussed above (i.e. high tide, barometric, wind and wave set up) plus the vertical height of wave uprush after breaking.

### 1.3.5 Coastal Entrances

Wollongong's coastline is also shaped by a number of coastal creek entrances, some of which also convey stormwater, and occasional stormwater outlets. Lake Illawarra is, conversely, a very large coastal lake system, that forms the southern end of the LGA. Lake Illawarra remains typically open due to the recent emplacement of training walls at the lake mouth at Windang.

The remaining creeks in the Wollongong LGA are far smaller, and typically classified as Intermittently Closed and Open Lakes or Lagoons (ICOLLs). These small water bodies from south to north include:

- Tom Thumb Lagoon (within Port Kembla);
- Fairy Lagoon, which divides North Beach and Fairy Meadow Beach;
- Towradgi Lagoon, which exits at the southern end of Corrimal Beach,

- Bellambi Lagoon, located south of Bellambi Head and exiting to the ocean on the northern end of Corrimal Beach, and is opened either naturally, or artificially by Council to alleviate flooding of low-lying adjacent property;
- Bellambi Gully, located at the southern end of Bellambi Beach, which has a small training wall at the northern side of its entrance, and rock protection along its southern side;
- An unnamed creek which exits to the ocean at the boundary between Woonona and Bellambi Beaches,
- Collins and Whartons Creeks which exit at the south and towards the north on Bulli Beach respectively
- Slacky Creek on Sandon Point Beach
- Hewitts Creek and Tramway Creek on the northern and southern ends of McCauleys Beach respectively
- Flanagans Creek and Thomas Gibson Creek which exit to the north and south respectively on Thirroul Beach
- A small creek / drainage outlet on Little Austinmer Beach
- Carricks, Stockyard and Dalys Creek which are now essentially stormwater drainage outlets at the south, north and centre of Coledale Beach respectively;
- A small creek / drainage outlet on Scarborough Beach;
- Stoney Creek on Coalcliff Beach;
- Stanwell Creek and Hargraves Creek on Stanwell Beach.



Entrance to Bellambi Gully

Waves, which generate longshore and cross shore transport, combined with tides, form a sandy berm across the creek entrances. Coastal processes act to build an entrance berm across the creeks however, where

there is sufficient flow out of the creeks through the entrance, the entrance will remain typically open. Where flows from the creeks are not sufficient to counter-balance coastal processes, the entrances will typically remain closed. The majority of coastal creek entrances in Wollongong are typically closed, as waves dominate the coastal entrance behaviour.

Catchment rainfall of sufficient volume will cause a breakout through the entrance berm, enabling flow out of the creek into the ocean. Many of the coastal creeks on Wollongong's coast respond quickly to rainfall and may open frequently. Fairy and Towradgi Lagoons respond quickly to rainfall, with water levels rising rapidly and which generates natural lagoon breakouts. Likewise, Bellambi lagoon opens frequently with sufficient rainfall (DECC, 2008). However, the small sized catchments and waterways have limited flow, and so waves and tides act quickly to re-close the entrance.

Where property has been sited too close to the lagoon edge, Council may be required to artificially open the lagoon entrance to alleviate inundation of such properties. To protect low-lying property (particularly the Live Steamers Site at 1.8 m AHD at Fairy Lagoon, and Park Parade crossing, stormwater assets and floor levels above 1.94 m), both Towradgi and Fairy Lagoons are opened artificially at 1.6 m (when rain is falling or impending), or 1.8 m and 1.85 m, respectively, to alleviate potential flooding (Cardno, 2007a; b).

The process of entrance breakouts may enable erosion of the entire unvegetated area of the entrance berm, and in extreme cases, (e.g. very high creek outflows combined with high wave conditions) there may be erosion of adjacent vegetated dune regions also.

At present, the migration of the Bellambi Lagoon entrance channel to the north is causing erosion of the northern dunes. Historical aerial photography indicates that vegetation of the foredune regions both south and particularly north of the channel has increased markedly since the late 1970s, from an active unvegetated region to a well-established vegetated dune. The erosion is said to be threatening sites of Aboriginal heritage significance within the northern dunes.

### 1.3.6 Stormwater Outlets

Under high rainfall events, as water is conveyed to the ocean via outlets on the beach, the high velocity flows may cause significant erosion around the outlet. Some of the smaller drainage lines and creeks noted in the section above act to convey stormwater from the urbanised catchment (such as Carricks, Dalys and Stockyard Creeks on Coledale Beach, and the unnamed creeks on Little Austinmer, Sharkies and Scarborough Beaches), and some of these creek lines contain stormwater infrastructure. The erosion around such outlets can also pose a hazard, and inundation in the future with sea level rise may cause flooding into urban areas upstream.

### 1.3.7 Aeolian (Windborne) Transport and Dune Vegetation

The key process for dune building is wind which transports sand landward from the sub-aerial beach berm (i.e. dry beach face) to form incipient dunes and foredunes. Dune vegetation will act to trap windborne sediments, allowing for ongoing accretion and increase in dune height. Dune evolution over thousands of years can allow for very high sand dunes to form (where the beach position remains stable over this time), for example up to 10 – 15 m high on the NSW north coast. However, on the Wollongong coastline, dunes are typically less than 5 m in height, demonstrating that such features formed relatively recently.

Unvegetated regions are termed active dunes or blowouts, where the sand is free to be mobilised by wind. In some cases, the sand blown from active dunes landward can represent a loss from the beach system (where it is not captured by dune vegetation). Sands can also drift into back beach development to become a nuisance.

Dune revegetation programs occurred widely across the Wollongong coast in the 1980s and 1990s, following damaging storms during the 1970s. It was recognised that dune vegetation captures beach sand, to provide a buffer to erosion during high wave and water level events. Dune heights have increased significantly across the Wollongong coastline since the revegetation program, as the revegetated areas have acted to capture mobile windborne sand. It is not known whether dunal systems were generally active and unvegetated in the Wollongong coastal zone prior to urban settlement. It is possible that the small sediment stores held within the rocky embayments typical of Wollongong's coast may have been frequently reworked by both storm events and wind, and so significant dune vegetation could not establish. Since the establishment of urban settlement, there has been a need to minimise losses of sediment from the



Dune vegetation and sand buffering City SLSC

beach system through windborne transport. Further, the sediment stores held within dune vegetation provide a buffer from storms. The revegetation program has provided well established dunes that can act to buffer back beach development from coastal erosion during storms.

In some locations, active dunes allow for sand to be transported between embayments. One example of this is the sand drift that once formed on the road way below Flagstaff Hill between City Beach and Brighton Beach. Local community noted such drifts could form up to 1 - 2 m deep. This sand drift probably enabled sediment transport from City Beach into Brighton Beach. Since dune revegetation works commenced at City Beach, the windborne sediment transport is now captured within the City Beach dunal system and sand drifts across the roadway are rare. The contribution of this to ongoing erosion observed at the southern end of Brighton Beach is unknown. However, it is widely accepted that the enhancement of sediment stores at City Beach (and other locations within Wollongong) through dune revegetation works has afforded protection from short term storm impacts.

### 1.3.8 Climate Change

Climate change induced by anthropogenic forces, particularly the burning of fossil fuels for energy (coal, oil and gas) is now widely accepted. In relation to coastal processes, climate change may increase sea levels and change rainfall (annual, seasonal, extreme), wind (speed and direction) and the frequency and intensity of extreme events. Current projections for these parameters were investigated during the Wollongong Coastal Zone Study. A summary of the parameters used by Cardno (2010) is given below:

- **Sea level rise** is projected to rise by up to 0.4 m by 2050 and 0.9 m by 2100, according to the latest science incorporated with the NSW Government's Sea Level Rise Policy Statement;
- **Rainfall** in the Illawarra region was assumed to increase in intensity by 10% to 2050 and by 20% to 2100, based on CSIRO predicted seasonal changes in average runoff depth of an increase in summer (-1% to +22%), possible increase in autumn (-6% to +14%), decrease in winter (-12% to +3%) and decrease in spring (-19% to +1%);
- **Wind** change predictions by CSIRO (2007) contained large uncertainty, and so no change from current and historical recorded winds were assumed for the study; and
- **Frequency of Extreme Events** is also highly uncertain, with IPCC (2007) suggesting the potential for an increase in frequency and intensity of coastal storms, compared with recent studies (CSIRO, 2007; McInnes et al., 2007) that are inconclusive as to whether storm events shall increase or decrease, depending on the model and / or climate change scenario selection, therefore there was

assumed to be no change in the frequency or intensity of coastal storm conditions from the current climatology and historical records.

While it is probable that, in addition to sea level rise, climate change will alter wind, rainfall and wave conditions and frequency of storm events, there is as yet no consensus regarding to what extent changes may occur. Climate change induced changes may modify the extent of coastal hazards experienced in the future, however, the current projections suggest changes that are within the natural climate variability already experienced. In this case, it is reasonable to assume the current wave and storm conditions for future time periods

## 1.4 Summary of Coastal Values and Features

### 1.4.1 Ecological Values

Key ecological attributes of the Wollongong coastal zone were investigated and mapped. A variety of different environments exist within the coastal zone including marine, intertidal, estuarine and terrestrial zones, resulting in a high diversity of flora and fauna.

Endangered Ecological Communities (EECs) in the study area (which are protected under the *Threatened Species Conservation Act 1995*) include (Cardno, 2010):

- Coastal Saltmarsh
- Freshwater Wetlands in the Sydney Basin Bioregion
- Freshwater Wetlands on Coastal Floodplains
- Swamp Oak Floodplain Forest
- Swamp Schlerophyll Forest on Coastal Floodplains
- Littoral Rainforest
- Illawarra Subtropical Rainforest
- Bangalay Sand Forest
- Illawarra Coastal Grassy Woodlands
- Southern Sydney Sheltered Forest and
- Themeda Grasslands.

Mapping of the EECs within the coastal zone has been included within the risk assessment conducted in preparing this CZMP. The study area also contains some SEPP No. 14 – Coastal Wetlands. There are also a number of threatened flora and fauna species listed on the *Threatened Species Conservation Act 1995*, *Fisheries Management Act 1994* or *Environment Protection and Biodiversity Conservation Act 1999* (including migratory terrestrial and marine species) that are likely or known to occur within the Wollongong coastal zone. The species were listed within the Wollongong Coastal Zone study (Cardno, 2010), and have been considered within the

mapping databases used as part of the risk assessment to prepare this CZMP.

A condition assessment for coastal vegetation was also conducted, comparing changes in such vegetation observed between aerial photography dates (1977, 1987, 1999, 2006). In general, it was found that over the ~ 30 year period, the total observed area of dune vegetation has increased, most likely as a result of extensive dune rehabilitation works, such as on Perkins Beach, carried out by on in partnership with Council. In contrast, the total observed area of estuarine vegetation has slightly decreased, mainly in areas around Port Kembla, as the port and industrial area has expanded. The majority of restoration works by Council over the last five years has occurred within the coastal zone, and has included both dune and estuarine areas.

An estuary condition assessment was also conducted, based upon estuary type (e.g. wave-dominated etc); catchment land use; waterway use; water quality (based upon monitoring data from Council); probability of acid sulphate soils; tributaries; entrance management (e.g. artificial, natural breakouts); and vegetation types. The condition assessment found:

- Hewitts Creek and Tramway Creek to be in good condition;
- Bellambi Gully, Bellambi Lagoon, Towradgi Creek and Lake Illawarra to be in extensively modified condition; and
- Fairy Creek to be in modified condition.

The other coastal creeks and lagoons in the study area were not investigated.

### 1.4.2 Human Values and Features

Mapping of infrastructure, such as roads, railways, stormwater features, parks, car parks, and public buildings (including SLSCs, amenities blocks) and heritage items was conducted as part of preparing the Wollongong CZMP.

### 1.4.3 Recreational Values

Coastal areas are known to have a high recreational value and offer aesthetic values to urban dwellers (DCC, 2009). The Wollongong coastal zone offers numerous recreational opportunities, particularly at the open coastal beaches and lagoon entrances. Recreational activities include (Cardno, 2010):

- Water based activities such as swimming (including within the numerous tidal rock pools along the coast), surfing, fishing and prawning, scuba diving, snorkelling, sailing, canoeing, kayaking, water skiing, wind surfing, kite surfing, boating (with many boat ramps in Lake Illawarra, as well as boat ramps at Bellambi, Sharkies Beach and Wollongong Harbour itself), parasailing and model boats;

- Land based activities such as walking and running (using the numerous coastal paths, bushland trails, including the cycleway), cycling (for example, using the shared coastal cycleway, or numerous off-road mountain bike trails in the area), bird-watching, pet exercising, picnicking (with the majority of beaches offering either park or coastal reserve with facilities), abseiling, rock climbing, and other sports; and
- Air based activities, such as hang gliding and paragliding (including the oldest hang gliding and paragliding club at Stanwell Park), and sky diving (such as into Stuart Park in North Wollongong).



Commercial operators, such as kiosks and restaurants also offer leisure and dining at a number of Wollongong's beaches.

There are a number of recreational clubs that operate from the coastal zone, including the Illawarra Yacht Club, Koonawarra Bay Sailing Club, the Port Kembla Sailing Club and the 17 Surf Life Saving Clubs (SLSCs) in the LGA. The facility of 17 patrolled beaches, through both volunteer and Council lifeguard patrols, is said to be a key attractant for residents and visitors to the Wollongong coast (Cardno, 2010). Further, the SLSCs provide for a sense of community for local beach users and members of the clubs, which run a range of competitions, sporting and social activities in addition to volunteer patrols for the community.

Private recreational facilities include the Wollongong Golf Club behind City/Coniston Beach, the Port Kembla Golf Club at Primbee, WIN Football Stadium (and associated Entertainment Centre) at City Beach. There are additional leisure centres, sports grounds, gyms in the coastal zone, however not in proximity to the identified hazard areas. Each of the private and public recreational assets of the coastal zone was mapped as part of preparing the Wollongong CZMP.

### 1.4.4 Aboriginal Heritage

The Aboriginal custodians of the Illawarra (from Stanwell Park to Bass Point, south of Wollongong) are the Wodi Wodi (Wadi Wadi), or are also known as the Dharawal, Tharawal or Thurrawal (Cardno, 2010 citing Organ and Speechley, 1997). Aboriginal people are thought to have inhabited the Illawarra region for 20,000 – 30,000 years. The land and landscape of the Illawarra is central to the culture of the local Aboriginal people, including the coastal zone. Cardno (2010) make reference to a number of documents outlining the occupation of coastal areas, first contact with Europeans and the impact on the Aboriginal people, including local land rights struggles until the 1960s.

Aboriginal objects and sites (listed or unlisted) are protected under the *National Parks and Wildlife Act 1974*. There are a number of significant Aboriginal places within the study area, for example the areas of Sandon Point, the Bulli Area, and Breakfast Creek area. There are also known to be midden sites located near to Bellambi Lagoon, Sandon Point, Waniora Point and Fairy Lagoon. There are known burial sites in the Windang and Lake Illawarra regions also. There are at least 766 recorded Aboriginal sites within the study area, and the number of unrecorded sites is likely to be many more than this. The exact location of Aboriginal sites and places of significance must be kept confidential, not only for their cultural sensitivity, but often to protect the sites from vandalism or (unwitting) damage by the wider public. Management of these sites particularly when they are uncovered due to the impacts of coastal processes (for example, erosion at midden sites) is outlined within the CZMP.

### 1.4.5 Non-indigenous Heritage

The Illawarra region was explored by European settlers in the early 1800s, with settlement soon after (from around 1817). The coastal zone, particularly Wollongong Harbour and Port Kembla has been utilised from the beginning of settlement, including shipping coal from the harbour until the late 1800s. After that time, Port Kembla became the primary facility for coal exports, due to its size and industrial development.

Wollongong Harbour itself has a convict built wall and steps, comprising the southern boundary of the harbour. The site is listed on the state heritage register. There are numerous other sites of local and state historical importance along the coastal zone, including North Beach Bathers Pavilion and nearby kiosk building, the many tidal rock pools, Continental Pool, Thirroul Pool and the nearby kiosk building, coal cuttings at the cycleway leading from the harbour, and stands of Norfolk Island Pines which form a marker of beachside settlement. Heritage items have been included in the coastal asset mapping prepared for the Wollongong CZMP.



### 1.4.6 Economic Values

Commercial and industrial operations in Wollongong form a significant part of the economy. Wollongong City is a local, regional and state level economic hub, comprising nearly half of the businesses within the region.

In terms of the coastal zone, the port facility at Port Kembla (although not strictly included within the plan) is a major facility of the region, providing for coal and steel exports, and base for general and bulk cargoes, containers, motor vehicle imports and grain exports. Port Kembla contributes \$418 million to the regional economy annually. Another key industry that is supported by the coastal zone is the Tallawarra natural gas power station located on the Lake Illawarra foreshore at Yallah, which powers 200,000 homes.

The coastal zone including beach and lake amenity are vital to Wollongong's tourism industry. After dining out, the next most popular activity for tourists (international and domestic) was going to the beach. This demonstrates the importance of the beach amenity to visitors as well as the resident community.

The scenic qualities and recreational activities supported by the beach amenity directly support the tourism industry. There are 4100 business that are tourist operations including surf schools, scuba diving, boat and fishing trips, sky diving, hotels, motels, camp grounds and other accommodation services, cafes, as well as restaurants and other food and beverage facilities that require the additional visiting population to survive.

The various beach reserves, tidal and formal ocean pools, parks and coastal kiosks business that support both the resident and visiting community were included in the coastal asset mapping prepared as part of the Wollongong CZMP.

## 1.5 Coastal Risks

Risk is defined as the combination of the likelihood of occurrence of an event and the consequence of the impacts if the event occurs.

$$\text{Risk} = \text{likelihood} \times \text{consequence}$$

The likelihood of coastal risks is determined as part of the definition of coastal hazards, and in accordance with the Australian Standard Risk Management Framework, ranges from 'almost certain' to 'rare'. The consequence of risks is dependent on the uses and values attributed to the coastal land affected by the hazard, and can range from 'insignificant' to 'catastrophic'. This means that shoreline recession within a National Park will have a different risk level than recession of an existing suburban development, given different land uses and community values.

Council's Enterprise-wide Risk Management Risk Ranking Tool outlines the risk hierarchy from 'low' to 'extreme' based on the combination of risk likelihood and consequence in **Error! Reference source not found..**

**Figure 2 Risk Hierarchy based on likelihood and consequence of risk**

Determining what risks to treat as part of the CZMP is based upon Council (and the community's) tolerance to risk, within Council's Enterprise-wide Risk Management Risk Ranking Tool. Thus the prioritised objectives for management actions in this CZMP are:

1. **'High' and 'extreme' risks are intolerable** and must be treated as a priority to eliminate or reduce the risk, and accept residual risk providing it is understood. Specific management actions are detailed in this Implementation Action Plan
2. **'Medium' risks are tolerable**, and may be reduced or accepted providing the residual risk is understood. Specific management actions were noted in the CZM Study for future use as required.
3. **'Low' Risks are acceptable**, with care given to monitoring to ensure management response can be changed should the risk level increase in the future. Specific management actions are not required.

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 2010, 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).

## 1.6 Management Approaches & Options

This CZMP has approached management of coastal risks in a number of ways. Firstly, risks associated with Future Development are different from risks to Existing Development. For Future Development, risks can be 'avoided' by not permitting vulnerable developments within high-risk areas (considered over the full design life of the development). Future development can also 'accommodate' risks by including provisions that reduce the consequence of impacts (e.g. having minimum floor levels to reduce property damage resulting from future coastal inundation) or 'accept' the risk where appropriate to the design life of the development.

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

accommodate the risk, where appropriate. Options for managing existing development therefore include the following approaches:

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

**Retreat options**, which aim to preserve beach amenity by allowing natural retreat due to coastal processes, particularly in response to future sea level rise. The options for existing development involve relocating or sacrificing infrastructure, public assets or private property, if and when impacts occur. The retreat options typically include compensation to private property owners where feasible, if existing landuse is diminished; and

**Accommodate options**, which aim to re-develop or retrofit existing infrastructure, public assets and private property in a manner that minimises losses from potential impacts (e.g. stronger foundations) or avoids losses from potential impacts (e.g. relocatable structures) through careful design.

A series of '**No regrets' options** have also been considered that offer a range of assessments and works to provide further information (including approvals) required prior to implementing larger scale options for specific assets, particularly where a more costly or difficult option may be needed. The 'no regrets' options also include activities that will improve resilience and preparedness for coastal risks in the future.

## 1.7 How to Read This Document

The technical assessment associated with identifying and defining the coastal risks and evaluating the potential management options is contained within the accompanying CZM Study. This Implementation Action Plan details the recommended Management Strategies that were found to be the most effective for management of the coastal risks along the Wollongong Coastline.

The following pages present a series of 'Implementation Schedules' for key management strategies. These schedules include specific details on what actions need to be undertaken and a timeframe or trigger for commencement. The schedules also include relative prioritisation, estimated costs and responsibilities for the various actions.

**A series of maps** is given in Section 18 immediately after the Implementation Schedules that show the relevant locations for actions from

the 15 Management Strategies, where they can be feasibly shown, for each beach along the Wollongong Coastline.

Recommended Management Strategies, in alphabetical order are:

BM	Beach Management
C	Cycleways
DC	Development Controls
H	Heritage
I	Infrastructure, Assets and Boat Harbours
M	Monitoring
P	Ocean Pools
PL	Private Land Acquisition
R	Roadways and Parking
RF	Recreational Facilities
S	Seawalls and Training Walls
SC	Surf Clubs and Public Buildings
SP	Further Studies and Plans
ST	Stormwater
V	Vegetation and Habitats
W	Whole of Council Actions



## 2 BEACH MANAGEMENT (BM)

### Description:

Beach Management involves moving sand on individual beaches to promote the formation of dunes in the upper beach profile. Coastal dunes are critical in providing protection to land and assets located behind beaches. The dunes provide for sacrificial losses of beach sand during severe storm events. Thus, the more sand held within the dunes, the greater the protection for land and assets behind.

The purpose of beach management is to move sand from the beach berm (which is affected by average wave action) into the dunes (where it is not affected by average wave action, and thus remains stored until the next storm event). Beach scraping is carried out when the beach begins to recover following beach erosion events, with sand taken as thin layers from the intertidal zone and moved above the area of fair weather wave action. Re-contouring of eroded profiles is not covered by this strategy, but rather is an emergency action to provide safe beach access following storms, as detailed in the Wollongong Emergency Action Sub Plan, Appendix G to the CZM Study.

Beach management generally requires earthmoving plant and equipment to move sand from the lower and intertidal sections of the beach profile up into the upper dune profile. Vegetation of the dunes is then required to help contain the sand from wind-blown drift and capture additional sands blown from the beach face.

Beach management in the form of 'beach scraping' was trialled by Wollongong City Council (WCC) at Bellambi Lagoon entrance in mid 2010. While the trial was aimed at management of the lagoon entrance, the success of the trial does justify the use of beach scraping elsewhere along the Wollongong coast, in this case to increase sand volume held within the beach dunes and thus enhance protection of the coastline.

Management of beaches and associated assets that are at a 'high' or 'extreme' level of risk at the current timeframe takes highest priority (i.e. Priority ranking '1'), while 'high' or 'extreme' risks that are not expected to materialise until 2050 or 2100 are given secondary priority (i.e. Priority ranking '2'). It is noted that, while all beaches are at high – extreme risk from erosion, beach management has only been suggested for those beaches where dunes are currently limited and need to be enhanced to protect the beach or back beach assets and / or the action is considered likely to be successful in enhancing coastal dune volumes.

The beach management actions noted below for individual beaches would be subject to the appropriate regulatory and approval processes under the Crown Lands Act 1989.

### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
Helensburgh / Stanwell Park SLSC	Medium	High	Extreme	Woonona Beach	High	Extreme	Extreme
Coalcliff Beach	High	Extreme	Extreme	North Beach	High	Extreme	Extreme
Scarborough Wombarra Beaches	High	Extreme	Extreme	North Beach: Stuart Park (on heritage list, local significance)	Medium	High	Extreme
Coledale Beach	High	Extreme	Extreme	City Beach: Football Ground (WIN Stadium) and Showground	High	Extreme	Extreme
Sharkys Beach	High	Extreme	Extreme	Coniston Beach	High	Extreme	Extreme
Little Austinmer Beach	High	Extreme	Extreme	Coniston Beach: Wollongong Golf Course	Medium	Medium	High
Austinmer Beach	High	Extreme	Extreme	Coniston Beach: Coastal Dune Systems	High	Extreme	Extreme
Sandon Point Local Roads: Blackall St, Ursula St, Alroy St	Medium	Medium	High				

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks



Trial beach scraping at Bellambi Lagoon entrance (2010)

Action List:

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
BM.1	Develop, adopt and implement a Council policy that requires any sand removed from estuary/lagoon entrances to be returned to the adjacent beaches, along with any local excavation material from construction sites immediately adjacent to beaches that have a suitable particle size distribution.	Entire LGA coastline	1	2016/17 or as soon as practical	WCC	Staff time only	nil	See 'BM' Option in Sect.5.4.2 of CZM Study report
BM.2	Undertake beach scraping and re-contouring to increase sand volumes of dunes directly in front of Helensburgh / Stanwell Park SLSC	Helensburgh / Stanwell Park	2	Opportunistically when monitoring shows that beaches are accreted following recovery from storm erosion	WCC	\$5,000 - \$10,000 per episode	M.1	See 'BM' Option in Sect.5.4.2 of CZM Study report
BM.3	Undertake beach scraping and re-contouring to increase sand volumes of dunes in front of existing wall.	Austinmer	1	Opportunistically when monitoring shows that beaches are accreted following recovery from storm erosion	WCC	\$5,000 - \$10,000 per episode	M.1	See 'BM' Option in Sect.5.4.2 of CZM Study report
BM.4	Undertake beach scraping and beach re-contouring to increase sand volumes of dunes directly in front of WIN Stadium. Investigate opportunities for financial contributions from stadium owner/manager	City Beach	1	Opportunistically when monitoring shows that beaches are accreted following recovery from storm erosion	WCC	\$5,000 - \$10,000 per episode	M.1	See 'BM' Option in Sect.5.4.2 of CZM Study report
BM.5	Undertake beach scraping and beach re-contouring to increase sand volumes held in upper beach profile dunes, thus enhancing storm protection.  Investigate opportunities for financial contributions from golf course owner/manager for section on Coniston Beach	Coalcliff Scarborough / Wombarra Coledale Sharkys Little Austinmer Woonona North Beach Coniston (including golf course and dunes)	1	Opportunistically when monitoring shows that beaches are accreted following recovery from storm erosion	WCC	\$7,000 - \$10,000 per episode	M.1	See 'BM' Option in Sect.5.4.2 of CZM Study report
BM.6	Undertake revegetation works for sand dunes supplemented through beach scraping and re-contouring episodes (see also Action V.1 – Dune Management Strategy)	Helensburgh / Stanwell Park Coalcliff Scarborough / Wombarra Coledale Sharkys Little Austinmer Austinmer Sandon Point Woonona North Beach City Beach Coniston	1	Immediately following beach scraping and re-contouring episodes	WCC Bushcare Groups	\$2,000 per episode	BM.2 – BM.5	See 'BM' Option in Sect.5.4.2 of CZM Study report

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
BM.7	Undertake beach scraping and re-contouring to increase sand volumes of dunes directly in front of Blackall St, Ursula St, Alroy St	Sandon Point Beach: Blackall St, Ursula St, Alroy St	2	Opportunistically when monitoring shows that beaches are accreted following recovery from storm erosion	WCC	\$5,000 - \$10,000 per episode	M.1	See 'BM' Option in Sect.5.4.2 of CZM Study report

#### Relevant Programs and Possible Funding Opportunities:

- NSW Government Coastal Management Program (for one-off beach scraping / dune building episodes)
- Council's parks and reserves maintenance and works program
- New Council levies or increased land rates
- South East Local Land Services/ State Government assisted Dunecare Program



### 3 CYCLEWAYS (C)

#### Description:

The Wollongong Coastline is served well by a sealed coastal cycleway extending from Thirroul to Coniston Beaches. The cycleway is an important recreational facility for the community, and provides a commuter link for many city workers living along the northern beaches. The cycleway is also an excellent pedestrian walkway, with commanding vistas over the beaches and headlands along the coastline.

Sections of the cycleway have been damaged due to storm erosion in the past, such as at Bellambi, resulting in *ad hoc* emplacement of protection works as an emergency response. It is expected that sections of the cycleway will again be damaged in the future due to storm erosion and sea-level rise induced shoreline recession. This strategy aims to provide a coordinated response to management of future damage to the cycleway as part of a whole of coastline plan. Remediation of the cycleway shall form part of Council's existing Asset Management Plan. That is, the cycleway needs to first be included as a specific Council asset, with future maintenance and repairs provided in accordance with Council's forward planning schedule for asset management.

Repairs to the cycleway following an erosion event will still need to be carried out as prioritised emergency works, while longer-term retreat and relocation of the cycleway in certain vulnerable sections needs to be planned in conjunction with future maintenance and as opportunities for relocation arise.

Land ownership and available space for landward retreat of the cycleway are two issues that will need to be resolved as part of long term management of this special and highly valued community asset.

No cycleways are under an immediate intolerable risk (i.e. 'high' or 'extreme' level of risk), therefore all actions associated with management of cycleways are given secondary priority (i.e. Priority ranking '2'), except for forward planning actions (C.1, C.2).



#### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
McCauleys Beach Cycleway / Shared Pathway (Northern Coastal Cycleway)	Medium	Medium	High	Bellambi Point Beach: Cycleway / Shared Pathway (W of Bellambi Lagoon, along Dobbie & Murray Ave)	Medium	Medium	High
Sandon Point Northern Cycleway / Shared Pathway (at S end of beach)	Medium	Medium	High	Corrimal: Cycleway (across & next to Towradgi Lagoon)	Medium	Medium	High
Bulli Beach Cycleway / Shared Pathway (extent between beach and tourist park)	Medium	High	Extreme	Towradgi Beach Cycleway / Shared Pathway	Medium	High	High
Woonona Beach Cycleway / Shared Pathway	Medium	Medium	High	North Beach Cycleway / Shared Pathway (includes heritage railway cuttings and embankments)	Medium	High	Extreme
Bellambi Beach Cycleway / Shared Pathway (N of Bellambi Gully entrance)	Low	Medium	Medium	City Beach Cycleway / Shared Pathway	Medium	High	Extreme
Bellambi Beach Cycleway / Shared Pathway (S of Bellambi Gully entrance)	Medium	Medium	High				

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks

Action List:

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
C.1	Undertake audit of cycleway to identify options available for at-risk sections.  Where relocation is not possible due to constraints from other land uses, consider the feasibility (technical and financial) for rock protection and / or raising the cycleway.	McCauleys Sandon Point Bulli Woonona Bellambi Bellambi Point Towradgi North Beach City Beach	1	2016/17, or as soon as practical	WCC	Staff time only or minor consultancy (say approx. \$25,000)	nil	See 'NR6' Option in Sect.5.4.1 of CZM Study report
C.2	Add cycleways to Council's Asset Management Plan, and based on the outcomes of the audit, incorporate remediation, maintenance, relocation or retrofit works into forward works programs.  <i>Actions C.3 to C.6 apply if supported by the Asset Management Plan.</i>	As above	1	2016/17 (as soon as practical following Action C.1)	WCC	Staff time only	C.1	See 'NR6' Option in Sect.5.4.1 of CZM Study report
C.3	Secure ownership of land (if not currently public land) and undertake detailed design, site investigations, and approvals as necessary to relocate cycleway outside of hazard zone. There appears to be sufficient land to relocate all of the at risk cycleway sections in the future, conducted progressively as impacts manifest.	Sandon Point Bulli Woonona	2	When monitoring shows that the Zone of Reduced Foundation Capacity (ZRFC) measured from erosion escarpment encroaches cycleway	WCC	Dependent on scale of works required and existing land ownership (say \$100 – 200,000, at each location)	C.2 SP.3 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
C.4	Secure ownership of land (if not currently public land) and undertake detailed design, site investigations, and approvals as necessary to relocate cycleway outside of hazard zone. 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 if this structure is maintained (refer Action S.5).	Bellambi	2	When monitoring shows that ZRFC measured from erosion escarpment encroaches cycleway  There is a low to medium risk at present, thus there is no immediate need for action.	WCC	Dependent on scale of works required and existing land ownership (say \$100 – 200,000)	C.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
C.5	Secure ownership of land (if not currently public land) and undertake detailed design, site investigations, and approvals as necessary to relocate cycleway outside of hazard zone. There are alternative locations for the at risk sections of cycleway.	Towradgi	2	When monitoring shows that ZRFC measured from erosion escarpment encroaches cycleway  A long section of cycleway is at risk over time.	WCC	Dependent on scale of works required and existing land ownership (say \$100 – 200,000)	C.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
C.6	Secure ownership of land (if not currently public land) and undertake detailed design, site investigations, and approvals as necessary to relocate cycleway outside of hazard zone. 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.	City Beach	2	When monitoring shows that ZRFC measured from erosion escarpment encroaches cycleway	WCC	Dependent on scale of works required and existing land ownership (say \$100 – 200,000)	C.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report

Relevant Programs and Possible Funding Opportunities:

- NSW Government Coastal Management Program or other recreational/leisure-based funding program
- State and Federal Government Grants (especially climate change adaptation and resilience building funds)

- 
- Council's routine asset maintenance and works program
  - New Council levies or increased land rates

## 4 DEVELOPMENT CONTROLS (DC)

### Description:

Wollongong's coastal zone is largely developed, with only a handful of undeveloped "greenfields" sites remaining. Most future development therefore will consist of either complete redevelopment of a site, including possible subdivision, or major alterations or refurbishments to existing structures and dwellings.

Redevelopment of coastal land offers an opportunity to avoid or accommodate existing and future coastal risks through the application of development controls, expected to last for the duration of the development. For residential development, a design life of 100 years is considered practical. This means that new developments today need to accommodate coastal risks that span to approximately 2100. For other development types, the design life may be shorter or longer.

Applying development controls as properties are redeveloped improves resilience to potential future climate change impacts. Importantly, development controls do not affect the future ability to protect or indeed retreat from the properties. The development controls can be revised and updated in the future in line with improving knowledge of climate change, including sea level rise, and the predicted coastline responses to these changes.

Development controls are already imposed in Flood Planning Areas across the Wollongong LGA as part of Council's integrated Development Control Plan (DCP) Chapter E13 Floodplain Management. Areas of coastal inundation should be specifically incorporated into the existing Chapter E13 Flood DCP provisions. Geotechnical hazard areas are already included in Council's Geotechnical DCP Chapter E12 Geotechnical Assessment, however the DCP chapter requires update to include actions of the sea as part of geotechnical assessments.



Development set back behind coastal dunes at Towradgi

It is proposed that new development controls relating to coastal erosion and recession and wave overtopping be captured within a new Coastal DCP Chapter. Different development controls can apply based on different levels of coastal risk, subject to further development of these planning provisions by Council.

Development Controls will address a range of intolerable risks, many of these being intolerable at the current timeframe. Although the level of risk differs from one beach to the next, the Development Controls are to be prepared for the whole LGA at the same time. As such, the actions for preparing and implementing Development Controls take highest priority (i.e. Priority ranking '1').

### Risks Addressed by Implementation of Strategy:

All risks to existing development and infrastructure, as well as potential future development along every beach within the Wollongong LGA (literally too many to itemise here – refer beach by beach assessment in Chapter 6 of the accompanying CZM Study report for details. Note that for Council's use, a summary table of recommended current and future actions for all private properties at risk to 2100 is given in Appendix A.

**Action List:**

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
DC.1	<p>Prepare, adopt and implement a new Coastal Management Chapter of Council's Development Control Plan (DCP) that specifies controls upon future development and re-development (including minor and major alterations and extensions) in erosion / recession risk areas.</p> <p>Different levels of development control will reflect the different levels of risk to individual properties. 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.</p> <p>The types of controls may relate to foundation capacity (bedrock), structural design (relocatable or permanent), minimum floor levels, distance to hazard zones (development setbacks) or distance based approvals. The controls shall address wave overtopping as well as erosion, and shall apply to all land uses including roads and stormwater infrastructure, and both private and public landholders.</p> <p>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.</p>	<p>All beaches All lands affected by coastal risks. (See further details below)</p>	1	2016/17 or as soon as practical	WCC	Staff time only	Nil	See Sect.5.3 and 'DCP' option in Section 5.4.4 of CZM Study report
DC.2	<p>Revise/update, adopt and implement Chapter E13 – Floodplain Management of Council's Development Control Plan (DCP) to include areas affected by Coastal Inundation as Low Risk Flood Precincts.</p> <p>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.</p>	<p>Stanwell Park Coledale Sharkys Austinmer Thirroul McCauleys Sandon Point Bulli Woonona Bellambi Bellambi Point Corrimal North Beach Lake Illawarra (See further details below)</p>	1	2016/17 or as soon as practical	WCC	Staff time only	nil	See Sect.5.3 and 'FDCP' option in Section 5.4.4 of CZM Study report
DC.3	<p>Revise/update, adopt and implement Chapter E12 – Geotechnical Assessment of Council's Development Control Plan (DCP) to ensure actions of the sea (overtopping, sea level rise) are included in the assessment of geotechnical stability and the DCP is applied to all areas of geotechnical hazard area on a case by case basis as property (private or public) is developed or re-developed.</p>	<p>Areas of identified geotechnical hazard</p>	1	2016/17 or as soon as practical	WCC	Staff time only	nil	See Sect.6.22 and 'GDGP' option in Section 5.4.4 of CZM Study report

**Further Details:**

<b>Beach</b>	<b>Coastal DCP Details</b>	<b>Flood DCP details</b>
<b>Stanwell</b>	Erosion and inundation impacts are likely to affect private land holdings at the southern end of the beach (refer map), however, the buildings are not likely to be affected for some time. Applying development controls when these buildings are redeveloped would improve their structural integrity and therefore the longevity of the developments. Management options to either retreat from or protect the buildings can be revised in the future, as the estimates for hazard impact change or impacts become imminent.  Development controls for erosion may include foundation piles down to bedrock, set back distances for structures etc.	The existing Flood DCP chapter is to be applied to properties at risk of coastal inundation, until Flood Studies are conducted for Stanwell and Hargraves Creeks (for combined catchment and ocean water level events, see Action SP.2). Development controls are to be applied at the "low risk" level.
<b>Coalcliff</b>	<i>Private Properties</i>  Erosion and overtopping impacts are shown to affect private properties, however, the residences are situated far landward and higher than the 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 or burdensome.  <i>Public Assets: SLSC, Boatshed, carpark</i>  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.	Inundation at Coalcliff is related to wave overtopping, rather than backwater inundation, and should be managed through Coastal DCP controls.
<b>Scarborough / Wombarra</b>	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.	Inundation at Scarborough and Wombarra is related to wave overtopping, rather than backwater inundation and should be managed through Coastal DCP controls.
<b>Coledale</b>	The amenities and roadway are currently at low risk, so there is no immediate need for action.  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.	The existing Flood DCP chapter is to be applied to those areas identified at risk from coastal inundation, as an interim measure until Flood Studies for Dalys, Stockyard and Carricks Creek are completed (refer Action SP.2). Development controls are to be applied at the "low risk" level.
<b>Sharkys</b>	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.  The Coastal DCP shall manage both inundation related to wave overtopping as well as erosion and recession.	The existing Flood DCP chapter is to be applied 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.
<b>Little Austinmer</b>	There is one private property where the Coastal DCP should be 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 buildings are redeveloped, thus improving longevity of the development. Additional controls can be considered as needed in the future, should risk levels be revised or hazard impacts advance more quickly.  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 relocation of these assets are prepared, when the asset needs to be replaced (either through wear and tear or coastal damage).	While the majority of inundation 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. In the interim, the existing Flood DCP chapter controls are to be applied at the "low risk" level, until such studies are conducted.
<b>Austinmer</b>	Planning controls shall apply to development in areas at risk regardless of protective structural options. Public assets including Lawrence Hargrave Drive, SLSC, carpark, boatshed and amenities are potentially at risk. The DCP will trigger investigations that will govern whether the asset needs to be relocated or redesigned to withstand impacts, either independently or prior to a seawall being implemented.  Given risk is currently high at assets affected, the DCP controls may be imposed in conjunction with the expected cost and timeframe for asset maintenance and replacement, or sooner should erosion and wave overtopping impacts threaten the development.	As above
<b>Thirroul</b>	Planning controls should apply to development that reflect the level of risk to the property and expected functional life of the development. DCP controls will apply to affected land prior to implementation of any seawall options, should seawalls be maintained or implemented in the future.	The existing Flood DCP chapter is to be applied to those areas identified at risk from coastal inundation outside of the existing Flood Planning Area at the "low risk" level, until Flood Studies are completed and updated for Flanagan's Creek and Thomas Gibson Creek, respectively. The majority of properties affected by coastal inundation in the Thomas Gibson catchment are also within the existing Flood Planning Area, therefore this strategy would have no additional effect on existing development restrictions.
<b>McCauleys</b>	Coastal DCP controls shall apply to any redevelopments in areas at risk. This includes the Aboriginal Tent Embassy and the beachfront 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 regarding foundation capacity (depth to bedrock), alternative locations, distance to erosion escarpments, permissible fixed	The existing Flood DCP chapter is to be applied 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. There are limited additional properties outside the Flood Planning

Beach	Coastal DCP Details	Flood DCP details
	structures etc that will govern the relocation or suitable design for developments.	Area. The majority of properties affected by coastal inundation are also within the existing Flood Planning Area, therefore this strategy would have no additional effect on existing development restrictions for the majority of properties.
<b>Sandon Pt</b>	Planning controls shall apply to four (4) private properties 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-development adequately considers alternative locations outside of the hazard zone.	The existing Flood DCP chapter is to be applied to those areas identified at risk from coastal inundation outside of the existing Flood Planning Area at the "low risk" level, until Flood Studies are completed and updated for Whartons Creek and Slacky Creek, respectively. There are limited additional properties around Slacky Creek, with most properties already within the Flood Planning Area, however, properties along Trinity Row are not currently within a flood planning area.
<b>Bulli</b>	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 or redesigned to withstand impacts at the current location.	The existing Flood DCP chapter is to be applied to those areas identified at risk from coastal inundation outside of the existing Flood Planning Area at the "low flood risk" level, until Flood Studies are conducted for Whartons and Collins Creeks (for combined catchment and ocean water level events, see Action SP.2). A flood study should be completed at Whartons Creek as a priority, as many houses may be affected.
<b>Woonona</b>	Coastal DCP controls are to apply to redevelopment of 18 existing 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 (depth to bedrock), alternative locations, distance to erosion escarpments, etc as relevant to the level of risk, to determine design controls for assets to remain in their current location or require relocation of developments landward of hazard zones. Wave overtopping shall also be managed by the Coastal DCP, as existing Flood DCP controls may not be applicable to the overtopping risk.	The existing Flood DCP chapter is to be applied 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 (for combined catchment and ocean water level events, see Action SP.2) should be completed for the creek at Lighthouse Drive as a priority, as many houses may be affected.
<b>Bellambi / Bellambi Point</b>	This option applies proposed Coastal DCP controls to any redevelopments on the Sewage Treatment Works site, as well as cycleways, Bellambi Pool and associated pool infrastructure (amenities etc) until such time as S.5 is implemented and local road access to the harbour (until such time as action R.4 is implemented).	The existing Flood DCP chapter is to be applied to Bellambi SLSC and carpark, and local roads, carpark and 10 properties adjacent to Bellambi Lagoon at the "low flood risk" level, until Flood Studies for Bellambi Gully and Bellambi Lagoon are conducted.
<b>Corrimal</b>	The Coastal DCP shall apply to minor public buildings (amenities blocks), to ensure erosion and overtopping risks are adequately managed (including relocating the structures) in the future when the assets require redevelopment.	The existing Flood DCP chapter is to be applied to those areas identified at risk from coastal inundation outside of the existing Flood Planning Area at the "low flood risk" level, until a Flood Study is updated for Towradgi Lagoon (for combined catchment and ocean water level events, see Action SP.2). The majority of land and assets within the coastal inundation area are already within the Flood Planning Area for Towradgi Lagoon, therefore this strategy would result in little to no change to extent of existing development controls.
<b>Towradgi</b>	Coastal DCP controls shall apply to redevelopments of at risk private property and public assets, and shall also manage wave overtopping. The development controls will reflect the level of risk and lifespan of the (re-)development. The location of the private properties and local road at the northern end of the beach suggests there may be stable foundation zone (bedrock) at close depth. In this case, private landowners (or Council's road) may be able to accommodate the risk to their buildings and / or the hazard estimate for recession could be revised. The geotechnical investigation for suitable foundation capacity would be initiated through the Coastal DCP for any proposed re-developments.	Inundation is related to wave overtopping, rather than backwater inundation and so shall be managed through Coastal DCP controls.
<b>Fairy Meadow</b>	Coastal DCP controls should apply to any future re-development of the lifeguard tower or other recreational facilities.	
<b>North</b>	Coastal DCP controls should apply to any proposed redevelopment of existing assets (SLSC, Kiosk, Pavilion, cycleway) in addition to other options, including seawall options, to improve resilience of future structures to coastal risks. The controls shall accommodate wave overtopping impacts.	The existing Flood DCP chapter is to be applied to assets (e.g. Lagoon Restaurant) at risk from coastal inundation at the "low risk" level, until a Fairy Lagoon Flood Study is completed (for combined catchment and ocean water level events, see Action SP.2).
<b>City</b>	The Coastal DCP shall apply to re-development of the Stadium and associated grounds to minimise future risk from hazards. The controls shall encompass both erosion and overtopping impacts.	Inundation is related to wave overtopping, rather than backwater inundation and so shall be managed through Coastal DCP controls.
<b>Coniston</b>	Coastal DCP development controls shall apply to Wollongong Golf Course lands, in the case of redevelopments on the site. The controls shall encompass both erosion and overtopping impacts.	Inundation is related to wave overtopping, rather than backwater inundation and so shall be managed through Coastal DCP controls.

Beach	Coastal DCP Details	Flood DCP details
Perkins	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.	
Lake Illawarra		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 the Flood DCP. This strategy re-iterates the use of the Flood DCP throughout Lake Illawarra, 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 calculation for use in planning.

#### Relevant Programs and Possible Funding Opportunities:

- No external funding required. To be undertaken by Council staff.



## 5 HERITAGE (H)

### Description:

The Wollongong Coastline is rich in heritage value from both an indigenous and non-indigenous perspective. While the non-indigenous heritage value is tied to specific features and structures, such as Norfolk Island Pines, War Memorials and Pavilions, the indigenous heritage value is more ubiquitous across the landscape. There are still many specific sites of significance to local Aboriginal people within the coastal zone, including middens, burial sites and significant places, however, many of these are not publicly known or listed for privacy and preservation purposes. A particular issue may arise in the future when coastal erosion starts to uncover previously buried heritage items in coastal dunes and foreshore lands. Where actions are proposed on Crown Land, consideration of Aboriginal Land Claims lodged under the NSW Aboriginal Land Rights Act 1983 will need to occur. In addition, any works will need to be compliant with the Commonwealth Native Title Act 1993.

Risks to heritage locations identified through the CZM process have therefore weighed in favour of non-indigenous heritage, as these have been more easily identified. Managing heritage locations that are under threat from existing or future hazards is a particular challenge for Council. While specific structures can feasibly be relocated to safer sites (e.g. a war memorial or even a building), others cannot be relocated (e.g. a jetty or an avenue of trees), and as such, may need to be sacrificed or abandoned in the future. Compensatory heritage may need to be considered, such as planting new Norfolk Island Pines to maintain the cultural connection with this species along the Wollongong coastline (see Action V.2). Heritage actions outlined below relate to identified sensitive sites as well as currently unidentified sites. For identified non-indigenous heritage items, specific strategies are contained as part of other strategies within this Implementation Action Plan (e.g. ocean pools, surf clubs and public buildings, etc).

### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
Coledale: Heritage Site: Norfolk Island Pines	Medium	Medium	High	Heritage Site: Sandon Point (also under NPW Act)	High	Extreme	Extreme
Sharkys: Heritage Site: Norfolk Island Pines (backing entire beach)	Medium	Medium	High	Heritage Site: Sandon Point Boat Sheds	Medium	High	High
Sharkys: Heritage Site: Site of Austinmer Jetty	High	Extreme	Extreme	Heritage Site: Sandon Pt Norfolk Island Pines (S end of beach)	Medium	Medium	High
Sharkys / Austinmer Boat Harbour (Heritage listed)	High	Extreme	Extreme	Bulli: Waniora Point (Heritage site) <i>Note works already in progress at site.</i>	High	Extreme	Extreme
Little Austinmer Heritage Site: Norfolk Island Pines (backing entire beach)	Medium	Medium	High	Bellambi Pt Heritage Site: Bellambi Lagoon and associated habitat	High	Extreme	Extreme
Austinmer Heritage Site: Norfolk Island Pines (backing entire beach)	Medium	Medium	High	Heritage Sites: Bellambi (Sandpit) Point	High	Extreme	Extreme
Austinmer War Memorial (Heritage Site)	High	Extreme	Extreme	North Beach: Stuart Park (on heritage list, local significance)	Medium	High	Extreme
Thirroul Pool (also heritage site)	High	Extreme	Extreme	North Beach: Puckeys Estate including Seafield House, Saltworks and gardens ruins	High	Extreme	Extreme
Heritage site: Thirroul Pavilion (being used as kiosk / restaurant) and residence	High	Extreme	Extreme	Heritage Site: North Beach Kiosk	Low	Medium	High
Heritage Site: Thirroul Beach Reserve (S of pool)	Medium	High	Extreme	Heritage Site: North Beach Pavilion	Low	Medium	Medium
Thirroul Heritage Site: Norfolk Island Pines	Low	Low	Medium	North Beach Heritage Site: Norfolk Island Pines	Medium	Medium	High
McCauleys Significant Aboriginal Site (Tent Embassy).	Medium	High	High	North Beach Cycleway / Shared Pathway (includes heritage railway cuttings and embankments)	Medium	High	Extreme
				Perkins Beach Heritage listed: Hill 60 Nature Reserve	Low	Medium	Medium

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks



Wollongong Harbour lighthouse

Action List:

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Reqd	Preceding Actions	Further Info.
H.1	In close consultation with NPWS, Local Aboriginal Groups and Historical Societies, develop a decision framework for managing Aboriginal and Non-Indigenous Heritage Items and places affected by coastal hazards. The decision framework would include what actions are necessary when currently buried sites are uncovered by erosion. This may include relocating the item (for example, as is conducted for burial sites), re-burying the item elsewhere (for example as is done for midden sites), sacrificing the item or protecting the item (as is done for midden sites also).	Applicable to all beaches. Specific sites of known heritage have not been identified for privacy reasons. This option also aims to manage assets that are currently unidentified.	1	2016/17 or as soon as practical. Implementation of the Framework is then only triggered once heritage items are uncovered or seriously threatened by future coastal erosion.	WCC	Staff time only	nil	See 'NR13' Option in Sect.5.4.1 of CZM Study report
	See also Norfolk Pines Planting - Action V.2, for Coledale: Heritage Site: Norfolk Island Pines Sharkys: Heritage Site: Norfolk Island Pines (backing entire beach) Little Austinmer Heritage Site: Norfolk Island Pines (backing entire beach) Austinmer Heritage Site: Norfolk Island Pines (backing entire beach) Thirroul Heritage Site: Norfolk Island Pines Sandon Point Norfolk Island Pines (S end of beach) North Beach Heritage Site: Norfolk Island Pines							
	Sharkys / Austinmer Boat Harbour – See Action I.4							
	Austinmer War Memorial (Heritage Site) – See Action S.4							
	Thirroul Pool - See Action P.4							
	Thirroul Pavilion (being used as kiosk / restaurant) and residence – See Action SC.6							
	Heritage Site: Thirroul Beach Reserve (S of pool) – See Action S.1							
	North Beach: Stuart Park (on heritage list, local significance) – See Action S.8							
	See Action S.7 for: Heritage Site: North Beach Kiosk Heritage Site: North Beach Pavilion North Beach Cycleway / Shared Pathway (includes heritage railway cuttings and embankments)							

Relevant Programs and Possible Funding Opportunities:

- No external funding required. To be undertaken by Council staff.

## 6 INFRASTRUCTURE, ASSETS & BOAT HARBOURS (I)

### Description:

In addition to the cycleways, seawalls, roadways and stormwater assets, which are addressed separately, there are other assets and infrastructure along the Wollongong Coastline that are under current and future risk of damage due to coastal processes and hazards. These include the boat harbours and associated boatramps and facilities at Austinmer and Bellambi, as well as the Bellambi Sewage Treatment Plan (STP).

Other services are also at risk, including electricity, telecommunications, gas, water and wastewater services, which are located on both public and private lands within the affected coastal zone. Indeed loss of key services and infrastructure may potentially affect a much larger catchment area, and should be considered and managed very carefully by the service providers.

The infrastructure, assets and boat harbours identified all have 'high' or 'extreme' level of risk at the current timeframe. As such, all actions associated with this strategy take highest priority (i.e. Priority ranking '1').

### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100
Sharkys / Austinmer Boat Harbour (Heritage listed)	High	Extreme	Extreme
Bellambi Boat Harbour	High	Extreme	Extreme
Bellambi / Bellambi Point Sewage Treatment Plant	High	Extreme	Extreme
Lake Illawarra Tru Energy Gas Powered Station	High	Extreme	Extreme

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks

### Action List:

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
I.1	For all Council assets within their Asset Management Plan, add a notation indicating its proximity to the coastal hazard zones and the type of coastal hazard(s) relevant (i.e., erosion/recession, inundation, geotechnical) and estimated timeframe for impacts on the assets (immediate/2010, 2050, 2100). Prioritisation and maintenance scheduling of forward works programs should then be re-considered based on the timeframe and type of hazard exposure. All relevant information is readily available to Council.	All beaches	1	2016/17 / Immediately	WCC	Staff time only	nil	See 'NR1' Option in Sect.5.4.1 of CZM Study report
I.2	Ensure all Council infrastructure, including boat harbours and other relevant services, are included in Council's Asset Management Plan, with appropriate consideration given to asset condition and functional life such that redesign, upgrade and protection works are included into forward works programs. <i>Actions I.4 and I.6 apply if supported by the Asset Management Plan. Land status and management arrangements relevant to these actions will need to be clarified. It is highly likely that upgrades to</i>	All beaches	1	2016/17 or as soon as practical	WCC	Staff time only	nil	See 'NR2 to NR7' Options in Sect.5.4.1 of CZM Study report



Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Reqd	Preceding Actions	Further Info.
	<i>existing infrastructure or new infrastructure may be sited, partly or fully on Crown Land. As a result, land owner consent and/or authorisation of the proposed works by way of Crown tenure/s is likely to be required in order to formalise the occupation of Crown Land and define ongoing maintenance responsibilities.</i>							
I.3	<p>For non-Council assets, such as water supply, wastewater, gas, telecommunications and electricity services infrastructure, undertake an audit and investigate design elements for infrastructure to withstand inundation with seawater and / or wave action.</p> <p>This would be facilitated by Council providing relevant coastal hazard mapping to all infrastructure owners and managers.</p> <p>The audit will identify where and when non-Council infrastructure will be affected by wave attack and/or permanent inundation with sea level rise. The audit is also to determine functional lifespan of existing infrastructure, noting that seawater is expected to yield shorter design life.</p>	<p>All beaches, notably:</p> <p>Trinity Row (Sandon Pt Beach),</p> <p>Woonona Beach (Beach Drive, Kurraba Road),</p> <p>STP at Bellambi,</p> <p>Marine Parade (Towradgi Beach), and</p> <p>other locations where erosion may affect infrastructure positions within road reserves and vulnerable private properties</p>	1	2016/17 or as soon as practical	<p><b>WCC</b> to advise asset owners of risks and encourage them to adopt this action, in consultation with WCC. Asset Owners include:</p> <p><b>SWC</b></p> <p><b>Ausgrid</b></p> <p><b>AGL</b></p> <p><b>Optus</b></p> <p><b>Telstra</b> etc</p>	Staff time only with financial contributions from asset owners	nil	See 'NR8' Option in Sect.5.4.1 of CZM Study report
I.4	Undertake detailed design, assessment, planning and works to redesign or retrofit Austinmer Boat Harbour to withstand wave forces and inundation due to sea level rise. Austinmer Boat Harbour could feasibly be redesigned, including raising the boat ramp and breakwalls, 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. Alternative designs without sand that retain or improve current functioning may also be acceptable.	Sharkys	1	<p>2016/17 or as soon as practical: Investigate options, prepare designs and approvals (as required)</p> <p>Undertake works when wave overtopping and mean sea level inundation causes the harbour to not be functional for the majority of sea conditions OR at major asset maintenance cycles, as required.</p>	WCC	Dependent on scale of works required (say \$1 – 2m)	I.2	See 'A2' Option in Sect.5.4.4 of CZM Study report
I.5	Undertake detailed design, assessment, planning and works to relocate activities on Sewage Treatment Plant compound. There appears to be sufficient vacant land within the Plant to relocate activities within the site to allow retreat. There may also be bedrock at shallow depth that could provide further protection from erosion, which would be confirmed through a geotechnical investigation.	Bellambi Pt	1	Move activities as erosion impacts manifest	<p><b>WCC</b> to advise <b>SWC</b> of risks and encourage SWC to adopt this action, in consultation with WCC</p>	Dependent on scale of works required (say \$1 – 2m)	I.3	See 'PR2' Option in Sect.5.4.3 of CZM Study report
I.6	Undertake detailed design, assessment, planning and works to upgrade Bellambi Boat Harbour in current location to withstand impacts. 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.	Bellambi	1	As maintenance to revetment and boat ramp is required over time, or following storm damage	WCC	Dependent on scale of works required (say \$1 – 2m)	I.2	See 'A2' Option in Sect.5.4.4 of CZM Study report

**Relevant Programs and Possible Funding Opportunities:**

- NSW Government Coastal Management Program or other recreational boating/maritime/leisure-based funding program
- Other State and Federal Government Grants (especially climate change adaptation and resilience building funds)
- Council's routine asset maintenance and works program

- New Council levies or increased land rates
- Sydney Water Corporation funding, and responsible for own infrastructure costs
- Contributions from other infrastructure owners / managers (e.g. SWC at Bellambi Boat Harbour)

## 7 MONITORING (M)

### Description:

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

Beaches are expected to erode and accrete in response to individual storms or series of storm events, and intervening quiet periods. Superimposed on this erosion / accretion cycle, however, is expected to be a longer-term trend of shoreline recession, which is induced by projected sea level rise. Monitoring of beach profiles is necessary to determine beach response to storms, and also to identify any underlying recession signals.

Most triggers for action presented in this Implementation Action Plan relate to the proximity of the Zone of Reduced Foundation Capacity (ZRFC) to a structure. The ZRFC is important for structures, as erosion scarps in dune sands will slump to a more stable dune profile shortly after a storm event, which may impact upon the area landward behind the erosion scarp. This zone is determined based on the landward erosion position, the erosion scarp slope, the dune or land height and the back beach material. It is noted that the ZRFC defined in Cardno (2010) assumes the back beach comprises dune sands. While the back beach area may comprise materials of greater structural integrity (which may reduce the ZRFC extent), for simplicity of monitoring, calculation of the ZRFC should assume the back beach and dunes comprise sand.

Other monitoring is also recommended, relating to coastal processes and responses to catchment rainfall and ocean storm conditions, including coastal inundation.

Monitoring is also important in the evaluation of the effectiveness of the Management Plan. As part of the monitoring, and as detailed further in Section 19, the risk evaluation process used to prioritise coastal risks should be repeated in the future to ensure that the highest priority risks always remain the focus of the CZMP.

Monitoring aims to help address a wide range of 'high' or 'extreme' risks across multiple beaches at the current timeframe. As such, all actions associated with the monitoring strategy take highest priority (i.e. Priority ranking '1')

### Risks Addressed by Implementation of Strategy:

Monitoring will not address identified risks specifically. Instead, monitoring will support the implementation of other strategies, will be used to define triggers for future action, and will provide information for future analysis and re-evaluation of risks as climate change impacts manifest.

### Action List:

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
M.1	Monitor beach profile and distance of immediate impact zone and ZFRFC from structural assets located behind the beach. Regular survey profiles should be established at approximately 100 metres along each beach, and adjacent to significant assets (e.g. seawalls, surf clubs, pavilions, cycleways, residences at risk).	All beaches, especially Thirroul Pool and Pavilion, Woonona (Beach Dr), and Sandon Point (Trinity Row)	1	2016/17, and minimum 6 months thereafter, and immediately after storm events	WCC	Staff time only (internal cost of about \$20,000 per year)	Nil	See 'NR14' Option in Sect.5.4.1 of CZM Study report



Beach profile monitoring by BMT WBM

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
M.2	Monitor lagoon / coastal creek entrance breakout level, frequency and berm height, as sea level rise (including recession) impacts upon the entrance configuration.	Stanwell Park (Hargraves & Stanwell Cks); Thirroul (Flanagans Ck); McCauleys (Hewitts & Tramway Cks); Sandon Pt (Slacky Ck); Bulli (Whartons and Collins Ck); Bellambi Gully; Bellambi Lagoon; Fairy Lagoon	1	Berm heights to be captured by beach profile monitoring	WCC	Staff time only	Nil	See 'NR14' Option in Sect.5.4.1 of CZM Study report
M.3	Monitor frequency, depth and spatial extents of coastal inundation events.	Priority locations include: Stanwell Park (Hargraves & Stanwell Creeks); Thirroul (Flanagans & Thomas Gibson Creeks), Bulli (Whartons Creek), Woonona, Bellambi Lagoon, and Fairy Lagoon.	1	Event-based monitoring	WCC	Staff time only	nil	See 'NR14' Option in Sect.5.4.1 of CZM Study report
M.4	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).	All beaches	1	After 5 – 10 years of monitoring	WCC	Staff time only, or minor sub-consultancy (up to \$25,000)	M.1 – M.3	See 'NR14' Option in Sect.5.4.1 of CZM Study report

#### Relevant Programs and Possible Funding Opportunities:

- State Government Coastal Management Program (particularly for re-evaluation of risks in future)
- Council's routine monitoring and works program
- New Council levies or increased land rates
- Contributions from Sydney Water Corporation and other infrastructure owners / managers (where monitoring also determines on-going risks to non-Council assets and infrastructure)

## 8 OCEAN POOLS (P)

### Description:

Wollongong is privileged to have a number of ocean pools along the coastline, which are mostly constructed on intertidal rock platforms. The pools are heritage listed as they date back to settlement of the Wollongong area. Given their age, they require reasonable annual maintenance to keep them functional. Bulli Pool is particularly vulnerable to sand build-up, and has required regular (~ 6 monthly) works to remove the sand from inside the pool.

Most pools are already overtopped during high tides, however, with future sea level rise, the pools will essentially become permanently submerged unless works are undertaken to raise the walls in line with future ocean levels. Given that the Wollongong Northern Beaches community is well served by no less than nine ocean pools, some rationalisation may be required in terms of future sea level rise accommodation works, with some pools raised and some pools abandoned.

Weighing into this decision is the current condition of each pool, and the ability of the structure to accommodate necessary structural modifications associated with raising of the walls.

Thirroul Pool is located behind the existing seawall in the middle of Thirroul Beach. It is possible for Thirroul Pool (and the heritage listed Thirroul Pavilion) to be relocated landward, further away from the existing and future potential erosion zone. An economic assessment carried out as part of the CZM Study (refer Appendix F of CZM Study) found that the amenity value of Thirroul Beach itself far outweighed the costs of relocating the structures further landward (Thirroul Pool, Pavilion etc).

Coledale, Austinmer, Bellambi and Towradgi are at 'high' or 'extreme' levels of risk at the current timeframe, and as such management of these pools takes highest priority (Priority level '1'). Those pools that won't reach 'high' or 'extreme' risks until 2050 or 2100 (e.g. Woonona Pool) are given a secondary priority (Priority level '2').



Bulli Ocean Pool

### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
Coalcliff Tidal Rock Pool (S end)	Medium	High	High	Bulli Pool	Medium	High	Extreme
Wombarra Rock Pool	Medium	Medium	High	Woonona Ocean Pool (Collins Pt)	Medium	High	Extreme
Coledale Rock Pool	High	Extreme	Extreme	Bellambi Pool	High	Extreme	Extreme
Austinmer Rock Pool	High	Extreme	Extreme	Towradgi Pool	High	Extreme	Extreme
Thirroul Pool (also heritage site)	High	Extreme	Extreme	Port Kembla Olympic Pool	High	Extreme	Extreme
Thirroul Pool office and amenities	High	Extreme	Extreme	Port Kembla Pool - Amenities/Kiosk/Lifeguard Tower	High	Extreme	Extreme
Thirroul Pool toilet	Medium	High	Extreme				
Thirroul Pool storage shed (large)	Medium	High	Extreme				
Thirroul Pool intake	High	Extreme	Extreme				

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks



Action List:

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
P.1	Undertake audit of all Ocean Pools in Wollongong LGA. 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.). The audit shall prioritise pools based on their ability to withstand hazard impacts versus maintenance regimes and other community needs.	Coalcliff Wombarra Coledale Austinmer Thirroul Bulli Woonona Bellambi Towradgi Port Kembla	1	2016/17 or as soon as practical	WCC	Staff time only	nil	See 'NR4' Option in Sect.5.4.1 of CZM Study report
P.2	Update / include ocean pools in Council's Asset Management Plan and, based on the outcomes of the audit, incorporate maintenance plans and priorities into forward works programs.  If it is determined that Ocean Pool(s) cannot be progressively repaired to withstand wave and sea level rise impacts into the future, the pool(s) will need to be abandoned and slowly removed as they fail over time, and this should be contained in the Asset Management Plan.  <i>Actions P.3 to P.5 apply if supported by the Asset Management Plan. Land status and management arrangements relevant to these actions will need to be clarified. It is highly likely that upgrades to existing infrastructure or new infrastructure may be sited, partly or fully on Crown Land. As a result, land owner consent and/or authorisation of the proposed works by way of Crown tenure/s is likely to be required in order to formalise the occupation of Crown Land and define ongoing maintenance responsibilities.</i>	As above	1	2016/17 or as soon as possible after Action P.1	WCC	Staff time only	P.1	See 'NR4' Option in Sect.5.4.1 of CZM Study report
P.3	Undertake detailed design, assessment, planning and works to retrofit Ocean Pools in current locations to withstand impacts. The decision to progressively retrofit selected Ocean Pools over time to withstand wave and sea level rise impacts shall depend upon the suitability of pool condition for this purpose, based upon outcomes of Action P.1.  It is likely Woonona Pool is more suitable to being maintained as the pool walls are already higher, buffering from sea level rise impacts.	Coalcliff	2	When damage to pool shell occurs OR the pool is being inundated at water levels lower than MSL OR as part of major asset refurbishment in accordance with the Asset Management Plan	WCC	Dependent on scale of works required (say \$1 – 2m per pool)	P.2	See 'A2' Option in Sect.5.4.4 of CZM Study report
		Wombarra	2					
		Coledale	1					
		Austinmer	1					
		Bulli	2					
		Woonona	2					
		Bellambi	1					
		Towradgi	1					
P.4	Undertake detailed design, assessment, planning and works to relocate Thirroul Pool outside of hazard zone. Consideration will need to be given to ensure that a relocated Thirroul Pool retains heritage character and value.  (See also Action SC.6)	Thirroul	1	When monitoring shows that ZRFC measured from erosion escarpment threatens pool foundations OR when pool reaches end of functional life and requires major refurbishment in accordance with Asset Management Plan.	WCC	Dependent on scale of works required (say \$2 – 4m)	P.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
P.5	Undertake detailed design, assessment, planning and works to raise Thirroul Pool intake. Thirroul Pool intake will be affected by inundation with sea level rise, and this impact will need to be accommodated (for example, raising the pipe line) if the structure cannot be relocated and the Pool is to be protected or retained in a	Thirroul	1	When Thirroul Pool undergoes major refurbishment / relocation as required OR when replacement / refurbishment of the Pool intake is required	WCC	Approximately \$100,000	P.4 unless intake affected before pool	See 'A2' Option in Sect.5.4.4 of CZM Study report

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
	similar form to present.							
	Port Kembla Olympic Pool (+Amenities/Kiosk/Lifeguard Tower) – See Action S.9							

#### Relevant Programs and Possible Funding Opportunities:

- State and Federal Government Grants (especially climate change adaptation and resilience building funds)
- Council's routine asset maintenance and works program
- New Council levies or increased land rates
- Potential revenue generated from public entry to pool (Thirroul Pool only)

## 9 PRIVATE LAND ACQUISITION (PL)

### Description:

There are many private properties along the Wollongong Coastline that are potentially affected by existing and future coastal risks. Coastal inundation is considered a relatively low risk, as it is temporary and usually does not occur with destructive impacts. Storm erosion on the other hand is of much greater consequence, as loss of land or foundation capacity can completely destroy buildings and other assets located within the impact zone.

There are two existing residential dwellings that are at significant risk in the future from storm erosion, one located at Thirroul Beach, and the other located at McCauleys Beach. It is impractical to protect these individual properties without having significant impact on the overall beach amenity. These properties should therefore be returned to public ownership, and abandoned/sacrificed in the future as the beaches slowly recede.

Given the anticipated timeframe for impact, it is expected that these dwellings could continue to be occupied until erosion directly threatens their structural integrity. As such, they could be leased back so that residents can continue to enjoy the amenity they offer, and to help recover the costs of the market-priced acquisition.

Neither of the two properties are at 'high' or 'extreme' risk at the current timeframe, and as such, actions associated with this strategy are given a secondary priority (i.e. Priority Level '2').



### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100
Thirroul: Existing Residences 1 ppty at centre of beach	Medium	High	Extreme
McCauleys: Existing Residences 1 ppty at N end of beach	Medium	Medium	High

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks

### Action List:

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
PL.1	Voluntary buy back – lease back. Council to seek finance to acquire affected property, at market value, on a voluntary basis. Once under Council ownership, the property is then leased at market rates, as a way of recouping financial investment, until such time as the hazard impact is imminent. If the sale of the property is delayed significantly, then the market value of the property is likely to reduce due to the increasing coastal risks.  Once the hazard impact is imminent, the property shall be demolished.	Thirroul – 1 property in middle of the beach	2	2016/17– consider options for financing of acquisition and commence consultation with landholder. Offer acquisition once funding becomes available.  Arrange lease once under Council ownership.  Terminate lease and demolish property when erosion impacts threaten building foundations or impacts are considered imminent (see Action M.1).	WCC	Current market value of property	Nil	See 'PR5' Option in Sect.5.4.3 of CZM Study report

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
PL.2	Voluntary acquisition. Council to seek finance to acquire affected property, at market value, on a voluntary basis. If the sale of the property is delayed significantly, then the market value of the property is likely to reduce due to the increasing coastal risks (thus incentive for private landholder to sell sooner).  <i>This action is an alternative to PL.1 if lease-back is not possible (meaning that recouping of acquisition costs also not possible).</i>	Thirroul – 1 property in middle of the beach	2	If and when buy-back / lease-back option is determined to not be feasible, seek finance for voluntary acquisition. Offer acquisition once funding becomes available.  <i>Property would be demolished upon acquisition. (see Action PL.5)</i>	WCC	Current market value of property	PL.1	See 'PR4' Option in Sect.5.4.3 of CZM Study report
PL.3	Voluntary buy back – lease back. Council to seek finance to acquire affected property, at market value, on a voluntary basis. Once under Council ownership, the property is then leased at market rates, as a way of recouping financial investment, until such time as the hazard impact is imminent. If the sale of the property is delayed significantly, then the market value of the property is likely to reduce due to the increasing coastal risks.  Once the hazard impact is imminent, the property shall be demolished.	McCauleys Beach – 1 property at the northern end of the beach	2	2016/17 – consider options for financing of acquisition and commence consultation with landholder. Offer acquisition once funding becomes available.  Arrange lease once under Council ownership.  Terminate lease and demolish property when erosion impacts threaten building foundations or impacts are considered imminent (see Action M.1).	WCC	Current market value of property	nil	See 'PR5' Option in Sect.5.4.3 of CZM Study report
PL.4	Voluntary acquisition. Council to seek finance to acquire affected property, at market value, on a voluntary basis. If the sale of the property is delayed significantly, then the market value of the property is likely to reduce due to the increasing coastal risks (thus incentive for private landholder to sell sooner).  <i>This action is an alternative to PL.3 if lease-back is not possible (meaning that recouping of acquisition costs also not possible).</i>	McCauleys Beach – 1 property at the northern end of the beach	2	If and when buy-back / lease-back option is determined to not be feasible, seek finance for voluntary acquisition. Offer acquisition once funding becomes available.  <i>Property would be demolished upon acquisition. (see Action PL.5)</i>	WCC	Current market value of property	PL.3	See 'PR4' Option in Sect.5.4.3 of CZM Study report
PL.5	Demolish properties, following termination of any leasing arrangements (if Actions PL.1 and/or PL.3 were adopted)	Thirroul – 1 property in middle of the beach, and McCauleys Beach – 1 property at the northern end of the beach	2	Assuming properties are in public ownership, demolish property when monitoring shows that the ZRFC encroaches the building foundations.	WCC	Approx. \$50,000	M.1 PL.1 or PL.2 and PL.3 or PL.4	See 'PR4 and PR5' Options in Sect.5.4.3 of CZM Study report

### Relevant Programs and Possible Funding Opportunities:

- NSW Government Coastal Management Program
- NSW Government Coastal Lands Protection Scheme
- Other State or Federal Government Grants (especially climate change adaptation and resilience building funds)
- New Council levies or increased land rates
- Private financial institutions (e.g. banks) if lease-back arrangement can repay capital + interest.

## 10 ROADWAYS & PARKING (R)

### Description:

Wollongong City is precariously positioned on the coastal plain that separates the Illawarra Escarpment from the Pacific Ocean. With distance north, the escarpment gets closer and closer to the coast, meaning that the coastal plain becomes narrower and narrower. Along the coastline, and particularly along the northern Wollongong Beaches, major and minor roads are positioned close to the coast. This culminates just north of Wollongong, wherein the coastal access road is perched hard against the sea cliffs, where the Illawarra Escarpment meets the ocean.

Lawrence Hargraves Drive is a major access road for the northern beaches, and is at risk of damage in the vicinity of Austinmer and Little Austinmer Beaches. Trinity Row at Sandon Point is also a major road positioned immediately behind the beach within the potential future erosion and recession zone. Other minor roads that mostly serve as access to local residences are also under threat at a number of locations along the coastline.

Where possible, roadways and parking should be relocated outside the areas of immediate coastal risk. Given the anticipated timeframe for impact, planning should commence now in earnest in order to reserve lands and access provisions for future road relocations.

No roadways are under an immediate intolerable risk (i.e. 'high' or 'extreme' level of risk), and therefore, aside from planning actions, all actions associated with management of roadways and parking are given secondary priority (i.e. Priority ranking '2').



Seaciff Bridge, north of Wollongong

### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
Sharkys: Austinmer Boat Harbour Car park	Medium	Medium	High	Sandon Point Local Roads: Trinity Row, Ursula St, Alroy St	Medium	Medium	High
Little Austinmer Lawrence Hargrave Drive (Major Coastal Road)	Medium	High	Extreme	Woonona Local Roads (Kurraba Rd)	Medium	Medium	High
Little Austinmer: local roads and carpark	Medium	Medium	High	Woonona Local Roads (Beach Drive, Liamina Ave, Robertson Rd, Dorrigo Ave)	Medium	Medium	High
Austinmer Lawrence Hargrave Drive (Major Coastal Road)	Medium	High	Extreme	Bellambi Beach Local access road along coastline to Bellambi Boat Harbour (does not service houses, but provides access to Pool and Harbour)	Medium	High	Extreme
Austinmer Beach access and car park	Medium	Medium	High	Towradgi Local Roads: Marine Parade (N end of beach)	Low	Medium	Medium

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks

**Action List:**

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
R.1	Undertake traffic assessments to determine the feasibility and costs associated with redirection of traffic compared with redesign/protection of roadways at risk of recession.  The assessments would be carried out for those local roads and major roads (Lawrence Hargrave Drive) that may be affected by recession in the future. The assessment needs to consider the broader impacts of redirected traffic 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 due to road/traffic constraints, protection and /or accommodation options for the roadway shall be considered as part of the traffic assessments.	Little Austinmer Austinmer Sandon Point Woonona Bellambi Towradgi	1	2016/17 or as soon as practical	WCC	Staff time only or minor consultancy (say \$25,000)	nil	See 'NR5' Option in Sect.5.4.1 of CZM Study report
R.2	Update local roads and major roads in Council's Asset Management Plan and, based on the outcomes of the traffic assessment, incorporate relocation/redirection and/or protection works into forward works programs.  <i>Actions R.3 to R.7 apply if supported by the Asset Management Plan.</i>	As above	1	2016/17 or as soon as possible after R.1	WCC	Staff time only	R.1	See 'NR5' Option in Sect.5.4.1 of CZM Study report
R.3	Undertake detailed design, assessment, planning and works to relocate beach access road and carpark to beach.	Little Austinmer	2	When erosion impacts occur to roadway foundations	WCC	Less than \$50,000	R.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
R.4	Undertake detailed design, assessment, planning and works to relocate Austinmer Boat Harbour carpark. As part of retaining a functioning boat harbour for the community, car parking facilities for boat users need to be retained. There is public open space landward of the current car park. Relocation to this site would need to be determined in conjunction with remodelling the harbour to remain functional with sea level rise inundation impacts (refer Action I.4).	Sharkys	2	When erosion or wave overtopping damages carpark such that it is not functional OR when Harbour is being redesigned	WCC	Less than \$100,000	R.2	See 'PR2' Option in Sect.5.4.3 of CZM Study report
R.5	Undertake detailed design, assessment, planning and works to relocate roadway (Trinity Row). The ability to redirect traffic off Trinity Row will need to be confirmed through Action R.1. Residential access would be permitted, with through traffic directed elsewhere. The current roadway would be sacrificed to allow for planned retreat of the beach.	Sandon Point	2	when ZRFC from erosion escarpment encroaches upon Trinity Row	WCC	Approximately \$500,000	R.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
R.6	Undertake detailed design, assessment, planning and works to relocate roadway (Kurraba Rd), based upon the outcomes of Action R.1. Access to residential properties must be retained.	Woonona	2	When ZRFC measured from erosion escarpment encroaches onto the roadway.	WCC	Approximately \$500,000	R.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
R.8	Undertake detailed design, assessment, planning and works to relocate roadways (Beach Drive, Liamina Ave, Robertson Rd, Dorrigo Ave).	Woonona	2	When ZRFC measured from erosion escarpment encroaches onto the roadway.	WCC	Approximately \$500,000	R.2 SP.3 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Reqd	Preceding Actions	Further Info.
R.7	Undertake detailed design, assessment, planning and works to relocate roadway (Marine Drive), as necessary. 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.	Towradgi	2	At scheduled time for asset maintenance OR when ZRFC measured from erosion escarpment encroaches onto building foundations or cabins, whichever is sooner	WCC	Less than \$100,000	R.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
	See Action S.4 for: Austinmer Lawrence Hargrave Drive (Major Coastal Road) Austinmer Beach access and car park							
	Bellambi access road along coastline to Bellambi Boat Harbour – refer Action S.5							
	WIN Stadium carparking – refer Action RF.4.	City	2					

#### Relevant Programs and Possible Funding Opportunities:

- State and Federal Government Grants (especially climate change adaptation and resilience building funds)
- Council's routine asset maintenance and works program
- New Council levies or increased land rates

## 11 RECREATIONAL FACILITIES (RF)

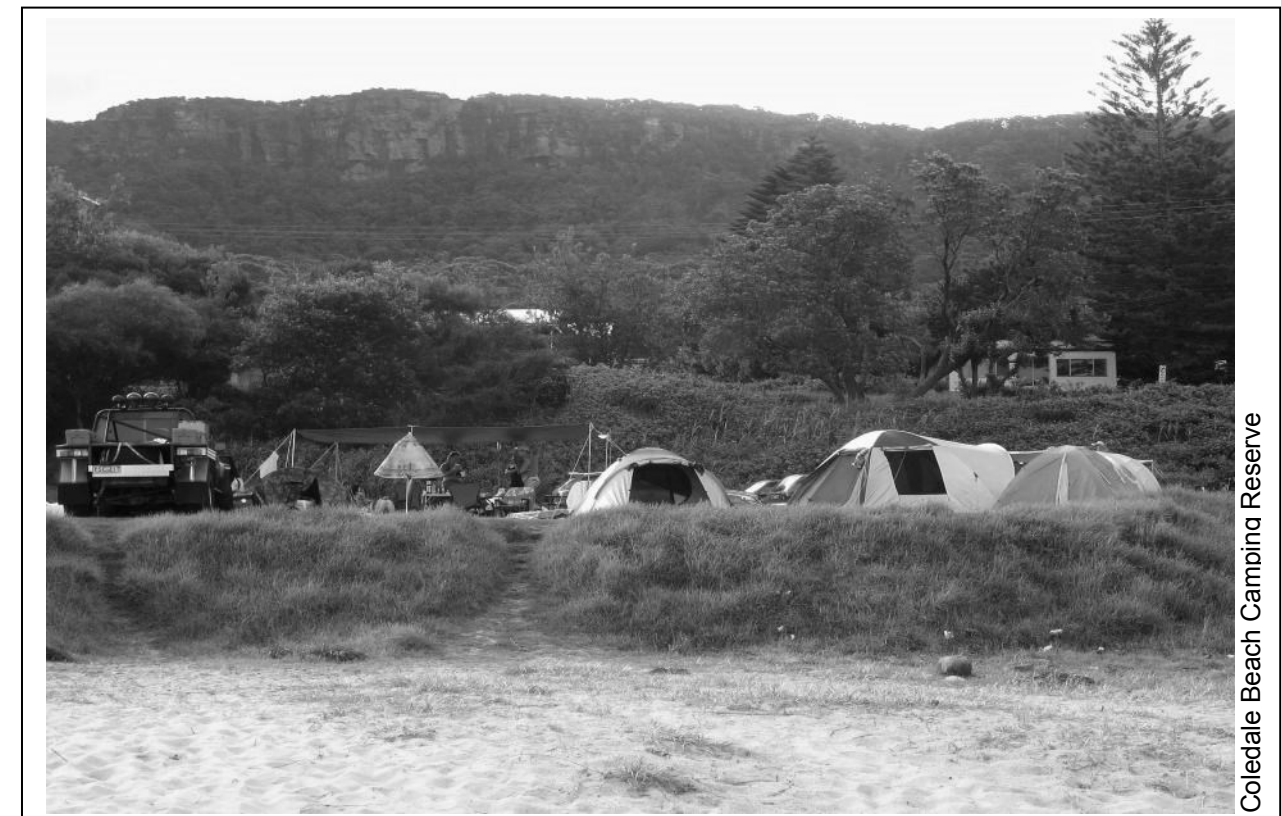
### Description:

There are many formal and informal recreational facilities located along the Wollongong Coastline. These include beach accessways, playgrounds, seating, campgrounds and tourist parks, and the WIN football stadium (note the cycleway and other major assets and infrastructure have been discussed separately). Recreational facilities also includes parklands and reserves, which can allow for natural retreat of the beach at the sacrifice of some parkland, without significant overall reduction in the functionality of the park. Allowing this natural retreat of the beach is the key to retaining a sandy beach for public enjoyment, the environmental and the economic benefits associated with the beach.

Recreational facilities (stand alone or within parks) require on-going maintenance and periodic replacement as they approach the end of their design life. As part of the Asset Management process that guides maintenance and remediation of Council assets, these facilities should be repaired as required following storm events, with the longer-term objective of relocation away from the area of immediate coastal risk (for example, relocating tourist cabins or picnic tables within a tourist park or reserve, to allow retreat of the beach). Given the anticipated timeframe for major impact on these facilities, it is expected that progressive landward relocation can be easily achieved as part of future upgrades and replacements.

No specific recreational facilities are under an immediate intolerable risk (i.e. 'high' or 'extreme' level of risk), and therefore, most actions associated with management of recreational facilities are given secondary priority (i.e. Priority ranking '2'). The exception is the general maintenance and repair of existing minor facilities, such as beach access tracks, which is required after any major storm event, and as such, is given a Priority Level of '1'.

It is noted that there are a number of parks and reserves at low to medium risk to 2100. Based upon the low levels of risk, no specific action is required at the current time (indeed, some of these assets are affected by inundation, for which no action is likely to be taken). Should impacts to these parks and reserves occur earlier than anticipated, again, repair storm damage to minor recreational facilities, access tracks etc to maintain public safety would occur in accordance with the EASP.



### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
Stanwell Park Recreation Area Park and Natural Area	Medium	Medium	High	McCauleys Beach Reserve	High	Extreme	Extreme
Coalcliff Beach Reserve Nature Area, Coalcliff Beach Reserve	Medium	Medium	High	Sandon Point Beach Reserve (not including Sandon Point Heritage area)	Medium	Medium	High
Coledale Beach Reserve	Medium	Medium	High	Bulli Beach Reserve, Ocean Park (Bulli Beach)	Medium	Medium	High
Coledale Beach Camping and Caravan Park	Medium	Medium	High	Bulli Tourist Park (caravan park)	Medium	Medium	High
Sharkys Beach Reserve	Medium	Medium	High	Woonona: Collins Point Reserve, Woonona Beach Reserve, Beach Drive Park	Medium	Medium	High
Little Austinmer Beach Reserve	Medium	Medium	High	Bellambi: Beach Drive Park, Bellambi Natural Area, Bellambi Point Reserve, Bellambi Pool Reserve	Medium	Medium	High
Austinmer Beach Reserve and Tuckermans Park	Medium	Medium	High	Stuart Park (on heritage list, local significance)	Medium	High	Extreme
Thirroul: Tingara Park	Medium	Medium	High	City Beach: Open space, parks including City Beach Foreshore	Medium	Medium	High
Heritage Site: Thirroul Beach Reserve (S of pool)	Medium	High	Extreme	City Beach: Football Ground (WIN Stadium) and Showground	High	Extreme	Extreme
McCauleys: Woodland Avenue Reserve, Corbett Ave Reserve, Sandon Point Reserve	Medium	Medium	High	Coniston: Wollongong Golf Course ** for inundation, this is only a very small section at far south end.	Medium	Medium	High

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks



Action List:

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Reqd	Preceding Actions	Further Info.
RF.1	Within the context of accepting loss (sacrifice) of park land to allow natural retreat of beaches into parklands behind, repair storm damage to minor recreational facilities, access tracks etc on an as-needed basis to maintain public safety. Where damage is extensive, consider abandoning and relocating assets and access as described in other actions.	Stanwell Park Coalcliff Coledale Sharkys Little Austinmer Austinmer Thirroul McCauleys Sandon Point Bulli Woonona Bellambi Bellambi Pt Corrimal Towradgi Fairy Meadow City Coniston Perkins	1	As needed following damaging erosion and/or inundation events	WCC, WCC in co-ordination with facilities owner for Golf Course land	Dependent on the degree and extent of storm damage.  Assume damage would be relatively minor, else the facilities would be relocated and replaced	nil	See 'PR1' Option in Sect.5.4.3 of CZM Study report
RF.2	Physically relocate/reposition Bulli tourist cabins. Tourist cabins are typically low key structures that are relatively easily relocatable.	Bulli	2	When ZRFC measured from erosion escarpment encroaches onto cabins foundations	WCC	Less than \$100,000	M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
RF.3	Undertake detailed design, assessment, planning and works to relocate WIN Stadium parking and ancillary buildings and minor football ground outside of hazard zone. There is potential to reconfigure the football ground landward to avoid hazards impacts. The actual WIN Stadium is currently at very low risk but parking and other small buildings adjacent would need to be relocated.	Coniston	2	When erosion escarpment encroaches on the assets	WCC to advise facilities owner of risk and encourage adoption of this action in consultation with WCC.	More than \$500,000	M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
	Thirroul Beach Reserve – see Action S.1							
	Austinmer Beach Reserve and Tuckermans Park – see Action S.1 and Action S.4							
	Stuart Park (North Beach) – see Action S.8							

Relevant Programs and Possible Funding Opportunities:

- State and Federal Government Grants (especially climate change adaptation and resilience building funds)
- Council's routine asset maintenance and works program
- Funding of private works by private facilities owners

## 12 SEAWALLS & TRAINING WALLS (S)

### Description:

There are a few coastal structures located along the Wollongong Coastline that offer protection to land and assets behind the structures to varying degrees of assurance. These include seawalls at Austinmer Beach, Thirroul Beach, Bellambi Beach (behind Bellambi Pool), Bellambi Boat Harbour and boat ramp, North Beach (from Pavilion to the kiosk) and Perkins Beach (at Port Kembla Olympic Pool). There are reports of a possible structure at Scarborough Beach, however details are minimal. Note that there are also extensive seawalls and breakwater structures at Port Kembla Harbour, which are under the direct management responsibility of Port Kembla Port Corporation (PKPC), and as such, are excluded from this CZMP.

The condition of the existing seawalls is expected to be variable, especially for the older structures. Foundation conditions are largely unknown. Storms in 1974 depleted many beaches of sand, and exposed the foundation piles of the structure at Thirroul Beach. The structure at North Beach adjacent to the North Beach Pavilion is currently being replaced.

The Lake Illawarra Entrance training walls have been constructed recently in order to provide a more consistent water level within the lake (the prolonged drought conditions in the early 2000's resulted in lake levels falling more than half a metre below normal ocean levels, causing extensive die-off of algae and seagrass). Whilst the design of these walls considered future sea level rise, on-going maintenance of the structures will still be required as overtopping frequency increases. Raising of the walls may be considered necessary in the future to minimise on-going damage.

Management of seawalls and training walls that are at 'high' or 'extreme' levels of risk at the current timeframe takes highest priority (i.e. Priority ranking '1'), while actions to address 'high' or 'extreme' risks that won't materialise until 2050 or 2100 are given secondary priority (i.e. Priority ranking '2').

*Under Section 55 of the Coastal Protection Act, 1979, seawalls may be partially or wholly funded by landholders that are additionally or wholly protected by the structure. In this case, WCC can lobby RMS, SWC and other private landholders for funding assistance, as proposed seawalls would additionally protect Lawrence Hargrave Drive (an RMS road), additionally and wholly protect Bellambi STP (SWC property) and private properties. Under Section 55, Council is permitted to apply a Coastal Protection Service Charge to such landholders to partially or wholly fund ongoing maintenance of the seawalls and offsite impacts.*

*Property Risk Categories (in accordance with the Coastal Protection Regulation, 2011) for private properties affected by erosion and recession; and Property Response Categories (in accordance with OEH, 2013) that outlines the potential for response in terms of protection works only for such private properties is listed in Appendix A. It is noted that this CZMP has adopted a far more detailed assessment of risk, and investigated many alternative actions additional to protection options. Thus, for Council's use, a summary table of recommended current and future actions for all private properties at risk to 2100 is given in Appendix A.*



### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
<u>Austinmer Beach</u>				<u>Thirroul cont.</u>			
Austinmer Beach Reserve and Tuckermans Park	Medium	Medium	High	Existing Residences (8 ppty at S end of beach, plus 8 ppty for geotechnical hazards extending along headland to McCauleys)	Medium	High	Extreme
Austinmer Surf Club	Medium	High	Extreme	<u>Bellambi</u>			
Heritage Site: Norfolk Island Pines (backing entire beach)	Medium	Medium	High	Cycleway / Shared Pathway (S of Bellambi Gully entrance)	Medium	Medium	High
Austinmer changeroom & toilets	Low	Medium	Medium	Bellambi Pool Toilet Block	Low	Medium	Medium
Austinmer Boatshed	Low	Low	Low	Bellambi Pool car park	Low	Medium	Medium

	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
Austinmer War Memorial (Heritage Site)	High	Extreme	Extreme	Bellambi Beach Local access road along coastline to harbour (does not service houses)	Medium	High	Extreme
Lawrence Hargrave Drive (Major Coastal Road) at Austinmer	Medium	High	Extreme	<u>Bellambi Point</u>			
Austinmer beach access and car park	Medium	Medium	High	Stormwater outlets and pipes (adjacent to STP)	High	Extreme	Extreme
Stormwater outlets and pipes at Austinmer	High	Extreme	Extreme	Sewage Treatment Plant	High	Extreme	Extreme
<u>Thirroul Beach</u>				<u>North Beach</u>			
Thirroul Surf Club	High	Extreme	Extreme	Stuart Park (on heritage list, local significance)	Medium	High	Extreme
Thirroul Pool (also heritage site)	High	Extreme	Extreme	Public open space adjacent to Pavilion, Kiosk	Low	Medium	Medium
Thirroul Pool office and amenities	High	Extreme	Extreme	North Beach Surf Club	High	Extreme	Extreme
Thirroul Pool toilet	Medium	High	Extreme	Heritage Site: North Beach Kiosk	Low	Medium	High
Thirroul Pool storage shed (large)	Medium	High	Extreme	Cycleway / Shared Pathway (includes heritage railway cuttings and embankments)	Medium	High	Extreme
Heritage site: Thirroul Pavilion (being used as kiosk / restaurant) and residence	High	Extreme	Extreme	Stormwater outlets / pipes (adjacent to Pavilion)	High	Extreme	Extreme
Heritage Site: Thirroul Beach Reserve (S of pool)	Medium	High	Extreme	<u>Perkins Beach</u>			
Local Roads (Bath St)	Low	Medium	Medium	Port Kembla Olympic Pool	High	Extreme	Extreme
Beach access and car park (S end of Beach)	Low	Low	Medium	Port Kembla Pool - Amenities/Kiosk/Lifeguard Tower	High	Extreme	Extreme
Stormwater outlet to Flanagans Creek	Medium	High	High	Stormwater outlets & pipes (one adjacent to Port Kembla Pool)	High	Extreme	Extreme
Thomas Gibson Creek - Major stormwater outlet	High	Extreme	Extreme	<u>Lake Illawarra Training Walls</u>	High	Extreme	Extreme

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks

### Action List:

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
S.1	<p>Conduct audit (dilapidation survey) of existing seawall structures and training walls, to determine their current condition, effectiveness, expected functional life, and future potential to mitigate storm erosion and wave overtopping under higher sea levels.</p> <p>The audit should be used to guide subsequent decisions at the relevant beaches, including future replacement with seawall protection or "manage to fail" (planned retreat) options.</p>	Scarborough Austinmer Thirroul Bellambi Bellambi Pt North Perkins Lake Illawarra Entrance	1	2016/17  Repeated on a 5 – 10yr cycle (or shorter for structures nearing the end of their functional life).	WCC	Staff time only, or minor consultancy (say \$20,000)	nil	See 'NR2' Option in Sect.5.4.1 of CZM Study report

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Reqd	Preceding Actions	Further Info.
S.2	Update hazard estimates for 2010, 2050 and 2100 where relevant to account for existing seawall protection, and update this action list, as necessary, to account for condition (life) of existing seawalls	As above	1	2016/17 (as soon as practical following Action S.1).	WCC	Staff time only or consultant	S.1	See 'NR2' Option in Sect.5.4.1 of CZM Study report
S.3	Add seawalls and training walls to Council's Asset Management Plan, and based on the outcomes of the audit, incorporate remediation, maintenance and replacement works into forward works programs.  <i>Actions S.4 to S.9 apply if supported by the Asset Management Plan. Land status and management arrangements relevant to these actions will need to be clarified. It is highly likely that upgrades to existing infrastructure or new infrastructure may be sited, partly or fully on Crown Land. As a result, land owner consent and/or authorisation of the proposed works by way of Crown tenure/s is likely to be required in order to formalise the occupation of Crown Land and define ongoing maintenance responsibilities.</i>	As above	1	2016/17 (as soon as practical following Action S.1).	WCC	Staff time only	S.1	See 'NR2' Option in Sect.5.4.1 of CZM Study report
S.4	Undertake detailed design, site investigations, approvals and works associated with repair or replacement of existing seawall along existing alignment, and associated beach nourishment. The design and approvals shall describe ongoing maintenance arrangements for any replacement structure and management of offsite impacts from the structure.	Austinmer	1	When end of functional life is reached (refer Action S.3) OR when wall is structurally damaged by storm event, whichever is sooner.	WCC <b>WCC</b> to advise <b>RMS</b> of risks and lobby for funding assistance, as this action additionally protects an RMS road.	Depending on scope of works. An entirely new wall may be up to \$3.5m	S.3	See 'S1' Option in Sect.5.4.2 of CZM Study report
S.5	Undertake detailed design, site investigations, and approvals as necessary for maintenance and upgrading works of existing seawall along existing alignment, and extension of wall along shoreline section between Bellambi Boat Harbour and Pool. The upgrade design shall provide for protection from wave overtopping; and shall describe adequate arrangements for ongoing maintenance management of impacts from the structure.  There is potentially bedrock below the site that could form suitable foundations e.g. between the Pool and Harbour along the roadway.	Bellambi, from Bellambi Gully entrance to Bellambi Pool, then to Bellambi Boat Harbour	2	On as needs basis for asset maintenance (refer Action A.3) or to repair storm damage (e.g. to roadway).	WCC <b>WCC</b> to advise <b>SWC</b> of risks and lobby for funding assistance, as this action additionally protects SWC assets and land.	Depending on scope of works. Indicative budget of \$1m	S.3	See 'S2' Option in Sect.5.4.2 of CZM Study report
S.6	Undertake detailed design, site investigations, and approvals as necessary for maintenance and upgrading works of existing seawall along existing alignment. Specific provision of stormwater outlet required in design of upgrading. The upgrade design shall also describe ongoing maintenance arrangements and management of offsite impacts from the structure.	Bellambi Pt along the boundary of the Sewage Treatment Plant between Bellambi Lagoon and Bellambi Point	1	On as needs basis for asset maintenance (refer Action A.3) or to repair storm damage.	<b>WCC</b> to advise <b>SWC</b> of risks and lobby for whole or partial funding for this action that protects SWC assets and land.	Depending on scope of works. Indicative budget of \$0.5m	S.3	See 'S2' Option in Sect.5.4.2 of CZM Study report

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Reqd	Preceding Actions	Further Info.
S.7	Undertake detailed design, site investigations, approvals and works associated with the construction of new seawall sections, to the south of North Beach Pavilion, and to north to replace the existing crib-lock wall. The seawall design shall provide for protection from wave overtopping. Design and approvals shall also describe ongoing maintenance arrangements and management of offsite impacts from the structure.	North Beach, (along cycleway to south of Pavilion and to north past existing SLSC, replacing existing crib-lock wall	1	2016/17: detailed designs and planning approvals.  Construct crib-wall replacement section subject to audit outcomes (refer Action S.1) and works program (refer Action S.3).  Construct section following next major storm erosion event.	WCC	Depending on scope of works, but expected to be in the order of \$2 million	S.3	See 'S2' Option in Sect.5.4.2 of CZM Study report
S.8	Undertake detailed design, site investigations, approvals and works associated with the construction of a new seawall section along specified alignment to retain salient and Stuart Park. Design and approvals shall also describe ongoing maintenance arrangements and management of offsite impacts from the structure.	North Beach: short wall section along salient landward of nearshore reef at seaward edge of Stuart Park	2	When monitoring indicates commencement of ongoing recession at salient behind nearshore reef on North Beach.	WCC	Depending on scope of works, but expected to be in the order of \$2 million	M.1	See 'S2' Option in Sect.5.4.2 of CZM Study report
S.9	Undertake detailed design, site investigations, and approvals as necessary for maintenance and upgrading works of existing seawall along existing alignment. Specific provision of stormwater outlet required in design of upgrading. The upgrade design shall also describe ongoing maintenance arrangements and management of offsite impacts from the structure.	Perkins (adjacent to Port Kembla Olympic Pool)	1	On as needs basis for asset maintenance (refer Action A.3) or to repair storm damage.	WCC	Depending on scope of works. Indicative budget of \$0.5m	S.3	See 'S2' Option in Sect.5.4.2 of CZM Study report
S.10	DoI – Lands & Forestry maintain the Lake Illawarra training walls to ensure their ongoing stability and function. Note that all river training walls managed by DoI – Lands & Forestry are included in an asset management plan that includes regular inspections by qualified engineer.	Lake Illawarra Entrance	1	When end of functional life is reached (refer Action S.3) OR when wave breaking destabilises armour stone OR when frequency of overtopping presents significant risk to pedestrian and boating public.	DoI – Lands & Forestry	In the order of \$1m for significant raising of training wall height.	S.3	See 'A2' Option in Sect.5.4.4 of CZM Study report
S.11	Undertake detailed design, site investigations, approvals and works associated with the construction of new seawall sections connecting along the headland from Thirroul to McCauleys Beach. The seawall design shall provide for protection from wave overtopping. Design and approvals shall also describe ongoing maintenance arrangements and management of offsite impacts from the structure.  As the seawall only protects private property, in accordance with Section 55 of the <i>Coastal Protection Act 1979</i> , Council can require construction and ongoing maintenance to be funded by the private property owners.	Southern end of Thirroul to McCauleys headland, covering 16 properties, for both erosion (8 pties) and geotechnical hazards (8 pties).	2	Prior to redevelopment / upgrading of any development identified as "at risk" or when the Immediate Impact Zone (including foundation stability allowance) intersects existing buildings.	<u>Private property owners</u> are responsible for seawall construction and maintenance. Seawalls must be constructed on private land only, not public land.  WCC responsible for development assessment.	Depending on scope of works. Indicative budget of \$1m.	nil	See 'S2' Option in Sect.5.4.2 of CZM Study report

### Relevant Programs and Possible Funding Opportunities:

- State and Federal Government Grants (especially climate change adaptation and resilience building funds)
- RMS funding (for on-going protection of Lawrence Hargrave Dr)
- Sydney Water Corporation funding (for on-going protection of STP directly through works on Bellambi Pt, and indirectly through works to protect roadway between Pool and Harbour)
- Council's routine asset maintenance and works program
- New Council levies or increased land rates

### 13 SURF CLUBS & PUBLIC BUILDINGS (SC)

#### Description:

Surf Club buildings are generally located immediately behind beaches to provide easy access for lifesaving crews and equipment, as well as commanding views over patrolled and unpatrolled sections of beach. This unfortunately means that the buildings are usually at risk of coastal inundation and storm erosion. With future sea level rise, many of the Surf Club buildings will also be at risk from shoreline recession.

The Surf Club buildings along the Wollongong coastline are in variable condition. City Beach Surf Club has recently been constructed, while there are plans in place for the imminent refurbishment of Sandon Point Surf Club building. A relocatable lifeguard structure is intended for Coledale, which would allow for the structure to be moved landward when beach conditions threaten to impact on the structure.

Other public buildings, such as Pavilions, Kiosks and amenities building are also at risk from current and future coastal erosion and shoreline recession. Relocation (i.e. rebuilding on a more landward site) at the end of their functional life is a viable option for many of these structures. A few of these structures are heritage-listed (e.g. Thirroul Pavilion, North Beach Pavilion, North Beach Kiosk), signifying their importance to the local community. Relocation of these structures to avoid loss and damage in the future may be a viable option.

Management of Surf Clubs and Public Buildings that are at 'high' or 'extreme' levels of risk at the current timeframe takes highest priority (i.e. Priority ranking '1'), while actions to address 'high' or 'extreme' risks that are not expected to materialise until 2050 or 2100 are given secondary priority (i.e. Priority ranking '2').



Sandon Point Surf Club

#### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
Helensburgh / Stanwell Park SLSC	Medium	High	Extreme	Sandon Point Surf Club	High	Extreme	Extreme
Coalcliff Surf Club	Low	Medium	Medium	Bulli Surf Club	High	Extreme	Extreme
Coledale Surf Club	Low	Medium	Medium	Bulli Kiosk and residence	Medium	Medium	High
Coledale Beach Camping Reserve - Amenities Building	Low	Medium	Medium	Woonona Surf Club	Low	Medium	High
Austinmer Surf Club	Medium	High	Extreme	Bellambi Surf Club (affected by inundation)	Medium	High	Extreme
Austinmer Boatshed (affected by wave overtopping)	Medium	Medium	High	Corrimal Surf Club (affected by inundation)	Medium	Medium	High
Thirroul Surf Club	High	Extreme	Extreme	Fairy Meadow SLSC Lifeguard Tower	Low	Medium	Medium
Thirroul Pavilion (Heritage site: currently being used as kiosk / restaurant and residence)	High	Extreme	Extreme	North Beach Kiosk (Heritage Site)	Low	Medium	High
Thirroul: Former Quest House (heritage site) affected by inundation	Medium	High	Extreme				

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks

**Action List:**

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
SC.1	<p>Conduct audit (dilapidation survey) of substantial public buildings (including Surf Clubs) to determine current condition, as well as site constraints for future redevelopment, including foundation capacity, and land availability to relocate the structures.</p> <p>Where the site is 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, and guide implementation of future works on these public structures.</p>	Helensburgh Surf Club Coalcliff Surf Club Coledale Surf Club Coledale Camping Amenities Austinmer Boatshed Austinmer Surf Club Thirroul Surf Club Thirroul Pavilion Sandon Pt Surf Club Bulli Surf Club Bulli Kiosk Woonona Surf Club Bellambi Surf Club Corrimal Surf Club North Beach Kiosk North Beach Pavilion	1	2016/17 or as soon as practical	WCC	Staff time only, or minor consultancy (say \$30,000)	nil	See 'NR3' Option in Sect.5.4.1 of CZM Study report
SC.2	<p>Add public buildings (including Surf Clubs) to Council's Asset Management Plan, and based on the outcomes of the audit, incorporate remediation, maintenance and replacement works into forward works programs, with specific notification of "relocate", "redesign", "retrofit" or "relocatable".</p> <p><i>Actions SC.3 to SC.17 apply if supported by the Asset Management Plan.</i></p>	As above	1	2016/17 (as soon as practical following Action SC.1)	WCC	Staff time only	SC.1	See 'NR3' Option in Sect.5.4.1 of CZM Study report
SC.3	Undertake detailed design, site investigations, and approvals as necessary to relocate and redesign Coledale SLSC to withstand coastal impacts, particularly inundation (the proposed relocatable lifeguard structure at Coledale reduces need to have clubhouse in close proximity to the shoreline, enabling relocation, subject to outcomes of SC.1)	Coledale	2	When monitoring shows that ZRFC measured from erosion escarpment threatens building foundations <u>OR</u> when building reaches end of functional life and requires major refurbishment.	WCC	More than \$500,000	SC.2	See 'A3' Option in Sect.5.4.4 of CZM Study report
SC.4	Undertake detailed design, site investigations, and approvals as necessary to relocate Helensburgh / Stanwell Park SLSC outside of hazard zone. There are likely to be some site constraints (Norfolk Is Pine) that limit relocating the surf club (subject to audit – SC.1).	Stanwell Park	2	When monitoring shows that ZRFC measured from erosion escarpment threatens building foundations <u>OR</u> when building reaches end of functional life and requires major refurbishment.  (within 20 years expected)	WCC	More than \$500,000	SC.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
SC.5	Undertake detailed design, site investigations, and approvals as necessary to redesign or retrofit construction of Austinmer SLSC in current location to withstand coastal impacts, such as wave impacts and inundation. Design parameters for the structure (e.g foundation requirements) will be dependent upon the presence and condition of a seawall structure (refer Action S.4). Subject to outcomes of audit (Action SC.1), relocation of the SLSC is unlikely due to land constraints.	Austinmer	2	When monitoring shows that ZRFC measured from erosion escarpment threatens building foundations <u>OR</u> when building reaches end of functional life and requires major refurbishment.  (within 20 years expected)	WCC	More than \$500,000	SC.2 M.1	See 'A2' Option in Sect.5.4.4 of CZM Study report

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
SC.6	Undertake detailed design, site investigations, and approvals as necessary to relocate Thirroul Pavilion outside of hazard zone. Consideration will need to be given to ensure that a relocated Thirroul Pavilion retains heritage character and value (i.e. by physically moving existing structure).	Thirroul	1	When monitoring shows that ZRFC measured from erosion escarpment threatens building foundations <u>OR</u> when building reaches end of functional life and requires major refurbishment. (within 20 years expected)	WCC	More than \$500,000	SC.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
SC.7	Undertake detailed design, site investigations, and approvals as necessary to relocate Thirroul SLSC outside of hazard zone (i.e. by constructing a new replacement structure).	Thirroul	1	When monitoring shows that ZRFC measured from erosion escarpment threatens building foundations <u>OR</u> when building reaches end of functional life and requires major refurbishment.	WCC	More than \$1m	SC.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
SC.8	Undertake detailed design, site investigations, and approvals as necessary to relocate Bulli Surf Club and Kiosk. There is likely to be sufficient space for relocating the surf club and kiosk in the future (subject to audit – SC.1).	Bulli	1	When buildings reach end of functional life and require major refurbishment. (within 20 years expected)	WCC	More than \$500,000	SC.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
SC.9	Undertake detailed design, site investigations, and approvals as necessary to relocate Woonona SLSC outside of hazard zone. There is likely to be sufficient space for relocating the surf club in the future (subject to audit – SC.1).	Woonona	2	When building reaches end of functional life and requires major refurbishment. (within 20 years expected)	WCC	More than \$500,000	SC.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
SC.10	Undertake detailed design, site investigations, and approvals as necessary to redesign or retrofit construction of Bellambi Surf Club in current location to withstand wave inundation. Development controls (such as the Flood DCP) would constrain redesign in respect to still water inundation.	Bellambi	2	When building reaches end of functional life and requires major refurbishment. (within 20 years expected)	WCC	More than \$200,000	SC.2 M.1	See 'A2' Option in Sect.5.4.4 of CZM Study report
SC.11	Undertake detailed design, site investigations, and approvals as necessary to redesign or retrofit construction of Corrimal Surf Club in current location to withstand inundation impacts. Development controls (such as the Flood DCP) would constrain redesign in respect to still water inundation.	Corrimal	2	When building reaches end of functional life and requires major refurbishment. (within 20 years expected)	WCC	More than \$200,000	SC.2 M.1	See 'A2' Option in Sect.5.4.4 of CZM Study report
SC.12	Relocate lifeguard tower structure outside of hazard zone. The lifeguard tower is at low risk, and there is no immediate need for action. When impacts become imminent, the tower is a low key structure that will be easily relocatable.	Fairy Meadow	2	When monitoring shows that ZRFC measured from erosion escarpment encroaches onto structure foundations	WCC	Approx. \$20,000	SC.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report
SC.13	Undertake detailed design, site investigations, and approvals as necessary to redesign or retrofit construction of the North Beach Kiosk structure in current location to withstand coastal impacts, such as wave erosion and inundation. The Kiosk structure could be retrofit during asset maintenance. Design parameters for the structure (e.g. foundation requirements) and possible future location will be dependent upon the presence and condition of a seawall structure (refer Action S.7).	North	2	When building requires significant maintenance <u>OR</u> when monitoring shows that ZRFC measured from erosion escarpment encroaches onto building foundations, whichever is sooner	WCC	More than \$200,000	SC.2 M.1	See 'A2' Option in Sect.5.4.4 of CZM Study report



Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Reqd	Preceding Actions	Further Info.
SC.14	Ensure re-development of Sandon Point Surf Club is designed to withstand wave inundation and coastal erosion impacts (e.g. suitable foundation capacity, floor levels, etc).	Sandon Point	1	Currently in progress	WCC	More than \$ 1m	nil	See 'PR2' Option in Sect.5.4.3 of CZM Study report
SC.15	Undertake detailed design, site investigations, and approvals as necessary to redesign or retrofit Austinmer Boatshed in current location to withstand wave impacts and wave inundation. <i>Design parameters for the structure (e.g foundation requirements) will be dependent upon the presence and condition of a seawall structure (refer Action S.4).</i>	Austinmer	2	When monitoring shows that wave inundation frequency is greater than 1/month <u>OR</u> when building reaches end of functional life and requires major refurbishment. (within 20 years expected)	WCC	More than \$500,000	SC.2 S.4 M.1	See 'A2' Option in Sect.5.4.4 of CZM Study report
SC.16	Undertake detailed design, site investigations, and approvals as necessary to retrofit the former Quest House in current location to withstand inundation impacts. Flood DCP provisions would provide guidance for requirements. May involve raising existing structure in current location.	Thirroul	2	At next major refurbishment of the heritage site (within 20 years expected)	WCC	More than \$200,000	SC.2 M.1	See 'A2' Option in Sect.5.4.4 of CZM Study report
SC.17	Undertake detailed design, site investigations, and approvals as necessary to relocate Coalcliff SLSC outside of hazard zone. There is likely to be sufficient space for relocating the surf club in the future (subject to audit – SC.1). (Redesign with suitable foundations is a secondary option, if relocation is not possible). <i>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.</i>	Coalcliff	2	When building reaches end of functional life and requires major refurbishment.	WCC	More than \$500,000	SC.2 M.1	See 'PR2' Option in Sect.5.4.3 of CZM Study report

### Relevant Programs and Possible Funding Opportunities:

- State and Federal Government Grants (especially climate change adaptation and resilience building funds, or community infrastructure funds)
- Council's routine asset maintenance and works program
- New Council levies or increased land rates
- Revenue generated from hire or rental of public buildings and amenities (e.g. pavilions and kiosks)

## 14 FURTHER STUDIES & PLANS (SP)

### Description:

While this CZMP has considered the impacts and risks of coastal processes, it is clear that risks can be amplified when coastal storms and inundation coincide with heavy rainfall and catchment-derived flooding. Consideration of future sea level rise is an important part of strategic flood planning.

There are a number of areas along the Wollongong Coastline where coastal inundation can combine with catchment flooding to exacerbate impacts and flood conditions. Further studies are required to investigate the likely flood levels and inundation extents under these conditions. Key areas needing investigation include Thirroul, where some 150 residences are potentially affected by coastal inundation, and Woonona, where up to 100 properties could be flooded through backwater inundation and wave overtopping of the coastal dunes.

Flooding and inundation of the narrow coastal plain along the Wollongong northern beaches is likely to have severe ramifications for traffic and access for emergency response crews, with Lawrence Hargrave Drive potentially affected. As such, an Emergency Response Plan should be developed in concert with Emergency Services (e.g. SES, NSW Police) and co-ordinated with the regional DISPLAN.

Some further studies and plans are required to help address 'high' or 'extreme' level of risk at the current timeframe, and as such, these take highest priority (i.e. Priority ranking '1'), while studies and plans to address 'high' or 'extreme' risks that won't materialise until 2050 or 2100 are given secondary priority (i.e. Priority ranking '2').



### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
Stanwell Park: Existing Residences (edge of 6 pptides at S end of beach next to Stanwell Ck)	Medium	High	Extreme	Thirroul: Existing Residences (151 cadastral parcels)	Medium	High	Extreme
Stanwell Park: Existing Residences (Edge of 13 pptides at upper reach of Stanwell Ck)	Medium	High	Extreme	McCauleys: Existing Residences (8 pptides at N end of beach)	Medium	High	Extreme
Stanwell Park: Vacant Land (Future Development) (edge of 4 pptides at S end of beach next to Stanwell Ck)	Low	Medium	High	Sandon Point: Existing Residences (adjacent to Slacky Creek; S end of beach off Blackall St)	Medium	High	Extreme
Stanwell Park: Kiosk (in Stanwell Park Recreation Area)	Medium	High	Extreme	Bulli Tourist Park (caravan park)	Medium	Medium	High
Stanwell Park: Reserve Dwelling	Medium	High	Extreme	Bulli: Existing Residences (adjacent to Whartons Creek & Stormwater System)	Medium	High	Extreme
Stanwell Park: Reserve Toilets	Medium	Medium	High	Existing Residences (19 at centre of beach)	Medium	Medium	High
Coledale Beach Camping and Caravan Park	Medium	Medium	High	Woonona: Existing Residences (80 along creek & stormwater alignments, centre of beach)	Medium	High	Extreme
Austinmer: Lawrence Hargrave Drive (Major Coastal Road)	Medium	High	Extreme	Bellambi: Bellambi SLSC and cycleways, next to Bellambi Gully	Medium	High	Extreme
Austinmer: Neighbourhood Business Centre (local shops)	Medium	Medium	High	Bellambi Point: Existing Residences (10 adjacent to Bellambi Lagoon)	Medium	Medium	High
Thirroul: Major Roads (Lawrence Hargrave Drive)	High	Extreme	Extreme	Corrimal: Existing Residences (37 adjacent to Towradgi Lagoon / Creek)	Medium	High	High
Thirroul: Local Roads (Bath St linking to the Esplanade, Henley St, Road reserve for Harbord & Ocean Sts)	Medium	High	Extreme	North Beach (Fairy Lagoon): Major roads (Pioneer Road)	Medium	High	High
				North Beach (Fairy Lagoon): Cycleway / Shared Pathway (adjacent to Squires Way)	Medium	Medium	High

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks

**Action List:**

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
SP.1	<p>Develop interim flood emergency response and evacuation plans for roads and properties affected by coastal inundation outside of existing flood planning areas. This includes arterial roads, such as Lawrence Hargrave Drive.</p> <p>As flood studies are completed for these areas (refer Action SP.2), update flood emergency response plans with more considered floodplain management strategies.</p>	Austinmer	2	2016/17 / Immediately	WCC	Staff time only or minor consultancy (say \$25,000)	nil	See 'NR9' Option in Sect.5.4.1 of CZM Study report
		Thirroul (Lawrence Hargrave Drive, local roads, affected properties)	1					
		Sandon Point to Bulli Beach (Whartons Ck)	2					
		Woonona (Beach Dr, affected properties)	2					
		Bellambi Lagoon (local roads & properties).	2					
		Bellambi Gully (local roads, SLSC, cycleways).	2					
		Fairy Lagoon (Pioneer Rd, cycleway, Stuart Park access)	2					
SP.2	<p>Update or commence flood studies at all catchments that are impacted by elevated ocean water levels in flood mapping and management. Update Flood Planning Areas and manage accordingly, such as through the NSW Government's Floodplain Risk Management process.</p> <p>Flood studies should consider combined catchment flooding and elevated oceanic water levels, including the latest sea level rise predictions. The combined flood modelling shall then be 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 WCC DCP Chapter E13).</p>	Stanwell Park (Hargraves & Stanwell Creeks)	1	As soon as practical, with priority to areas where a significant number of private properties are potentially affected.	WCC	Depending on the scope and extents of flood areas (typically \$40,000 - \$80,000 per major catchment / floodplain)	nil	See 'NR10' Option in Sect.5.4.1 of CZM Study report
		Coledale (Carricks, Daly, Stockyard Creeks)	2					
		Austinmer	1					
		Thirroul (Flanagans & Thomas Gibson Creeks)	1					
		Bulli (Whartons Creek)	1					
		Woonona (Creek at Lighthouse Drive)	1					
		Bellambi Lagoon, Bellambi Gully	2					
		Fairy Lagoon	2					
		Update existing flood studies to include sea level rise and elevated oceanic water levels.	1					
SP.3	<p>Undertake further investigations to determine an appropriate response to managing risks to both Council assets and 19 properties at risk by 2100 on Woonona Beach.</p> <p>Risks to private properties on Woonona Beach are not expected to materialise until 2100. However, services to the properties, in particular road access along Beach Drive, are likely to be affected well before 2100. Indeed the seaward edge of the road may be impacted by extreme storm erosion at present. Therefore, a decision is required at the present time regarding the response to managing the private properties, as this affects how the road and services shall be managed and vice versa.</p> <p>The key long term options available are:</p> <ul style="list-style-type: none"> <li>• construction of seawall protection, which would significantly alter the morphology and amenity of the beach; or</li> </ul>	Woonona Beach	1	2016/17 / Immediately	WCC	Staff time only, or minor consultancy	R.2 (for Beach Drive) C.2 (for cycleway along beach) ST.2 (for outlet under Beach Drive)	See Section 6.11 of CZM Study report

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Reqd	Preceding Actions	Further Info.
	<ul style="list-style-type: none"> <li>acquisition of the 19 private properties and relocation of Council's assets, to allow the beach to retreat landward, preserving the sandy beach amenity for the greater community and environment.</li> </ul> <p>However, selecting one of these options for Woonona Beach is complicated by the following factors, and therefore requires further investigation through detailed studies:</p> <ul style="list-style-type: none"> <li>ensuring ongoing services to the properties, such as road access, sewer, water and stormwater, all of which are likely to be affected well before the properties themselves</li> <li>SWC in particular must be involved in the selection of a preferred management option for their sewer pipeline (that is seaward of the properties) that is considerate of Council, private properties owners and other beach users and stakeholders ;</li> <li>the legal implications of current legislation, particularly the <i>Coastal Protection Act, 1979</i>, that may limit / constrain options for managing the private properties; and</li> <li>the political will and financial assistance required for either of the options.</li> </ul> <p>Further details to be considered as part of this Action are outlined below</p>							

Further Details for SP.3 at Woonona:

Beach	Aspects to be considered as part of further investigations
Woonona	<p>As a seawall would additionally protect private property owners, Council may levy such owners for ongoing maintenance of the wall under the <i>Coastal Protection Act, 1979</i>. However, there is no mechanism to levy private owners for the capital cost of a seawall, which would be a significant upfront expense (&gt; \$5 million) for either private owners and / or Council.</p> <p>Seawall construction would significantly affect the character and amenity of the beach. With sea level rise, it will not be sustainable to maintain sand across the walled section of beach. Instead, the seawall would essentially form a headland, with adjacent beach sections retreating further landward. Current legislation requires minimal impacts and ongoing maintenance of beach amenity as a condition for new seawall construction, thus a seawall at Woonona may not be able to meet such requirements.</p> <p>Council may not need to protect its own assets, and this should be determined through Action R.2, Action C.2 and Action ST.2. A key consideration will also be the approach of SWC to managing its sewer pipeline, located seaward of the properties. Any decision by SWC will necessarily affect the approach taken by Council and also affect the private properties, and vice versa. Collaboration on an approach from the three parties is required. Council's roadways are largely provided for the residential properties and therefore are not required unless the properties are retained (indeed there is a possibility of provision of rear access to these properties). The cycleway and stormwater assets adjacent and below the road can be relocated. However, should Council choose to sacrifice and abandon its assets, services to the 19 private properties would be affected. Further, should Council abandon its own assets and permit private property owners to construct a seawall at their own expense, it is not possible to maintain access to the private properties without protecting Councils assets, and therefore any privately funded seawall would still need to be constructed on public land. This is inconsistent with current legislation, unless Council is a partner in construction of the option.</p> <p>Acquisition of the 19 properties and relocation of Council's assets would provide the best outcome for the beach environment and the larger number of nearby residents and other community users. This is because the assets and properties would be removed to allow the beach to retreat, therefore retaining a sandy beach amenity. The "buy back/ lease back" option would enable the private properties to be utilised until the roadway access is impacted to a level that it is no longer safe, enabling some recouping of costs for property purchase. However, there is currently no suitable or sufficient financial assistance for Council to undertake such an action, through mortgage arrangements or otherwise. That is, while mortgage repayments would be assisted by long term leasing of the properties, the initial deposit for property purchase and low interest loan arrangements require State or Federal government assistance. There is currently no arrangement or mechanism for Council to apply for such assistance. In considering acquisition and retreat as an option, the human impacts to the 19 property owners, and the potential for long term impacts to rear properties (i.e. well into the future when the front lots have been eroded) needs also to be considered.</p> <p>Should long term acquisition and retreat be the selected action, it is imperative that concerted community education be undertaken to ensure that the greater community understands the advantages to them from such an action (compared with seawall protection that favours the individual seafront owners protected because of the long term impacts on beach amenity discussed above).</p>

Relevant Programs and Possible Funding Opportunities:

- NSW Government Grants (including the Floodplain Management Program)
- Federal and State Government Emergency Management Funding

## 15 STORMWATER (ST)

### Description:

Catchment runoff from the Illawarra Escarpment and the coastal plain is all directed into the ocean through natural waterways and urban stormwater systems. There are a large number of stormwater outlets that discharge directly onto beaches along the Wollongong Coastline. As outlined previously, there is a small local hazard associated with erosion of sand at these stormwater outlets, however, these typically do not have major implications for broader beach erosion or shoreline recession.

The stormwater outlets themselves are structures that are at risk from coastal processes and hazards. Erosion around the structures can compromise their integrity, causing failure, while coastal inundation may create backwater effects along the stormwater system, or prevent effective drainage during heavy rains.

It is recommended that stormwater outlets be relocated landward wherever feasible, as part of Council's on-going stormwater maintenance and refurbishment program. Where it is not feasible for relocation, then stormwater outlets would need to be redesigned or retrofitted to withstand coastal impacts in the future, without compromising their function from a drainage perspective.

Management of stormwater assets that are at 'high' or 'extreme' level of risk at the current timeframe takes highest priority (i.e. Priority ranking '1'), while actions to address 'high' or 'extreme' risks to stormwater that won't materialise until 2050 or 2100 are given secondary priority (i.e. Priority ranking '2').



Outflow adjacent to Thirroul Pool

### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
Stanwell Park: Stormwater outlets and pipes (servicing upper reaches surrounding Stanwell Ck)	High	Extreme	Extreme	Woonona: Stormwater outlets and pipes (N end at Kurraba Rd)	High	Extreme	Extreme
Stanwell Park: Stormwater outlets and pipes (servicing across Stanwell Park adjacent to Kiosk and from N carpark to Hargraves Ck)	High	Extreme	Extreme	Woonona: Stormwater outlets and pipes (connecting line from Kurraba Rd to Beach Drive along beachfront)	High	Extreme	Extreme
Coalcliff: Stormwater outlet and pipe (S end of beach)	Low	Medium	High	Woonona: Stormwater outlets and pipes (along seaward edge of Beach Drive)	High	Extreme	Extreme
Scarborough / Wombarra: Stormwater outlets and pipes (3 at S end Wombarra Beach)	High	Extreme	Extreme	Bellambi: Stormwater outlets and pipes (adjacent to Bellambi Pool carpark)	High	Extreme	Extreme
Coledale: Stormwater outlets and pipes (1 at S end at Carrick Ck, 2 beach parallel at Dalys Ck)	High	Extreme	Extreme	Bellambi: Stormwater outlets and pipes (under Bellambi SLSC carpark)	High	Extreme	Extreme
Sharkys: Stormwater outlets and pipes	High	Extreme	Extreme	Bellambi Point: Stormwater outlets and pipes (adjacent to STP)	High	Extreme	Extreme
Little Austinmer : Stormwater outlets and pipes	High	Extreme	Extreme	Bellambi Point: Stormwater outlets and pipes (into Bellambi Lagoon)	High	Extreme	Extreme
Austinmer: Stormwater outlets and pipes	High	Extreme	Extreme	Corrimal: Stormwater outlets and pipes	High	Extreme	Extreme
Thirroul: Stormwater outlet to Flanagans Creek	Medium	High	High	Towradgi: Stormwater outlet / pipe (N end)	High	Extreme	Extreme
Thirroul: Stormwater outlets and pipes to upper Flanagans Ck catchment	High	Extreme	Extreme	North Beach: Stormwater outlets / pipes (at Lagoon entrance)	High	Extreme	Extreme
Thirroul: Thomas Gibson Creek - Major stormwater outlet	High	Extreme	Extreme	North Beach: Stormwater outlets / pipes (adjacent to Pavilion)	High	Extreme	Extreme
McCauleys: Stormwater outlets and pipes (N end of beach)	High	Extreme	Extreme	North Beach: Stormwater outlets / pipes (at Lagoon Restaurant)	High	Extreme	Extreme

Sandon Pt: Stormwater outlets and pipes (S end of beach)	High	Extreme	Extreme	Perkins: Stormwater outlets & pipes (one adjacent to Port Kembla Pool)	High	Extreme	Extreme
Sandon Pt: Stormwater outlets and pipes (Centre of beach)	High	Extreme	Extreme	Lake Illawarra: Stormwater outlets / pipes	Medium	High	High
Bulli: Stormwater outlets and pipes	High	Extreme	Extreme				

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks

### Action List:

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
ST.1	<p>Undertake stormwater asset audit and investigate appropriate design elements for stormwater infrastructure for periodic inundation with seawater and / or wave action and utilise as assets are replaced.</p> <p>The audit will identify where and when stormwater assets will be affected by wave attack and/or permanent inundation with sea level rise, to determine future conveyance capacity. The audit is also to determine functional lifespan of existing stormwater assets, noting that seawater is expected to yield shorter design life.</p> <p>For assets affected by erosion, simply withstanding wave attack may not be sufficient if erosion of land around the structure makes it impractical.</p>	Stanwell Park Coalcliff Scarborough / Wonbarra Coledale Sharkys Little Austinmer Austinmer Thirroul McCauleys Sandon Pt Bulli Woonona Bellambi Bellambi Pt Towradgi Corrimal North Beach Perkins Lake Illawarra	1	2016/17 or as soon as practical	WCC	Staff time only, or minor consultancy (say \$50,000)	nil	See 'NR7' Option in Sect.5.4.1 of CZM Study report
ST.2	<p>Update stormwater assets in Council's Asset Management Plan, and based on the outcomes of the audit, incorporate remediation, maintenance, relocation and replacement works into forward works programs.</p> <p><i>Actions ST.3 and ST.4 apply if supported by the Asset Management Plan.</i></p>	As above	1	2016/17 or as soon as possible after ST.1	WCC	Staff time only	ST.1	See 'NR7' Option in Sect.5.4.1 of CZM Study report
ST.3	<p>Undertake detailed design, assessment, planning and works to relocate stormwater assets landward of hazard zone. Subject to confirmation by Action ST.1, it is likely that the outlets and pipes can be progressively removed and relocated landward as erosion occurs. However, the new outlets will also need to be designed to withstand inundation with sea level rise and wave overtopping.</p> <p>Relocation of outlet to Thomas Gibson Creek at Thirroul will be dependent upon outcomes of Action S.1</p>	Coalcliff Scarborough / Wombarra Little Austinmer Thirroul McCauleys (N end of beach) Sandon Pt Bulli	2 1 1 1 2 1 2	When erosion or wave overtopping destabilises outlet OR when inundation frequency impedes effective conveyance of stormwater OR when asset replacement is required, whichever is sooner.	WCC	Dependent on size, siting and degree of relocation of the stormwater outlet.  Typically less than \$50,000 each.	ST.2	See 'PR2' Option in Sect.5.4.3 of CZM Study report

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
		Woonona	1					
		Towradgi (N end of beach)	2					
		North (Fairy Lagoon)	1					
ST.4	Undertake detailed design, assessment, planning and works to redesign or retrofit stormwater structures in current location to withstand impacts. In the first instance, stormwater assets should be relocated out of the hazard zone (refer ST.3), but for some locations this will not be practical or feasible. The outcomes of Action ST.1 shall guide suitable designs for ensuring conveyance of stormwater with more frequent inundation with sea level rise.  <i>This provision will still be required for assets protected by seawalls (i.e. Austinmer; Bellambi adjacent to pool carpark; Bellambi Point adjacent to STP; and Perkins Beach adjacent to Port Kembla Pool)</i>	Stanwell Park	1	When erosion or wave overtopping destabilises outlet OR when inundation frequency impedes effective conveyance of stormwater OR when asset replacement is required, whichever is sooner.	WCC	Dependent on size, siting and degree of protection required at the stormwater outlet.  Typically less than \$50,000 each.	ST.2	See 'A2' Option in Sect.5.4.4 of CZM Study report
		Coledale	1					
		Sharkys (Austinmer Boat Harbour)	1					
		Austinmer	2					
		McCauleys	1					
		Sandon Pt (Trinity Row)	1					
		Bulli	1					
		Woonona (Lighthouse Dr Ck)	1					
		Bellambi (pool carpark)	1					
		Bellambi Pt (next to STP)	1					
		Corrimal	1					
		North Beach	1					
		Perkins	2					
		Lake Illawarra	2					

#### Relevant Programs and Possible Funding Opportunities:

- State and Federal Government Grants (especially climate change adaptation and resilience building funds)
- Council's routine asset maintenance and works program
- New Council levies or increased land rates

## 16 VEGETATION & HABITATS (V)

### Description:

Although much of the Wollongong Coastline is developed, it still retains a number of pockets of vegetation that provide significant habitat value. Indeed there are several Endangered Ecological Communities (EEC) located within the Wollongong Coastal Zone.

The vegetated coastal dune systems also provide significant habitat value to coastal species. Significant efforts have been made over the past 30 years to vegetate and rehabilitate coastal dunes through Council's Dunecare program. This has effectively eliminated risks associated with sand drift, and has helped to secure healthy sand reserves along many of the beaches to act as a buffer against future storm erosion events.

Bitou bush and other invasive species are still problematic along the coast, meaning that Council's efforts in coastal dune rehabilitation will be on-going for many years to come. There are also local issues associated with dune vegetation, for example the monoculture of *Acacia sophorae* dominating dune vegetation at Woonona Beach (and other beaches) that is affecting beach amenity. The development of a Dune Management Strategy shall seek to address issues associated with weeds and dune vegetation species, to alleviate such local concerns. The sightline requirements of the surf clubs, particularly in those locations where lifeguard towers are not able to be provided, is also of key concern.

All beaches and beach dunes are under 'high' or 'extreme' risk at the current timeframe, and as such, dune revegetation works are given the highest priority (Priority Level '1'). With the exception of Bellambi Lagoon, other important habitats along the coastal zone are not under immediate risk ('high' or 'extreme' risks won't materialise until 2050 or 2100), and therefore are given a secondary priority (Priority Level '2').



### Risks Addressed by Implementation of Strategy:

	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
Stanwell Park Beach	High	Extreme	Extreme	Bulli: Collins Creek	Medium	High	Extreme
Stanwell Park Coastal Dune Systems	High	Extreme	Extreme	Woonona Beach	High	Extreme	Extreme
Stanwell Park: Hargraves Creek	Medium	Medium	High	Woonona Coastal Dune Systems	High	Extreme	Extreme
Stanwell Park: Stanwell Creek	Medium	High	High	Woonona: Creek at Lighthouse Drive and adjacent habitat	Medium	Medium	High
Coalcliff Beach	High	Extreme	Extreme	Bellambi Beach	High	Extreme	Extreme
Coalcliff: Stoney Creek	Medium	Medium	High	Bellambi Beach Coastal Dune Systems	High	Extreme	Extreme
Scarborough and Wombarra Beaches	High	Extreme	Extreme	Bellambi Gully and adjacent habitat	Medium	High	Extreme
Scarborough / Wombarra: Small creek / drainage lines (S end and centre of Scarborough beach)	Low	Medium	Medium	Bellambi Point Beach	High	Extreme	Extreme
Scarborough Recreation Reserve, Jim Allen Oval Natural Area	Low	Medium	Medium	Bellambi Point Coastal Dune Systems	High	Extreme	Extreme
Coledale Beach	High	Extreme	Extreme	Heritage Site: Bellambi Lagoon and associated habitat	High	Extreme	Extreme
Coledale: Carricks Creek	Medium	High	Extreme	Corrimal Beach	High	Extreme	Extreme



	Risk Now	Risk at 2050	Risk at 2100		Risk Now	Risk at 2050	Risk at 2100
Coledale: Stockyard Creek	Medium	High	Extreme	Corrimal Coastal Dune Systems (Corrimal Beach Natural Area, Towradgi Park)	High	Extreme	Extreme
Coledale: Dalys Creek	Medium	Medium	High	Corrimal Beach: Towradgi Lagoon and adjacent EEC Habitat	Medium	High	Extreme
Coledale: EEC - Coastal Headland Banksia Scrub	Medium	Medium	High	Towradgi Beach	High	Extreme	Extreme
Sharkys Beach	High	Extreme	Extreme	Towradgi Coastal Dune Systems	High	Extreme	Extreme
Little Austinmer Beach	High	Extreme	Extreme	Towradgi Beach Reserve (dune vegetation)	Low	Low	Medium
Little Austinmer Coastal Dune Systems	High	Extreme	Extreme	Fairy Meadow Beach	High	Extreme	Extreme
Austinmer Beach	High	Extreme	Extreme	Fairy Meadow Coastal Dune Systems	High	Extreme	Extreme
Thirroul Beach	High	Extreme	Extreme	Fairy Lagoon and Habitat (part of Puckeys Estate lands)	Medium	High	Extreme
Thirroul: Tingara Park	Medium	Medium	High	North Beach	High	Extreme	Extreme
Thirroul: Flanagans Creek	Medium	Medium	High	North Beach: Stuart Park (on heritage list, local significance)	Medium	High	Extreme
Thirroul Coastal Dune System (small area adjacent to creek entrance)	High	Extreme	Extreme	City Beach	High	Extreme	Extreme
McCauleys Beach	High	Extreme	Extreme	Open space, parks including City Beach Foreshore, dune lands part of WIN Stadium Grounds	Medium	High	Extreme
McCauleys: Hewitts Creek	Medium	Medium	High	City Beach Coastal Dune Systems	Medium	Medium	High
McCauleys: Tramway Creek	Low	Medium	Medium	Coniston Beach	High	Extreme	Extreme
McCauleys Coastal Dune Systems (S end)	High	Extreme	Extreme	Coniston Coastal Dune Systems; dune lands part of Wollongong Golf Course	High	Extreme	Extreme
Sandon Point Beach	High	Extreme	Extreme	Fishermans Beach & MM Beach	High	Extreme	Extreme
Sandon Point: Slacky Creek	Medium	Medium	High	Perkins Beach, including Port Kembla Beach and Windang Beach	High	Extreme	Extreme
Sandon Pt Coastal Dune Systems (N end of beach)	High	Extreme	Extreme	Coastal Dune Systems: Port Kembla Beach, Perkins Beach Reserve, Windang Beach	High	Extreme	Extreme
Bulli Beach	High	Extreme	Extreme	Lake Illawarra: EEC Swamp Oak Floodplain Forest	Medium	Medium	High
Bulli Coastal Dune Systems	High	Extreme	Extreme	Lake Illawarra: EEC Coastal Swamp Oak Forest	Low	Medium	Medium
Bulli: Whartons Creek	Medium	Medium	High				

Refer accompanying CZM Study for beach by beach assessment of erosion/recession risks and inundation risks

## Action List:

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Reqd	Preceding Actions	Further Info.
V.1	<p>Prepare and implement an LGA-wide Dune Management Strategy that incorporates reviewing and enhancing existing dunecare programs, recruits new volunteers (including targeting SLSC members) and prioritised locations for dune vegetation and weed removal across the LGA and within individual beach compartments.</p> <p>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 <i>Acacia sophorae</i> (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.</p> <p>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 the Dune Management Strategy.</p> <p>Dune vegetation works can be used as an opportunity to educate the community regarding the growth of dune volumes and value as beach protection. 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.</p>	All beaches and coastal dune systems along the Wollongong coastline	1	2016/17 or as soon as practical	WCC	Staff time only Costs for on-going dunecare works subject to funding availability	Nil	See 'DV' Option in Sect.5.4.2 of CZM Study report
V.2	<p>Utilise Norfolk Island Pines in new coastal plantings by Council, as appropriate. 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.</p> <p>This action recognises the cultural importance of Norfolk Island Pines in coastal development along the Wollongong Coastline.</p>	<p>All beaches (see Heritage strategy for listings), especially:</p> <ul style="list-style-type: none"> <li>• Coledale</li> <li>• Sharkys</li> <li>• Little Austinmer</li> <li>• Thirroul</li> <li>• Sandon Pt</li> <li>• North Beach</li> </ul>	2	2016/17 / immediately	WCC	Staff time only	Nil	See 'NR12' Option in Sect.5.4.1 of CZM Study report

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
V.3	<p>Undertake an audit of all EECs and important habitat areas within the hazard zones and implement buffers and rehabilitation as appropriate.</p> <p>This option would involve:</p> <ul style="list-style-type: none"> <li>Identifying important flora/fauna species that, due to their limited distribution, will need to be translocated;</li> <li>Prioritising rehabilitation requirements based upon the relative threat to distributions from coastal hazard impacts, to ensure lower risk distributions are protected and enhanced; and</li> <li>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.</li> </ul> <p>The outcomes of the audit should feed into existing biodiversity strategies (e.g. <i>Illawarra Regional Biodiversity Strategy, 2010</i>). Hazards impacts investigated should include both permanent inundation as well as recession due to sea level rise.</p>	<p>All known EEC and important habitat areas, including parks, reserves and waterways at:</p> <ul style="list-style-type: none"> <li>Stanwell Park (including Stanwell and Hargraves Creeks)</li> <li>Coalcliff (including Stoney Creek)</li> <li>Scarborough / Wombarra</li> <li>Coledale (including Carricks, Daly and Stockyards Creeks)</li> <li>Little Austinmer</li> <li>Thirroul (including Flanagans Creek)</li> <li>McCauleys (including Hewitts and Tramway Cks)</li> <li>Sandon Pt (including Slacky Creek)</li> <li>Bulli (including Whartons and Collins Creeks)</li> <li>Woonona (inc. Creek at Lighthouse Drive)</li> <li>Bellambi Gully &amp; Lagoon</li> <li>Towradgi Lagoon</li> <li>Fairy Lagoon</li> <li>North Beach</li> <li>City Beach</li> <li>Coniston Beach</li> <li>Perkins Beach</li> <li>Lake Illawarra foreshores</li> </ul>	2*	2016/17 or as soon as practical	WCC	Staff time only or minor consultancy (say \$40,000)	nil	See 'NR11' Option in Sect.5.4.1 of CZM Study report

\* Bellambi Lagoon habitat is under intolerable risks at the current timeframe and as such should be given priority for assessment.

#### Relevant Programs and Possible Funding Opportunities:

- State and Federal Government Grants (especially climate change adaptation and resilience building funds)
- Department of Industry - Lands & Forestry (weed control / dune management)
- Council's annual dunecare and community education / participation programs
- New Council levies or increased land rates

## 17 WHOLE OF COUNCIL ACTIONS (W)

### Description:

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. Further, 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, 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.

Listed below are over-arching actions that should be undertaken by Council to better incorporate coastal risk management into Council decision making processes.

Whole of Council Actions will address a range of intolerable risks, many of these being intolerable at the current timeframe. Although the level of risk differs from one beach to the next, the Whole of Council actions apply to Council's operations, strategic approach such as through the LEP, and so variously affect the approach to management for the whole coast. As such, the actions for preparing and implementing Whole of Council Actions take highest priority (i.e. Priority ranking '1').



Flagstaff Hill Looking to Wollongong Harbour and City

### Risks Addressed by Implementation of Strategy:

All risks to existing recreational assets and land (including beaches), existing development and infrastructure and future development along the beaches variously within the Wollongong LGA.

### Action List:

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
W.1	<p>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.</p> <p>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.</p> <p>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.</p>	Relates to entire coastal zone	1	2016/17 or as soon as practical	WCC	Staff time only	Nil	See Sect.5.2 of CZM Study report

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Req'd	Preceding Actions	Further Info.
W.2	<p>Preparation of Community &amp; Crown Land Plans of Management and Masterplans</p> <p>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</p>	All Community and Crown Lands	1	<p>At next update to POMs and masterplans for Community and Crown Lands, i.e.:</p> <ul style="list-style-type: none"> <li>• Stanwell Park Reserve and Bald Hill Plan of Management August 2009</li> <li>• Wollongong City Foreshore Plan of Management, January 2008 and Blue Mile Masterplan</li> <li>• Coledale Beach Plan of Management, June 2004</li> <li>• Judbooley Parade, Windang Plan of Management, June 2008</li> <li>• The Community Land of Wollongong Generic Plan of Management 2010</li> </ul>	WCC DoI – Lands & Forestry	Staff time only	Nil, but preferably W.1	See Sect.5.2 of CZM Study report
W.3	<p>Consideration of hazards and development controls for Council works not requiring development consent.</p> <p>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.</p>	All Council works within the Wollongong coastal zone	1	At time of preparing REFs for Council works not requiring development consent.	WCC	Staff time only	Nil, but preferably W.1	See Sect.5.2 of CZM Study report
W.4	<p>Prepare a foreshore building line for entire LGA based upon the existing hazard lines</p> <p>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 Action DC.1). 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.</p> <p>For those beaches where seawall protection is being considered as an option, a recommended seawall alignment was mapped in the CZM Study. At all other locations, the immediate (2010) ZRFC line is recommended as an appropriate foreshore building line to be adopted by Council.</p> <p>The foreshore building line shall be adopted within the LEP and any future LEP review.</p> <p>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.</p>	Entire LGA of Wollongong, to form part of LEP	1	2016/17 or as soon as practical	WCC	Staff time only.	Nil	See Sect.5.2 of CZM Study report

Ref.	Action	Beach Location(s)	Priority	Timing / Trigger	Responsibilities	Estimated Costs or Resources Reqd	Preceding Actions	Further Info.
W.5	<p>Community Education for Resilience Building</p> <p>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.</p> <p>This action supports the overarching approach to implement “no regrets” options now and delay more difficult or costly options for when impacts are imminent. There may be many years before impacts eventuate, however, at that time, the community will be better prepared to accept and implement the action that has been signalled many years in advance within the CZMP.</p>	At various locations across the LGA	1	2017, with ongoing repeats of community consultation every 2 years	WCC	Staff time only, with possibly minor consultancy assistance (\$10,000 - \$20,000)	Nil	See Sect.5.2 of CZM Study report
W.6	<p>Consideration of coastal risk zones when reviewing land zones in the Wollongong Local Environment Plan</p> <p>This would allow for rezoning of land where appropriate to the level of risk from coastal hazards at the time that land zones are revised as part of a review of the Wollongong LEP.</p> <p>A key location that should be rezoned is Sharkys Park at Sharkys Beach. The land is zoned residential, but owned by Council, so can feasibly be rezoned to public recreation or environmental management without the need for compensation. This ensures the land is not considered for development at any time in the future, which is appropriate to the high level of risk to this land.</p>	Wollongong LGA Sharkys Park – rezoned from residential to public recreation land	1	At the next LEP review (~ 5 – 10 yrs)	WCC	Staff time only	Nil	See Sect.5.2 of CZM Study report

#### Relevant Programs and Possible Funding Opportunities:

- Largely no external funding required, with actions to be undertaken by Council staff.
- State and Federal Government Grants (especially climate change adaptation and resilience building funds) for community and internal staff education actions

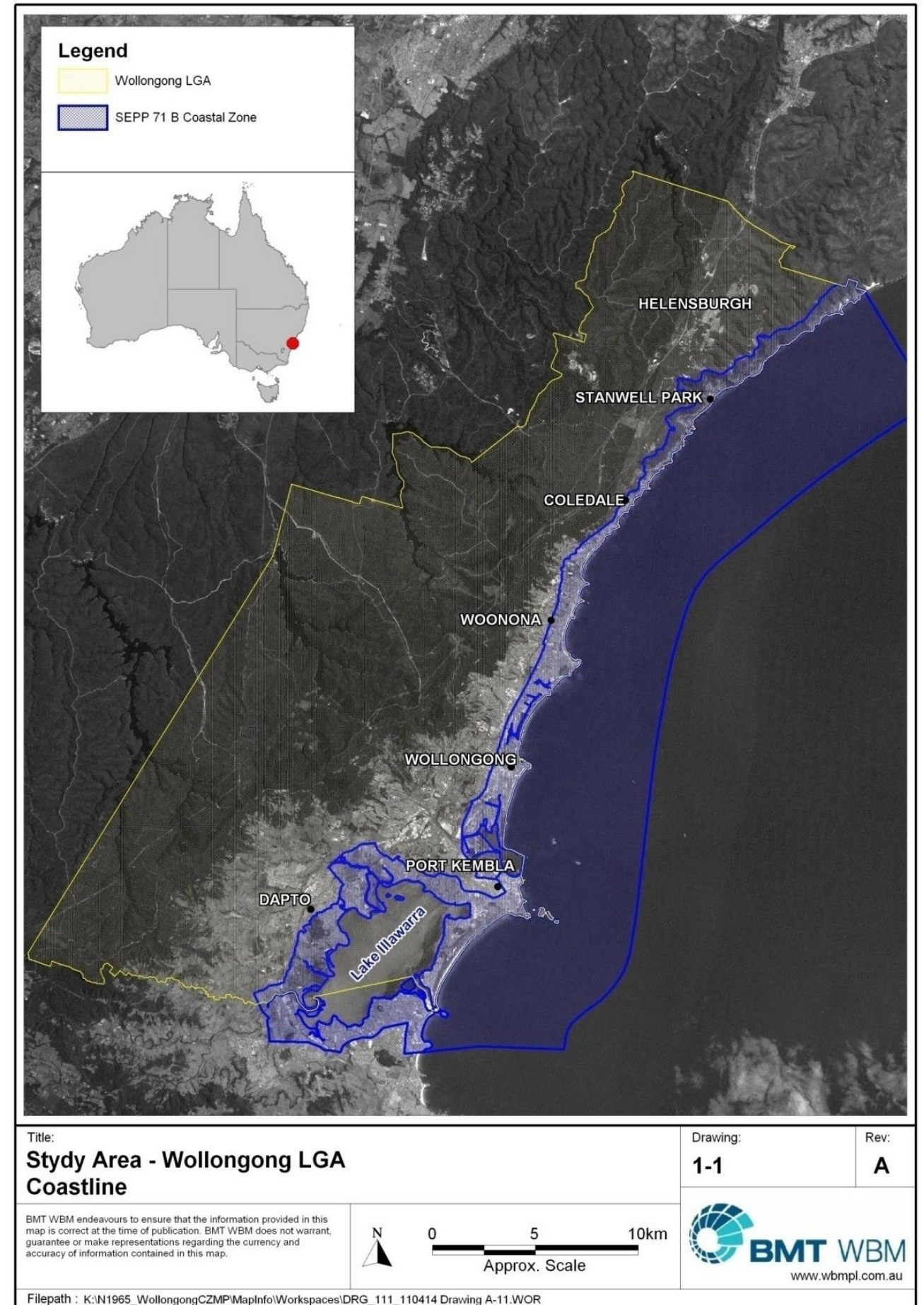
## 18 MAPS FOR INDIVIDUAL BEACHES

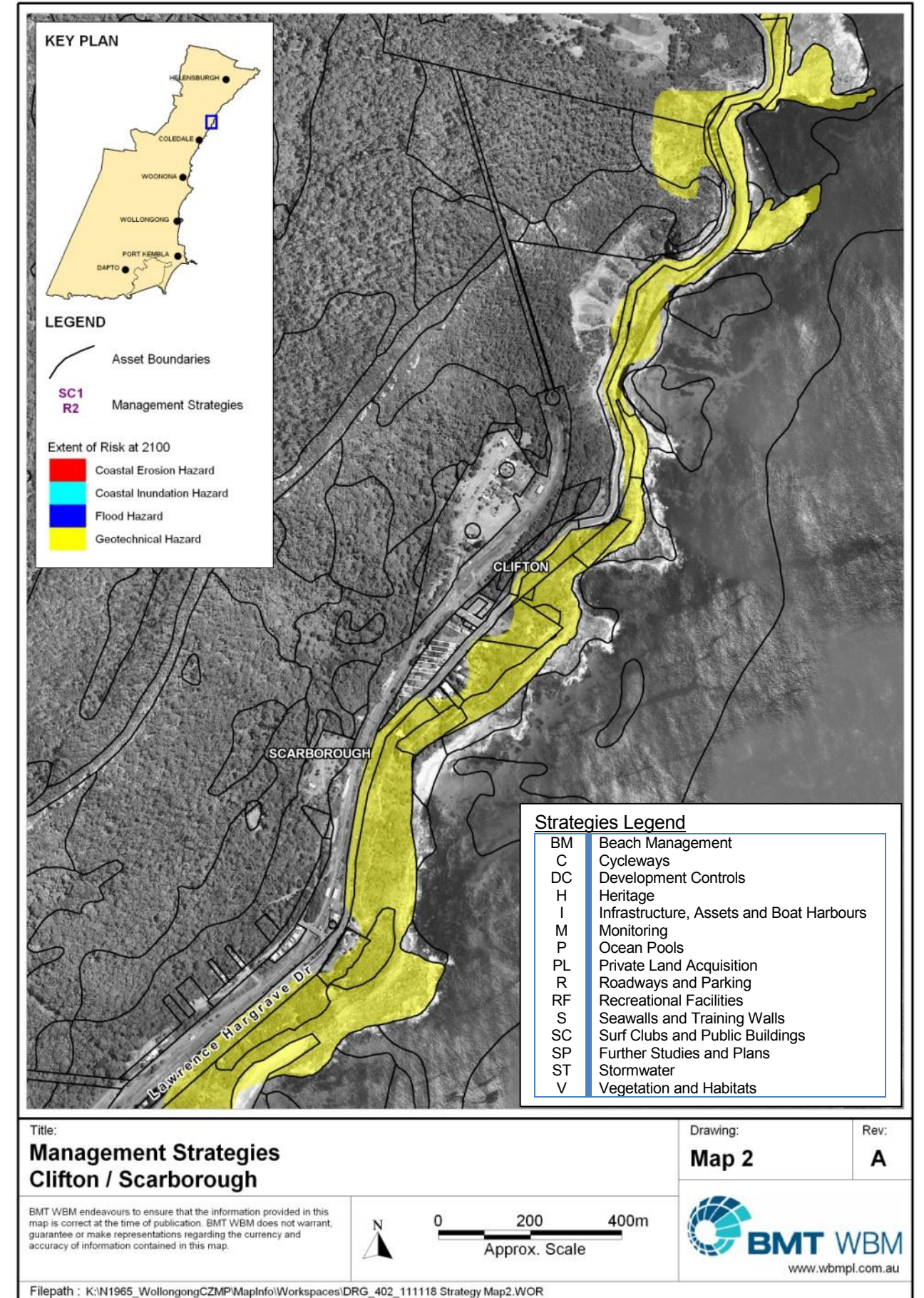
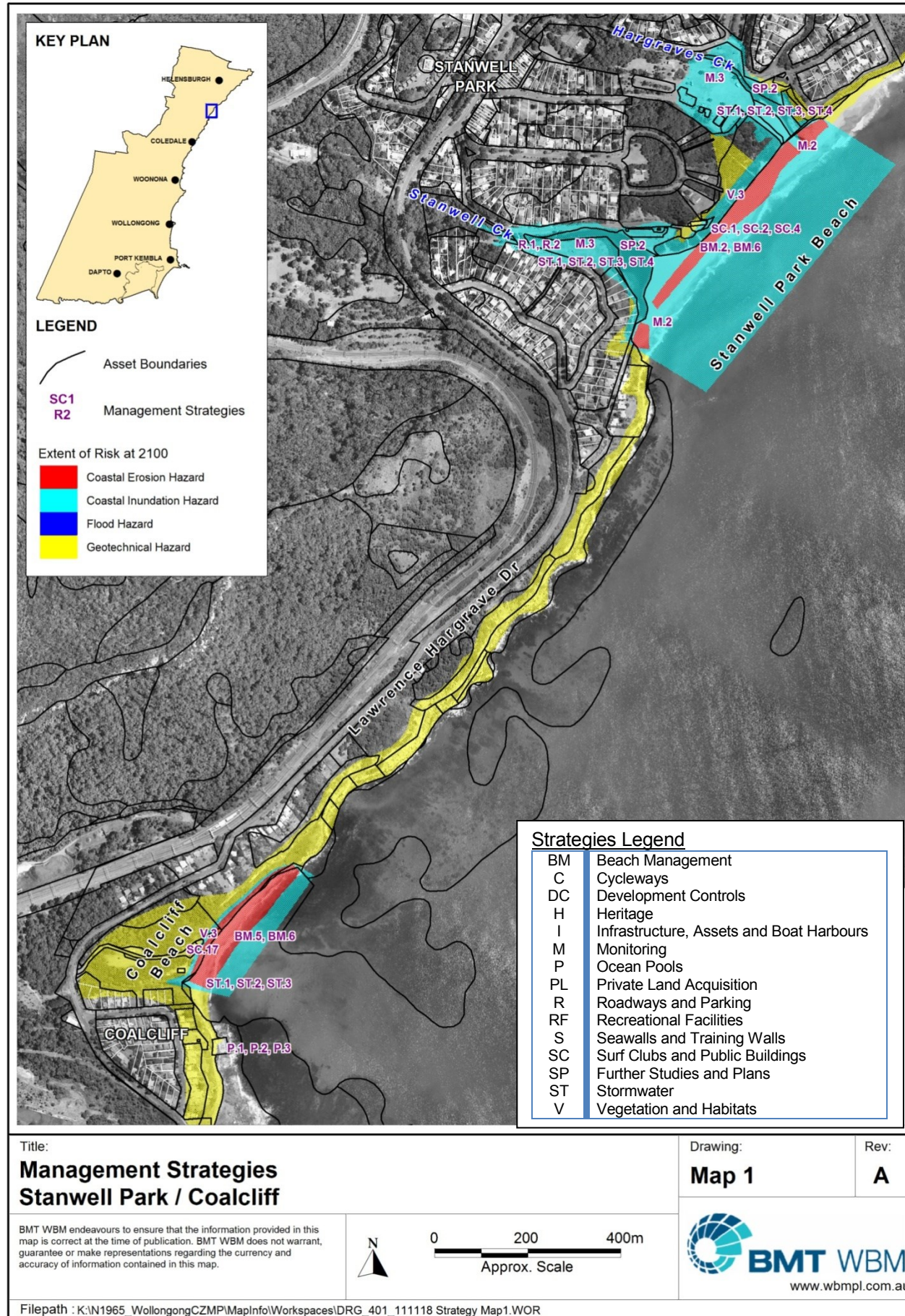
A series of maps is provided in Section 18, after the Implementation Schedules, to show the relevant locations for actions from the Management Strategies, where they can be feasibly shown, for each beach along the Wollongong Coastline (e.g. BM strategies are shown, DC strategies that apply to numerous assets are not shown).

The Coastal Erosion Hazard and Coastal Inundation Hazard areas on the strategy maps present the entire risk areas from present to 2100 (including the zone of reduced foundation capacity for the Erosion Hazard).

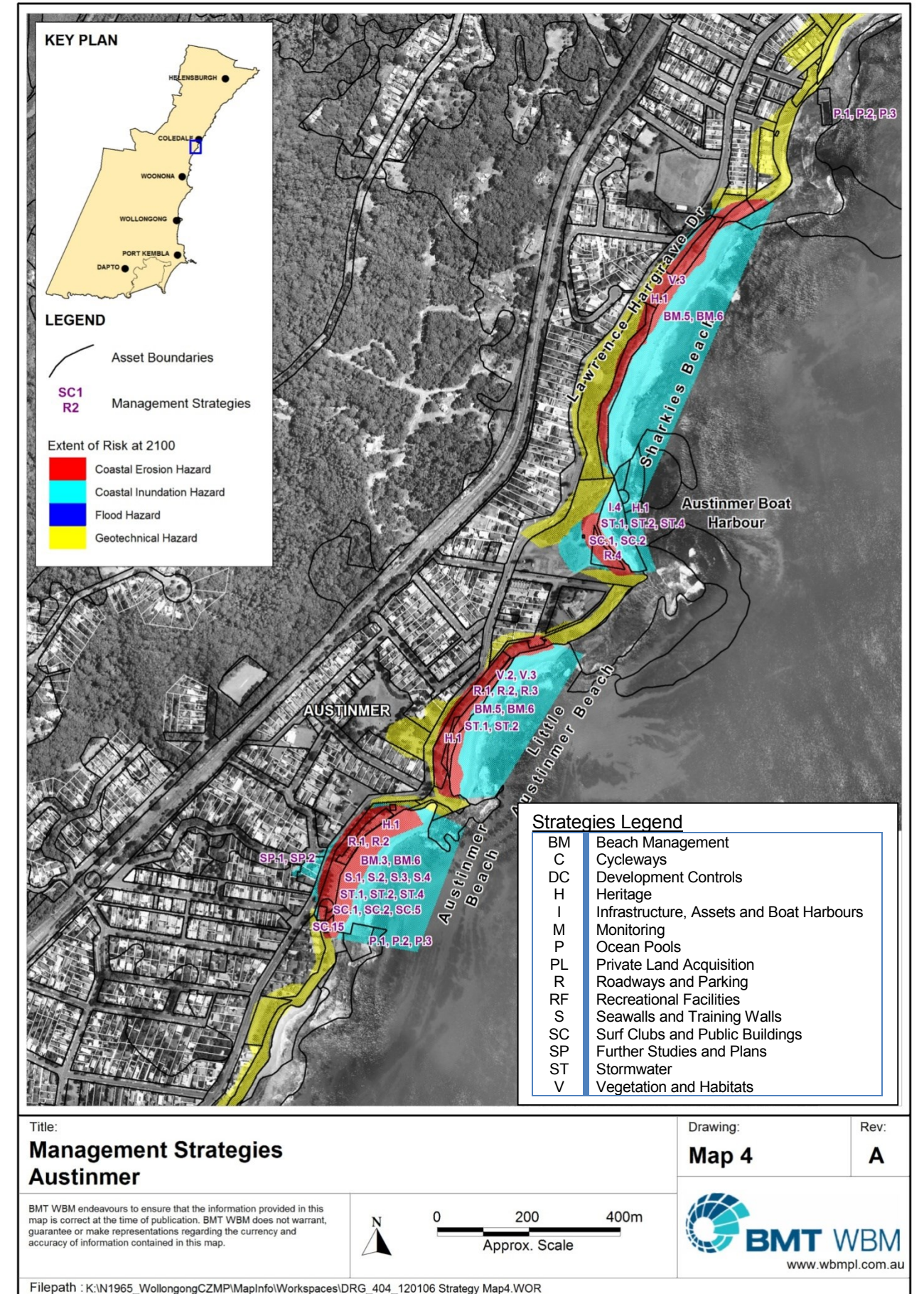
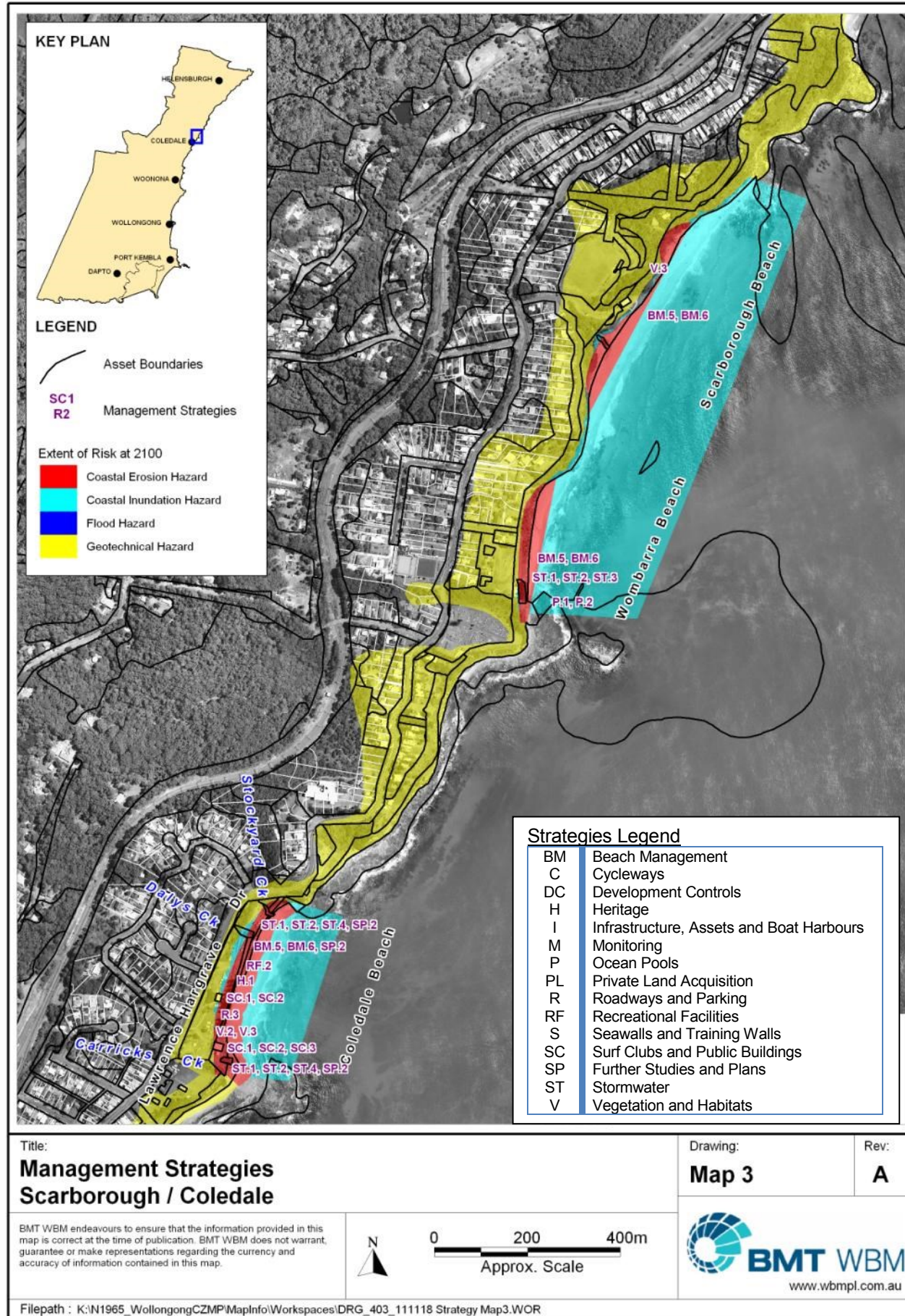
The Flood Hazard presents Council's Flood Planning Area, which is Council's known High to Low Flood Risk Precincts combined. The Flood Hazard relates to inundation due to catchment rainfall only, except at Lake Illawarra where the flood study investigated the combined impacts from catchment rainfall, 1 in 20 year ocean water levels and sea level rise. As specified by the Further Studies and Plans strategy, the most accurate estimation for potential inundation impact should consider the combined impact of catchment rainfall, ocean storm water levels and future sea level rise.

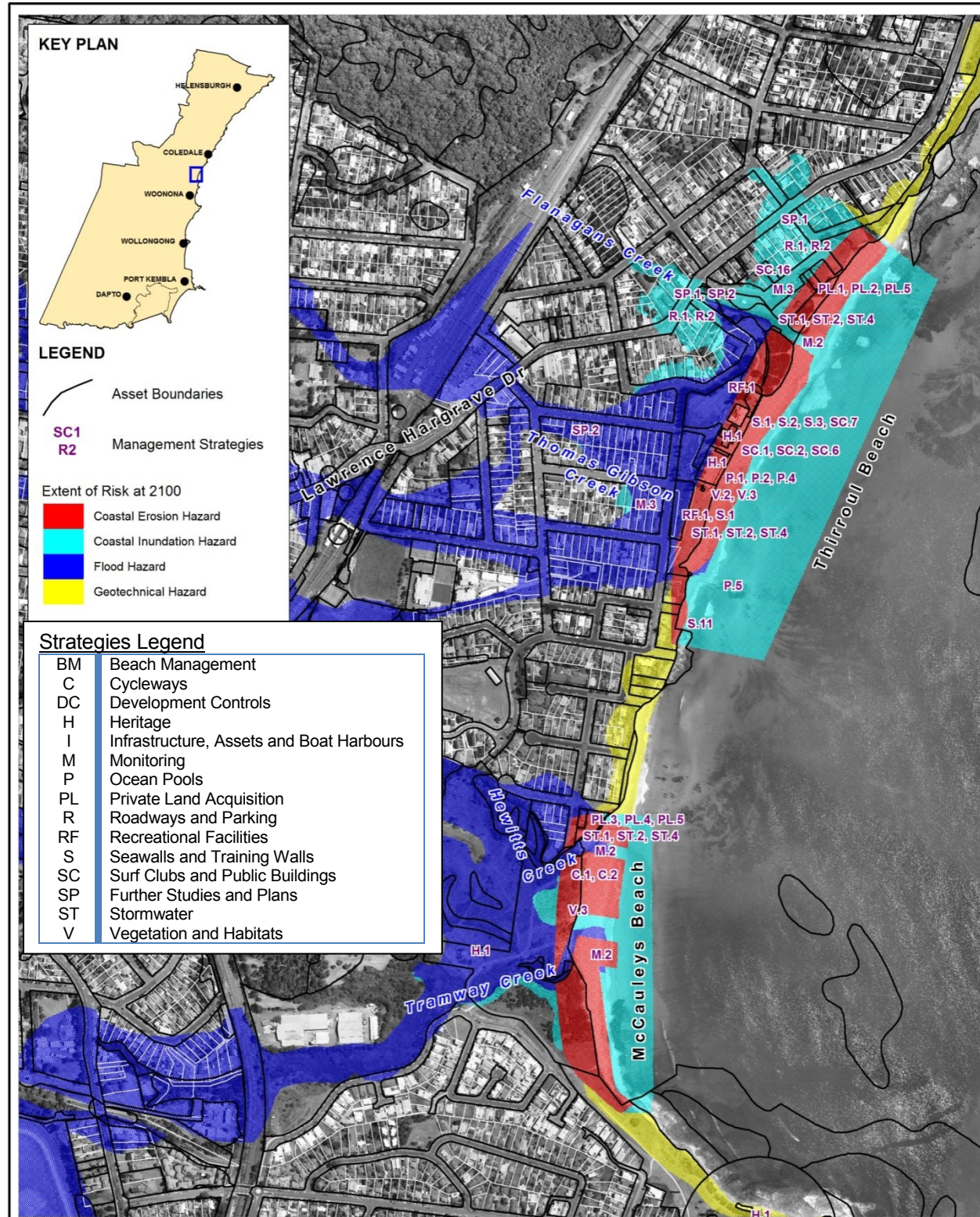
The Flood Hazard has been overlain on the Coastal Inundation Hazard on the maps to clearly portray those areas of backwater coastal inundation that are outside of existing Flood Planning Areas, and which require further action through this plan. Actions to address wave overtopping have been specified where required in this Plan, as this is a separate component of the Coastal Inundation Hazard that is not necessarily addressed by existing controls on Flood Precincts.



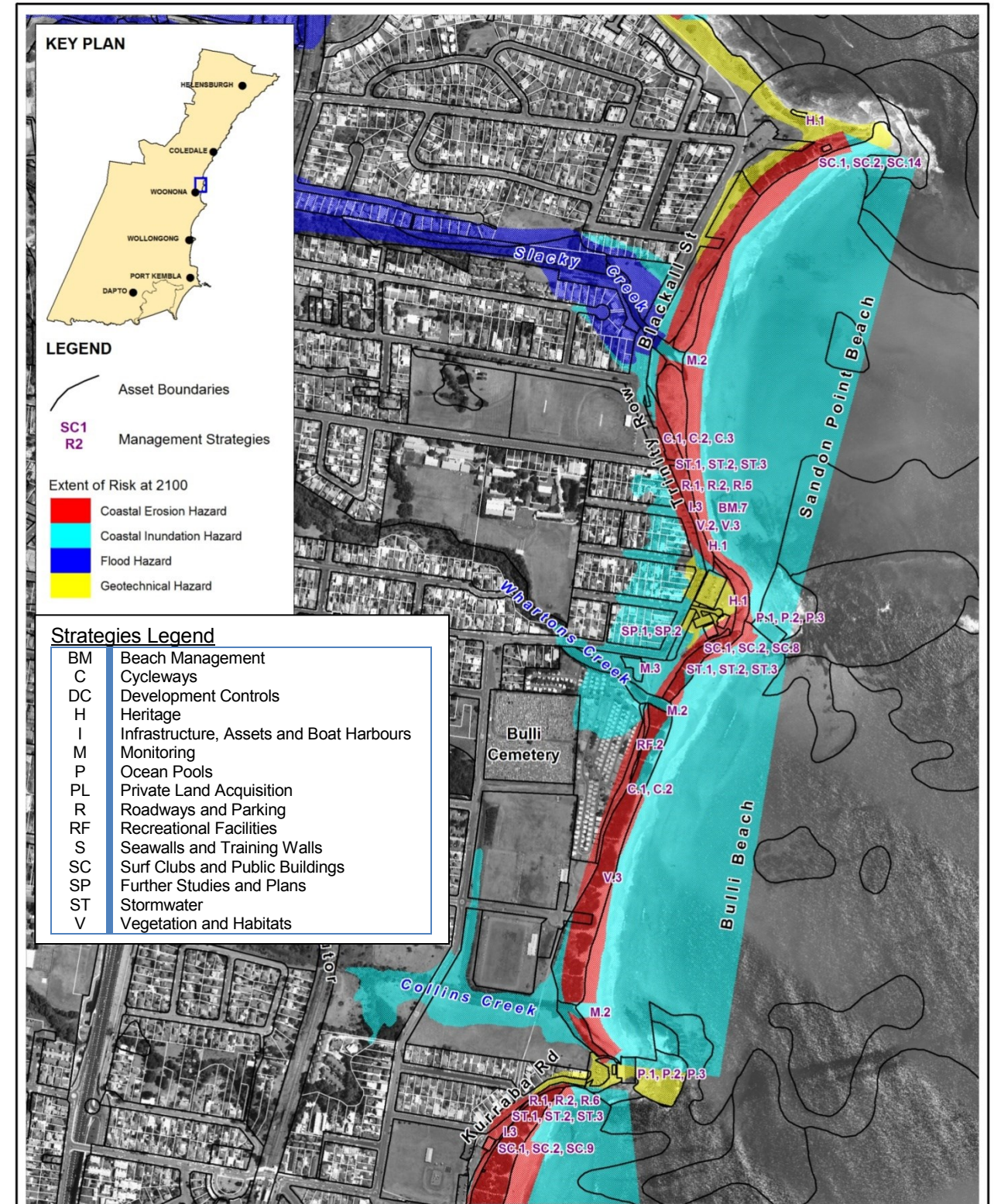




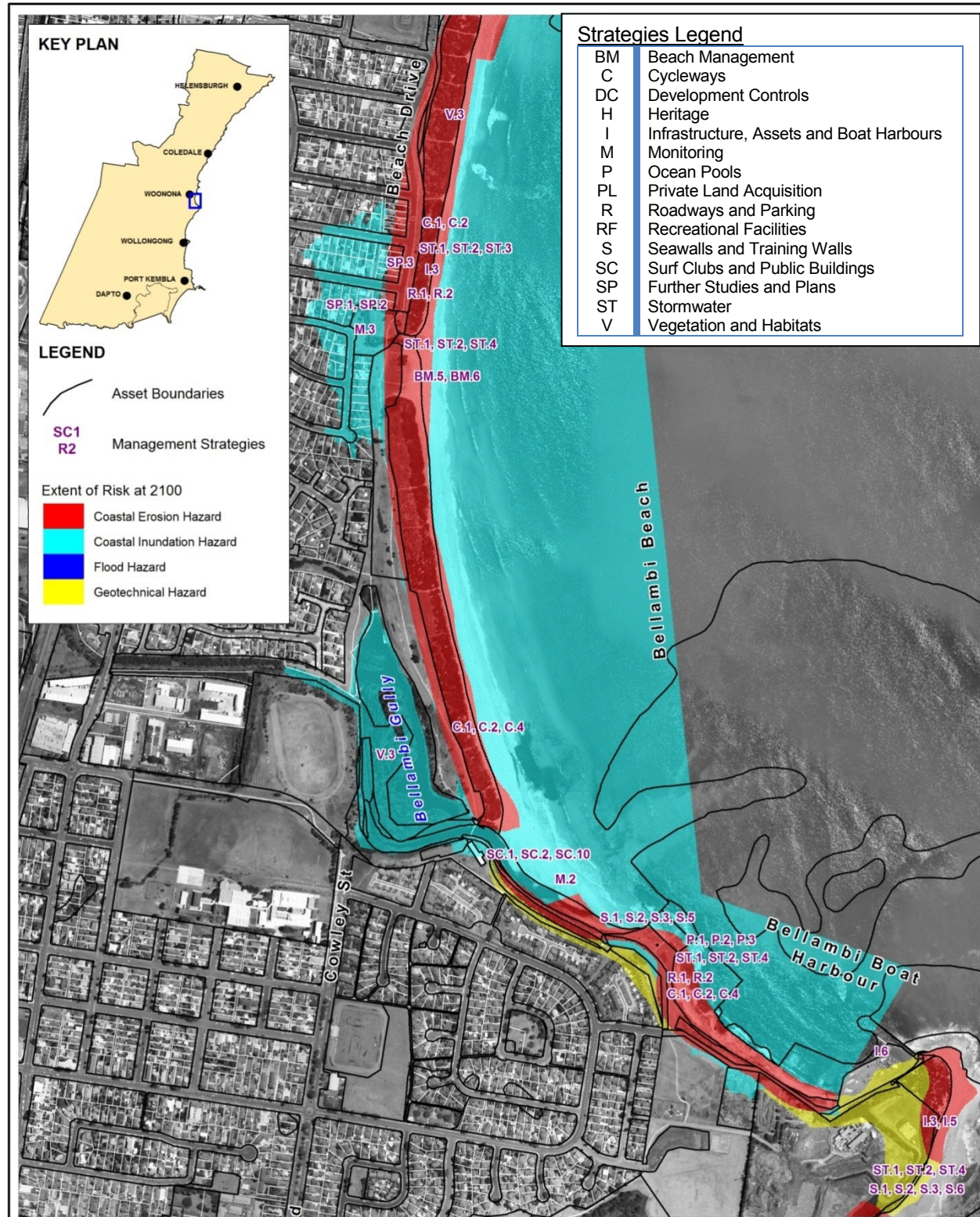




Title: <b>Management Strategies Thirroul / McCauleys</b>		Drawing: <b>Map 5</b>	Rev: <b>A</b>
<p>BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.</p>		<p>Approx. Scale</p>	
<p>www.wbmpi.com.au</p>		<p>Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_405_120106 Strategy Map5.WOR</p>	

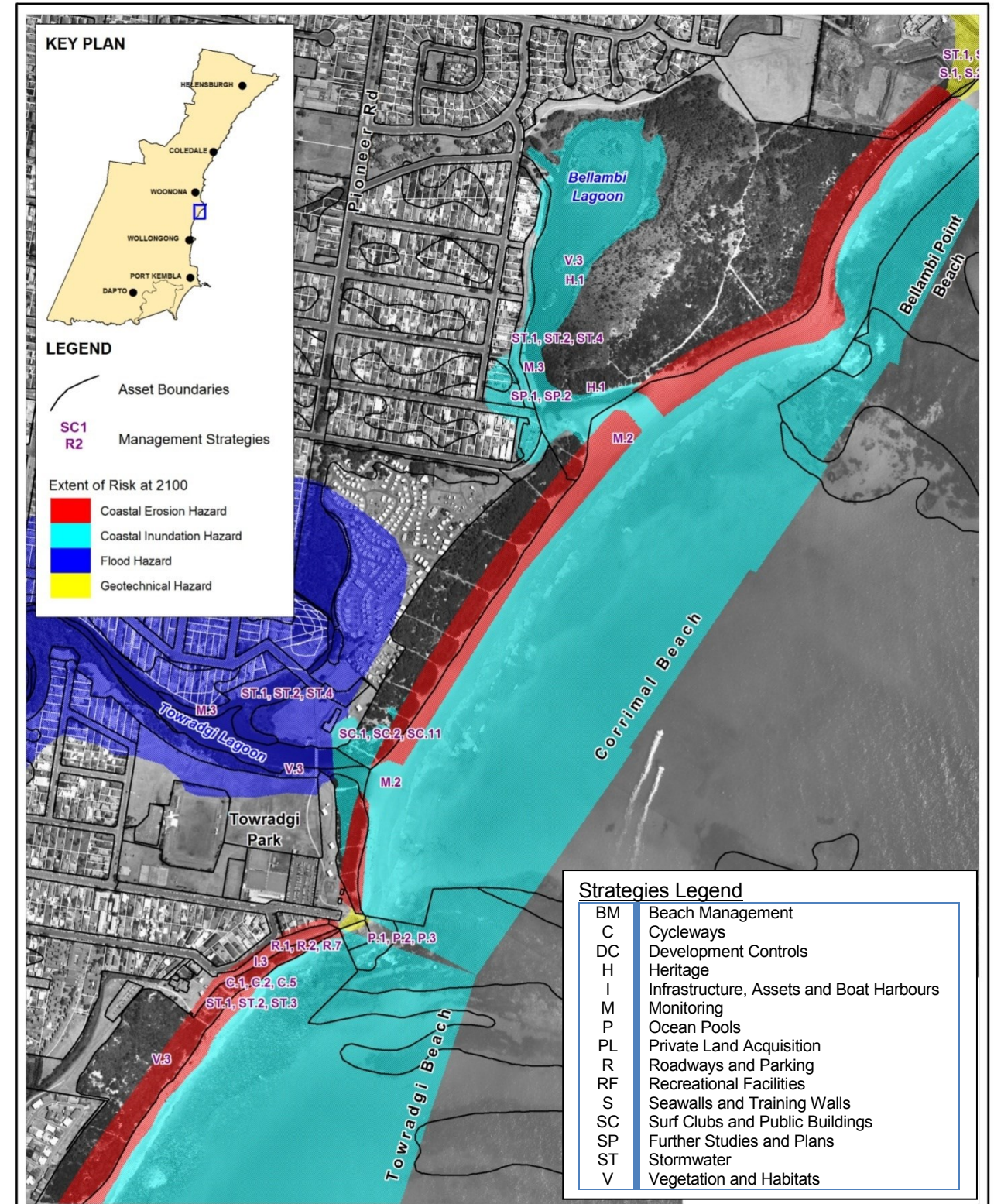


Title: <b>Management Strategies Sandon / Bulli</b>		Drawing: <b>Map 6</b>	Rev: <b>A</b>
<p>BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.</p>		<p>Approx. Scale</p>	
<p>www.wbmpi.com.au</p>		<p>Filepath : K:\N1965_WollongongCZMP\MapInfo\Workspaces\DRG_406_120106 Strategy Map6.WOR</p>	



BM	Beach Management
C	Cycleways
DC	Development Controls
H	Heritage
I	Infrastructure, Assets and Boat Harbours
M	Monitoring
P	Ocean Pools
PL	Private Land Acquisition
R	Roadways and Parking
RF	Recreational Facilities
S	Seawalls and Training Walls
SC	Surf Clubs and Public Buildings
SP	Further Studies and Plans
ST	Stormwater
V	Vegetation and Habitats

—	Asset Boundaries
SC1	Management Strategies
R2	Management Strategies
Extent of Risk at 2100	
Red	Coastal Erosion Hazard
Cyan	Coastal Inundation Hazard
Blue	Flood Hazard
Yellow	Geotechnical Hazard

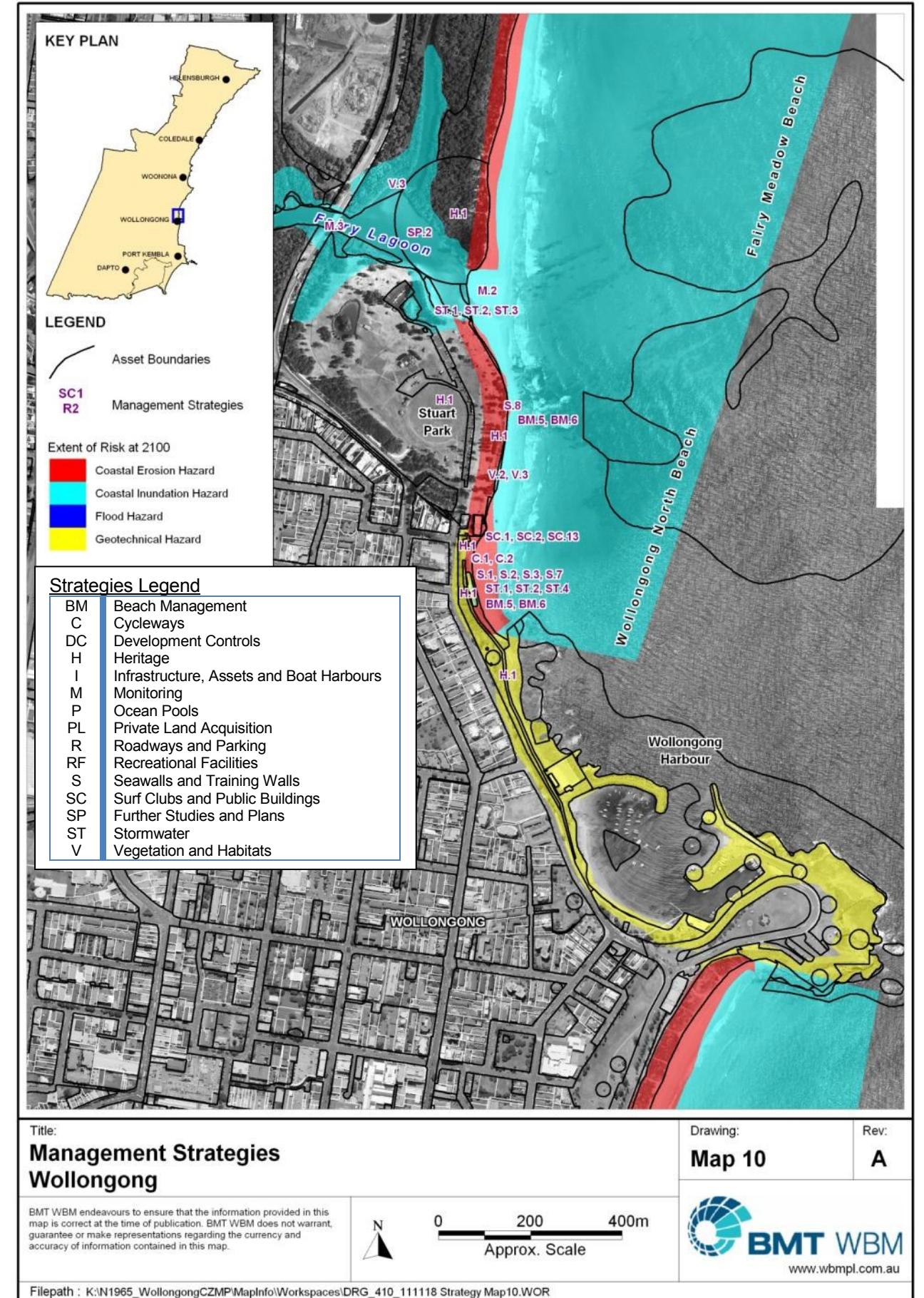
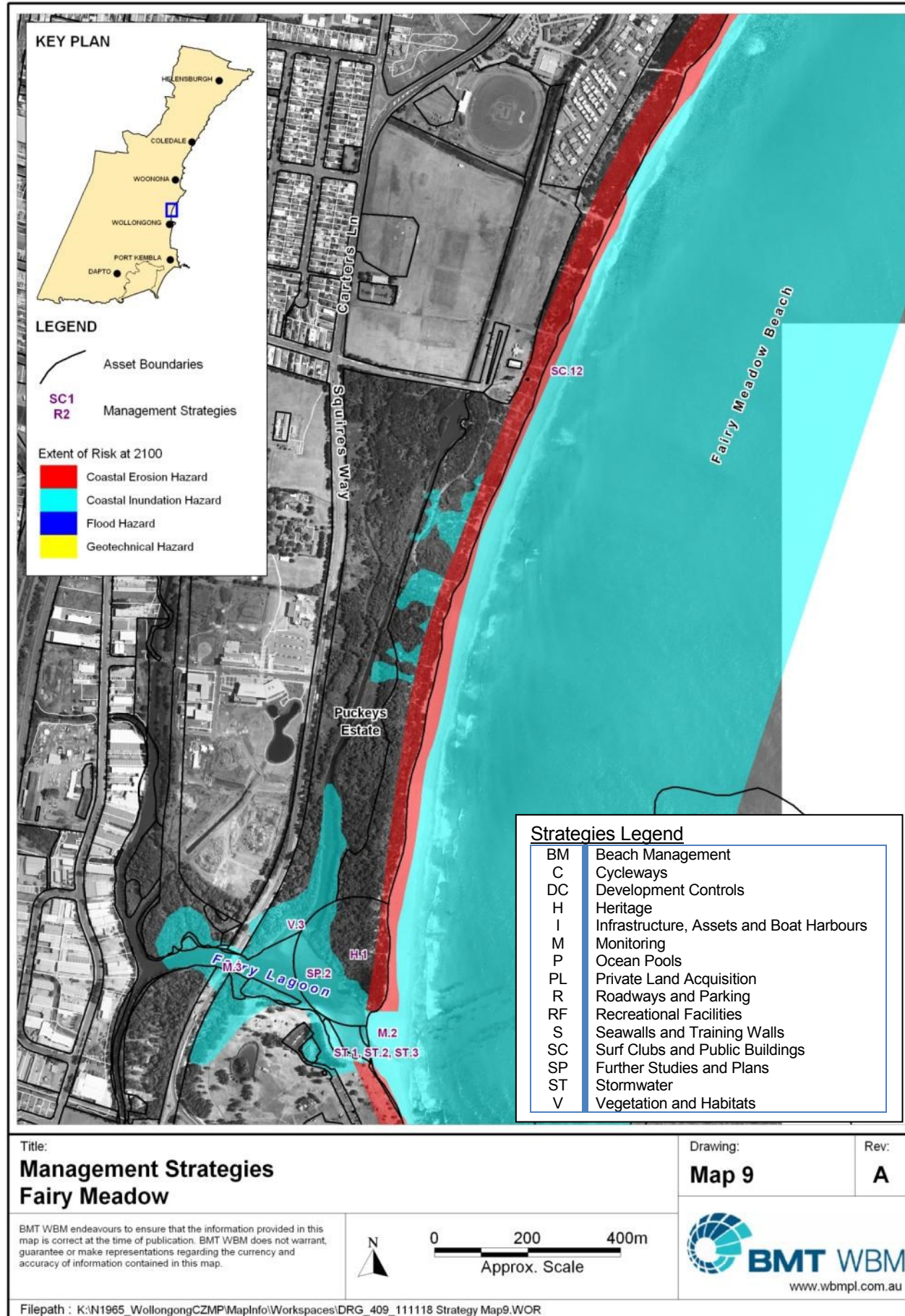


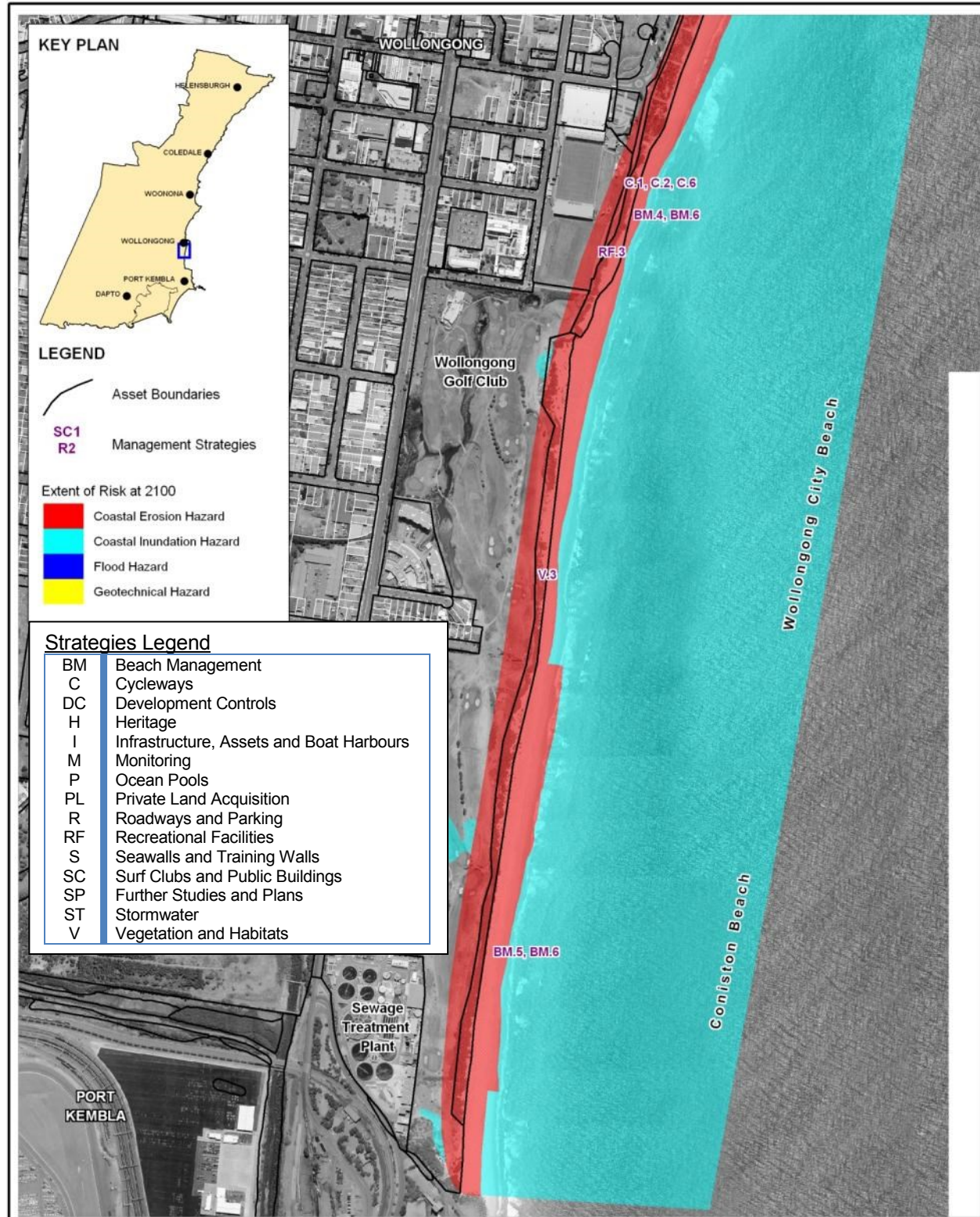
BM	Beach Management
C	Cycleways
DC	Development Controls
H	Heritage
I	Infrastructure, Assets and Boat Harbours
M	Monitoring
P	Ocean Pools
PL	Private Land Acquisition
R	Roadways and Parking
RF	Recreational Facilities
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—	Asset Boundaries
SC1	Management Strategies
R2	Management Strategies
Extent of Risk at 2100	
Red	Coastal Erosion Hazard
Cyan	Coastal Inundation Hazard
Blue	Flood Hazard
Yellow	Geotechnical Hazard

Title: <b>Management Strategies Woonona / Bellambi</b>		Drawing: <b>Map 7</b>	Rev: <b>A</b>
<p>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.</p>			
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Title: <b>Management Strategies Corrimal Beach</b>		Drawing: <b>Map 8</b>	Rev: <b>A</b>
<p>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.</p>			
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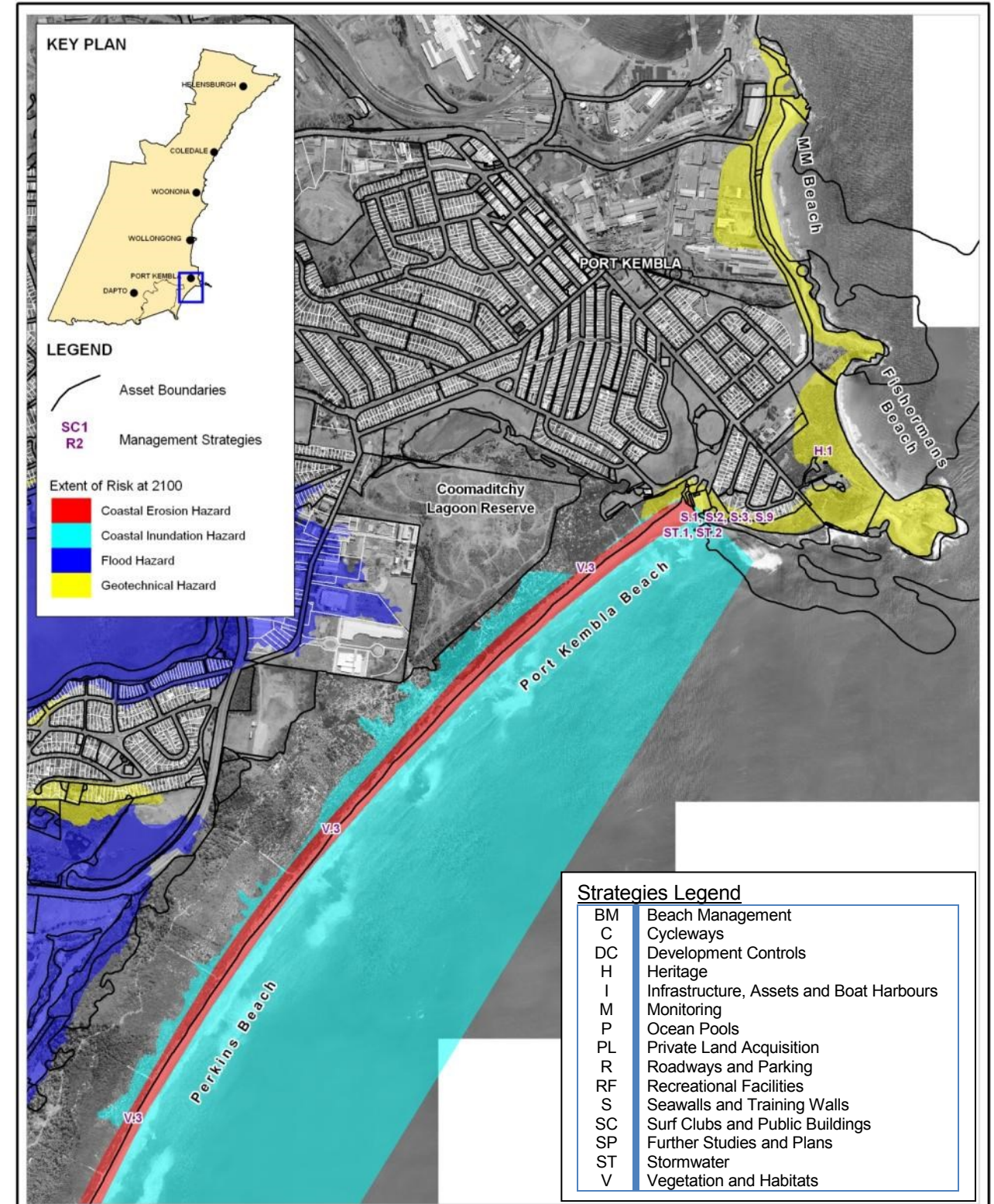
Title: **Management Strategies Wollongong City Beach**  
 Drawing: **Map 11** Rev: **A**

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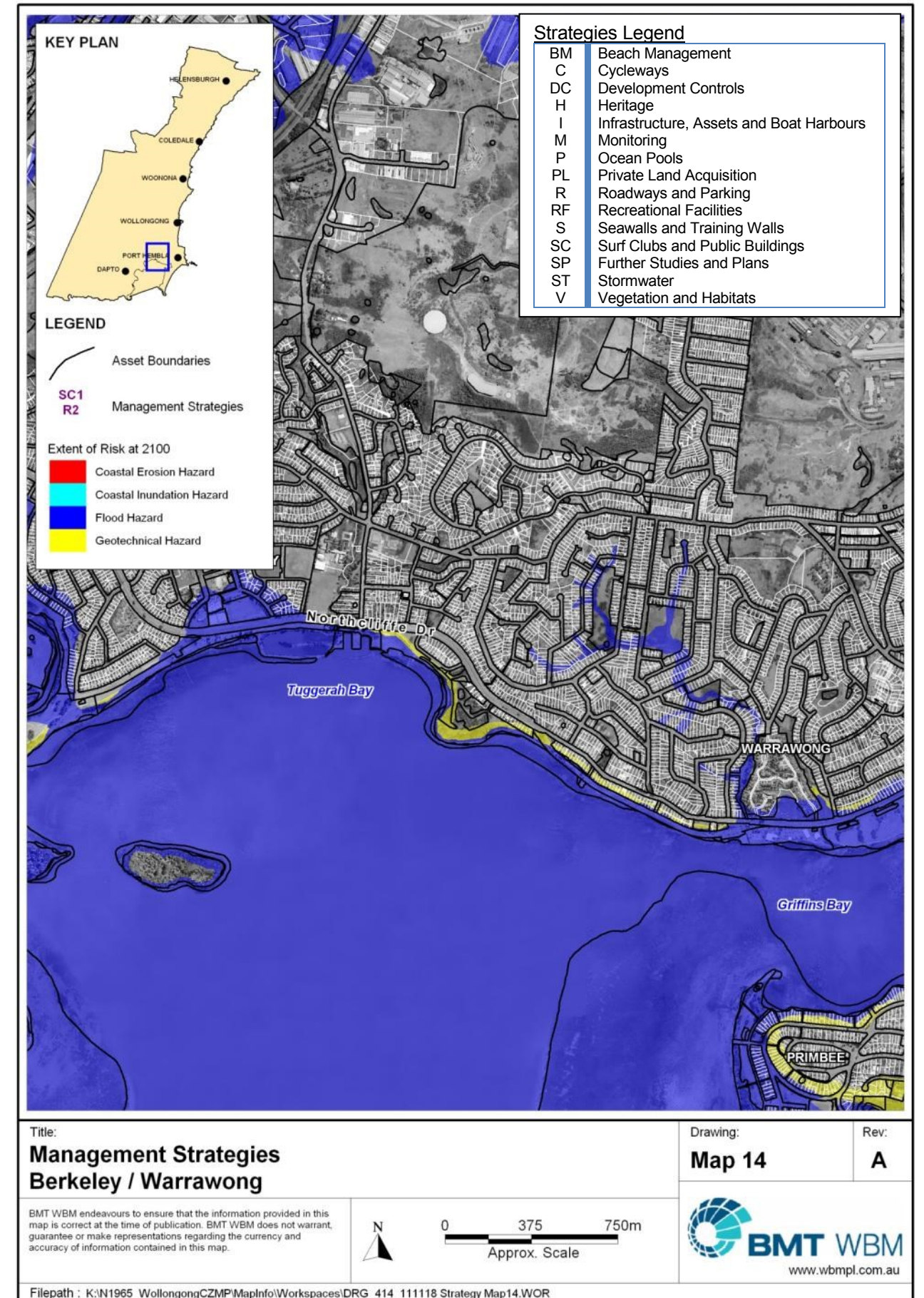
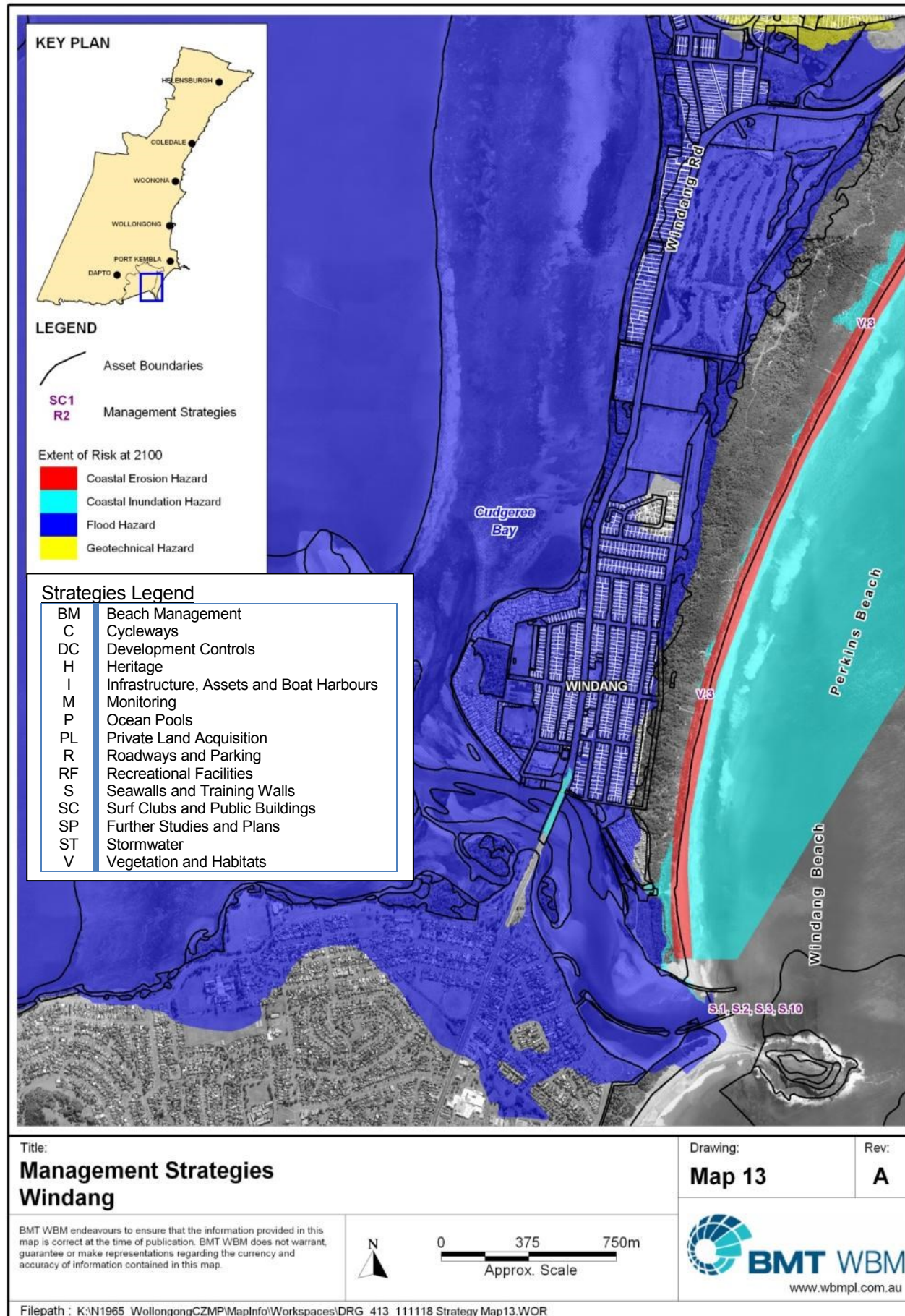
Title: **Management Strategies Port Kembla**  
 Drawing: **Map 12** Rev: **A**

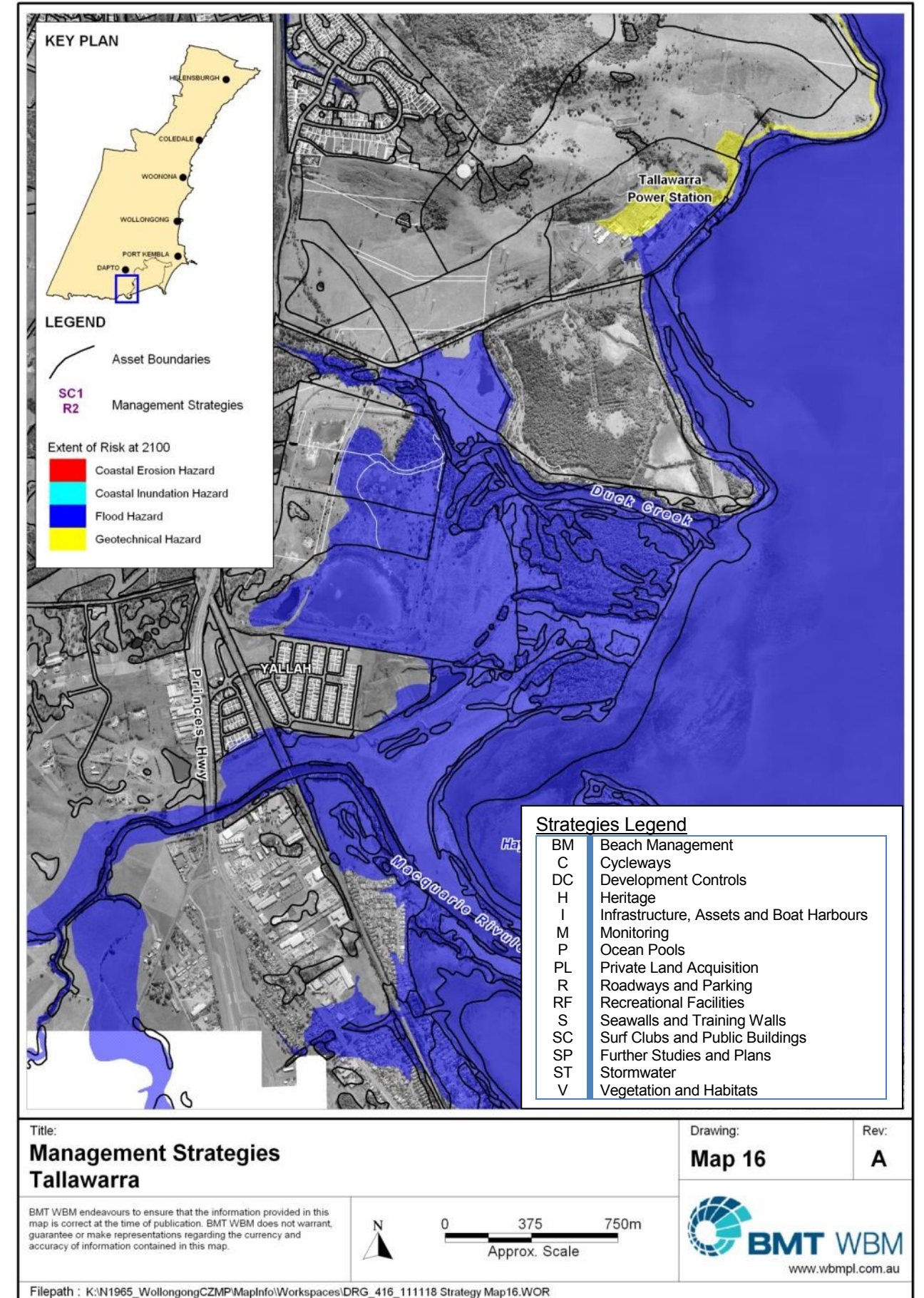
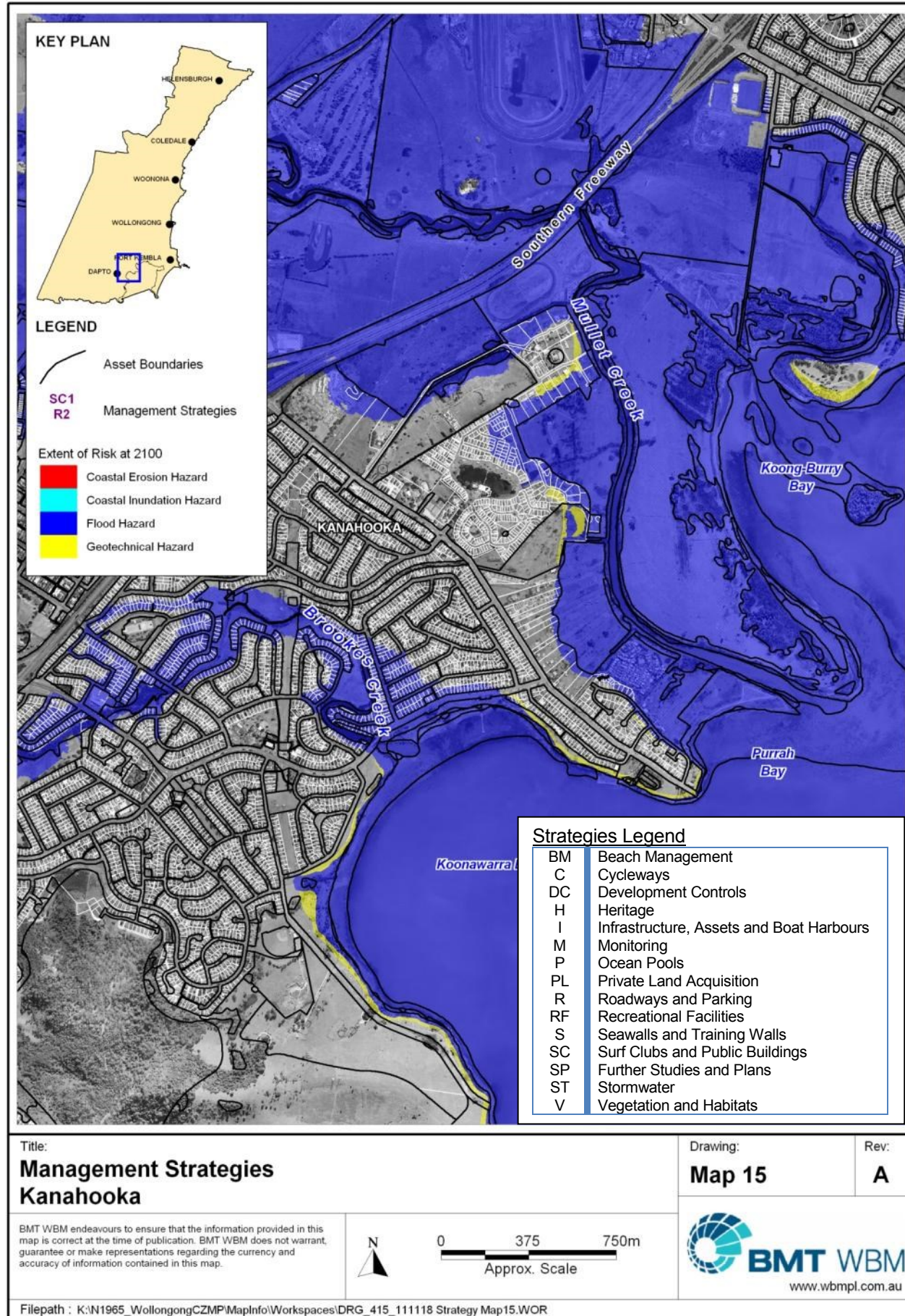
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## 19 EVALUATION AND REPORTING

### 19.1 Performance Evaluation

The Wollongong Coastal Zone Management Plan requires evaluation and reporting regarding its successful implementation, and thus the successful management of existing and future coastal risks. Where implementation performance is sub-optimal, contingencies should be emplaced to remedy the situation. A series of performance measures to assist in the evaluation process are discussed below.

#### 19.1.1 Primary Performance Measures

The first set of performance measures should ascertain whether the strategies are actually being implemented or not in accordance with the timeframe and triggers designated in the Plan. As such, the primary performance measures are simply a *measure of action initiation*.

Organisations (mostly WCC) responsible for implementation will need to review the Plan carefully and ensure that adequate funding and resources are allocated to the various strategies and actions to ensure that the timeframe for implementation is achieved.

Specific questions to be answered as part of an evaluation process are:

- What strategies have actually been implemented (regardless of outcome – see Secondary Performance Measure)?
- What strategies are outstanding, and should have been implemented within this nominated timeframe?

If it is determined that the strategies are not being implemented in accordance with the nominated timeframe, then one or both of the following *contingencies* should be adopted:

- Determine the cause for the delay in implementation. If delays are funding based, then seek alternative sources of funding. If delays are resource-based, seek additional assistance from stakeholder agencies and/or consider using an external consultancy to coordinate implementation of the Plan; and
- Modify and update the Coastal Zone Management Plan to reflect a timeframe for implementation that is more achievable. The revised Plan would need to be endorsed by all relevant stakeholders and agencies responsible for implementation.

#### 19.1.2 Secondary Performance Measures

The second set of performance measures are aimed at *measuring the overall outcomes of the Plan* in terms of actually managing and reducing

the risks to the community associated with existing and future coastal hazards. That is, 'how has the Plan made a difference?'

The main mechanism for gauging whether the overall outcomes of the Plan have been achieved, or not, is to re-evaluate the risks through a follow-up risk reassessment process. As for the first risk assessment, consideration will need to be given to all relevant mechanisms in place that assist with managing future risks and increasing Council's and the community's resilience to a changing climate as associated coastline responses (including erosion, recession and ocean inundation).

The specific question to be answered here is:

- Have the identified risks been adequately managed / mitigated?

If, after a reasonable period of time it is determined that the risks have not been adequately managed/mitigated, then the following contingencies should be adopted:

- Carry out a formal review of the implemented management strategies, identifying possible avenues for increasing the effectiveness of the strategy in managing the risks along the coastline;
- Commence implementation of additional management strategies that may assist in meeting the objectives of the Coastal Zone Management Plan (possibly 'fast-tracking' some longer term strategies as necessary);
- Reconsider the objectives of the risk management. For example, accommodating future changes may no longer be feasible and an alternative approach of abandonment and planned retreat may be necessary. Any such changes to the Plan would need to be endorsed by the stakeholders and relevant government agencies, as well as the public.

### 19.2 Factors for Success

The success of the Wollongong Coastal Zone Management Plan can be improved by the following factors:

- Certification by the Minister and Adoption by Council;
- Broad stakeholder and community agreement on the overall Plan strategies and objectives for risk management;
- Understanding and agreement on implementation responsibilities and funding opportunities by Council and other government agencies, stakeholders and the general community;

- Commitment by organisations involved to dedicate appropriate time and resources to achieve the objectives and timeframe of the Plan; and
- Actively sourcing of appropriate resources and funds, through grants, user contributions, and in-kind commitments from the agencies, stakeholders and community.

A particularly important aspect is the acceptance and agreement by the local community. Without significant support and pressure by the local community, Council may find it difficult to prioritise coastal management works when considering the full range of Council assets and lands requiring attention in the future.

### 19.3 Plan Review

It is recommended that this Implementation Action Plan be reviewed annually, to determine progress with individual actions and strategies, while a broader audit and update be conducted every 5 years. The annual review should focus on funding, resources and barriers to implementation of the individual actions and strategies, whereas the 5 year audit should target re-evaluation of risks to determine progress with overall risk management and reduction. From the 5 year audit, changes can be made to the Plan to ensure the document remains current, and relevant to the changing landuse and community demands along the Wollongong Coastline.



## 20 REFERENCES

BMT WBM (2016) Wollongong Coastal Zone Management Study, prepared for Wollongong City Council by BMT WBM, Broadmeadow, NSW. (Companion document to this Implementation Action Plan)

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

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

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

## 21 ACRONYMS

CZM	Coastal Zone Management
CZMP	Coastal Zone Management Plan
DCP	Development Control Plan
DoI	Department of Industry
DISPLAN	Wollongong Local Disaster Action Plan
EEC	Endangered Ecological Community
FDCP	Flood Development Control Plan
GDCP	Geotechnical Development Control Plan
LEMC	Wollongong Local Emergency Management Cttee
LGA	Local Government Area
MSL	Mean Sea Level
NPW Act	NSW National Parks & Wildlife Act 1974
NPWS	National Parks & Wildlife Service (part of OEH)
OEH	NSW Office of Environment & Heritage
PKPC	Port Kembla Port Corporation
SES	State Emergency Service
SLSC	Surf Life Saving Club
STP	Sewage Treatment Plant
SWC	Sydney Water Corporation
RMS	Roads and Maritime Services
WCC	Wollongong City Council
ZRFC	Zone of Reduced Foundation Capacity



## APPENDIX A: PROPERTY RISK AND RESPONSE CATEGORIES

DECCW (2010) and the Coastal Protection Regulation (2011) require the risk to properties to be specified according to the estimated timeframe for impact, i.e. current year, 2050 or 2100. The Coastal Protection Regulation (2011) indicates that the risk category and the year it was assessed be indicated on planning certificates under Section 149 of the Environmental Planning and Assessment Act, 1979. Risk Categories specified by the Coastal Protection Regulation (2011) are provided in Table 1 below.

In addition, DECCW (2010) advise that the intended response to the potential hazard impact be indicated within a CZMP (i.e., the intended response does not need to be attached to the Section 149 certificate). Response Categories specified by DECCW (2010) are provided in Table 2 below. Property risk and response categories of a format specified by DECCW (2010) and the Coastal Protection Regulation (2011) are provided herein.

It is noted that this Wollongong CZMP has provided considerably greater detail as to the likely risk to private property, and furthermore, has provided a range of suitable actions for such risks to private property that go far beyond structural protection options. For Council's use, a summary table of recommended current and future actions for all private properties at risk to 2100 is given in Table 4.

It is noted that the guidance provided by DECCW (2010) indicated the risk category need only refer to the coastal erosion and recession hazard (and not the coastal inundation hazard), and this is the approach taken to the list of properties provided in Table 3.

**Table 1 Coastal Hazard Risk Category (NSW Government, 2011)**

Risk Category	Intended public authority response
1	The land is, or is likely to be, adversely affected by the coastal hazard at the present time ( <b>a current coastal hazard</b> ).
2	The land is not, and is not likely to be, adversely affected by the coastal hazard at the present time, but is likely to be adversely affected by the coastal hazard in the year 2050 ( <b>a 2050 coastal hazard</b> ).
3	the land is not, and is not likely to be, adversely affected by the coastal hazard at the present time or in the year 2050, but is likely to be adversely affected by the coastal hazard in the year 2100 ( <b>a 2100 coastal hazard</b> )

**Table 2 Coastal Hazard Response Category (DECCW, 2010)**

Response Category	Intended public authority response
A	Coastal protection works are considered technically feasible and cost-effective funding is being sought for implementation
B	Coastal protection works are considered technically feasible but not cost effective for public funding – unlikely to be implemented by a public authority
C	Coastal protection works are not considered technically feasible – no intended public authority works

**Table 3 Wollongong Risk and Response Categories**

Parcel_Details	Suburb	Risk Category	Response Category	Comment
Lot 1 DP 948547	STANWELL PARK	3	C	Only 1 property in middle of beach; Sea wall in front of property will affect beach amenity in future
Lot 74 DP 7664	STANWELL PARK	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 73 DP 7664	STANWELL PARK	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 721 DP 1075403	STANWELL PARK	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 71 DP 7664	STANWELL PARK	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 1 DP 849241	STANWELL PARK	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 35 DP 8450	COALCLIFF	1	C	Affected property at bottom of cliff and house at top. Impacts unlikely to reach residential building
Lot 27 DP 8450	COALCLIFF	1	C	Affected property at bottom of cliff and house at top. Impacts unlikely to reach residential building
Lot 36 DP 8450	COALCLIFF	1	C	Affected property at bottom of cliff and house at top. Impacts unlikely to reach residential building
Lot 34 DP 8450	COALCLIFF	1	C	Affected property at bottom of cliff and house at top. Impacts unlikely to reach residential building
Lot 29 DP 8450	COALCLIFF	1	C	Affected property at bottom of cliff and house at top. Impacts unlikely to reach residential building
Lot E DP 25596	COALCLIFF	1	C	Affected property at bottom of cliff and house at top. Impacts unlikely to reach residential building
Lot 30 DP 8450	COALCLIFF	1	C	Affected property at bottom of cliff and house at top. Impacts unlikely to reach residential building
Lot 33 DP 8450	COALCLIFF	1	C	Affected property at bottom of cliff and house at top. Impacts unlikely to reach residential building
Lot 31 DP 8450	COALCLIFF	1	C	Affected property at bottom of cliff and house at top. Impacts unlikely to reach residential building
Lot 32 DP 8450	COALCLIFF	1	C	Affected property at bottom of cliff and house at top. Impacts unlikely to reach residential building
Lot 3 DP 1119139	AUSTINMER	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 3 DP 206574	THIRROUL	1	C	In middle of beach; not advisable to protect; CZMP recommends acquisition
Lot 2 DP 508419	THIRROUL	1	B	CZMP provides for protection
Lot B DP 421085	THIRROUL	1	B	CZMP provides for protection
Lot 6 DP 5736	THIRROUL	1	B	CZMP provides for protection
Lot 1 DP 508419	THIRROUL	1	B	CZMP provides for protection
Lot 4 DP 5736	THIRROUL	1	B	CZMP provides for protection
Lot 5 DP 5736	THIRROUL	1	B	CZMP provides for protection

Table 3 continued Wollongong Risk and Response Categories

Parcel_Details	Suburb	Risk Category	Response Category	Comment
Lot 1 SP 12590	THIRROUL	1	C	In middle of beach; not advisable to protect; CZMP recommends acquisition
Lot 2 SP 12590	THIRROUL	1	C	In middle of beach; not advisable to protect; CZMP recommends acquisition
Lot 3 SP 12590	THIRROUL	1	C	In middle of beach; not advisable to protect; CZMP recommends acquisition
Lot 4 SP 12590	THIRROUL	1	C	In middle of beach; not advisable to protect; CZMP recommends acquisition
Lot 3 DP 5736	THIRROUL	1	B	CZMP provides for protection
Lot A DP 421085	THIRROUL	1	B	CZMP provides for protection
Lot 24 DP 7133	THIRROUL	2	C	Isolated property surrounded by public lands; not feasible to protect; CZMP recommends acquisition
Lot 37 DP 7525	BULLI	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 35 DP 7525	BULLI	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 102 DP 714032	BULLI	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 101 DP 714032	BULLI	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 36 DP 7525	BULLI	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 4 DP 201691	WOONONA	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 71 DP 12235	WOONONA	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 73 DP 12235	WOONONA	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 65 DP 12235	WOONONA	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 72 DP 12235	WOONONA	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 67 DP 12235	WOONONA	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 61 DP 12235	WOONONA	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 70 DP 12235	WOONONA	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 1 DP 825544	WOONONA	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 62 DP 12235	WOONONA	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 1 SP 57806	WOONONA	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 2 SP 57806	WOONONA	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 63 DP 12235	WOONONA	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 64 DP 12235	WOONONA	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 77 DP 12235	WOONONA	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 76 DP 12235	WOONONA	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 74 DP 12235	WOONONA	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 75 DP 12235	WOONONA	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 66 DP 12235	WOONONA	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 68 DP 12235	WOONONA	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 69 DP 12235	WOONONA	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 210 DP 13182	TOWRADGI	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 2 SP 13877	TOWRADGI	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 208 DP 13182	TOWRADGI	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 4 SP 13877	TOWRADGI	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 209 DP 13182	TOWRADGI	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 5 SP 13877	TOWRADGI	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 207 DP 13182	TOWRADGI	3	B	CZMP recommends monitoring and DCP implementation for now.
Lot 3 SP 13877	TOWRADGI	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 1 SP 13877	TOWRADGI	2	B	CZMP recommends monitoring and DCP implementation for now.
Lot 6 SP 13877	TOWRADGI	2	B	CZMP recommends monitoring and DCP implementation for now.

**Table 4 Summary of Recommended Future Action for Private Properties at Erosion and Recession Risk**

This table provides a summary of the recommended future action for all private land found to be at low to extreme risk by 2100. In many cases only implementation of the proposed Coastal Management DCP is recommended at the current time, due either to the low level of risk to 2100, the physical location of building footprints compared with the hazard line estimate, and so on. In some cases, specific additional actions have been provided in this plan. Further details are given in the table below.

	Risk Now	Risk at 2050	Risk at 2100	Coastal DCP	FDCP	Recommended Future Strategy
Stanwell Park: Existing Residences (1 centre of beach)	Low	Medium	Medium	✓		Low risk, therefore no action required at present. Likely to be suitable for acquisition (e.g. PL.1/PL.2) and retreat in future, as only one property affected, to ensure beach amenity is retained.
Stanwell Park: Existing Residences (4 pptides S end)	Medium	Medium	High	✓		Building footprints are landward of 2100 hazard estimate, further action unlikely to be required. DCP controls will trigger geotechnical investigation for foundation capacity as properties are redeveloped, properties likely to be located near bedrock. Otherwise, recommend acquisition (e.g. PL.1/PL.2) and retreat in future.
Stanwell Park: Vacant Land (Future Development) (1 block at S end)	Low	Low	Medium	✓		Low to medium risk, no current action required. Suitable location for acquisition (e.g. PL.2) in future. .
Coalcliff: Existing Residences (10 pptides N end, but only affects edge of ppty below cliff (i.e. not the buildings))	Medium	Medium	High	✓		Hazard affects land within property boundaries at the base of cliffs, not the buildings. Further action unlikely to be required.
Vacant Land (Shark Park, currently zoned residential)	Medium	Medium	High	✓		Refer Action W.6, which recommends rezoning to public recreation
Little Austinmer: Existing Residences (1 at N end)	Low	Medium	Medium	✓		Future action dependent upon outcome to manage Lawrence Hargrave Drive.
Thirroul: Existing Residences 1 ppty at centre of beach	Medium	High	Extreme	✓		Refer Action PL.1/PL.2 & PL.5
Thirroul, McCauleys: Existing Residences (8 ppty at S end of beach, plus 8 pptides for geotechnical hazards extending along headland to McCauleys)	Medium	High	Extreme	✓		Refer Action S.11.
McCauleys: Existing Residences 1 ppty at N end of beach	Medium	Medium	High	✓	✓	Refer Action PL.3/PL.4 & PL.5
Sandon Point: Existing Residences (edge of 5 pptides at S end of beach)	Low	Medium	Medium	✓		Low risk at present, no action currently required. DCP will manage building setbacks as properties re-developed.
Woonona: Existing Residences (19 pptides at centre of beach)	Medium	Medium	High	✓		Refer Action SP.3
Towradgi: Existing Residences (3 pptides at N end)	Low	Medium	Medium	✓		Likely to be bedrock at depth to provide stable foundation. Geotechnical investigation would be triggered through DCP, mitigating risk.
Towradgi: Existing Residences (1 ppty at N end)	Medium	Medium	High	✓		Likely to be bedrock at depth to provide stable foundation. Geotechnical investigation would be triggered through DCP, mitigating risk.



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“Where will our knowledge take you?”

# Wollongong Coastal Zone Management Plan: Management Study

Final Report September 2017



# 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)

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<b>Title :</b>	Wollongong Coastal Zone Management Plan: Management Study Final Draft Report
<b>Author :</b>	Verity Rollason
<b>Synopsis :</b>	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
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& 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.

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# 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 (OEHL, 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.

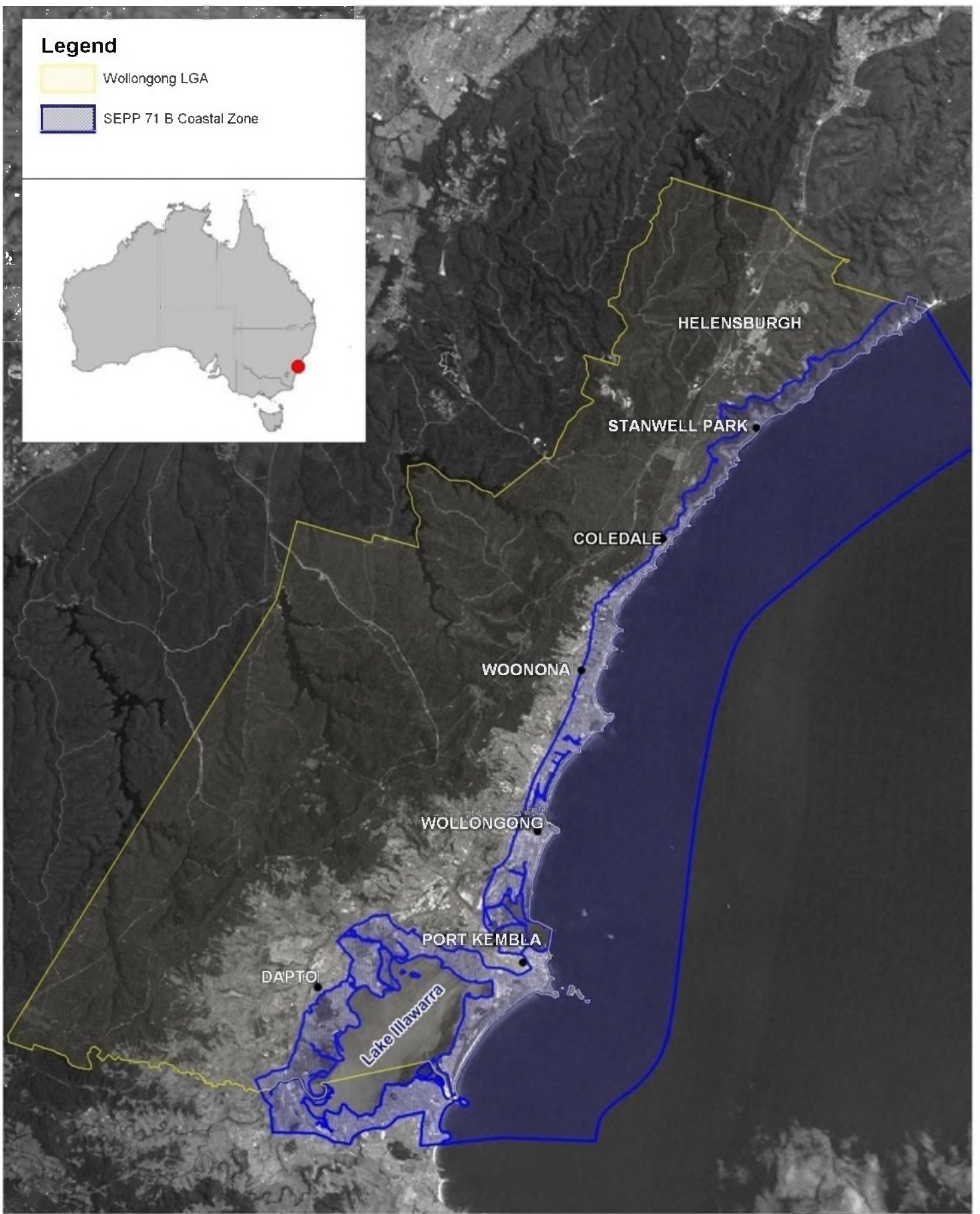
Wollongong's beaches are typically high energy sandy beaches with occasional rocky shorelines. Wollongong has in places steep and rugged cliffs and bluffs, creating small pocket beaches. In the far northern part of the LGA, cliffs and bluffs dominate the coastline, as the Illawarra escarpment trends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

**Legend**

 Wollongong LGA

 SEPP 71 B Coastal Zone



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**Stydy Area - Wollongong LGA  
Coastline**

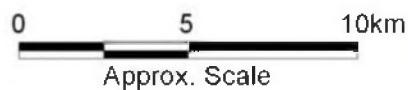
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BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.



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### 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.

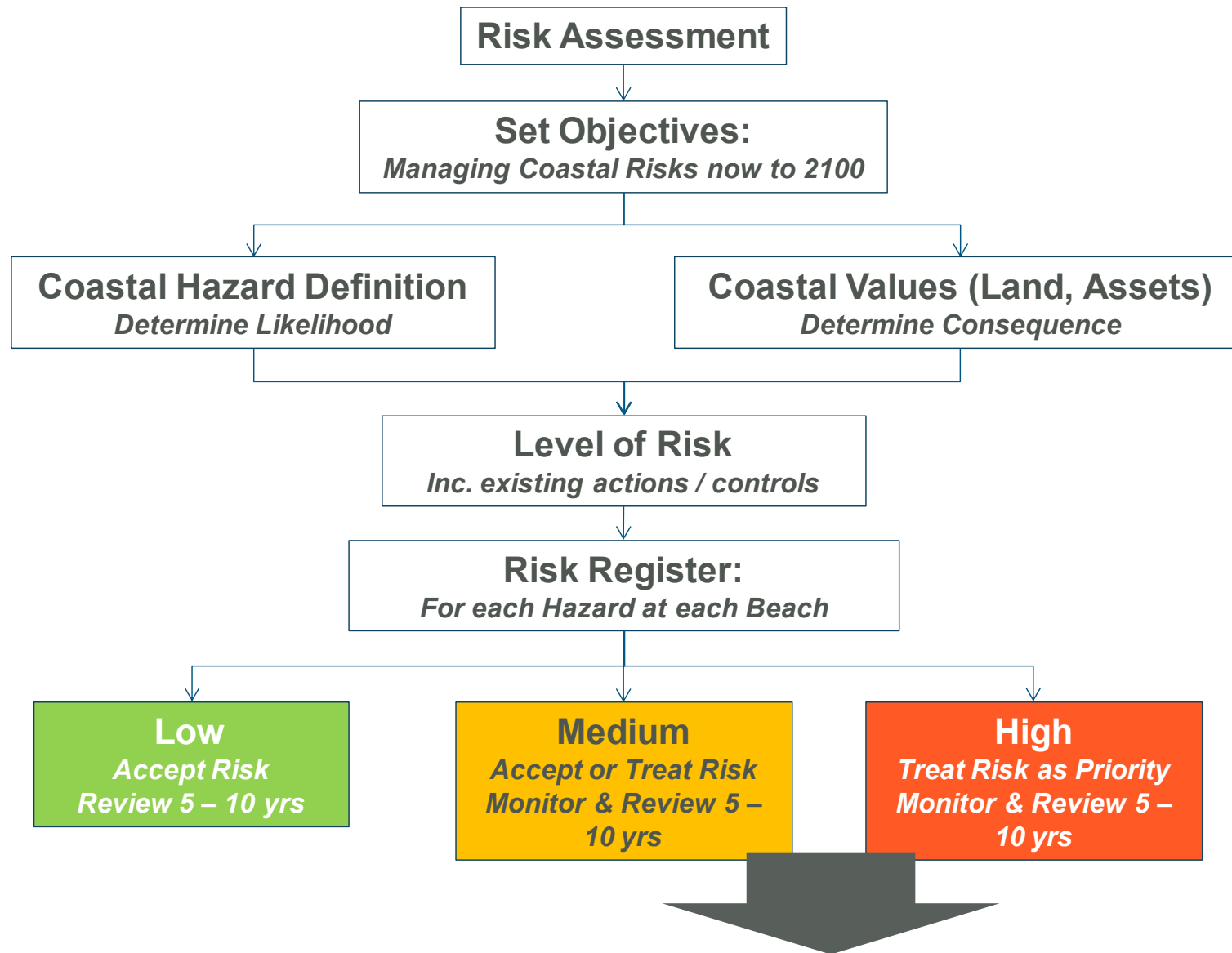


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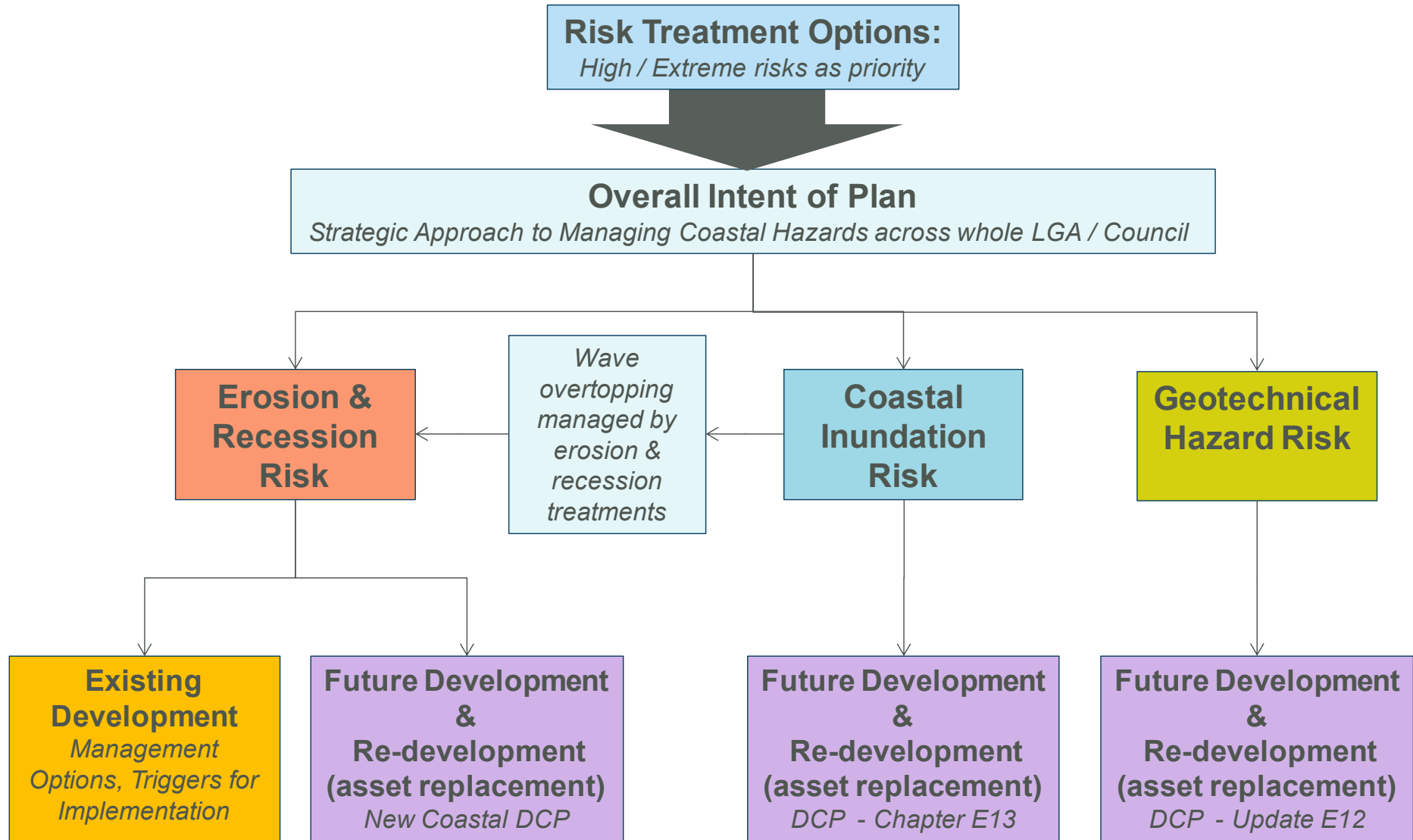


Figure 1-2 Plan Hierarchy / Framework for Management Options

## 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 Practice 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**

<b>Rural Zones</b>	<b>Residential Zones</b>	<b>Business Zones</b>	<b>Industrial Zones</b>
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	
<b>Special Purpose Zones</b>	<b>Recreation Zones</b>	<b>Environment Protection Zones</b>	<b>Waterway Zones</b>
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<sup>3</sup>/m and 160 m<sup>3</sup>/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.



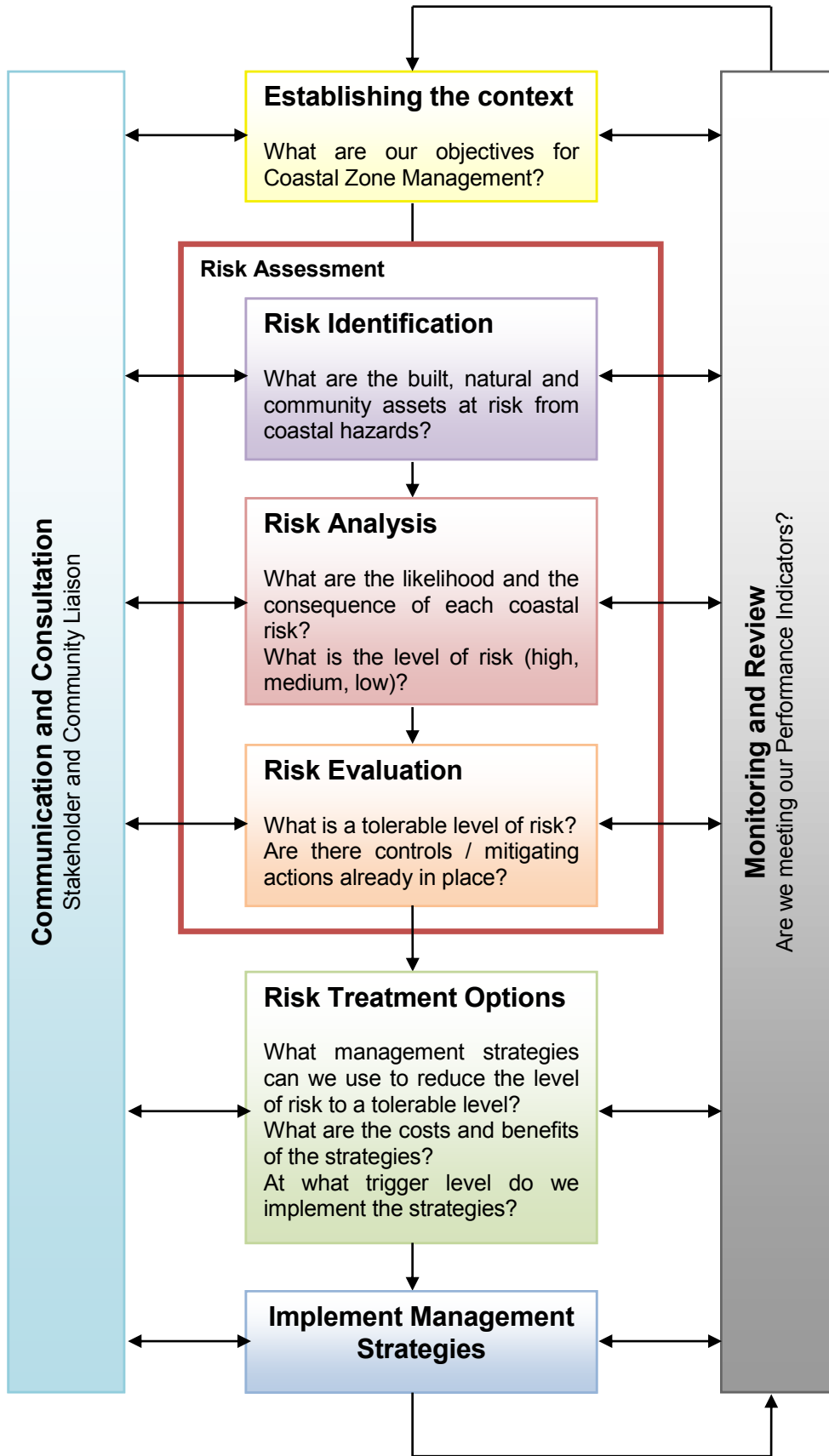


Figure 4-1 Risk Management Framework (ISO 3100:2009) adapted to Coastal Zone Management

- **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
<b>Almost Certain</b>	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.
<b>Likely</b>	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.
<b>Possible</b>	The event has occurred at least once in the past and may occur again.
<b>Unlikely</b>	There is a low possibility that the event will occur, however, there is a history of infrequent and isolated occurrence.
<b>Rare</b>	It is highly unlikely that the event will occur, except in extreme / exceptional circumstances, which have not been recorded historically.

Probability			At 2100
<b>Almost Certain</b>		At 2050	2010 erosion / inundation
<b>Likely</b>	At 2010	2010 erosion / inundation	2050 erosion / inundation
<b>Possible</b>	2010 erosion / inundation	2050 erosion / inundation	2100 erosion / inundation
<b>Unlikely</b>	2050 erosion / inundation	2100 erosion / inundation	
<b>Rare</b>	2100 erosion / inundation		

**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
<b>Catastrophic</b>	Widespread permanent impact to community's services, wellbeing, finances, <u>or</u> 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
<b>Major</b>	Major permanent or widespread medium term (somewhat reversible) disruption to community's services, wellbeing, finances, <u>or</u> 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
<b>Moderate</b>	Minor long term or major short term (mostly reversible) disruption to services, wellbeing, finances, <u>or</u> 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
<b>Minor</b>	Small medium – short term (reversible) disruption to services, wellbeing, finances, <u>or</u> 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 ltr oil spill) with localised impact (e.g. street, precinct) for less than one month
<b>Insignificant</b>	Very small short term disruption to services, wellbeing, finances, <u>or</u> 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**

<b>Coastal Assets Categories and Asset items</b>	
<b><i>Parks, Beaches and open space</i></b>	<b><i>Transport Infrastructure</i></b>
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
<b><i>Community Infrastructure</i></b>	<b><i>Water and sewage infrastructure</i></b>
Surf Clubs	Stormwater outlets and pipes
Caravan Parks	Sewage Treatment Plants, sewage pumping stations, water supply networks
Heritage / Historic Sites and Significant Aboriginal Sites	<b><i>Residential Development</i></b>
Heritage Norfolk Island Pines	Existing Residences
Cycleway / Shared Pathway	Vacant Land (Future Development)
Ocean Pools	<b><i>Commercial and Industrial Development</i></b>
Community halls, libraries, other public buildings	<b><i>Institutional Infrastructure</i></b>
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 landslide 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)
<b>Parks, Beaches and open space</b>				
Beaches	Major	<p>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.</p> <p>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.</p>	Insignificant	The impact of inundation ( <u>as separate from erosion</u> ) 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 ( <u>as separate from erosion</u> ) 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 ( <u>as separate from erosion</u> ) 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 ( <u>as separate from erosion</u> ) 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 ( <u>as separate from erosion</u> ) 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.
<b>Community Infrastructure</b>				
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 ( <u>as separate from erosion</u> ) 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 ( <u>as separate from erosion</u> ) 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 ( <u>as separate from erosion</u> ) 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 ( <u>as separate from erosion</u> ) 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.
<b>Transport Infrastructure</b>				
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.
<b>Water and sewage infrastructure</b>				

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.
<b>Residential Development</b>				
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.
<b>Commercial and Industrial Development</b>	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.
<b>Institutional Infrastructure</b>				
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.

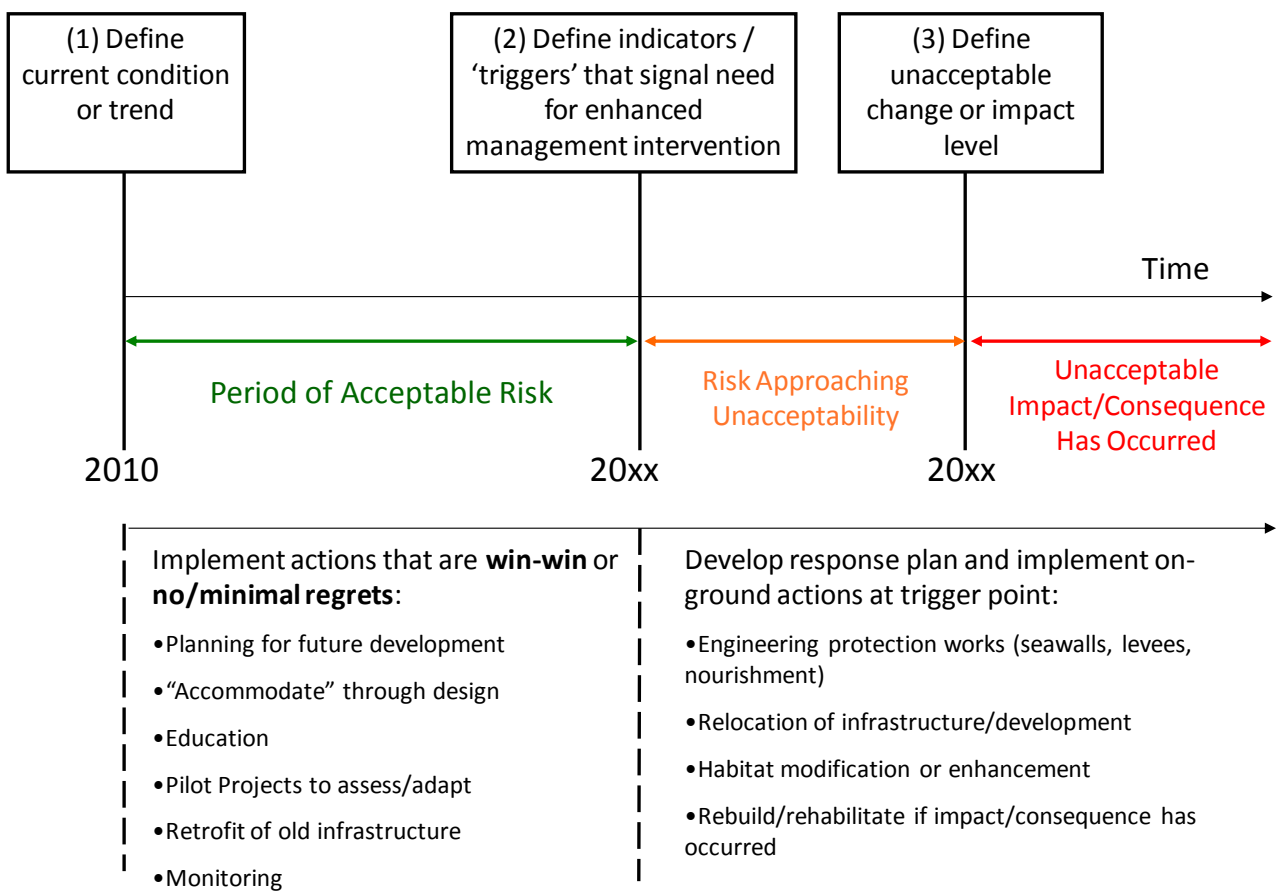
Table 4-8 Risk Tolerance Scale

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

### 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 > 40m <sup>2</sup>
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 <i>Planning People Places</i> (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 <ol style="list-style-type: none"> <li>Determine priority for this action from Council's Asset Management Plan.</li> <li>If supported by the Asset Management Plan, review audit of all tidal pools affected by erosion / recession and sea level rise.</li> <li>Update Asset Management Plan to include future action ("managed to fail" or "retrofit") and identify the trigger for implementation of future action.</li> <li>Utilise findings for prioritisation of asset maintenance and replacement schedules.</li> </ol> <p>This action is required prior to implementing PR2 or A2.</p>
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 <ol style="list-style-type: none"> <li>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.</li> <li>Update relevant strategic plans to include future action determined, including triggers for implementation.</li> </ol> <p>This action is required prior to implementing PR2, A2 or S1 / S2.</p>
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 <ol style="list-style-type: none"> <li>Determine priority for this action from Council's Asset Management Plan.</li> <li>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.</li> <li>Update Asset Management Plan to note future action ("relocate" or "retrofit") and identify the trigger for future action.</li> <li>Utilise findings within prioritisation of asset maintenance and replacement schedules.</li> </ol> <p>This action is required prior to implementing PR2, A2 or S1 / S2.</p>



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	<p>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.</p> <p>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.</p> <p>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.</p>	<p>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.</p> <p>NB - Erosion impacts to stormwater outlets shall be noted in NR1, with expected action through PR2.</p>	<p>All stormwater infrastructure affected by coastal inundation (ie, within the coastal inundation hazard area) or by erosion and recession.</p>	<p>Current Action</p> <ol style="list-style-type: none"> <li>Determine priority for this action from Council's Asset Management Plan.</li> <li>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).</li> <li>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).</li> <li>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.</li> <li>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.</li> </ol> <p>This action is required prior to implementing PR2 or A2.</p>
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	<p>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.</p>	<p>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.</p>	<p>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</p>	<p>Current Action</p> <ol style="list-style-type: none"> <li>Council shall advise relevant authorities of the extent of current and future hazards.</li> <li>Management as in NR7 above, with responsibility of implementation falling to SWC and electricity utilities.</li> <li>Opportunity for clear strategies to be developed should be provided and where practical, feed into determining future management elements by Council.</li> </ol> <p>This action is required prior to implementing PR2 or A2, and in some locations may govern implementation of S1 / S2.</p>
NR9	Develop evacuation plans for local roads and property affected by coastal inundation outside of existing flood planning areas.	No Regrets	<p>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.</p>	<p>This option addresses the changing consequence of coastal inundation to people's safety, as climate change impacts occur.</p>	<p>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 &amp; property).</p>	<p>Current Action</p> <ol style="list-style-type: none"> <li>Develop evacuation plans for catchments without existing flood mapping as a priority.</li> <li>Update evacuation plans with existing flood mapping or Local Emergency Management Plans to include coastal inundation area</li> <li>Collate evacuation plans on an LGA-wide scale, to ensure consistency and safety across LGA</li> </ol> <p>Trigger Implement evacuation plans as needed.</p>

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 be 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 Flanagan's 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. <i>Illawarra Regional Biodiversity Strategy, 2010</i> ). 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	<p>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.</p> <p>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.</p> <p>For coastal inundation risks, monitoring should consider the depth and frequency of events over time.</p>	<p>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.</p> <p>Regular monitoring will support the identification of triggers for adaptation measures to be implemented.</p>	<p>Whole coastline, Thirroul Pool and Pavilion, Beach Dr at centre of Woonona, Trinity Row southern end of Sandon Pt Beach</p>	<p>Current Action</p> <ol style="list-style-type: none"> <li>1. Set up a baseline monitoring programme for long term trend and condition following major events.</li> <li>2. Review results for particular asset triggers regularly, eg within SoE reporting.</li> <li>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).</li> </ol> <p>Trigger</p> <ol style="list-style-type: none"> <li>1. Erosion – Beach surveys and distance from scarp to structures every three years or following major events</li> <li>2. Inundation – Monitor inundation levels and extents following major events, and compare with continued mean sea level monitoring.</li> </ol>

### 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	<p>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 <i>Acacia sophorae</i> (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.</p> <p>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.</p>	<p>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.</p> <p>It is noted that species such as spinifex and <i>Acacia sophorae</i> 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.</p> <p><i>Acacia sophorae</i> is a commonly found dune species that can occasionally 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.</p> <p>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.</p>	All beaches	<p>Current Action:</p> <ol style="list-style-type: none"> <li>1. Prepare and implement an LGA-wide Dune Management Strategy, including: <ul style="list-style-type: none"> <li>• review and enhancement of current dune care program,</li> <li>• Involving local volunteers, particularly SLSC members in dune care works, to additionally provide an opportunity for education regarding coastal processes and environments, and</li> <li>• Prioritising locations to ensure beaches with limited vegetation or weed species are rehabilitated as a priority.</li> </ul> </li> <li>2. Implement improved program.</li> </ol>
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Protect	<p>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.</p> <p>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.</p>	<p>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.</p> <p>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.</p>	Beaches with limited sand reserves and or to assist protection of assets identified at risk.	<p>Current Action:</p> <p>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.</p> <p>These actions will need to be incorporated into Council's Asset Management Plan</p> <p>Trigger:</p> <p>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.</p> <p>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.</p>

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	<p>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.</p> <p>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</p> <p>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).</p>	<p>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<sup>3</sup>, with typical volumes of up to 200 m<sup>3</sup>/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<sup>3</sup>, 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.</p> <p>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.</p> <p>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.</p> <p>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.</p>	<p>Wollongong City Beach (adjacent to WIN Stadium extending to City Beach SLSC); Thirroul, Austinmer, Little Austinmer, refer individual beach maps / tables for all locations.</p>	<p>Current Actions:</p> <ol style="list-style-type: none"> <li>1. Undertake investigation of sand sources for detailed costing, detailed design of nourishment profiles, planning approvals and to determine funding mechanisms.</li> <li>2. Implement DCP (prior to implementing N)</li> <li>3. Continued monitoring (NR14) for trigger point</li> </ol> <p>Trigger</p> <p>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.</p>

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	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>	<p>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.</p> <p>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.</p> <p>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).</p> <p>However, funding is limited, and Gillespie Economics found that compared with both S1 &amp; 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.</p> <p>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.</p> <p>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 through the Local Government Grants programs on a competitive statewide priority basis.</p> <p>Restrictions on re-development (i.e. DCP) should be used until protection works are in place.</p>	Thirroul (S end of beach); Austinmer (length of beach), Sandon Point Beach (southern half of beach). Refer to beach maps for proposed seawall alignments.	<p>Current Actions:</p> <ol style="list-style-type: none"> <li>Undertake NR2, to investigate viability of existing walls on beaches.</li> <li>Consider outcomes of NR3, NR5, NR6, NR7 &amp; NR8 to determine protection needs for assets (refer beach tables for more specific locations), which shall be consistent with Council's Asset Management Plan.</li> <li>Undertake investigation of rock and sand sources for detailed costings, detailed design of seawall &amp; nourishment requirements, planning approvals and to determine funding mechanisms.</li> <li>Implement DCP (prior to implementing S1)</li> <li>Continued monitoring (NR14) for trigger point</li> </ol> <p>Trigger</p> <ol style="list-style-type: none"> <li>For private development and significant public development where the present day impact line (including foundation stability allowance) encroaches on the existing development foundations.</li> <li>Alternatively for private development where the most recent erosion escarpment crest encroaches the seaward property boundary.</li> <li>For undeveloped reserve or public land, where the most recent erosion escarpment encroaches the predetermined protection line along the beach.</li> </ol>

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	<p>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.</p> <p>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.</p> <p>This may also be considered in certain locations to treat the geotechnical risk (cliff retreat).</p> <p>Generic comments relating to seawall types and construction for S1 are also applicable.</p>	<p>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.</p> <p>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 &amp; 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.</p> <p>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).</p> <p>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.</p> <p>Restrictions on re-development (i.e. DCP option) should be used until protection works are in place.</p>	<p>Thirroul Beach, McCauleys Beach (northern end if headland also completed) Woonona Beach (along Beach Drive to Dorriggo Ave), North Beach (inc. as an “artificial headland”), Bellambi Point Beach &amp; Harbour,</p>	<p>Current Actions</p> <ol style="list-style-type: none"> <li>1. Undertake NR2, to investigate viability of existing walls on beaches.</li> <li>2. Consider outcomes of NR3, NR5, NR6, NR7 &amp; NR8 to determine protection needs for assets (refer beach tables for more specific locations), which shall be consistent with Council’s Asset Management Plan..</li> <li>3. Undertake investigation of rock and sand sources for detailed costings detailed design of seawall &amp; nourishment, planning approvals and determine funding mechanisms.</li> <li>4. Implement DCP (prior to implementing S2).</li> <li>5. Continued monitoring (NR14) for trigger.</li> </ol> <p>Trigger</p> <ol style="list-style-type: none"> <li>1. Where walls are to be developed in sections a common alignment and design needs to be agreed.</li> <li>2. For development, triggers outlined in S1 are applicable for seawall implementation.</li> </ol>

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	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>	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	<p>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.</p> <p>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.</p> <p>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.</p>	<p>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.</p> <p>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.</p>	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	<p>Planned retreat to allow the natural recession of the shoreline over the long term, is particularly considered for the following land uses:</p> <ul style="list-style-type: none"> <li>- 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.</li> <li>- Norfolk Island Pines, as the trees have a finite lifespan (~ 100 yrs).</li> <li>- 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.</li> <li>- For creek / lagoon entrances, to allow the natural process response to recession.</li> </ul>	<p>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.</p> <p>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.</p> <p>At Thirroul Beach, compared with both S1 &amp; 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 &amp; 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.</p> <p>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).</p> <p>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. .</p> <p>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).</p> <p>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.</p> <p>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.</p>	<p>Key locations include: Stanwell Park, Coalcliff, Scarborough, Wombarra, Coledale, Sharkies, Macauleys, Secondary: Austinmer, Little Austinmer, Thirroul, Sandon Point Beach, refer individual beach maps / tables.</p>	<p>Current Action:</p> <ol style="list-style-type: none"> <li>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.</li> <li>2. Monitoring (NR14) to identify when trigger is reached.</li> </ol> <p>Trigger</p> <ol style="list-style-type: none"> <li>1. Low key structures can be repaired, maintained, upgraded until such time as they are "at risk".</li> <li>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.</li> <li>3. Indicative removal timelines should be continually updated in Councils Asset Register (i.e. following NR1, NR3 – 7).</li> </ol>

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	<p>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.</p> <p>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.</p> <p>Applicable assets/ locations are identified upon beach maps, however this will need to be confirmed by investigations NR2, NR3, NR4 and NR5.</p>	<p>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.</p> <p>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.</p> <p>However, there are some locations where erosion or inundation impacts may occur prior to the asset replacement cycle.</p>	<p>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.</p>	<p>Current Action</p> <ol style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>Monitoring (NR14) to identify when trigger is reached.</li> </ol> <p>Trigger for Implementation:</p> <ul style="list-style-type: none"> <li>When asset replacement is required <b>OR</b></li> <li>When immediate impact zone encroaches the asset location (e.g. erosion escarpment &lt; 10 m from asset) (as identified through NR14) <b>OR</b></li> <li>When frequency / extent of storm inundation becomes unacceptable (e.g. frequency of inundation &gt; 6 times /year).</li> <li>whichever occurs sooner.</li> </ul>
PR3	Prohibit expansion of existing use rights	Planned Retreat	<p>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.</p>	<p>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.</p> <p>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.</p>	<p>Thirroul existing residences (1 ppty centre of beach)</p>	<p>Current Action</p> <p>Implement Now, through Coastal DCP</p>
PR4	Voluntary acquisition	Planned Retreat	<p>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.</p> <p>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.</p>	<p>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).</p> <p>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.</p> <p>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.</p> <p>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.</p>	<p>Thirroul existing residences (1 ppty centre of beach, 3 ppts at southern end, refer maps); Woonona existing residences (4 at centre of beach, refer Maps)</p>	<p>Current Actions</p> <ol style="list-style-type: none"> <li>Apply for funding through Coastal Lands Protection Scheme and Coastal management Program for acquisition of priority properties</li> <li>Offer voluntary acquisition at current market rates. This rate shall progressively discount as impacts manifest, to accurately reflect the reduction in asset value.</li> </ol>

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	<p>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.</p> <p>The offer shall be discounted in accordance with the length of time remaining before the property becomes uninhabitable due to erosion.</p> <p>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.</p>	<p>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.</p> <p>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.</p> <p>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.</p> <p>This option is as yet untested.</p>	<p>Thirroul existing residences (1 ppty centre of beach, 3 ppts at southern end, refer maps); Woonona existing residences (4 at centre of beach, refer Maps)</p>	<p>Current Action</p> <ol style="list-style-type: none"> <li>1. Apply for loan</li> <li>2. Offer voluntary acquisition at current market rates. This rate shall progressively discount as impacts manifest, to accurately reflect the reduction in asset value.</li> <li>3. Rent property at market rates</li> <li>4. Monitoring (NR14) to identify when trigger is reached.</li> </ol> <p>Trigger</p> <p>Demolish the property when the immediate impact zone (including allowance for reduced foundation capacity) encroaches the building foundations.</p>

**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	<p>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.</p> <p>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.</p> <p>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.</p> <p>The controls apply to all land uses including roads and stormwater infrastructure, and both private and public landholders.</p> <p>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.</p>	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>	All land identified “at risk” from erosion / recession in the coastal zone over the designated planning period.	<p>Current Action</p> <p>Following completion and endorsement of CZMP by Council, prepare a Coastal Management DCP, including:</p> <ol style="list-style-type: none"> <li>1. Determining level of risk to apply to development types</li> <li>2. Determining appropriate controls for erosion and wave overtopping to be specified in the DCP, or Foreshore Building Line</li> <li>3. Approval of the DCP chapter by Council, ready for implementation</li> <li>4. Apply DCP to all properties within all hazard risk zones in the LGA</li> </ol> <p>Trigger:</p> <ul style="list-style-type: none"> <li>• Implement DCP as properties are redeveloped and assets are replaced <b>OR</b></li> <li>• As existing assets are affected by hazards, requiring repair.</li> </ul>

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	<p>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.</p> <p>Redesign of existing structures shall necessarily include provisions for managing wave overtopping and inundation, as well as erosion and recession impacts.</p> <p>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.</p>	<p>This option aims to retain existing community services in needed locations but reduce the risk (consequence) of coastal hazards.</p> <p>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.</p> <p>In some locations this option shall involve a retrofit of an existing structure (e.g. coastal harbours, selected ocean pools).</p> <p>It is not applicable to design residential dwellings seaward of the Immediate Impact zone to withstand ocean wave attack.</p>	<p>Bellambi Boat Harbour, Sharkies (Austinmer) Boat Harbour, Lawrence Hargrave Drive at Austinmer &amp; Little Austinmer, Sandon Point SLSC, North Beach SLSC.</p> <p>This option is not applicable to residential dwellings seaward of the immediate impact zone.</p>	<p>Current Action</p> <ol style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>Monitoring (NR14) to identify when trigger is reached.</li> </ol> <p>Trigger for Implementation:</p> <ul style="list-style-type: none"> <li>When asset replacement is required <b>OR</b></li> <li>When immediate impact zone encroaches the asset location (e.g. erosion escarpment &lt; 10 m from asset when identified through NR14) <b>OR</b></li> <li>When frequency / extent of storm inundation becomes unacceptable (e.g. frequency of inundation &gt; 6 times /year).</li> </ul> <p>whichever occurs sooner.</p>
A3	Replace existing structure with relocatable structure.	Accommodate	<p>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.</p>	<p>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.</p> <p>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.</p> <p>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.</p> <p>However, the relocatable structure may not provide for additional commercial enterprise (e.g. function centres, restaurants) that can be associated with surf club developments.</p> <p>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.</p>	<p>Coledale, Stanwell Park, Bulli SLSCs.</p>	<p>Current Action</p> <ol style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>Monitoring (NR14) to identify when trigger is reached.</li> </ol> <p>Trigger for Implementation:</p> <ul style="list-style-type: none"> <li>When asset replacement is required <b>OR</b></li> <li>When immediate impact zone encroaches the asset location (e.g. erosion escarpment &lt; 10 m from asset, when identified from NR14) <b>OR</b></li> <li>When frequency / extent of storm inundation becomes unacceptable (e.g. frequency of inundation &gt; 6 times /year).</li> </ul> <p>whichever occurs sooner.</p>

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	<p>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.</p> <p>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).</p>	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>	<p>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).</p>	<p>Current Actions</p> <ol style="list-style-type: none"> <li>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)</li> <li>2. Implement the planning controls given for Low Flood Risk Precincts in DCP Chapter E13 – Floodplain Management, for future development or re-development.</li> </ol>
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	<p>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.</p>	<p>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.</p> <p>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.</p>		<p>Current Action</p> <p>Update existing provisions within the DCP Chapter E12 - Geotechnical Assessment to:</p> <ul style="list-style-type: none"> <li>• 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;</li> <li>• 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.</li> </ul>

**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"	<p>The "do nothing" option assumes all levels of risk are accepted.</p> <p>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.</p> <p>The "do nothing" scenario provides the basis for comparison of all other options.</p>	<p>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.</p> <p>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).</p> <p>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.</p> <p>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.</p>	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**

	<b>Capital Cost</b>	<b>Recurrent Costs</b>	<b>Environmental or Social Impact</b>	<b>Community Acceptability</b>	<b>Reversible / Adaptable in Future</b>	<b>Effectiveness over time</b>	<b>Legal / Approval Risk</b>
<b>STOP &amp; reassess</b>	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
<b>SLOW</b>	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
<b>GO</b>	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														"Do Nothing" (Accept Risk)	
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets		
				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN	
<b>Parks, Beaches and open space</b>																			
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	
<b>Community Infrastructure</b>																			
Helensburgh / Stanwell Park SLSC	Medium	High	Extreme					✓		✓✓				✓✓	✓	✓		NR3, NR14	•
<b>Transport Infrastructure</b>																			
Beach Access Car Park	Low	Low	Medium											✓✓				NR5	✓
<b>Residential Development</b>																			
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											✓✓					

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

**KEY PLAN**

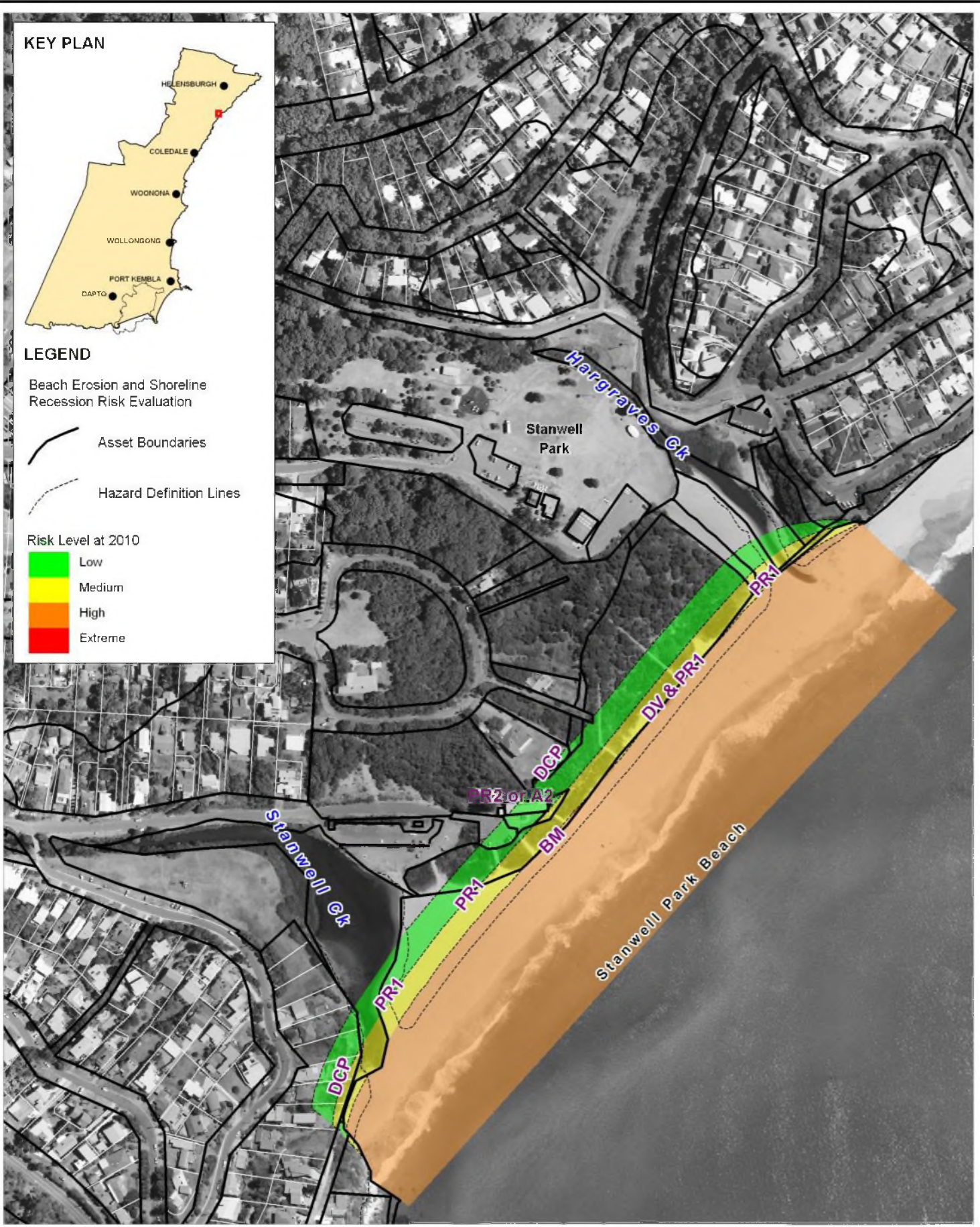
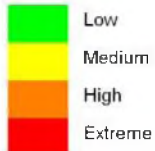


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

**Immediate Erosion Risk Levels and Treatment Options  
Stanwell Park Beach**

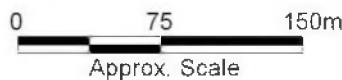
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6.1.2 Coastal Inundation Risk Level and Treatment Options

Stanwell Park Beach	Inundation Risk Level			Inundation Risk Treatments					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					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						✓
<b>Community Infrastructure</b>									
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	
<b>Transport Infrastructure</b>									
Local Roads, (including car parks)	Medium	High	Extreme			✓✓	✓	NR10	
<b>Water and sewage infrastructure</b>									
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	•
<b>Residential Development</b>									
Existing Residences (edge of 6 pptides at S end of beach next to Stanwell Ck)	Medium	High	Extreme	✓		✓✓	✓	NR10, NR9	•
Existing Residences (Edge of 13 pptides at upper reach of Stanwell Ck)	Medium	High	Extreme			✓✓	✓	NR10, NR9	•
Vacant Land (Future Development) (edge of 4 pptides at S end of beach next to Stanwell Ck)	Low	Medium	High			✓✓	✓	NR10, NR9	

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

**KEY PLAN**

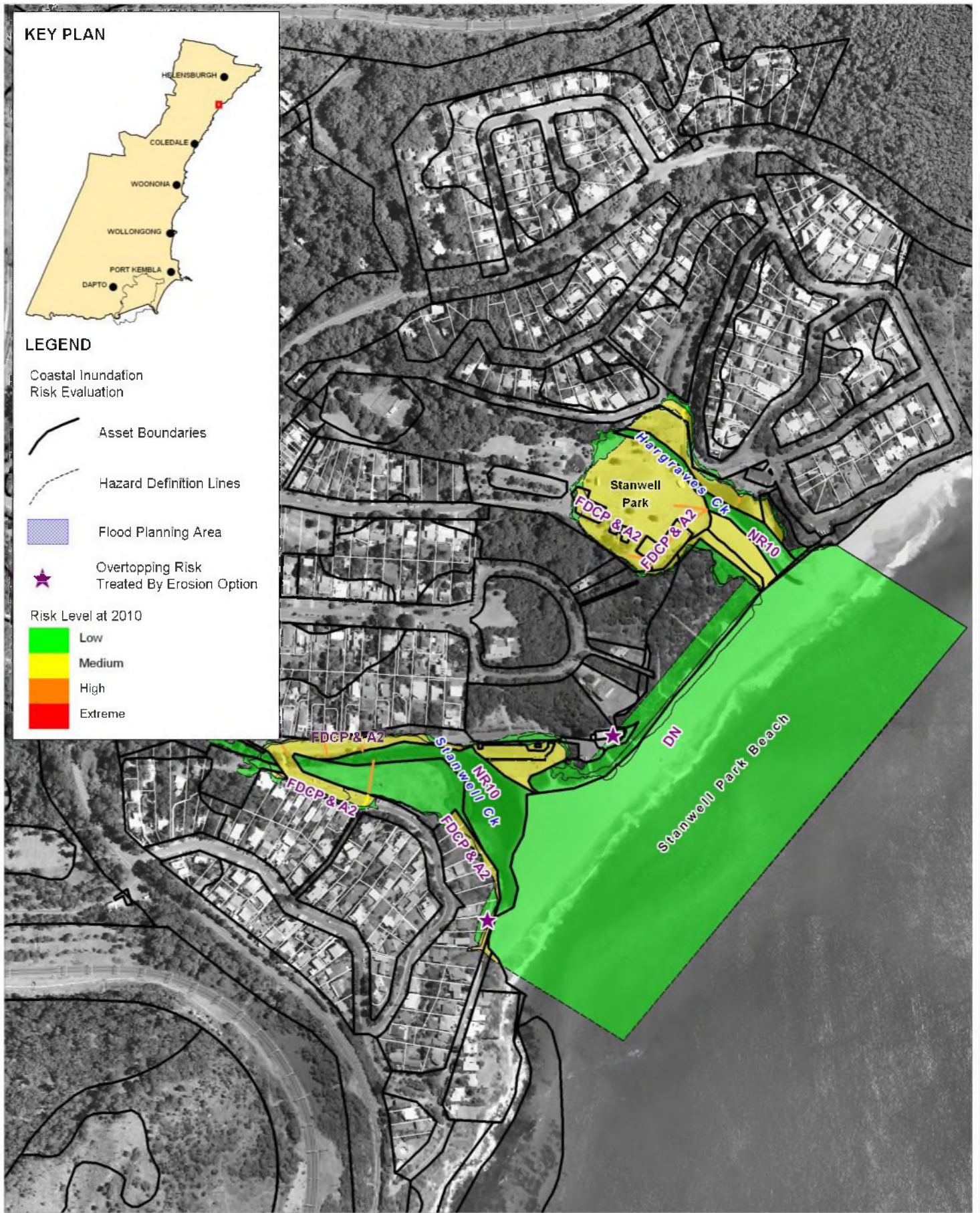


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines
- Flood Planning Area
- Overtopping Risk Treated By Erosion Option

Risk Level at 2010

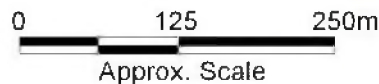


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
Stanwell Park Beach**

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**6-2**

Rev:  
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### 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	✓	✓	x								Dune care programs must be considerate of sightline requirements for SLSC activities. <i>Refer to Protect Options Table for further cost benefit details of DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details for BM.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended
PR2	Relocate SLSC outside of hazard zone	<b>Current Action:</b> NR3 <b>Trigger:</b> When SLSC needs to be refurbished <u>OR</u> erosion escarpment threatens building foundations.	✓	✓	x								There are likely to be site constraints (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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓	✓	x								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. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) <input checked="" type="checkbox"/> Council (Current Programs, increased rates and levies?) - cost to prepare DCP and implement at public assets <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR7 <b>Trigger:</b> When inundation frequency impedes effective conveyance of stormwater <u>OR</u> when asset replacement is required, whichever is sooner.	x	x	✓								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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR3 <b>Trigger:</b> When SLSC needs to be refurbished <u>OR</u> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR3 <b>Trigger:</b> When SLSC needs to be refurbished <u>OR</u> erosion escarpment threatens building foundations.	✓	✓	✓								Depending upon site constraints, 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. <i>Refer to Accommodate Options Table for further cost benefit details for A3.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	x	x	✓								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). <i>Refer to Accommodate Options Table for further cost benefit details for FDCP.</i>	N/A State Government (external funding unlikely to be needed) <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Not Recommended
NR	NR1, NR3, NR5, NR7, NR9, NR10, NR11, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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														"Do Nothing" (Accept Risk)
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	
				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
<b>Parks, Beaches and open space</b>																		
Coalcliff Beach	High	Extreme	Extreme				✓✓	✓✓	✓✓									NR14
Coalcliff Beach Reserve Nature Area, Coalcliff Beach Reserve	Medium	Medium	High						✓✓									
Stoney Creek	Medium	Medium	High						✓✓									NR11
<b>Community Infrastructure</b>																		
Coalcliff Surf Club	Low	Medium	Medium							✓				✓✓				NR3
Coalcliff Boatshed	Low	Low	Medium											✓✓				
Coalcliff Tidal Rock Pool (S end)	Medium	High	High						✓						✓			NR4, NR14
<b>Transport Infrastructure</b>																		
Beach access road and car park	Low	Medium	Medium											✓✓				
<b>Water and sewage infrastructure</b>																		
Stormwater outlet and pipe (S end of beach)	Low	Medium	High							✓✓				✓				NR7, NR14
<b>Residential Development</b>																		
Existing Residences (10 ppty N end, but edge of ppty below cliff)	Medium	Medium	High											✓✓				

Symbol	
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

**KEY PLAN**

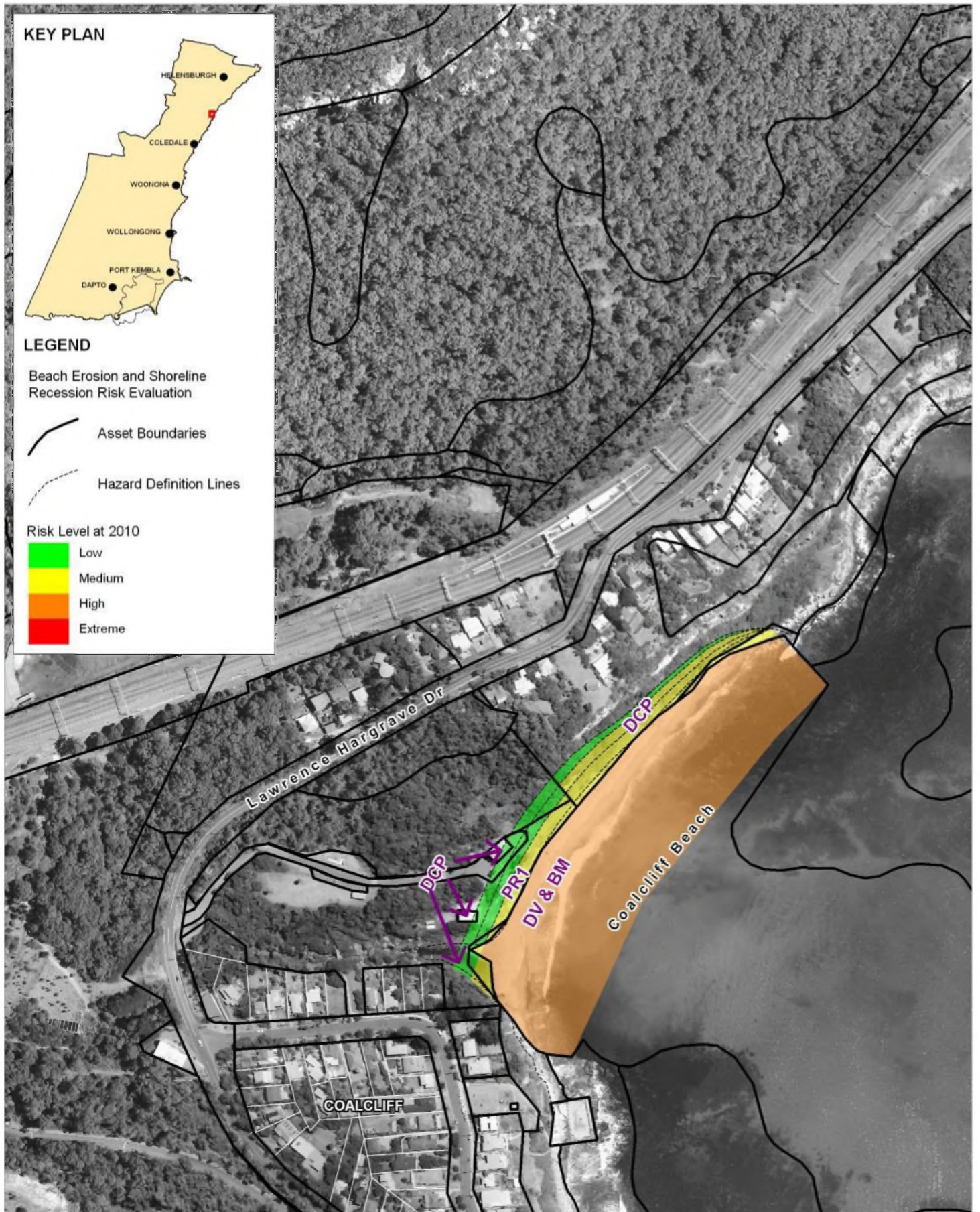


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:  
**Immediate Erosion Risk Levels and Treatment Options  
Coalcliff Beach**

Drawing: <b>6-3</b>	Rev: <b>A</b>
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### 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	Accommodate	No Regrets	"Do Nothing" (Accept Risk)	
<b>Parks, Beaches and open space</b>					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						✓✓
<b>Community Infrastructure</b>									
Coalcliff Tidal Rock Pool (S end)	Low	Medium	Medium						✓✓
<b>Transport Infrastructure</b>									
Beach access road and car park	Low	Low	Low						✓✓
<b>Residential Development</b>									
Existing Residences (10 pptides 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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

**KEY PLAN**

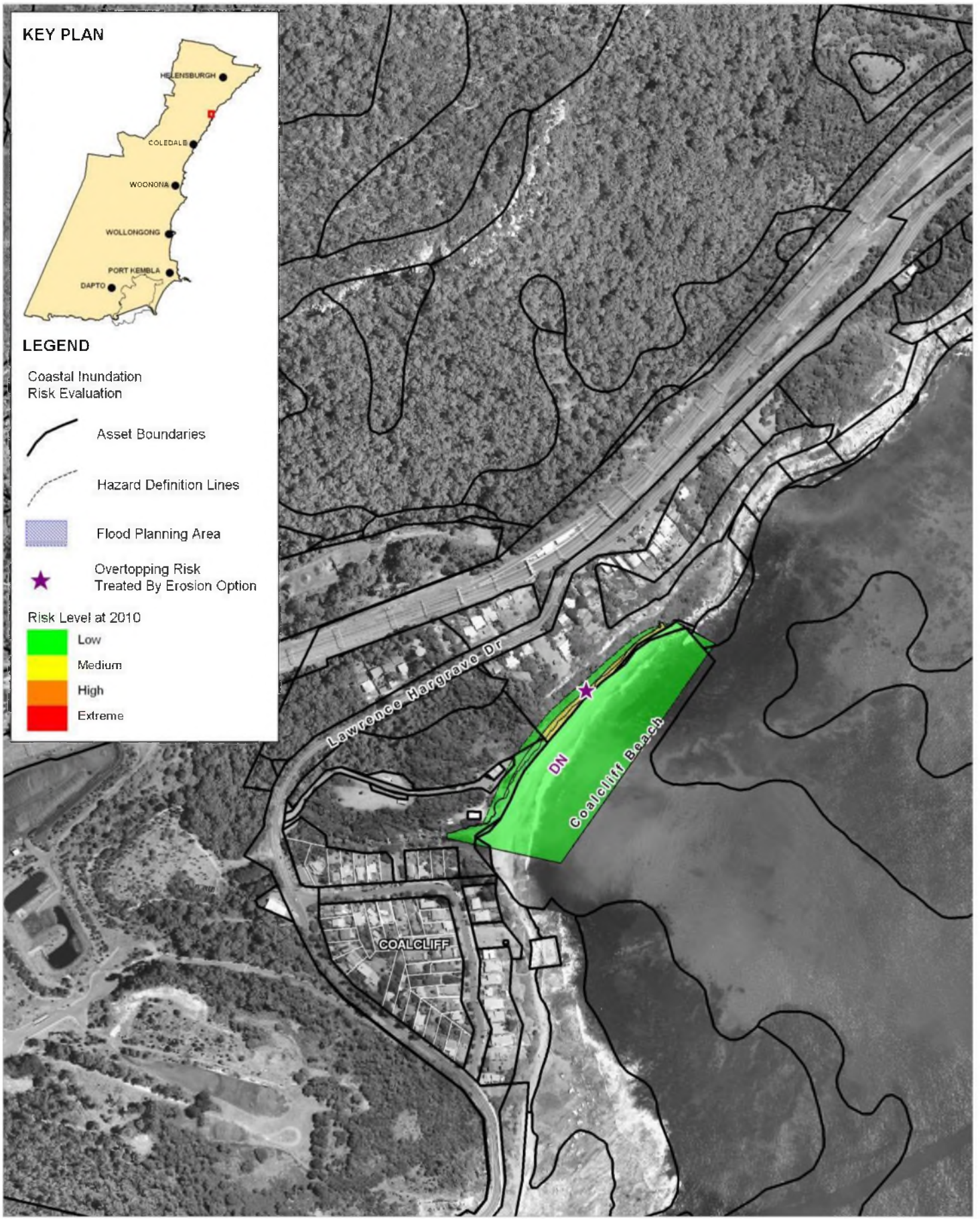


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines
- Flood Planning Area
- Overtopping Risk Treated By Erosion Option

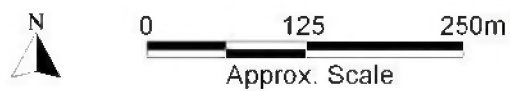
Risk Level at 2010



Title:  
**Immediate Inundation Risk Levels and Treatment Options  
Coalcliff Beach**

Drawing: <b>6-4</b>	Rev: <b>A</b>
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### 6.2.3 Assessment of Treatment Options

Coalcliff															
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 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. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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. <i>Refer to Protect Options Table for further cost benefit details for BM.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended
PR2	Relocate stormwater assets landward of hazard zone	<b>Current Action:</b> NR7 <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) N/A Private landholders who directly benefit from option	Recommended
PR2	Relocate Coalcliff SLSC landward of hazard zone	<b>Current Action:</b> NR3 <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) N/A Private landholders who directly benefit from option	Recommended

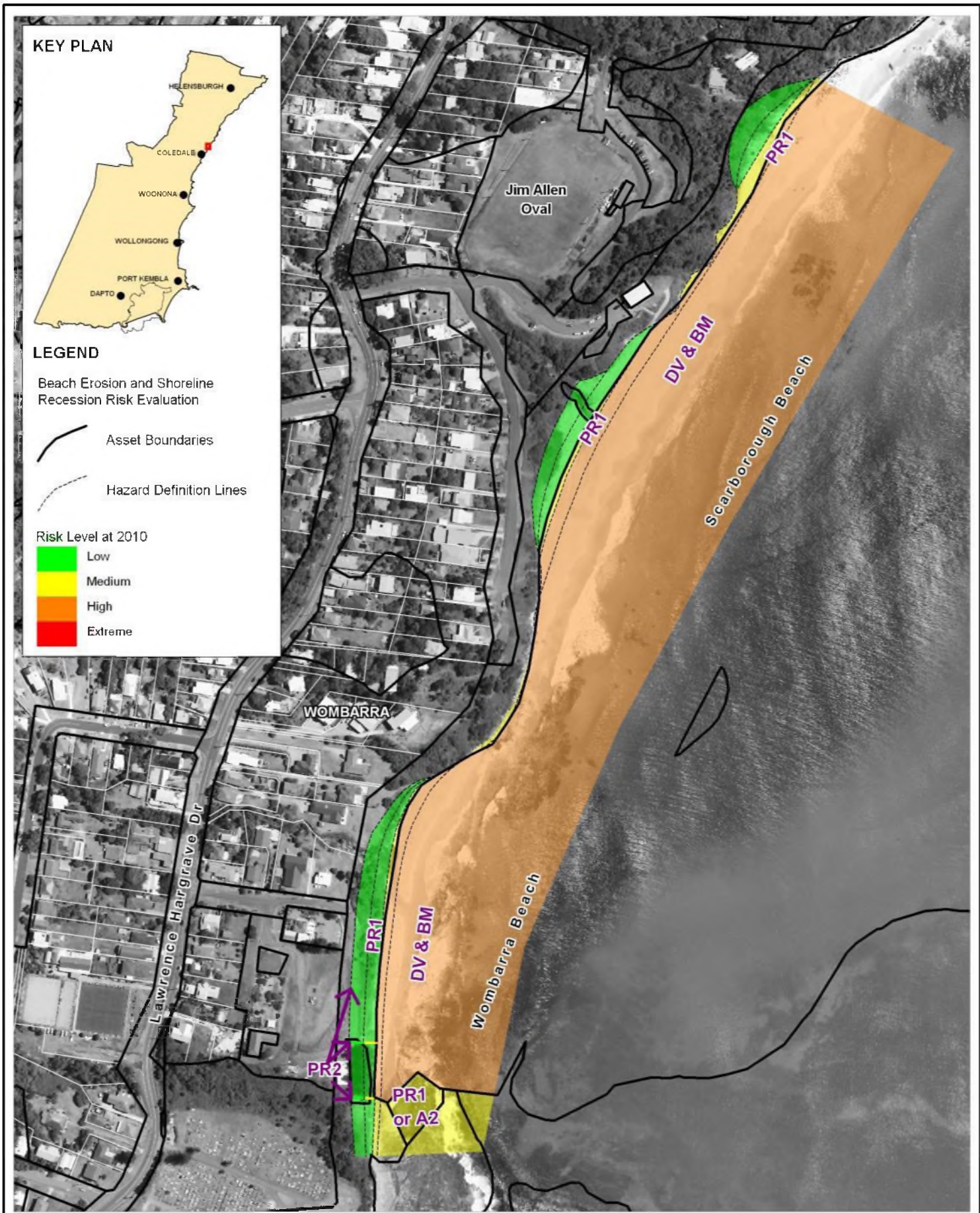
Symbol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability***	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for 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								<p><i>Private Properties</i> 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.</p> <p><i>Public Assets: SLSC, Boatshed, carpark</i> 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 &amp; replacement.</p> <p>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</p>	? State Government (Grant programs) <input checked="" type="checkbox"/> Council (Current Programs, increased rates and levies?) - cost to prepare DCP and implement at public assets <input checked="" type="checkbox"/> Private landholders - cost to implement DCP	Recommended
A2	Retrofit Coalcliff Pool in current location to withstand impacts.	<b>Current Action:</b> NR4 <b>Trigger:</b> When damage to pool shell occurs <u>OR</u> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Marginal
NR	NR1, NR3, NR4, NR7, NR11, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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													"Do Nothing" (Accept Risk)	
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate				No Regrets
				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
<b>Parks, Beaches and open space</b>																		
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	✓
<b>Community Infrastructure</b>																		
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											✓✓				✓
<b>Water and sewage infrastructure</b>																		
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

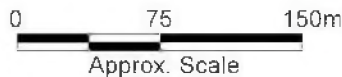


Title:  
**Immediate Erosion Risk Levels and Treatment Options  
Scarborough/Wombarra Beach**

Drawing:  
**6-5**

Rev:  
**A**

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### 6.3.2 Coastal Inundation Risk Level and Treatment Options

Scarborough / Wombarra Beach	Inundation Risk Level			Inundation Risk Treatments					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					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						✓✓
<b>Community Infrastructure</b>									
Wombarra Rock Pool	Low	Low	Medium						✓✓
Wombarra Rock Pool Amenities	Low	Low	Low						✓✓
<b>Water and sewage infrastructure</b>									
Stormwater outlets and pipes (3 at S end Wombarra Beach)	High	Extreme	Extreme	✓✓				NR7, NR14	

Symbol	
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

**KEY PLAN**

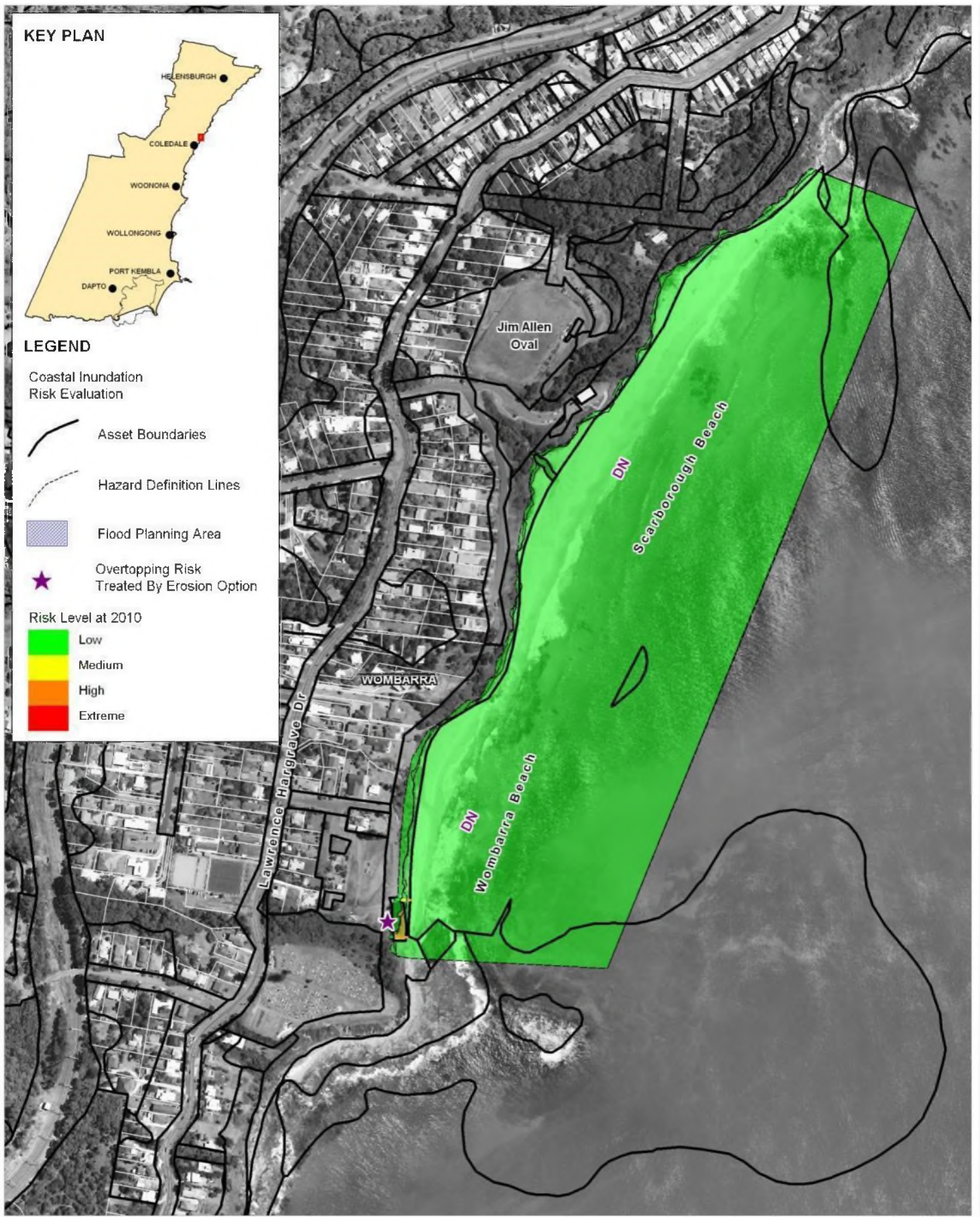


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines
- Flood Planning Area
- Overtopping Risk Treated By Erosion Option

Risk Level at 2010

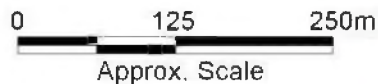


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Scarborough/Wombarra Beach**

Drawing:  
**6-6**

Rev:  
**A**

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### 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. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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. <i>Refer to Protect Options Table for further cost benefit details for BM.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended
PR2	Relocate stormwater assets landward of hazard zone	<b>Current Action:</b> NR7 <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR7; NR4 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe <u>QR</u> when asset replacement is required, whichever is sooner; When damage to pool shell occurs <u>QR</u> 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) <input checked="" type="checkbox"/> 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 <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> 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) <input checked="" type="checkbox"/> 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														"Do Nothing" (Accept Risk)
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	
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	
<b>Community Infrastructure</b>																		
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	
<b>Transport Infrastructure</b>																		
Local Beach Access Road and car parking	Low	Low	Medium											✓✓				✓
<b>Water and sewage infrastructure</b>																		
Stormwater outlet and pipe (1 at S end = Carricks CK)	Medium	High	Extreme								✓✓			✓			NR7, NR14	
<b>Institutional Infrastructure</b>																		
Coledale Public School - Grounds only	Low	Low	Medium											✓				✓

Symbol	
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

**KEY PLAN**

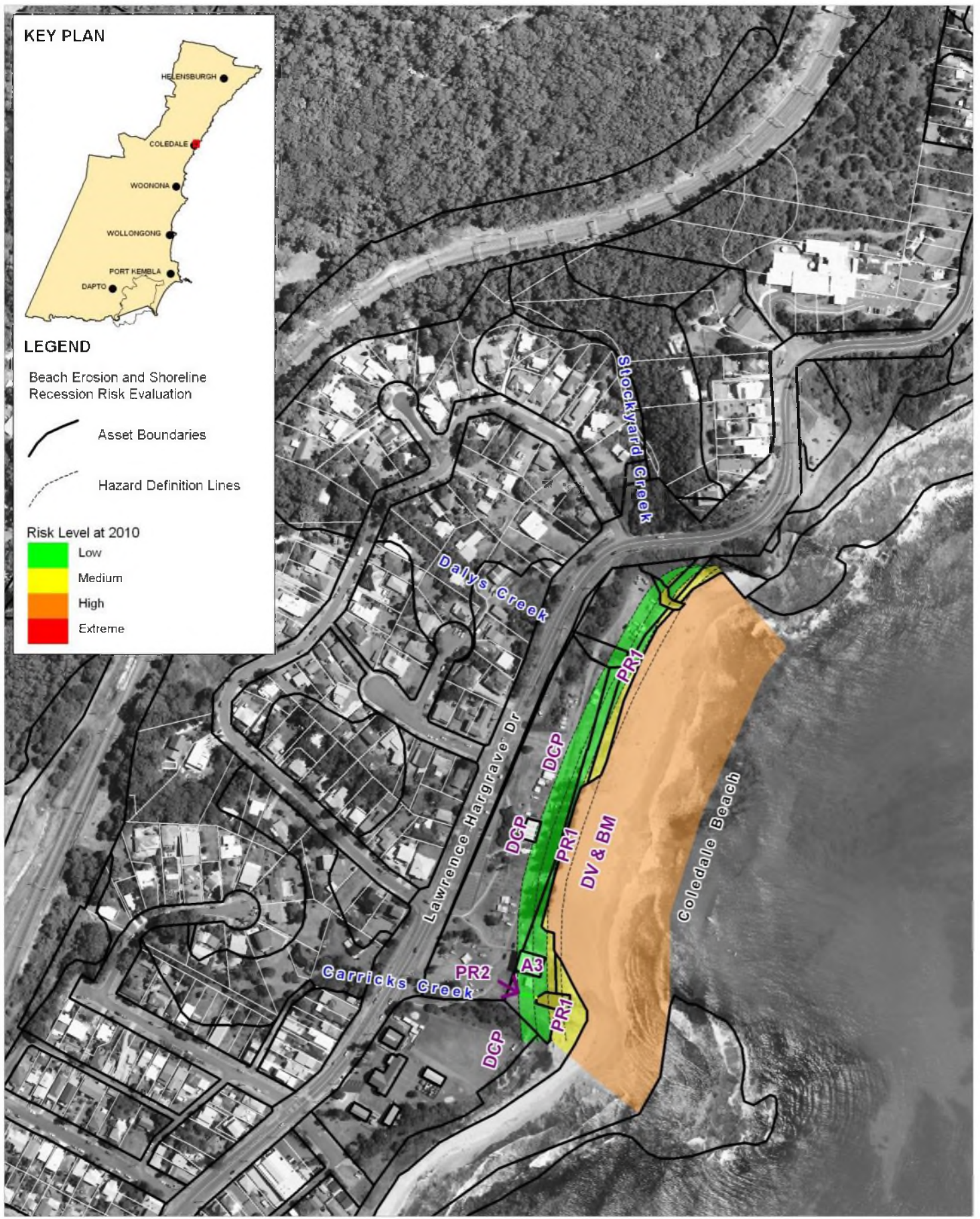
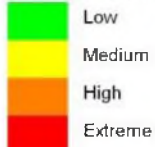


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

**Immediate Erosion Risk Levels and Treatment Options  
Coledale Beach**

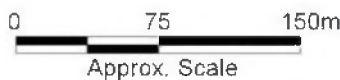
Drawing:

**6-7**

Rev:

**A**

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**6.4.2 Coastal Inundation Risk Level and Treatment Options**

Coledale Beach	Inundation Risk Level			Inundation Risk Treatments					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate		No Regrets	
<b>Parks, Beaches and open space</b>					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	✓
<b>Community Infrastructure</b>									
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	✓					
<b>Transport Infrastructure</b>									
Local Beach Access Road and car parking	Low	Low	Medium						✓
<b>Water and sewage infrastructure</b>									
Stormwater outlets and pipes (1 at S end at Carrick Ck, 2 beach parallel at Dalys Ck)	High	Extreme	Extreme		✓	✓	✓✓	NR7, NR14	•
<b>Institutional Infrastructure</b>									
Coledale Public School - Grounds only	Low	Low	Medium	✓✓		✓			✓

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

**KEY PLAN**

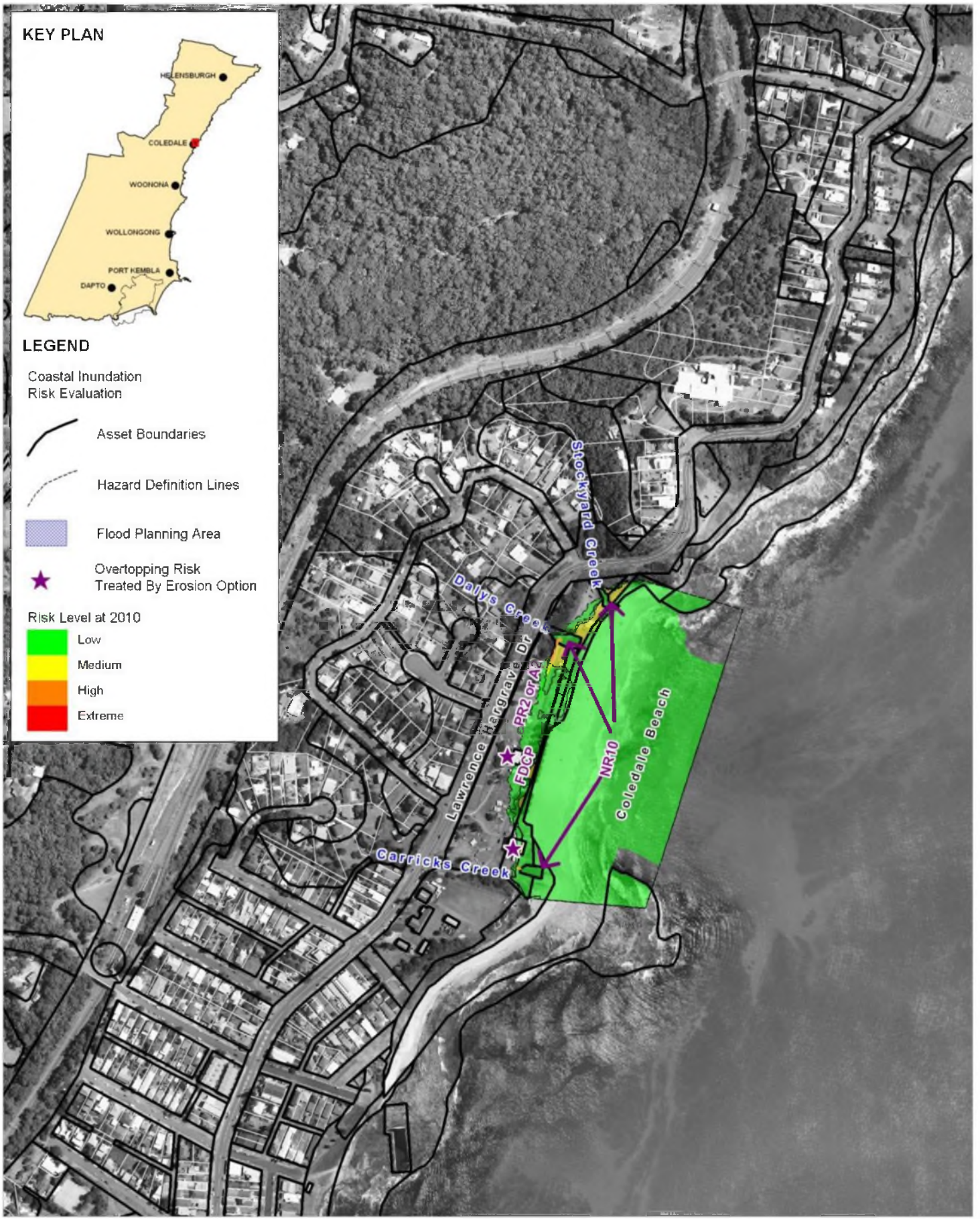


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines
- Flood Planning Area
- Overtopping Risk Treated By Erosion Option

Risk Level at 2010

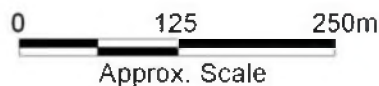


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Coledale Beach**

Drawing:  
**6-8**

Rev:  
**A**

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### 6.4.3 Assessment of Treatment Options

Coledale															
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 Coledale Beach	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	x								Dune care programs must be considerate of sightline requirements for SLSC activities. There are limited dunes here at present. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? 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	✓	✓	x								This option involves scraping and contouring beach sands to accumulate in and increase sand volumes held in dune storage for storm protection. <i>Refer to Protect Options Table for further cost benefit details for BM.</i>	? 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 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? 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	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner.	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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.	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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. <i>Refer to Accommodate Options Table for further cost benefit details for A3.</i>	? State Government (Grant Programs) ☑ Council (Current Program) N/A Private landholders who directly benefit from option	Recommended

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 DCP Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit stormwater structures and Coledale Pool in current location to withstand impacts.	<b>Current Action:</b> NR7, NR4 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe <u>OR</u> when asset replacement is required, whichever is sooner; When damage to pool shell occurs <u>OR</u> 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) <input checked="" type="checkbox"/> 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	✓	✓	x								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) <input checked="" type="checkbox"/> 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	x	x	✓								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) <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> 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 <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> 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) <input checked="" type="checkbox"/> 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													"Do Nothing" (Accept Risk)	
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate				No Regrets
				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
<b>Parks, Beaches and open space</b>																		
Sharkys Beach	High	Extreme	Extreme				✓✓	✓✓	✓✓									NR14
Sharkys Beach Reserve	Medium	Medium	High						✓✓									
<b>Community Infrastructure</b>																		
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
<b>Transport Infrastructure</b>																		
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
<b>Water and sewage infrastructure</b>																		
Stormwater outlets and pipes	High	Extreme	Extreme							✓				✓	✓✓			NR7, NR14
<b>Residential Development</b>																		
Vacant Land (Shark Park, currently zoned residential)	Medium	Medium	High											✓✓				NR14

Symbol	
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

**KEY PLAN**

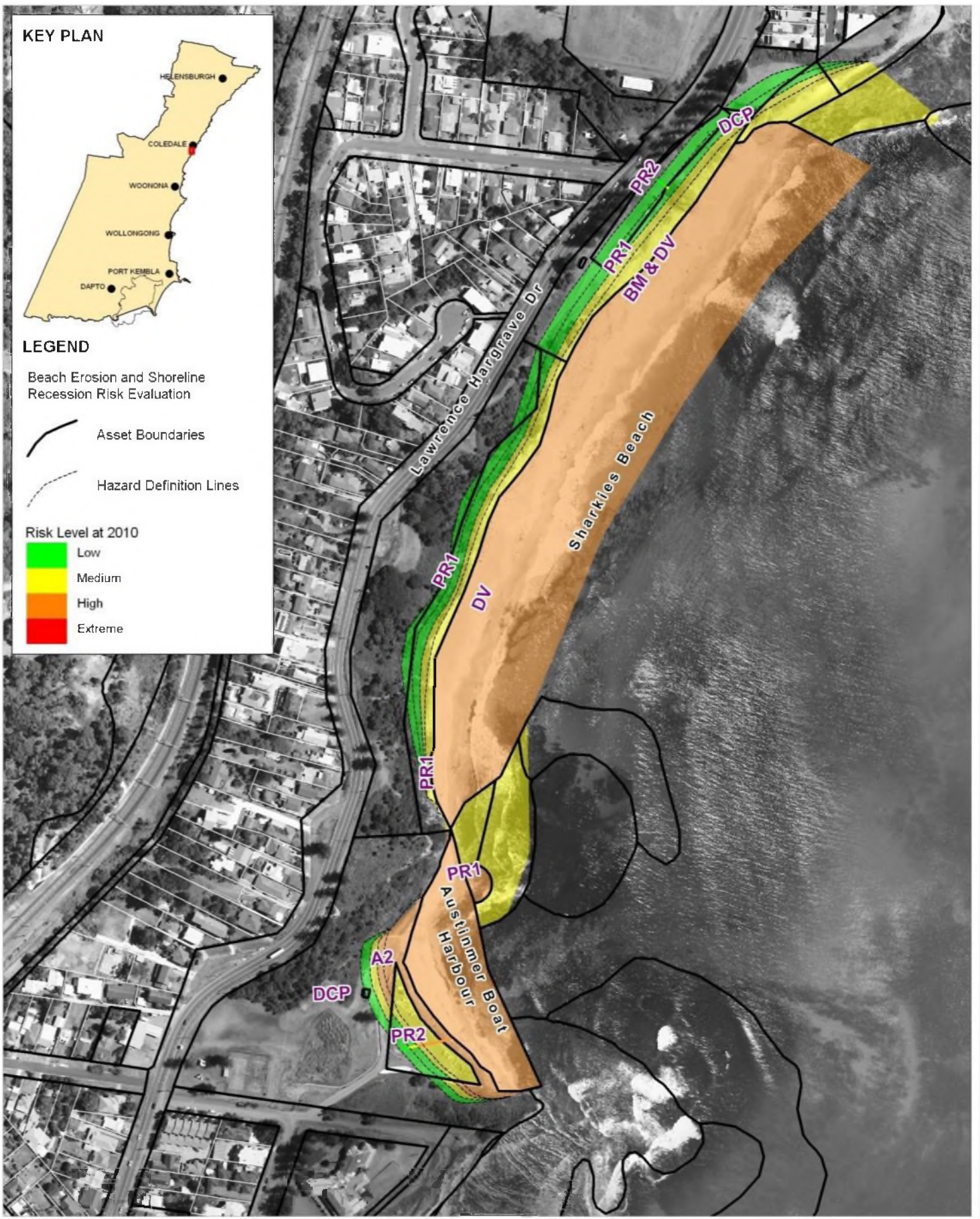


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:  
**Immediate Erosion Risk Levels and Treatment Options  
Sharkies Beach**

Drawing:  
**6-9**

Rev:  
**A**

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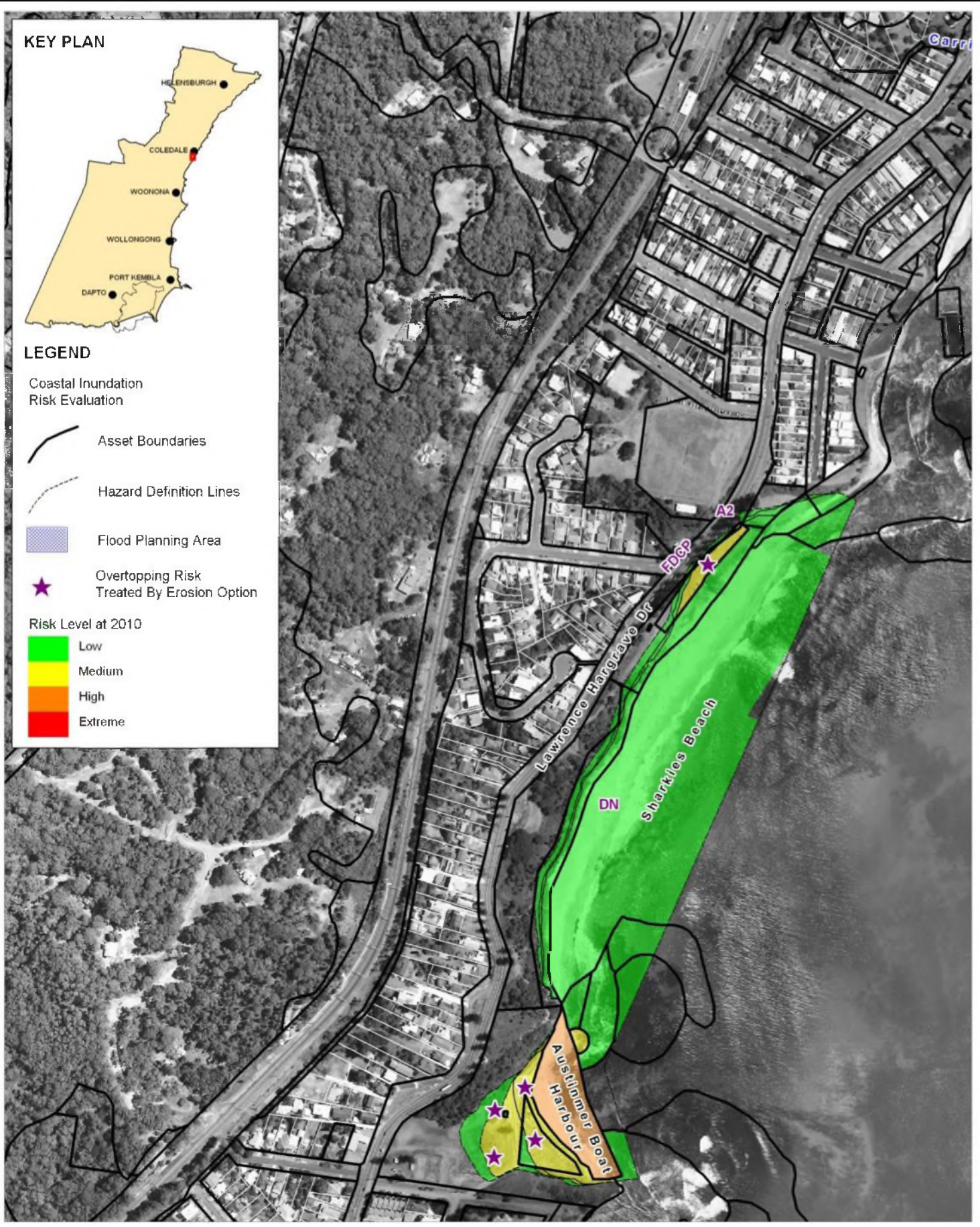


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### 6.5.2 Coastal Inundation Risk Level and Treatment Options

Sharkies Beach	Inundation Risk Level			Inundation Risk Treatments				"Do Nothing" (Accept Risk)	
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					PR2	FDCP	A2	Investigate*	DN
Sharkys Beach	Low	Low	Medium						✓✓
Sharkys Beach Reserve	Low	Low	Medium						✓✓
<b>Community Infrastructure</b>									
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	✓✓					✓
<b>Transport Infrastructure</b>									
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	✓✓					•
<b>Water and sewage infrastructure</b>									
Stormwater outlets and pipes	High	Extreme	Extreme	✓✓			✓	NR7, NR14	•
<b>Residential Development</b>									
Vacant Land (Shark Park)	Low	Low	Medium	✓✓					

Sym- bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revisit 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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

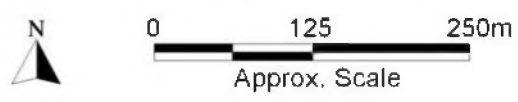


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Sharkies Beach**

Drawing:  
**6-10**

Rev:  
**A**

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6.5.3 Assessment of Treatment Options

Sharkys															
Symbol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	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	✓	✓	x								Dune care programs must be considerate of sightline requirements for SLSC activities. There are currently limited dunes, this action would be supported by BM. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? 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	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details for BM.</i>	? 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								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? 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	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner.	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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	<b>Trigger:</b> When erosion or wave overtopping damages carpark such that it is not functional OR when Harbour is being redesigned	✓	✓	x								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 conjunction with remodelling the harbour to remain functional with sea level rise inundation impacts. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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.	<b>Current Action:</b> NR7 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) ☑ Council (Current programs, new levies or increased rates?) N/A Private landholders who directly benefit from option	Recommended

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 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.	<b>Current Action:</b> Investigate options, prepare approvals (as required) now <b>Trigger:</b> When wave overtopping and mean sea level inundation cause harbour to not be functional for the majority of sea conditions <b>OR</b> at major asset maintenance cycles, as required.	✓	✓	x								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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? 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	✓	✓	x								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. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? 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	x	x	✓								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. <i>Refer to Accommodate Options Table for further cost benefit details for FDCP.</i>	? 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government ☑ Council (new levies and increased rates) ☑ Private landholders in Future Generations	Not Recommended
NR	NR1, NR3, NR7, NR11, NR12, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? 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														"Do Nothing" (Accept Risk)
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	
				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
<b>Parks, Beaches and open space</b>																		
Little Austinmer Beach	High	Extreme	Extreme				✓✓	✓✓	✓✓									NR14
Little Austinmer Beach Reserve	Medium	Medium	High						✓✓									
Coastal Dune Systems	High	Extreme	Extreme				✓		✓✓									
<b>Community Infrastructure</b>																		
Heritage Site: Norfolk Island Pines (backing entire beach)	Medium	Medium	High						✓									NR12
Tuckerman Park Toilet/Shed	Low	Medium	Medium											✓✓				
<b>Transport Infrastructure</b>																		
Lawrence Hargrave Drive (Major Coastal Road)	Medium	High	Extreme	?		?								✓✓	✓		NR5, NR14	•
Local roads and car park	Medium	Medium	High							✓✓				✓				
<b>Water and sewage infrastructure</b>																		
Stormwater outlets and pipes	High	Extreme	Extreme							✓✓				✓			NR7, NR14	
<b>Residential Development</b>																		
Existing Residences (1 at N end)	Low	Medium	Medium											✓✓				

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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													"Do Nothing" (Accept Risk)	
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate				No Regrets
				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
<b>Parks, Beaches and open space</b>																		
Austinmer Beach	High	Extreme	Extreme				✓	✓	✓								NR2, NR14	
Austinmer Beach Reserve and Tuckermans Park	Medium	Medium	High		✓				✓								NR2	
<b>Community Infrastructure</b>																		
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	
<b>Transport Infrastructure</b>																		
Lawrence Hargrave Drive (Major Coastal Road)	Medium	High	Extreme		✓									✓	✓		NR2, NR5, NR14	•
Beach access and car park	Medium	Medium	High		✓				✓								NR14	
<b>Water and sewage infrastructure</b>																		
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"
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NR5	Assess Roads for "accommodate" or "relocate"
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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

**KEY PLAN**



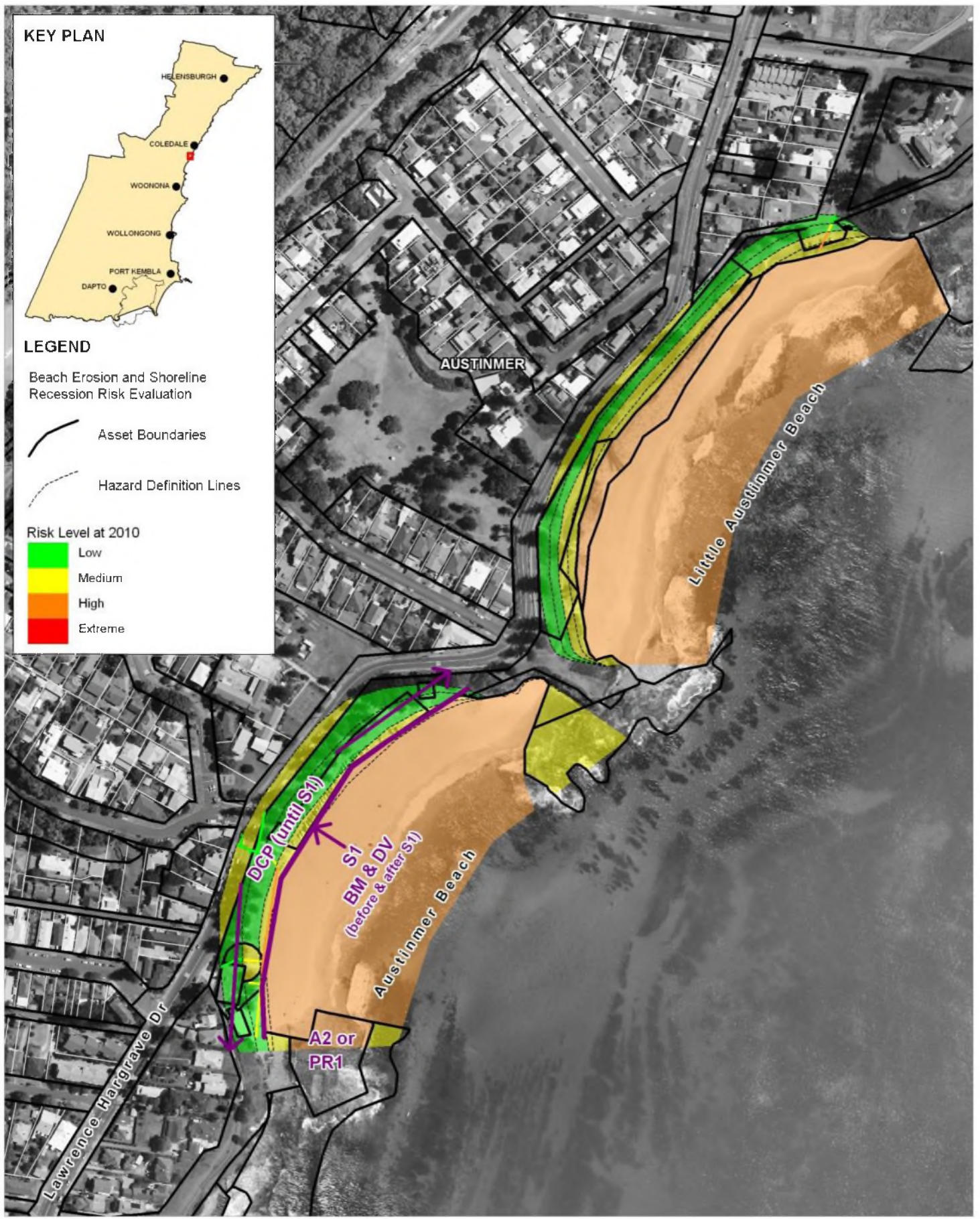
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

- Low
- Medium
- High
- Extreme



Title:

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

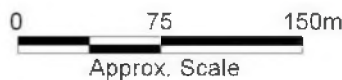
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**6-11**

Rev:

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**KEY PLAN**

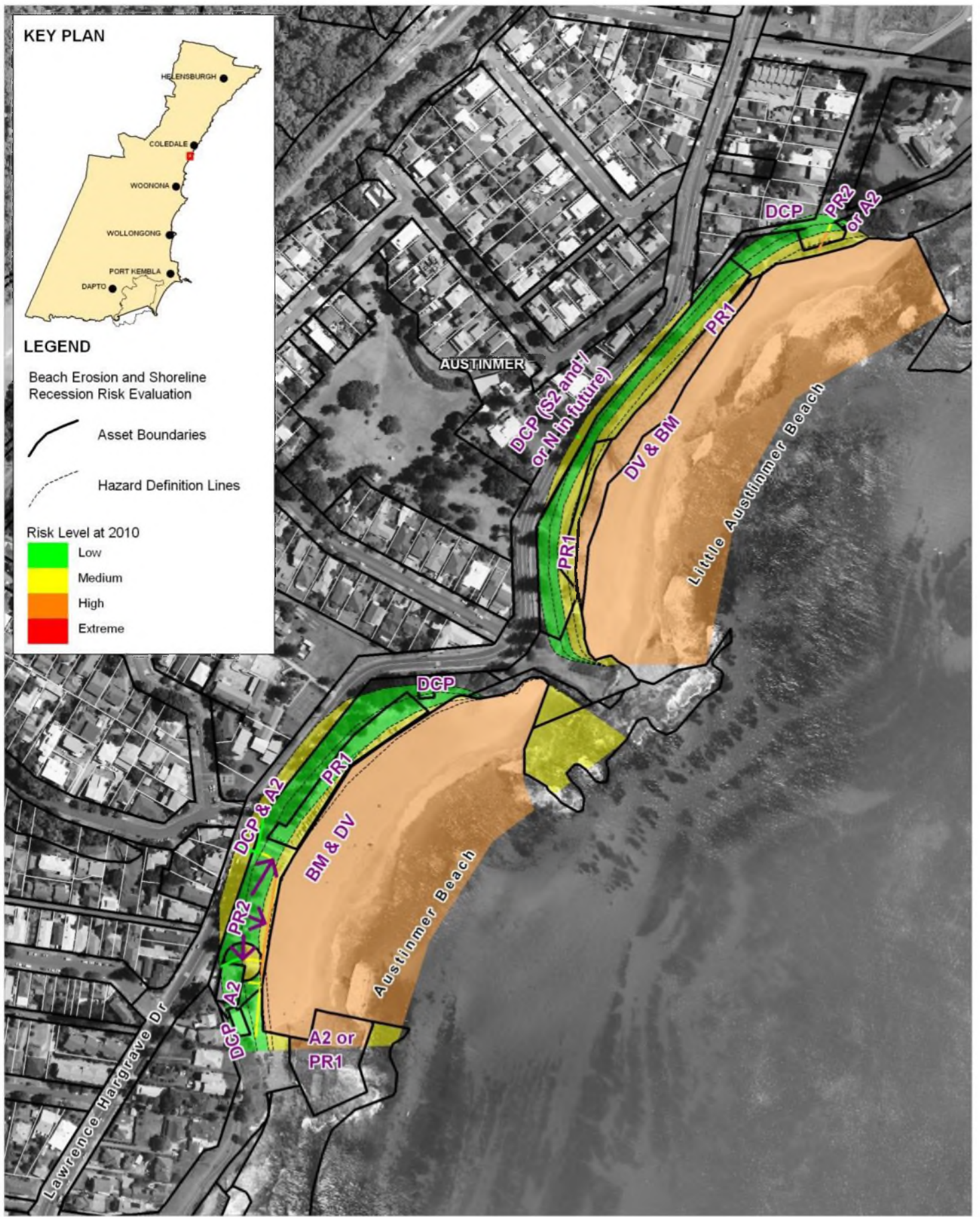


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

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

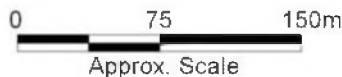
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**6-12**

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### 6.6.3 Coastal Inundation Risk Level and Treatment Options – Little Austinmer

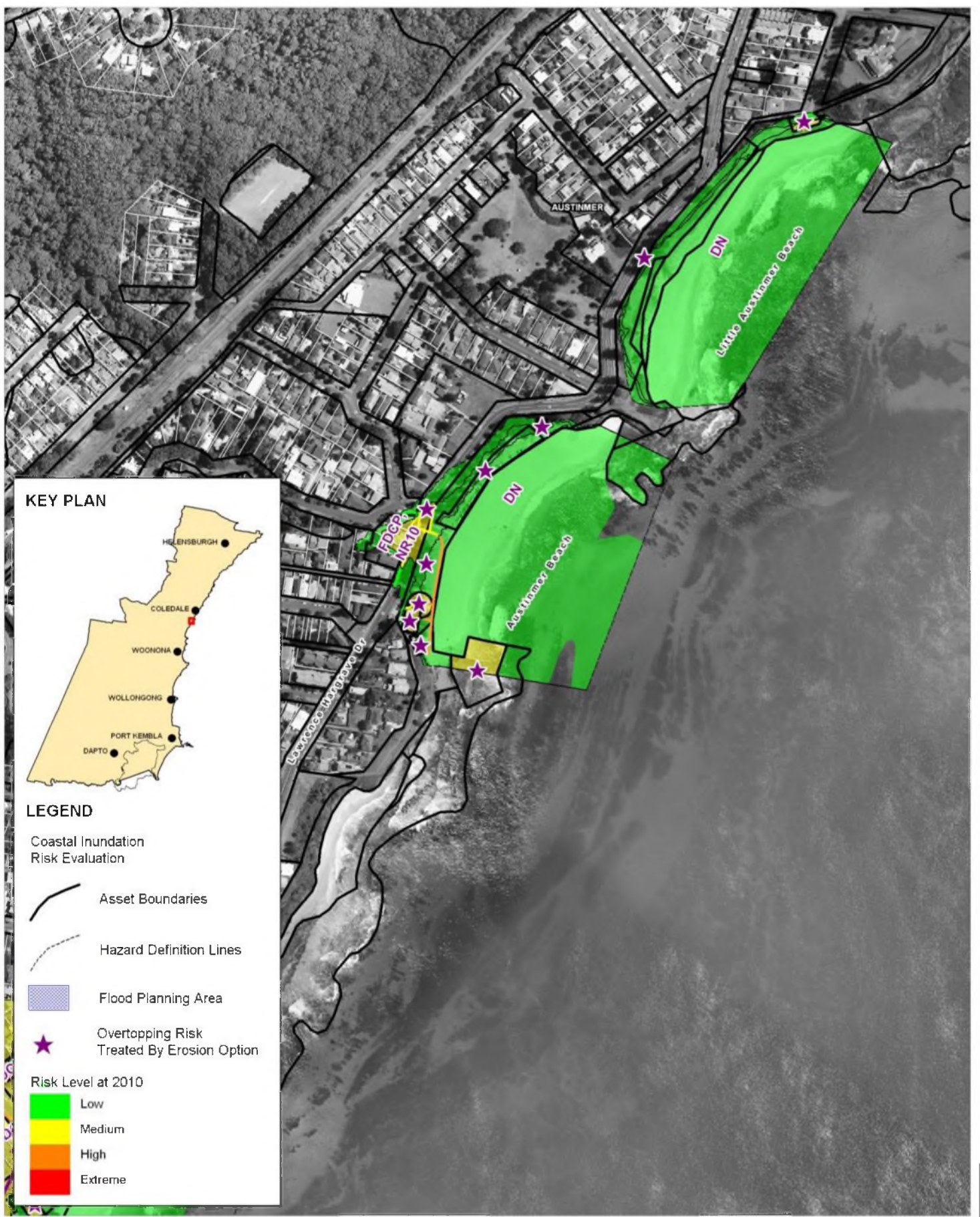
Little Austinmer Beach	Inundation Risk Level			Inundation Risk Treatments					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets	Investigate*	
<b>Parks, Beaches and open space</b>					PR2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

Symbol	
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					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					PR2	FDCP	A2	Investigate*	DN
Austinmer Beach	Low	Low	Medium						✓
Austinmer Beach Reserve and Tuckermans Park	Low	Low	Medium						✓
<b>Community Infrastructure</b>									
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	✓					
<b>Transport Infrastructure</b>									
Lawrence Hargrave Drive (Major Coastal Road)	Medium	High	Extreme	✓		✓	✓	NR10, NR14	
Beach access and car park	Low	Low	Medium	✓					✓
<b>Water and sewage infrastructure</b>									
Stormwater outlets and pipes	High	Extreme	Extreme	✓				NR10, NR14	
<b>Commercial and Industrial Development</b>									
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
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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

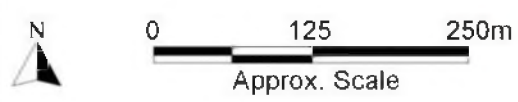


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Austinmer Beach & Little Austinmer Beach**

Drawing:  
**6-13**

Rev:  
**A**

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### 6.6.5 Assessment of Treatment Options – Little Austinmer

Little Austinmer															
Symbol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overlapping 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	<b>Current Action:</b> NR5 <b>Trigger:</b> Implement when ZRFC measured from the erosion escarpment reaches the roadway.	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details for N.</i>	? 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)	<b>Current Action:</b> NR5 <b>Trigger:</b> Implement when ZRFC measured from the erosion escarpment reaches the roadway.	✓	✓	x								Lawrence Hargrave Drive is the major traffic pathway for the northern Wollongong LGA, and will need to be retained 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. <i>Refer to Protect Options Table for further cost benefit details for S2.</i>	? 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	✓	✓	x								Dune coverage is limited at this location at present. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) ☑ Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended



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 BM Beach	Potential Funding Sources (Who may pay)	Conclusion
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details for BM.</i>	? 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 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). <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? 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	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner.	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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	✓	✓	x								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. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) ☑ Council (Current Programs) - cost to prepare DCP and implement at public assets N/A Private landholders	Recommended

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 PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	<b>Current Action:</b> NR7 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR5 <b>Trigger:</b> 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 <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Not Recommended
NR	NR1, NR5, NR7, NR11, NR12, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended

6.6.6 Assessment of Treatment Options – Austinmer

Austinmer															
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 Austinmer Beach	Potential Funding Sources (Who may pay)	Conclusion
S1	Replace or repair seawall (revetment) along existing alignment covering entire beach length	<p><b>Current Action:</b> NR2, then detailed design and approvals to replace or repair existing wall as required</p> <p><b>Trigger:</b> When upgrade / replacement required (based on Current Action) <u>OR</u> structure is damaged by storm event, whichever is sooner</p>	✓	✓	x								<p>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.</p> <p>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.</p> <p>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</p>	<p>? State Government - through RTA as major road asset protected by this option; Grant Programs</p> <p><input checked="" type="checkbox"/> Council (new levies or increased rates)</p> <p>N/A Private landholders who directly benefit from option</p>	Recommended
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	x								<p>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.</p> <p>Refer to Protect Options Table for further cost benefit details for DV.</p>	<p>? State Government (Grant Programs)</p> <p><input checked="" type="checkbox"/> Council (Current Programs)</p> <p>N/A Private landholders who directly benefit from option</p>	Recommended
BM	Beach Sand Management (beach scraping or nature assisted beach management)	Now and continuing	✓	✓	x								<p>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")</p> <p>Refer to Protect Options Table for further cost benefit details for BM.</p>	<p>? State Government (Grant Programs)</p> <p><input checked="" type="checkbox"/> Council (Current Programs)</p> <p>N/A Private landholders who directly benefit from option</p>	Recommended

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 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	✓	✓	x								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) <input checked="" type="checkbox"/> 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	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe <u>OR</u> when asset replacement is required, whichever is sooner; Relocate War Memorial when ZRFC measured from erosion escarpment encroaches foundations	✓	✓	x								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) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR4 <b>Trigger:</b> When damage to pool shell occurs <u>OR</u> 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) <input checked="" type="checkbox"/> Council (Current Programs, new levies or increased rates?) N/A Private landholders who directly benefit from option	Recommended

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 PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit stormwater structures in current location to withstand impacts	<b>Current Action:</b> NR7 <b>Trigger:</b> 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). <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? 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	<b>Current Action:</b> NR3 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? 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	✓	✓	x								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. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? 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

Symbol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overlapping 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	x	x	✓								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. <i>Refer to Accommodate Options Table for further cost benefit details for FDCP.</i>	? State Government (Grant programs), cost to implement at RTA road <input checked="" type="checkbox"/> Council (Current Programs, increased rates and levies?) - cost to prepare and implement DCP <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Not Recommended
NR	NR1, NR2, NR3, NR4, NR5, NR7, NR10, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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														"Do Nothing" (Accept Risk)
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect				Planned Retreat					Accommodate			No Regrets		
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	•

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

**KEY PLAN**

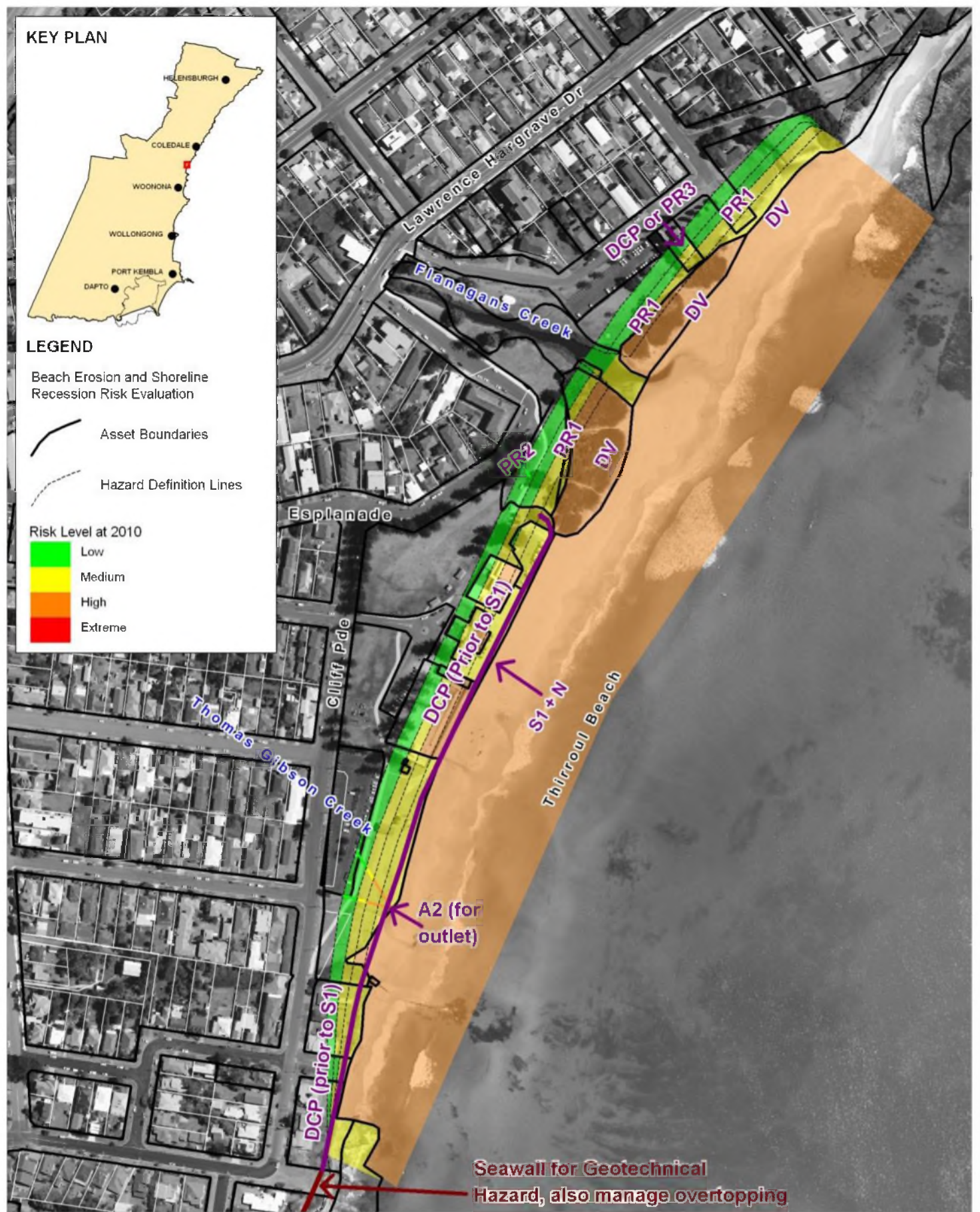
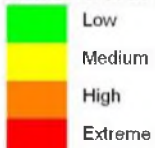


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

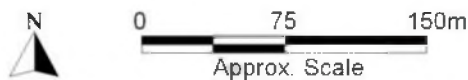


Title:  
**Erosion Risk Levels and Treatment Options  
Thirroul Beach - Seawall S1 Option**

Drawing:  
**6-14**

Rev:  
**A**

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**KEY PLAN**

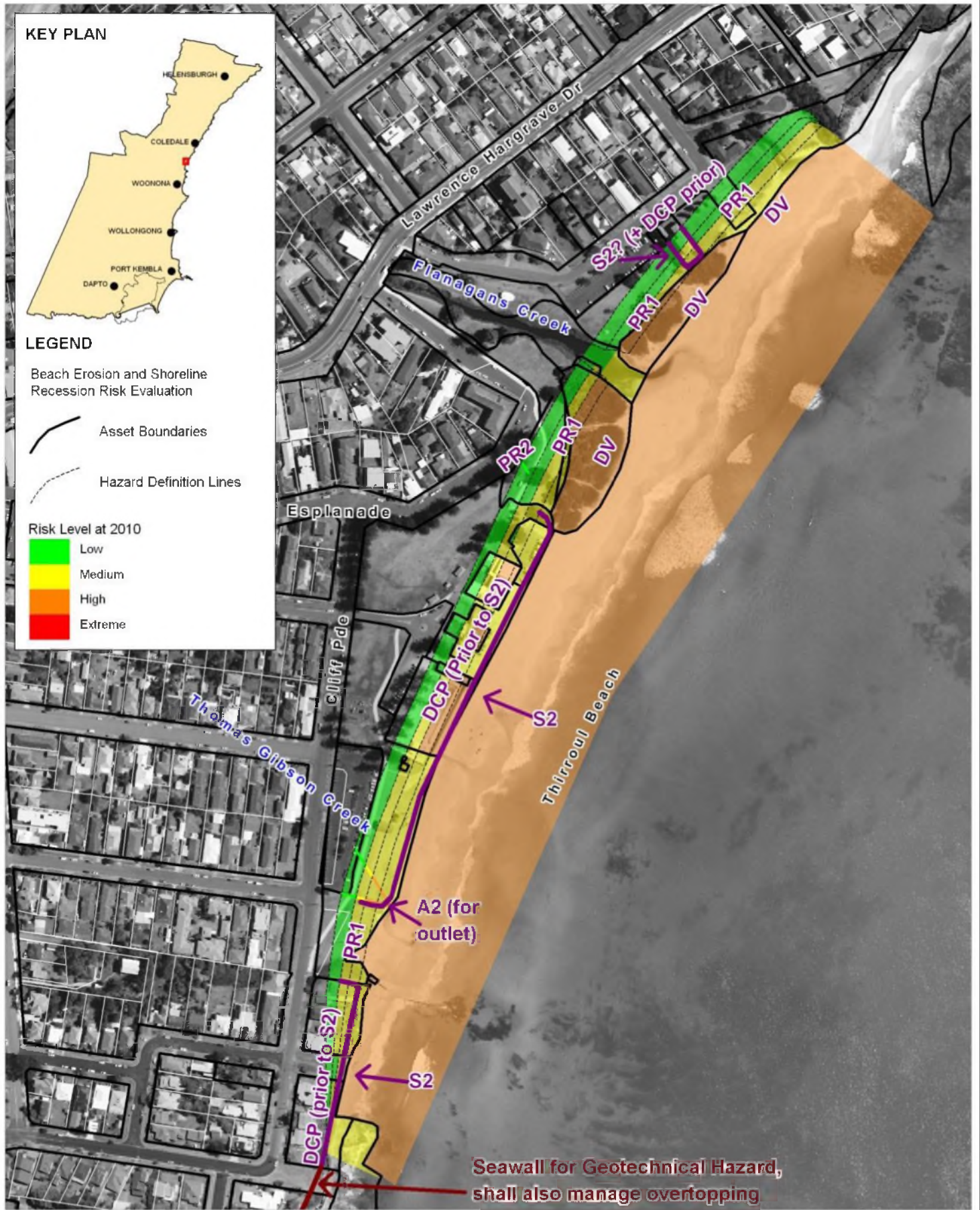


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

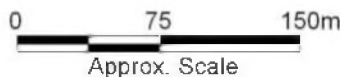


Title:  
**Erosion Risk Levels and Treatment Options  
Thirroul Beach - Seawall S2 Option**

Drawing:  
**6-15**

Rev:  
**A**

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**KEY PLAN**

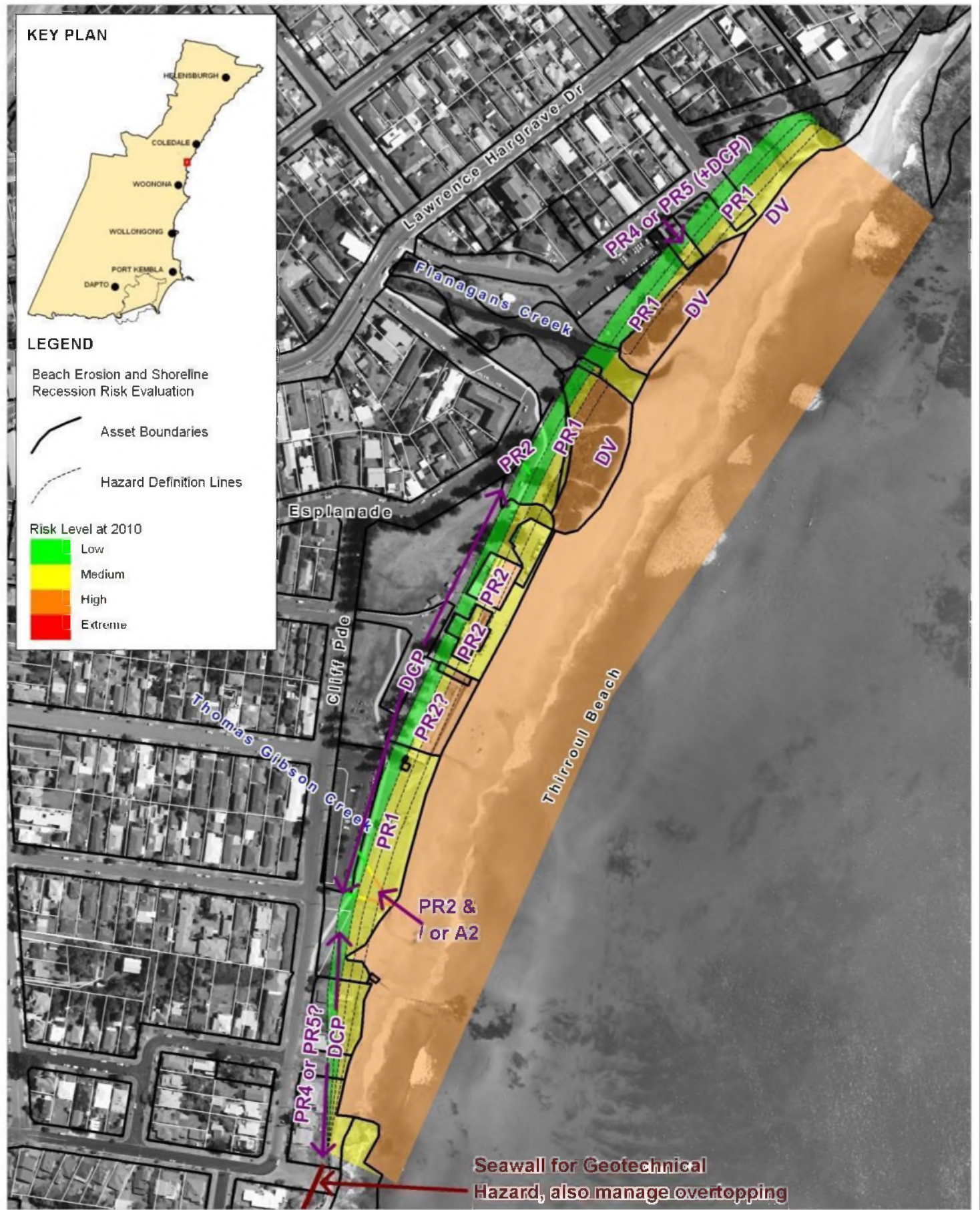


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



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

Drawing:  
**6-16**

Rev:  
**A**

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### 6.7.2 Coastal Inundation Risk Level and Treatment Options

Thirrour Beach	Inundation Risk Level			Inundation Risk Treatments					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					PR2	FDCP	A2	Investigate*	DN
Thirrour 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						✓
<b>Community Infrastructure</b>									
Thirrour Surf Club	Medium	High	Extreme	✓		✓			•
Thirrour Pool (also heritage site)	Medium	High	Extreme	✓		✓			•
Thirrour Pool office and amenities	Medium	High	Extreme	✓		✓			•
Thirrour Pool toilet	Medium	High	Extreme	✓		✓			•
Thirrour Pool storage shed (large)	Medium	High	Extreme	✓		✓			•
Thirrour Pool intake	Medium	High	Extreme	✓		✓			•
Heritage site: Thirrour Pavillion (being used as kiosk / restaurant) and residence	Medium	High	Extreme	✓		✓			•
Heritage Site: Thirrour Beach Reserve	Low	Medium	Medium						✓
Heritage Site: Norfolk Island Pines	Low	Medium	Medium						✓
Heritage site: Former Quest House	Medium	High	Extreme			✓	✓		
<b>Transport Infrastructure</b>									
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						✓
<b>Water and sewage infrastructure</b>									
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		•
<b>Residential Development</b>									
Existing Residences (151 cadastral parcels)	Medium	High	Extreme			✓	NR10, NR9		•

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

**KEY PLAN**



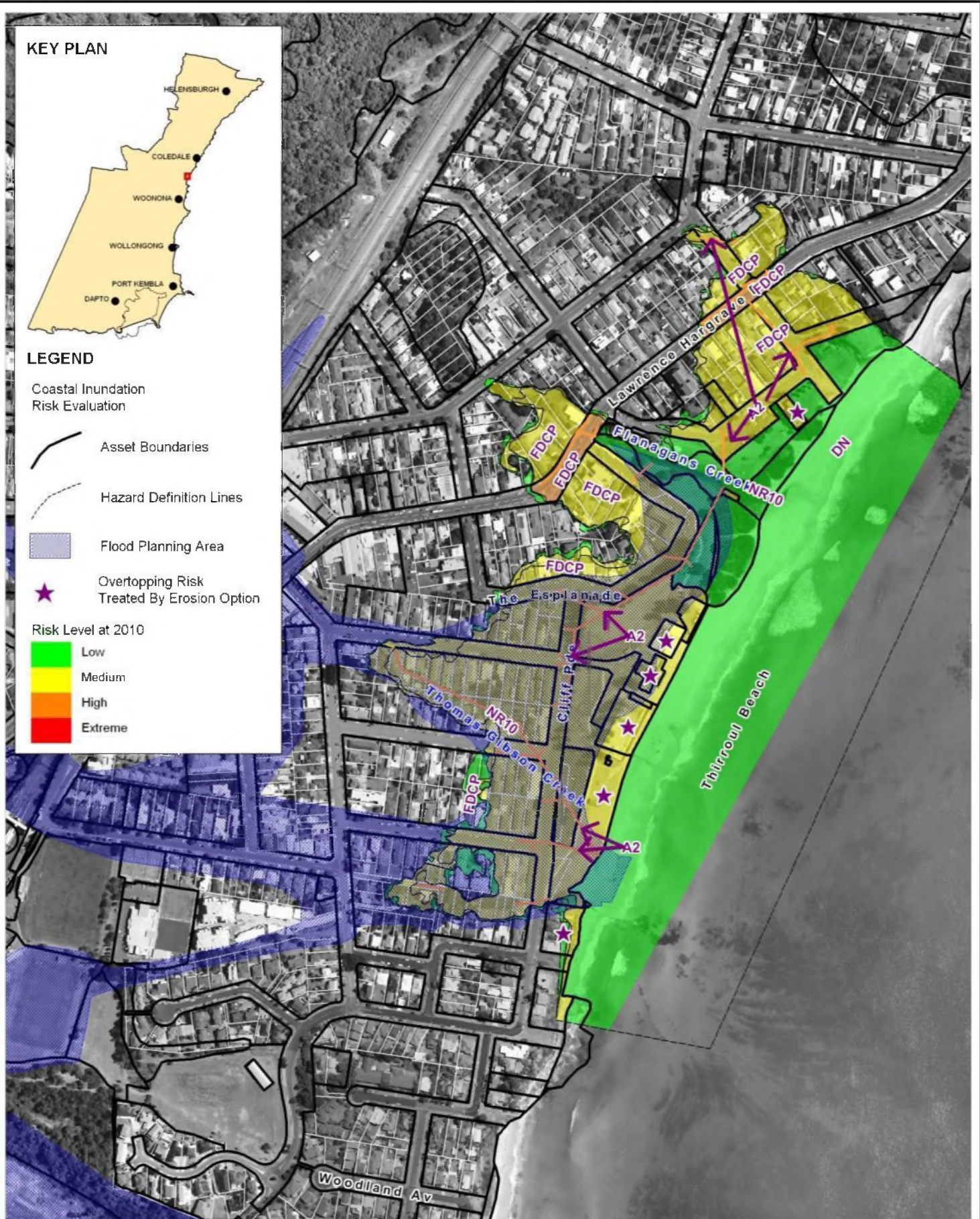
**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines
- Flood Planning Area
- Overtopping Risk Treated By Erosion Option

Risk Level at 2010

- Low
- Medium
- High
- Extreme

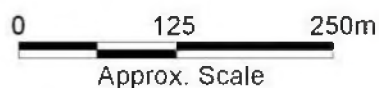


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
Thirroul Beach**

Drawing:  
**6-17**

Rev:  
**A**

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6.7.3 Assessment of Treatment Options

Thirroul Beach			Rapid Cost Benefit Analysis (Traffic Light)									Specific Cost Benefit Considerations for Thirroul Beach	Funding Sources / Who pays	Conclusion	
Option Symbol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overlapping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time				Legal / Approval Risk
N	Beach nourishment	Immediately and whenever sand reserve is below the identified storm demand seaward of development being protected (following storms)	✓	✓	x								<p>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 frequency of nourishment events shall increase, resulting in increasing costs over time. Refer to Protect Options Table for further cost benefit details for N.</p>	<p>? State Government (Grant Programs) - unlikely to fund private property protection  <input checked="" type="checkbox"/> Council (new levies or increased rates)  <input checked="" type="checkbox"/> Private landholders who directly benefit from option (personal investment or directed by Council)</p>	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).	✓	✓	x								<p>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 &amp; 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</p>	<p>? State Government (Grant Programs) - unlikely to fund private property protection  <input checked="" type="checkbox"/> Council (new levies or increased rates)  <input checked="" type="checkbox"/> Private landholders who directly benefit from option (personal investment or directed by Council)</p>	Not Recommended

Option Symbol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overlapping 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. <i>Refer to Protect Options Table for further cost benefit details for</i>	? State Government (Grant Programs) - unlikely to fund private property protection <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> 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) <input checked="" type="checkbox"/> 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. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended

Option Symbol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overlapping 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	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) N/A Private landholders who directly benefit from option	Recommended
PR3	Prohibit expansion of existing use rights	Now	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR3.</i>	<input checked="" type="checkbox"/> State Government <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> Private landholders	Not Recommended
PR4	Voluntary acquisition	<b>Current Action:</b> Apply for government funding. <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR4.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> Private landholders who directly benefit from option	Recommended
PR5	Buy back – lease back	<b>Current Action:</b> Apply for mortgage now <b>Trigger:</b> 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 financial 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR5.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> Private landholders who directly benefit from option	Recommended

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 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 property and expected life of the development. DCP controls will apply to land prior to implementation of seawalls also, should this be selected. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) <input checked="" type="checkbox"/> Council (Current Programs) - cost to prepare DCP and implement for public assets <input checked="" type="checkbox"/> Private landholders - cost to implement DCP	Recommended
A2	Redesign or retrofit stormwater structures and Thirroul Pool intake in current location to withstand impacts	<b>Current Action:</b> NR7 <b>Trigger:</b> 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 accommodated (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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) N/A Private landholders who directly benefit from option	Recommended
A3	Replace existing SLSC with relocatable structure.	<b>Current Action:</b> NR3 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A3.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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) <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> 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 <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Not Recommended
NR	NR1, NR2, NR3, NR4, NR5, NR7, NR9, NR10, NR11, NR12, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended

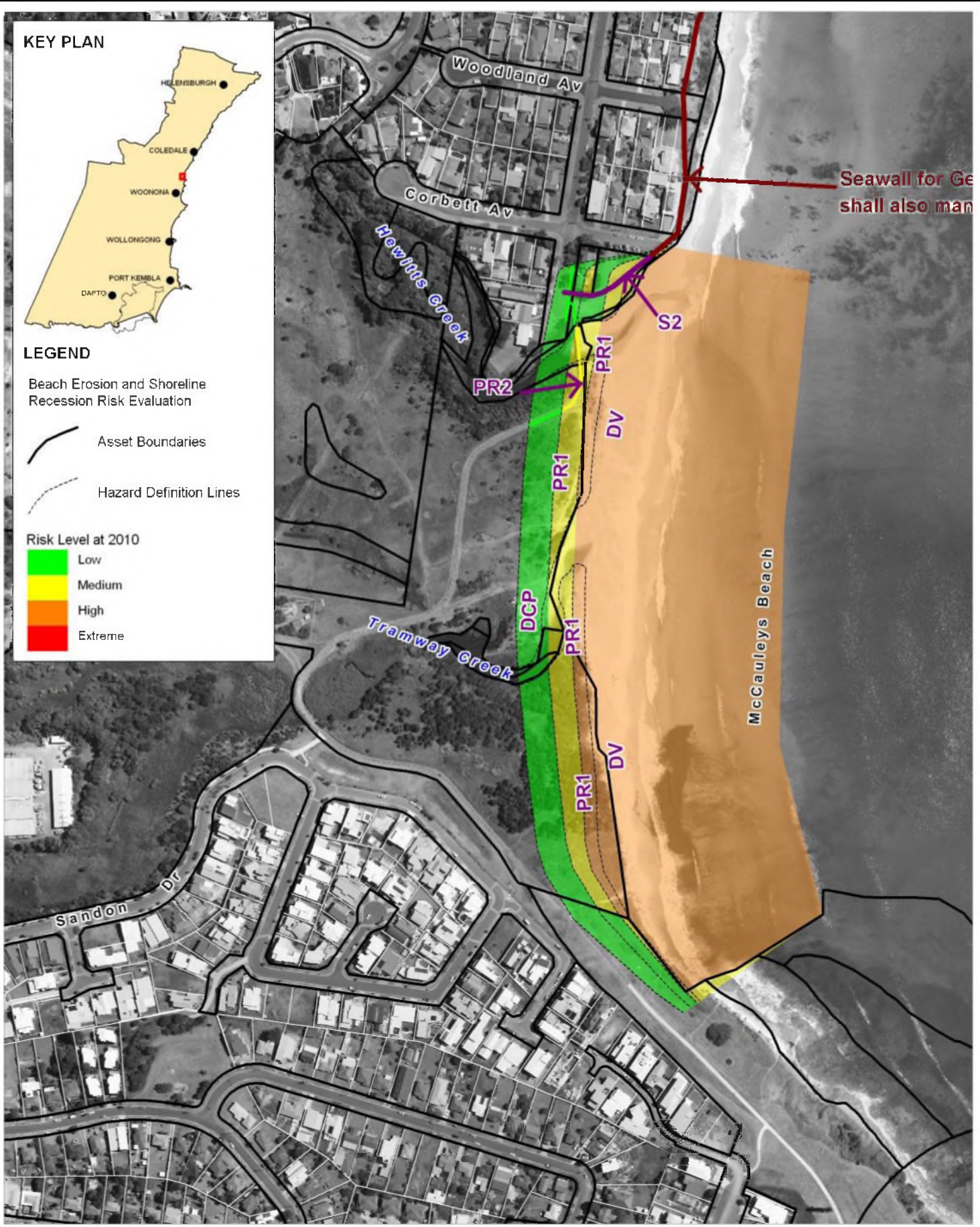


## 6.8 McCauleys Beach

### 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														"Do Nothing" (Accept Risk)
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	
				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
<b>Parks, Beaches and open space</b>																		
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				✓✓		✓✓									
<b>Community Infrastructure</b>																		
Significant Aboriginal Site (Tent Embassy).	Medium	High	High							✓				✓✓				NR14
Cycleway / Shared Pathway (Northern Coastal Cycleway)	Medium	Medium	High							✓✓				✓	✓			NR6, NR14
<b>Transport Infrastructure</b>																		
Local Roads (inc Woodlands Ave, Corbett Ave)	Low	Medium	Medium			✓			✓									
<b>Water and sewage infrastructure</b>																		
Stormwater outlets and pipes (N end of beach)	Low	Medium	High			✓				✓				✓	✓			NR7
<b>Residential Development</b>																		
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



**KEY PLAN**



**LEGEND**

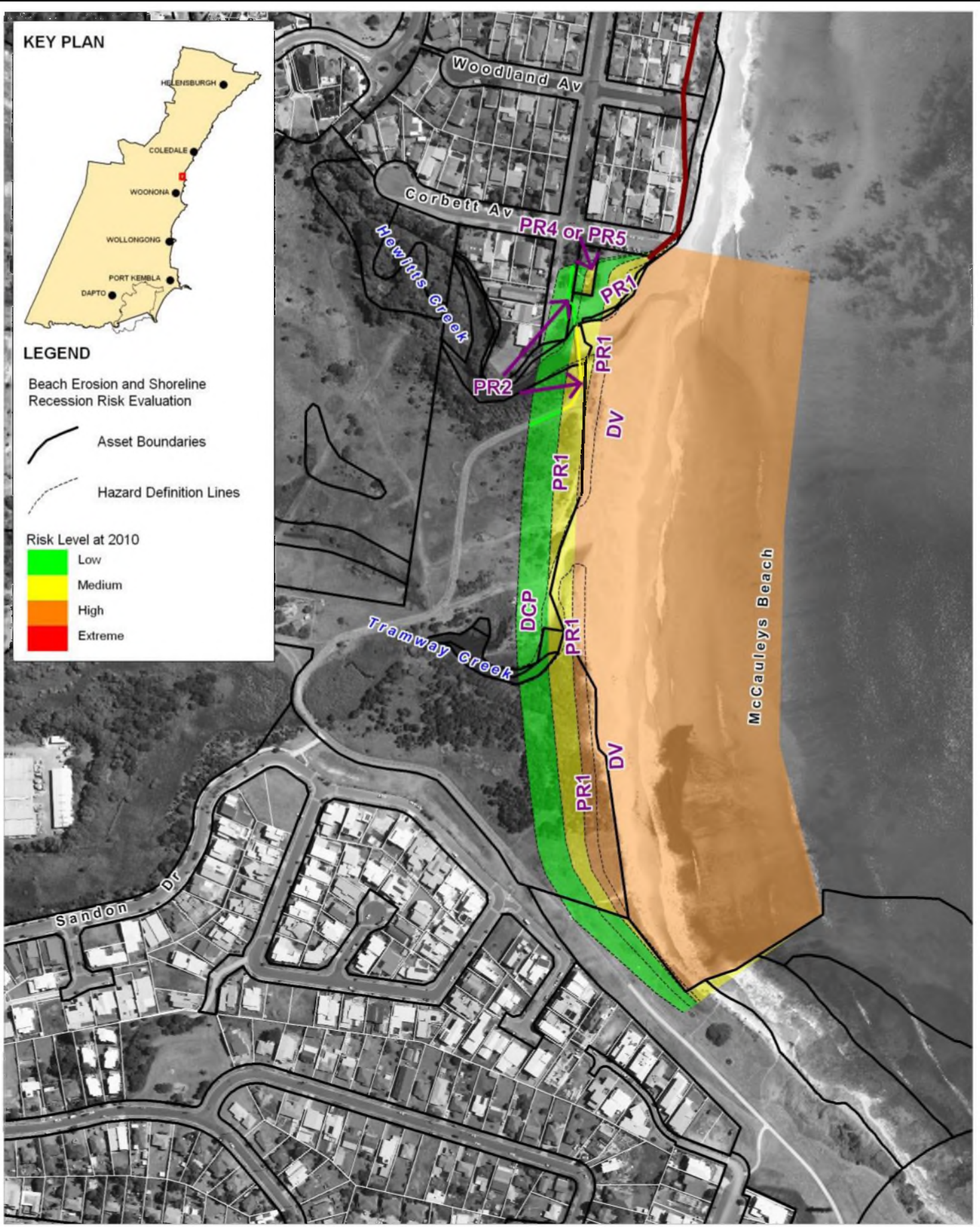
Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

- Low
- Medium
- High
- Extreme

<p>Title: <b>Immediate Erosion Risk Levels and Treatment Options McCauley's Beach - Seawall S2 Option</b></p>		<p>Drawing: <b>6-18</b></p>	<p>Rev: <b>A</b></p>
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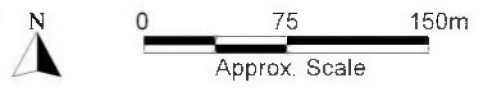


Title:  
**Immediate Erosion Risk Levels and Treatment Options  
McCauley's Beach - Planned Retreat Option**

Drawing:  
**6-19**

Rev:  
**A**

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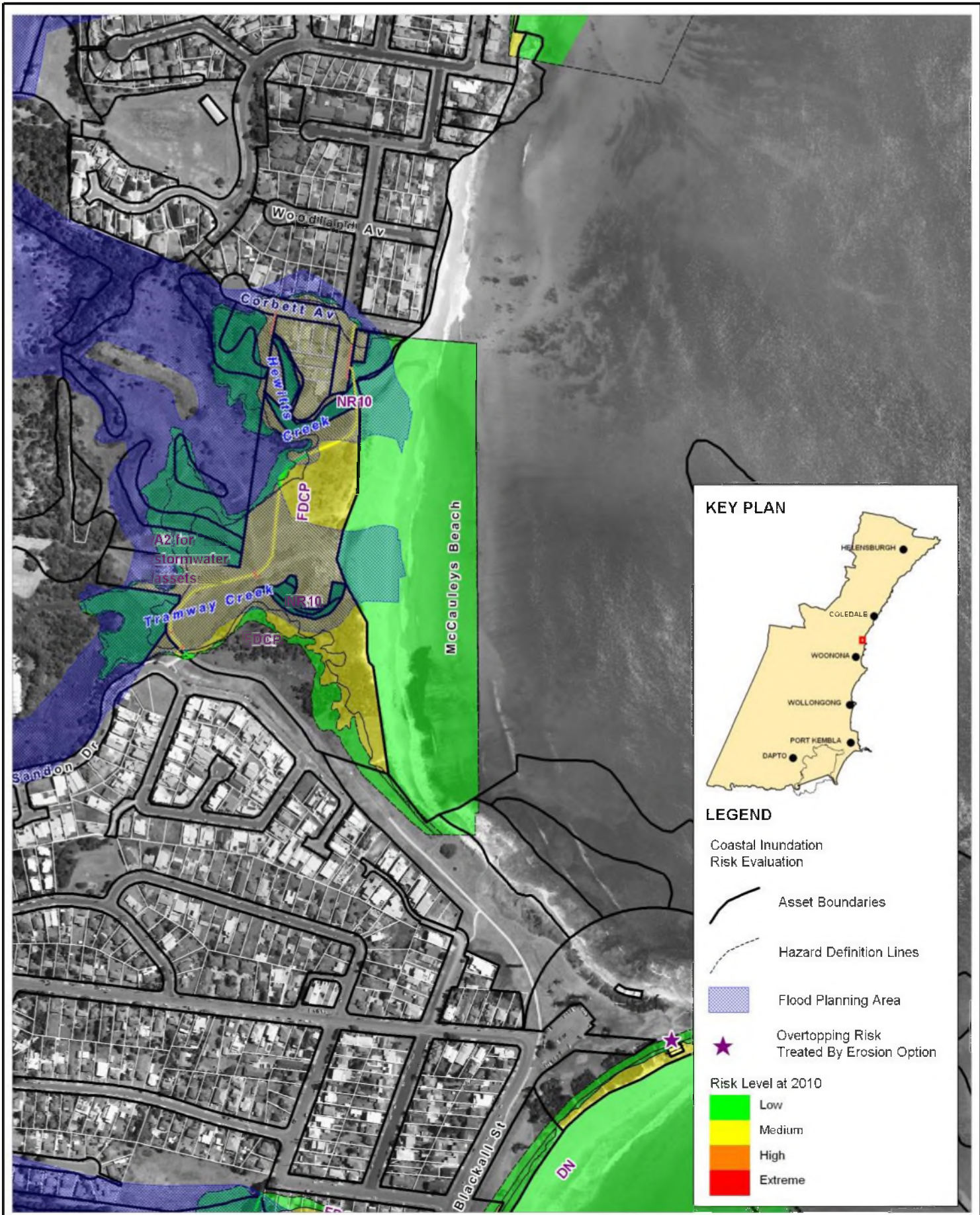


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### 6.8.2 Coastal Inundation Risk Level and Treatment Options

McCauleys Beach (not inc Sandon Pt)	Inundation Risk Level			Inundation Risk Treatments					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					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						✓
<b>Community Infrastructure</b>									
Significant Aboriginal Site (Tent Embassy).	High	Extreme	Extreme			✓✓	✓		
Cycleway / Shared Pathway (Northern Coastal Cycleway)	Medium	Medium	High		✓	✓✓	✓		
<b>Transport Infrastructure</b>									
Local Roads (inc Corbett Ave, Hamilton Rd)	Medium	High	Extreme			✓✓	✓	NR14	
<b>Water and sewage infrastructure</b>									
Stormwater outlets and pipes (N end of beach)	High	Extreme	Extreme			✓	✓✓	NR7, NR14	
<b>Residential Development</b>									
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	

Symbol	
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



**KEY PLAN**

**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines
- Flood Planning Area
- Overtopping Risk Treated By Erosion Option

Risk Level at 2010

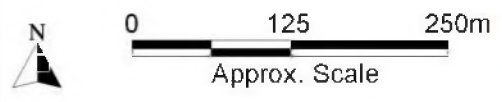
- Low
- Medium
- High
- Extreme

Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 McCauley's Beach**

Drawing:  
**6-20**

Rev:  
**A**

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### 6.8.3 Assessment of Treatment Options

McCauleys															
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 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.	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details fo S2.</i>	? State Government (Grant Programs) - unlikely to fund private property protection <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> Private landholders who directly benefit from option (personal investment or directed by Council)	Marginal
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	x								Dune care programs would be suitable to enhance the existing dune vegetation on this largely natural beach. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended
PR2	Relocate stormwater structures outside of hazard zone	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner.	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs, new levies or increased rates?) N/A Private landholders who directly benefit from option	Recommended

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 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR3.</i>	<input checked="" type="checkbox"/> State Government <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> Private landholders	Not Recommended
PR4	Voluntary acquisition	<b>Current Action:</b> Apply for government funding. <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR4.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> Private landholders who directly benefit from option	Recommended
PR5	Buy back – lease back	<b>Current Action:</b> Apply for mortgage now <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR5.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> 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 escarpments, permissible fixed structures etc that will govern the relocation (e.g. PR2) or suitable design for developments (e.g. A2, A3). <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) <input checked="" type="checkbox"/> Council (Current Programs, increased rates and levies?) - cost to prepare DCP and implement at public assets <input checked="" type="checkbox"/> Private landholders - cost to implement DCP	Recommended

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 PR5 Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe OR when inundation no longer allows conveyance of stormwater <u>OR</u> 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) <input checked="" type="checkbox"/> 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) <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> 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 <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> 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) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended

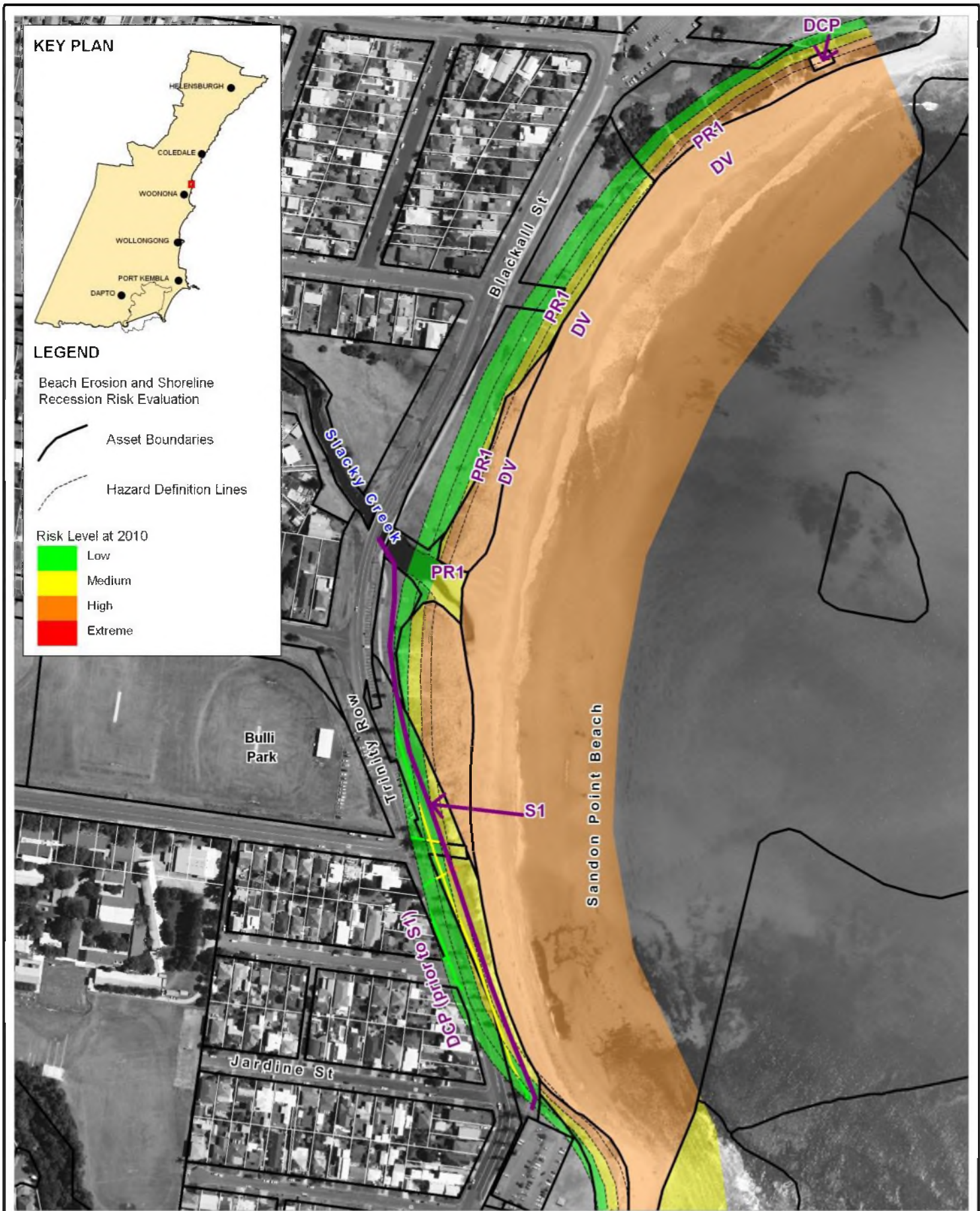


## 6.9 Sandon Point Beach

### 6.9.1 Erosion and Recession Risk Level and Treatment Options

Sandon Point Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														"Do Nothing" (Accept Risk)
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	
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				✓		✓									
<b>Community Infrastructure</b>																		
Sandon Point Surf Club	High	Extreme	Extreme											✓	✓		NR14	
Heritage 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	
<b>Transport Infrastructure</b>																		
Local Roads: Blackall St, Ursula St, Alroy St)	Medium	Medium	High		✓		✓	✓		✓				✓			NR5, NR8, NR14	
Beach car parks (S end of Beach)	Low	Low	Medium		✓				✓									✓
<b>Water and sewage infrastructure</b>																		
Stormwater outlets and pipes (S end of beach)	High	Extreme	Extreme		✓					✓				✓			NR7, NR8, NR14	
<b>Residential Development</b>																		
Existing Residences (edge of 5 ppts at S end of beach)	Low	Medium	Medium		✓							✓	✓	✓			NR8	

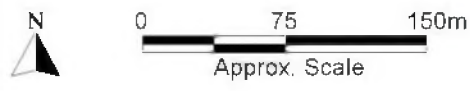
Symbol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	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: <b>6-21</b>	Rev: <b>A</b>
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**KEY PLAN**

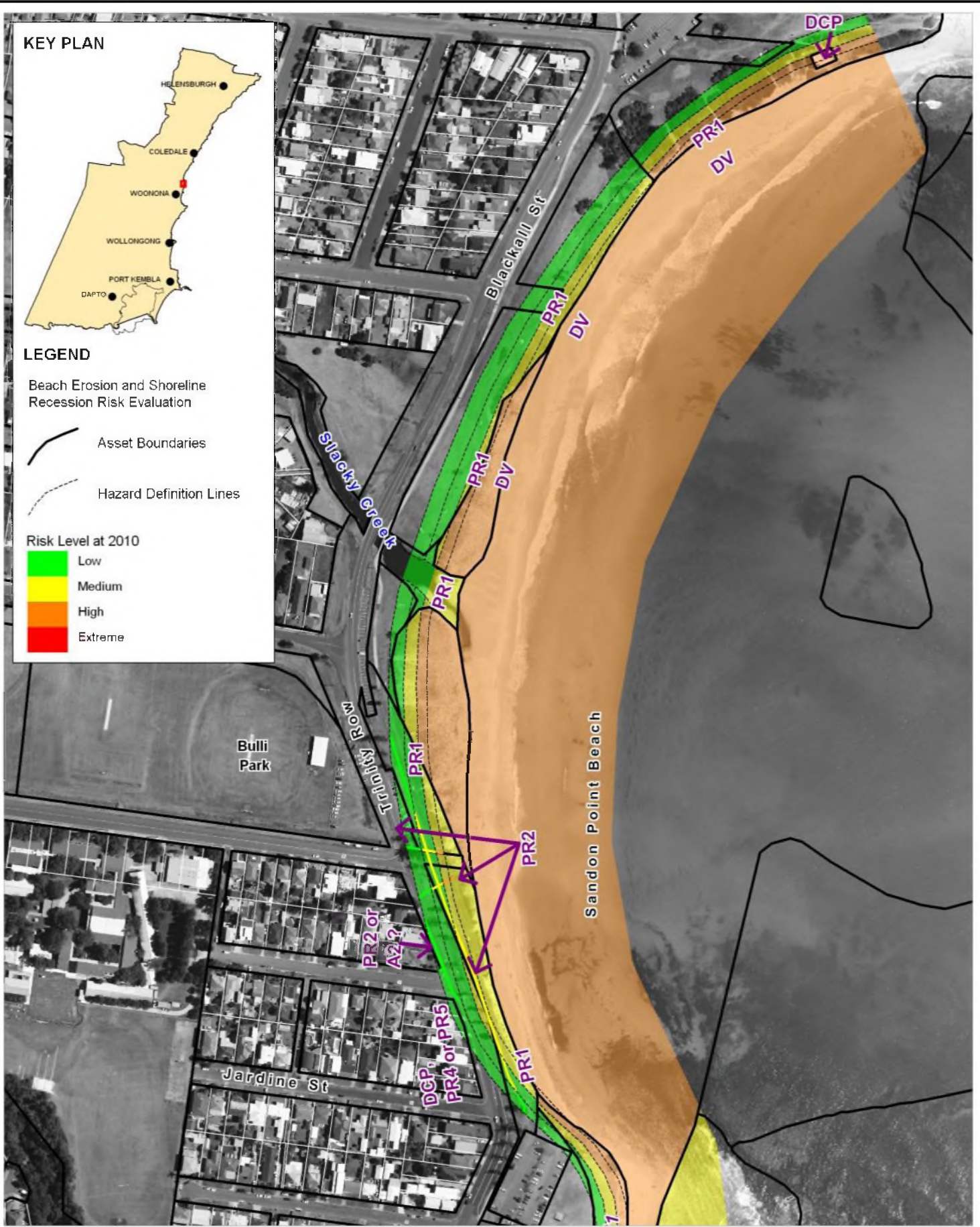


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

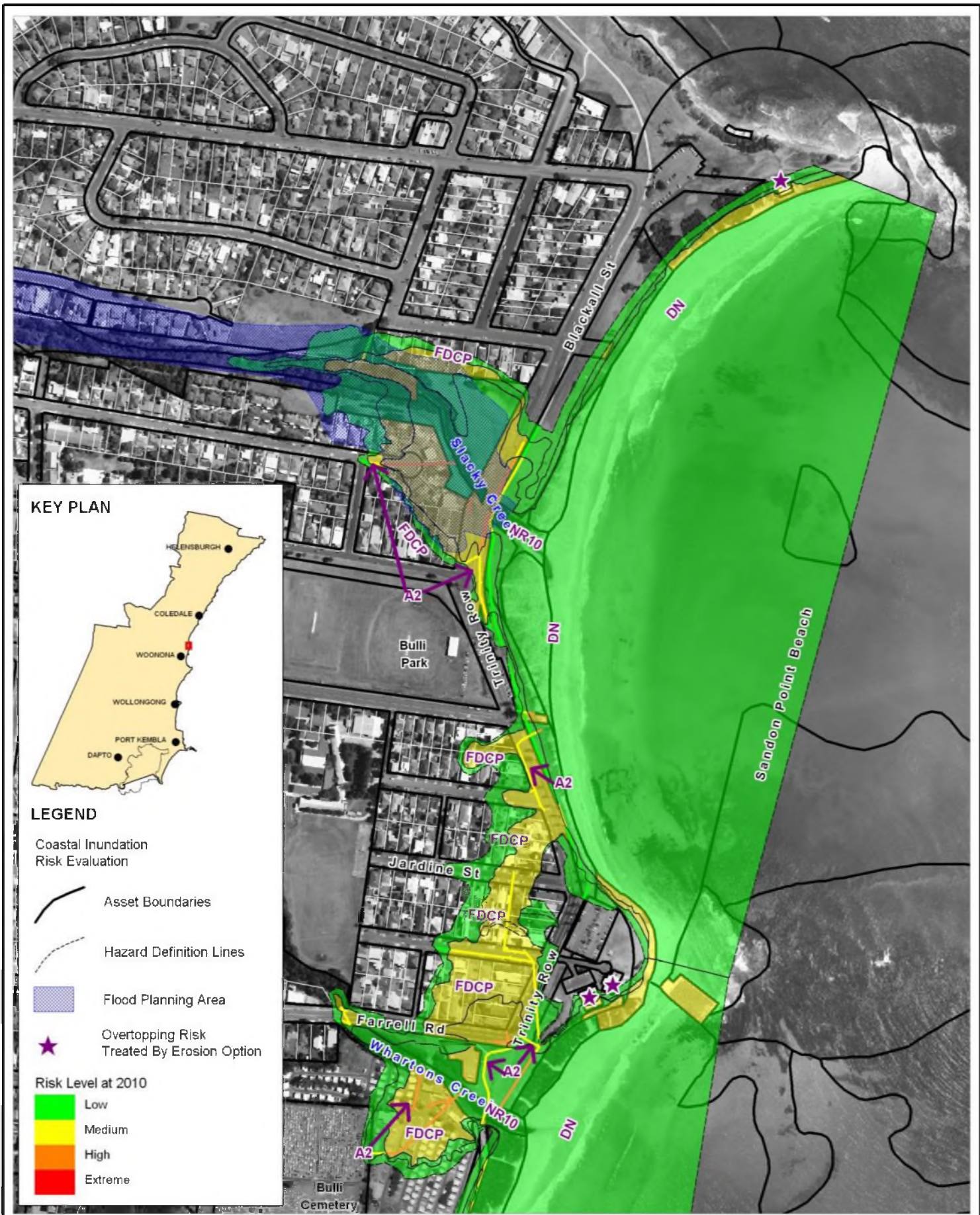


Title: <b>Immediate Erosion Risk Levels and Treatment Options Sandon Point Beach - Planned Retreat Option</b>		Drawing: <b>6-22</b>	Rev: <b>A</b>
<p>BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.</p>		<p>Approx. Scale</p>	
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**6.9.2 Coastal Inundation Risk Level and Treatment Options**

Sandon Point Beach	Inundation Risk Level			Inundation Risk Treatments					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					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						✓
<b>Community Infrastructure</b>									
Sandon Point Surf Club	Medium	High	Extreme	✓		✓			
Heritage 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						✓
<b>Transport Infrastructure</b>									
Local Roads: Blackall St adjacent to Slacky Creek)	Medium	High	Extreme			✓	✓	NR10, NR14	
Local Roads: Blackall St, Ursula St, Aloy St)	Medium	Medium	High	✓		✓	✓	NR10, NR14	
<b>Water and sewage infrastructure</b>									
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	
<b>Residential Development</b>									
Existing Residences (adjacent to Slacky Creek)	Medium	High	Extreme			✓	✓	NR10	
Existing Residences (S end off Blackall St)	Medium	Medium	High			✓	✓	NR10, NR9	

Symbol	
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

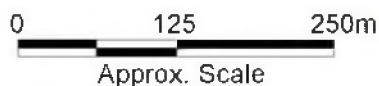


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Sandon Point Beach**

Drawing:  
**6-23**

Rev:  
**A**

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6.9.3 Assessment of Treatment Options

Sandon Point															
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 Sandon Point Beach	Potential Funding Sources (Who may pay)	Conclusion
S1	Construct seawall (revetment) along specified alignment covering half of beach length	<b>Current Action:</b> Undertake concept design for entire length, plus approvals <b>Trigger:</b> implement progressively as erosion threatens cycleway	✓	✓	x								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 slowly 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	✓	✓	x								Dune care programs must be considerate of sightline requirements for SLSC activities. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? 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, 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). <i>Refer to Planned Retreat Options Table for further cost benefit details.</i>	? State Government (Grant Programs) ✓ Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended

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 PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
PR2	Relocate cycleway and roadway outside of hazard zone	<b>Current Action:</b> NR6; NR5 <b>Trigger:</b> When erosion escarpment encroaches cycleway foundations OR when ZRFC from erosion escarpment encroaches upon Trinity Row.	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe OR when asset replacement is required, whichever is sooner.	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs, new levies or increased rates?) N/A Private landholders who directly benefit from option	Recommended
PR4	Voluntary acquisition	<b>Current Action:</b> Apply for government funding. <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR4.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> Private landholders who directly benefit from option	Marginal
PR5	Buy back – lease back	<b>Current Action:</b> Apply for mortgage now <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR5.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> Private landholders who directly benefit from option	Marginal

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 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	✓	✓	x								This option shall apply planning controls to 4 private properties 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. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) <input checked="" type="checkbox"/> Council (Current Programs, increased rates and levies?) - cost to prepare DCP and implement at public assets <input checked="" type="checkbox"/> Private landholders - cost to implement DCP	Recommended
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	<b>Current Action:</b> NR7 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	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. 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). <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	N/A State Government (external funding unlikely to be needed) <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> 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								Particularly 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Not Recommended
NR	NR1, NR5, NR6, NR7, NR8, NR9, NR10, NR11, NR12, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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														"Do Nothing" (Accept Risk)	
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect				Planned Retreat				Accommodate		No Regrets					
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	
<b>Community Infrastructure</b>																			
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	
<b>Transport Infrastructure</b>																			
Car parks (Bulli SLSC, Collins Pt reserve)	Low	Low	Medium							✓✓				✓					✓
<b>Water and sewage infrastructure</b>																			
Stormwater outlets and pipes	Low	Medium	High							✓				✓	✓			NR7	

Symbol	
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

**KEY PLAN**

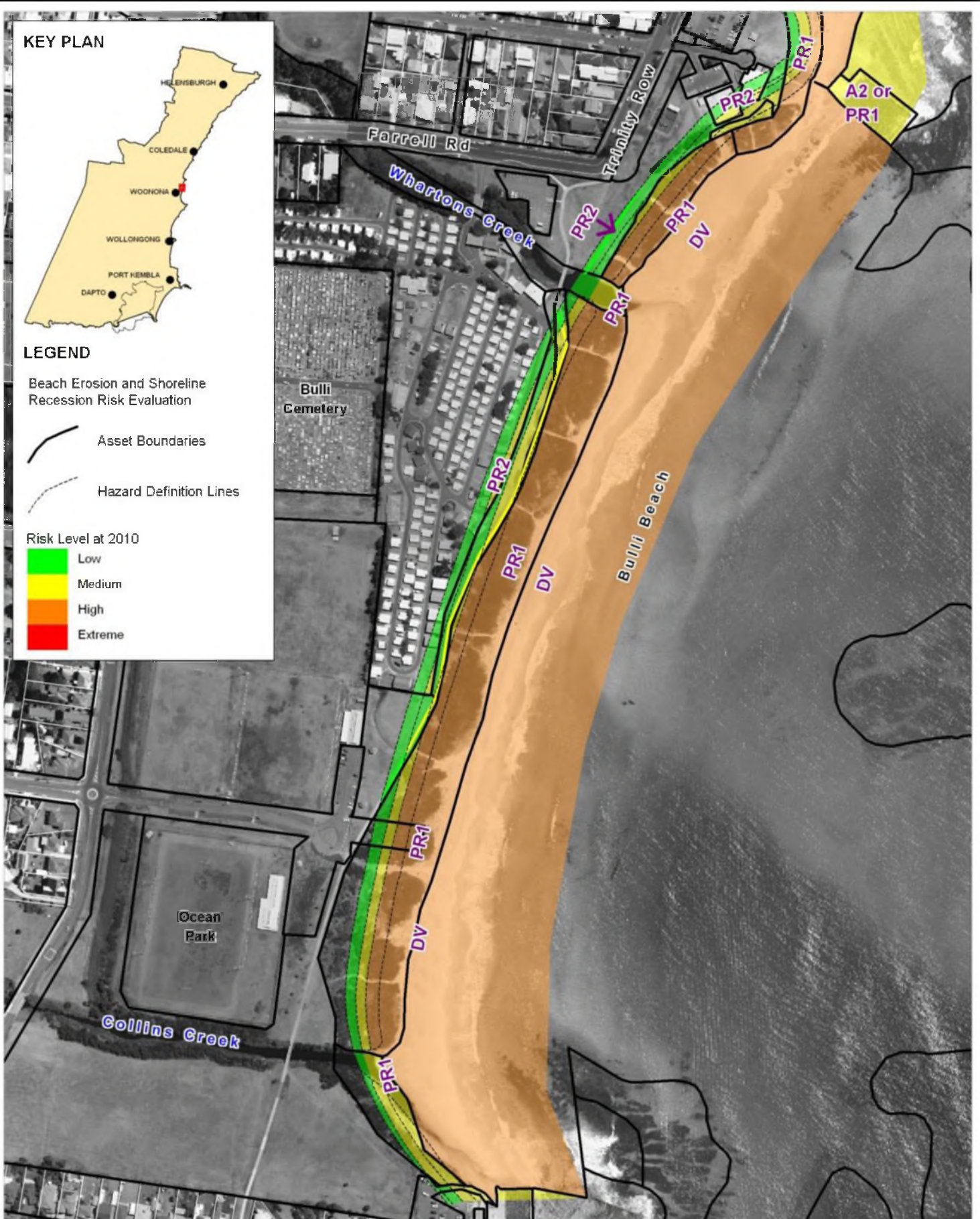
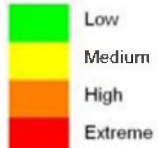


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:  
**Immediate Erosion Risk Levels and Treatment Options  
Bulli Beach**

Drawing:  
**6-24**

Rev:  
**A**

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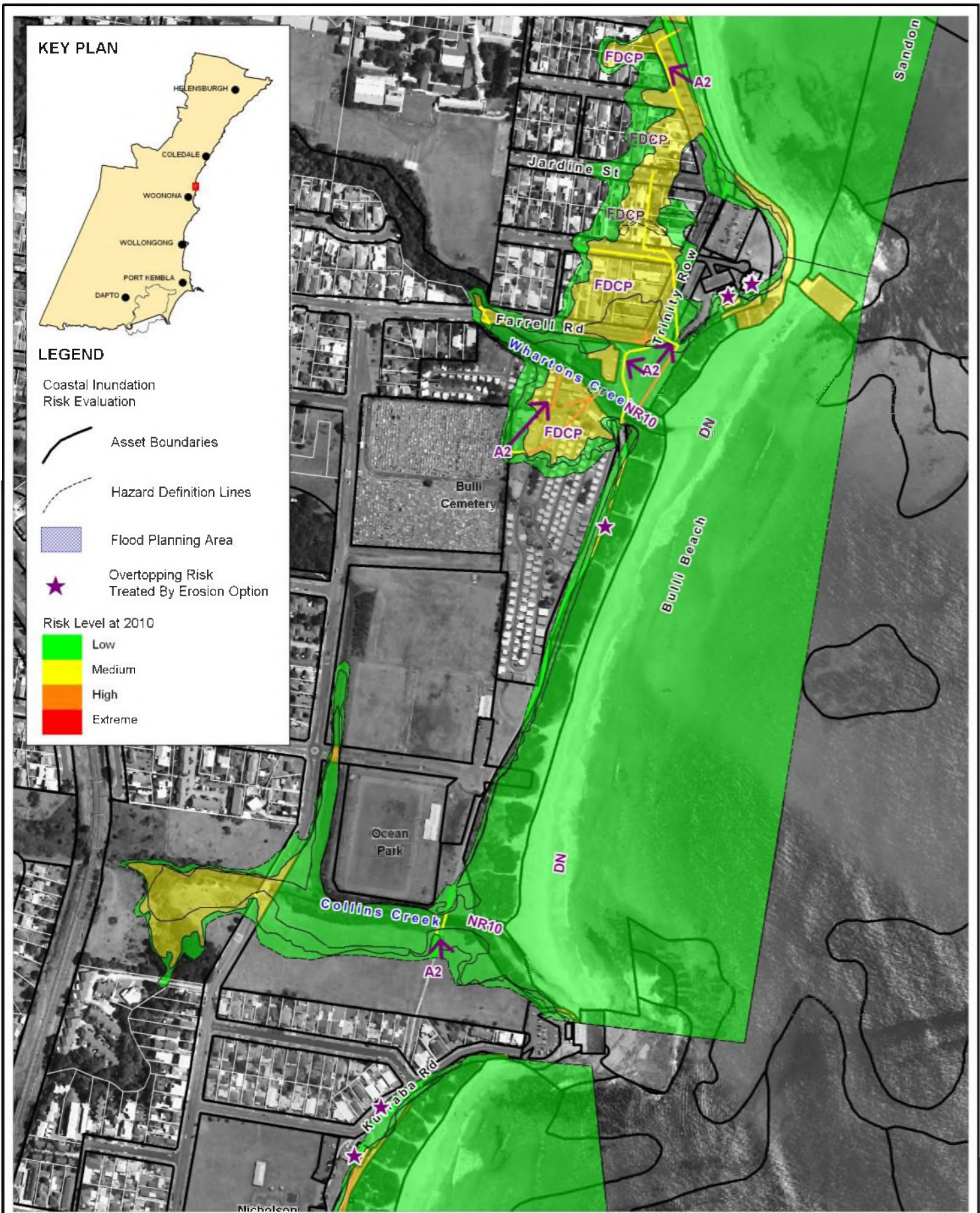


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6.10.2 Coastal Inundation Risk Level and Treatment Options

Bulli Beach	Inundation Risk Level			Inundation Risk Treatments					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					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	✓					
<b>Community Infrastructure</b>									
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						✓
<b>Transport Infrastructure</b>									
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	
<b>Water and sewage infrastructure</b>									
Stormwater outlets and pipes	High	Extreme	Extreme			✓	✓	NR7, NR10	
<b>Residential Development</b>									
Existing Residences (adjacent to Whartons creek & Stormwater System)	Medium	High	Extreme			✓	✓	NR10, NR9	
<b>Institutional Infrastructure</b>									
Bulli High School	Low	Medium	Medium			✓		NR10	

Symbol	
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

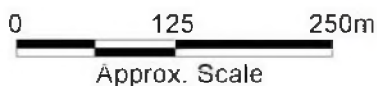


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
Bulli Beach**

Drawing:  
**6-25**

Rev:  
**A**

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6.10.3 Assessment of Treatment Options

Bulli															
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 Bulli Beach	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	<b>Current Action:</b> NR3, NR6 <b>Trigger:</b> At scheduled time for asset maintenance OR when ZRFC measured from erosion escarpment encroaches onto building foundations, cabins or cycleway, whichever is sooner	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe OR the pipe requires replacement, whichever is sooner.	✓	✓	x								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). <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓	✓	x								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). <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) <input checked="" type="checkbox"/> Council (Current Programs) - cost to prepare and implement DCP N/A Private landholders	Recommended

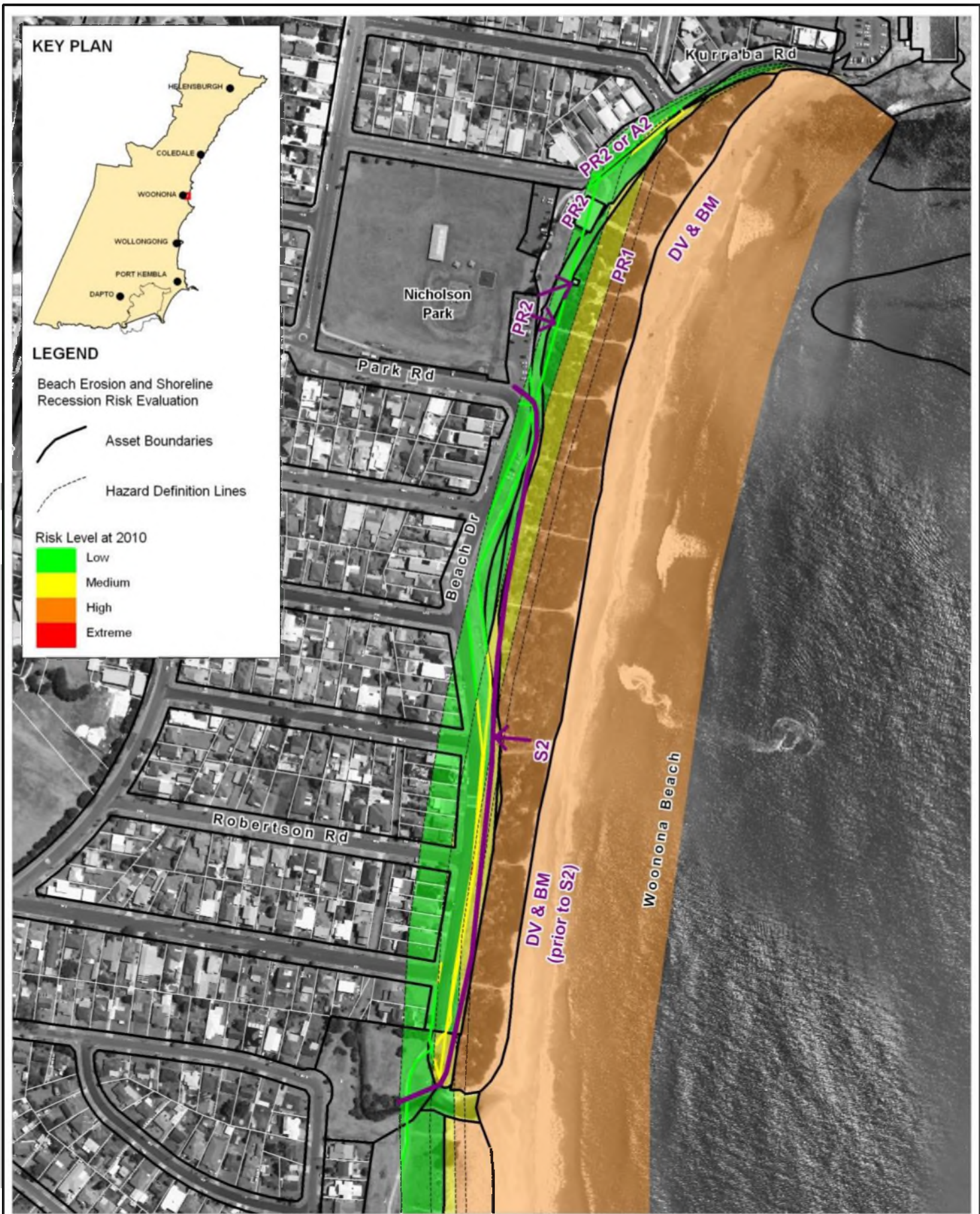
Symbol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for DCP Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit surf club and kiosk structures in current location to withstand impacts.	<b>Current Action:</b> NR3 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR7 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR4 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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 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. <i>Refer to Accommodate Options Table for further cost benefit details for FDCP.</i>	N/A State Government (external funding unlikely to be needed) <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Not Recommended
NR	NR1, NR3, NR4, NR6, NR7, NR9, NR10, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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													"Do Nothing" (Accept Risk)	
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate				No Regrets
				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
<b>Parks, Beaches and open space</b>																		
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				✓		✓✓									
<b>Community Infrastructure</b>																		
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
<b>Transport Infrastructure</b>																		
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
<b>Water and sewage infrastructure</b>																		
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
<b>Residential Development</b>																		
Existing Residences (19 at centre of beach)	Medium	Medium	High			✓			✓			?	?	✓				NR8, NR14

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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**

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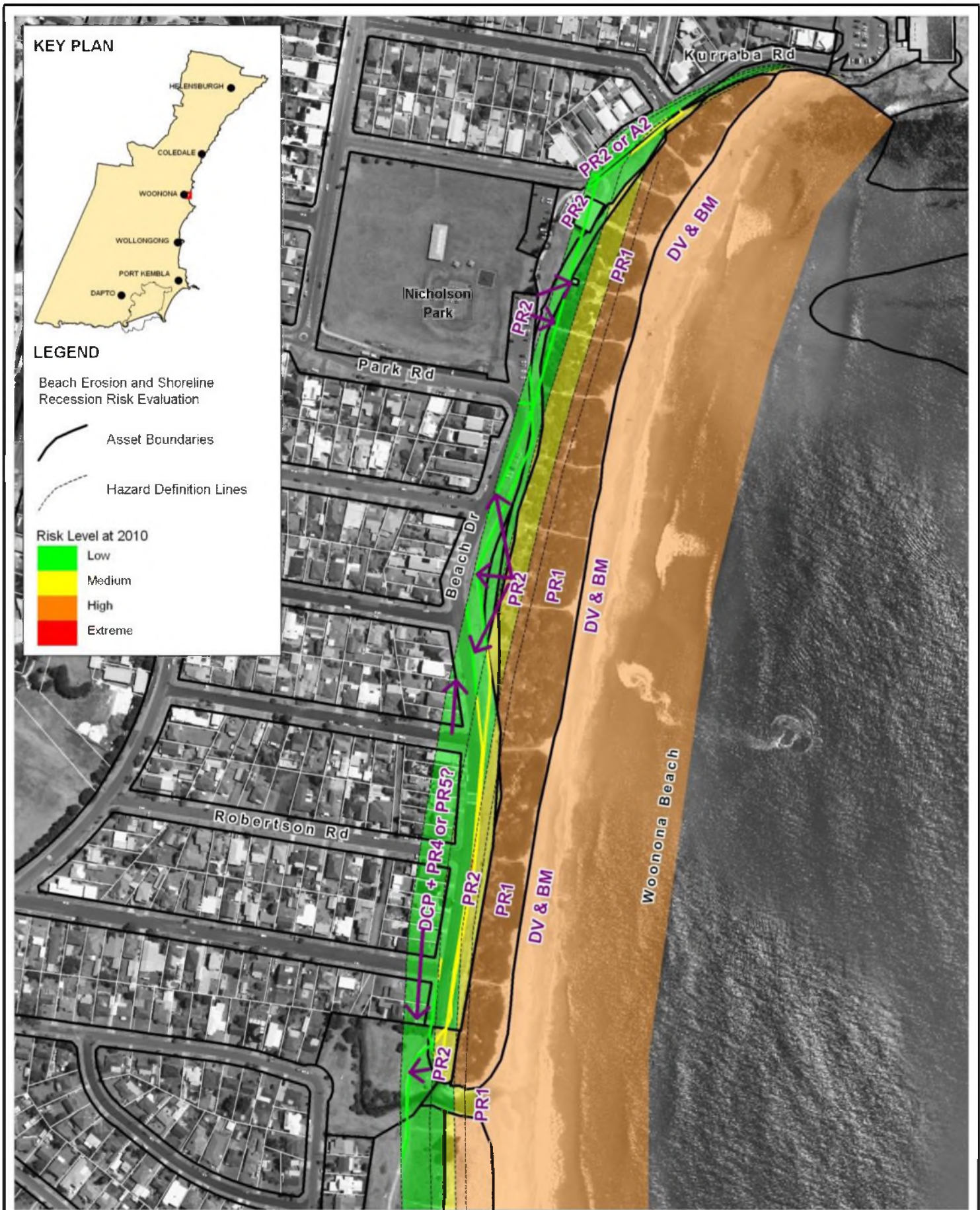


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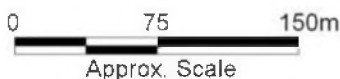


Title:  
**Immediate Erosion Risk Levels and Treatment Options  
 Woonona Beach - Planned Retreat Option**

Drawing:  
**6-27**

Rev:  
**A**

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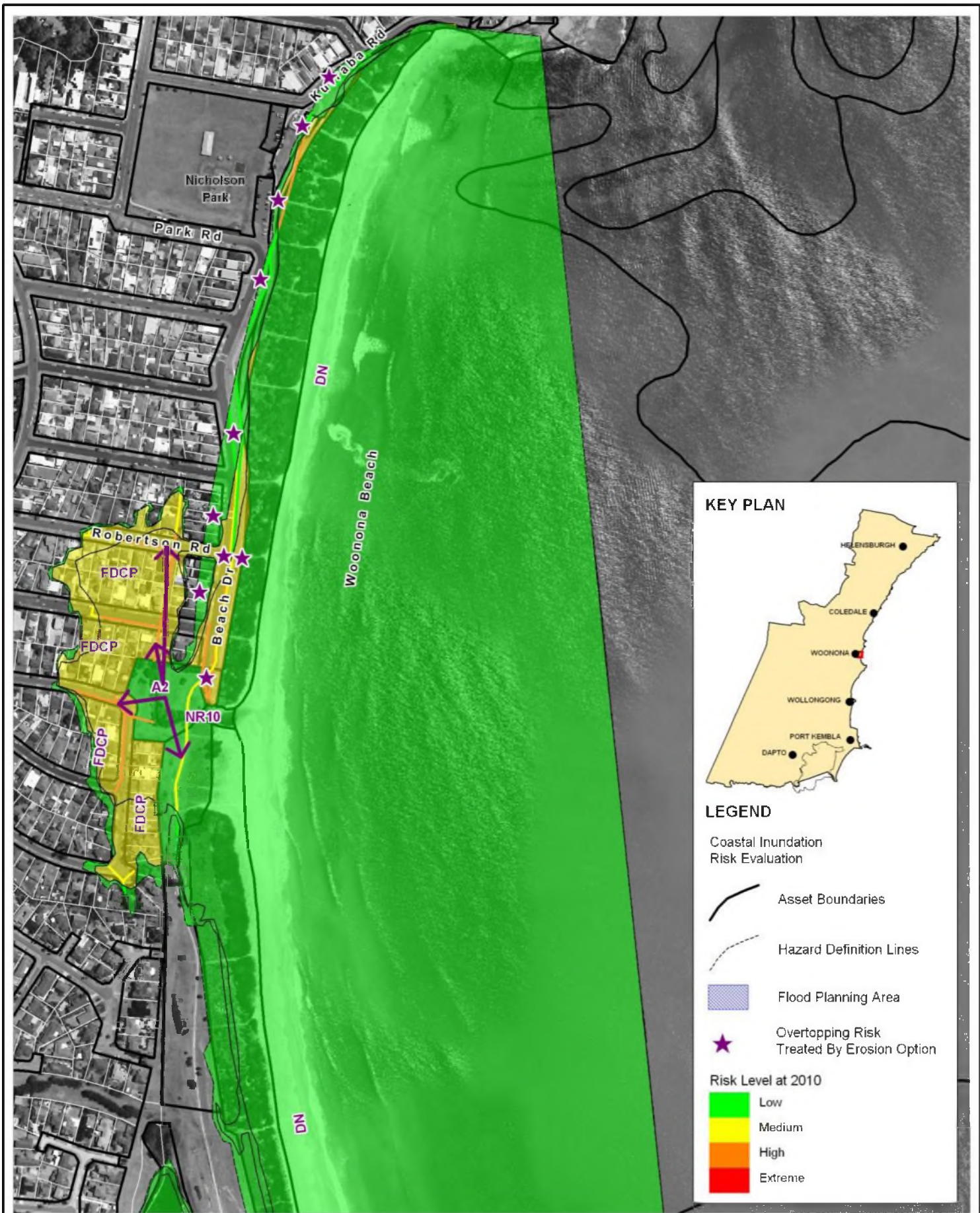


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6.11.2 Coastal Inundation Risk Level and Treatment Options

Woonona Beach (beach extends to creek at centre of beach)	Inundation Risk Level			Inundation Risk Treatments					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					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						✓
<b>Community Infrastructure</b>									
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	✓		✓			✓
<b>Transport Infrastructure</b>									
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	✓
<b>Water and sewage infrastructure</b>									
Stormwater outlets and pipes	High	Extreme	Extreme	✓		✓	✓	NR7, NR14	
<b>Residential Development</b>									
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	

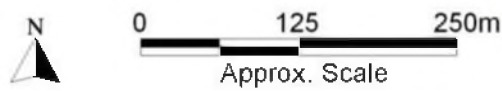
Sym- bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	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**

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6.11.3 Assessment of Treatment Options

Woonona															
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 Woonona Beach	Potential Funding Sources (Who may pay)	Conclusion (provisional)
S2	Construct seawall (revetment) along specified alignment to protect specific asset(s)	<b>Current Action:</b> Detailed design and approvals <b>Trigger:</b> When ZRFC measured from erosion escarpment encroaches onto Beach Drive	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details for S2.</i>	? State Government (Grant Programs) - unlikely to fund private property protection. May assist funding to protect water supply and waste water assets. <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> Private landholders who directly benefit from option (personal investment or directed by Council)	Marginal
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	x								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 <i>Acacia sophorae</i> 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 <i>Acacia sophorae</i> will become less common as the beach is impacted by storms and the dune is eroded periodically. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details for BM.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended

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 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	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? 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	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? 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)	<b>Current Action:</b> NR3 <b>Trigger:</b> At scheduled time for asset maintenance OR when ZRFC measured from erosion escarpment encroaches onto building foundations or cabins, whichever is sooner	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe OR the pipe requires replacement, whichever is sooner.	✓	✓	x								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 redesigned 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). <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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	<b>Current Action:</b> NR5, NR6 <b>Trigger:</b> When ZRFC measured from erosion escarpment encroaches onto the cycleway and roadway.	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) ☑ Council (new levies or increased rates) N/A Private landholders who directly benefit from option	Recommended

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 PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
PR4	Voluntary acquisition	<b>Current Action:</b> Apply for government funding. <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR4.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> Private landholders who directly benefit from option	Marginal
PR5	Buy back – lease back	<b>Current Action:</b> Apply for mortgage now <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR5.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> 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	✓	✓	x								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 escarpments, 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. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) <input checked="" type="checkbox"/> Council (Current Programs) - cost to prepare DCP and implement at public assets <input checked="" type="checkbox"/> Private landholders - cost to implement DCP	Recommended

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 DCP Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign Kurraba Rd in current location to withstand impacts.	<b>Current Action:</b> NR5 <b>Trigger:</b> When ZRFC measured from erosion escarpment encroaches onto the roadway.	✓	✓	x								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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR7 <b>Trigger:</b> 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 surrounding 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR4 <b>Trigger:</b> When damage to pool shell occurs OR the pool is being inundated at water levels lower than MSL.	✓	✓	x								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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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 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 Drives a priority, as many houses may be affected (refer NR10). <i>Refer to Accommodate Options Table for further cost benefit details for FDCP.</i>	N/A State Government (external funding unlikely to be needed) <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Not Recommended
NR	NR1, NR3, NR4, NR5, NR6, NR7, NR8, NR9, NR10, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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														"Do Nothing" (Accept Risk)	
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets		
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	
<b>Community Infrastructure</b>																			
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	✓	
<b>Transport Infrastructure</b>																			
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		
<b>Water and sewage infrastructure</b>																			
Stormwater outlets and pipes (adjacent to Bellambi Pool carpark)	High	Extreme	Extreme							✓				✓			NR2, NR7, NR14		
Sewage Treatment Plant	High	Extreme	Extreme							✓				✓			NR2, NR8		

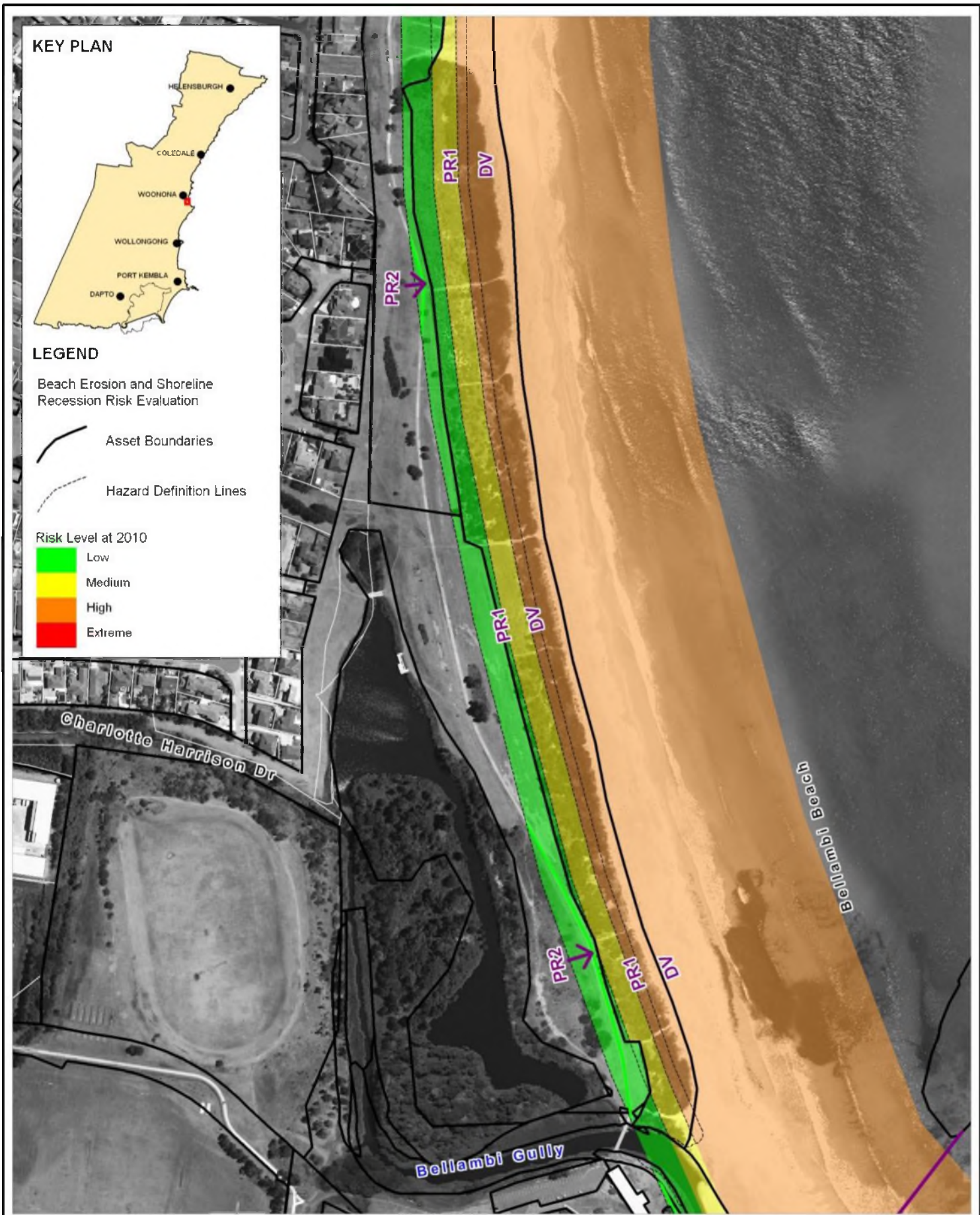
Symbol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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													"Do Nothing" (Accept Risk)				
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate				No Regrets			
				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3		Investigate*			
<b>Parks, Beaches and open space</b>																					
Bellambi Point Beach	High	Extreme	Extreme				✓✓		✓✓											NR14	
Coastal Dune Systems	High	Extreme	Extreme				✓✓		✓✓												
Heritage Site: Bellambi Lagoon and associated habitat	High	Extreme	Extreme						✓✓											NR11	
<b>Community Infrastructure</b>																					
Heritage Sites: Bellambi (Sandpit) Point	High	Extreme	Extreme			?	✓✓		✓✓											NR2	
<b>Water and sewage infrastructure</b>																					
Stormwater outlets and pipes (adjacent to STP)	High	Extreme	Extreme				✓				✓✓				✓					NR2, NR7, NR14	
Sewage Treatment Plant	High	Extreme	Extreme				✓				✓✓				✓					NR2, NR8, NR14	

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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**

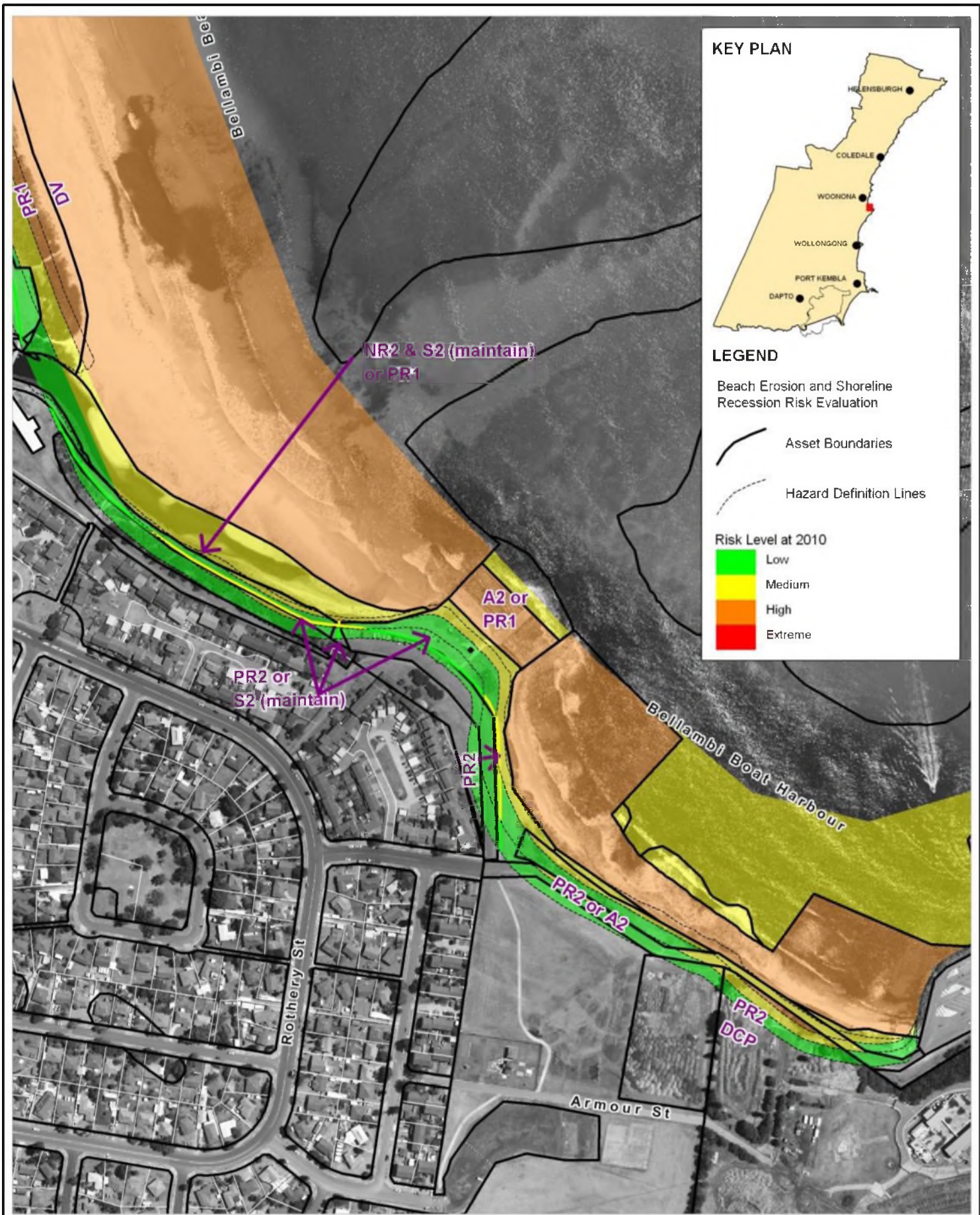
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Approx. Scale



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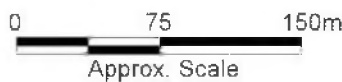


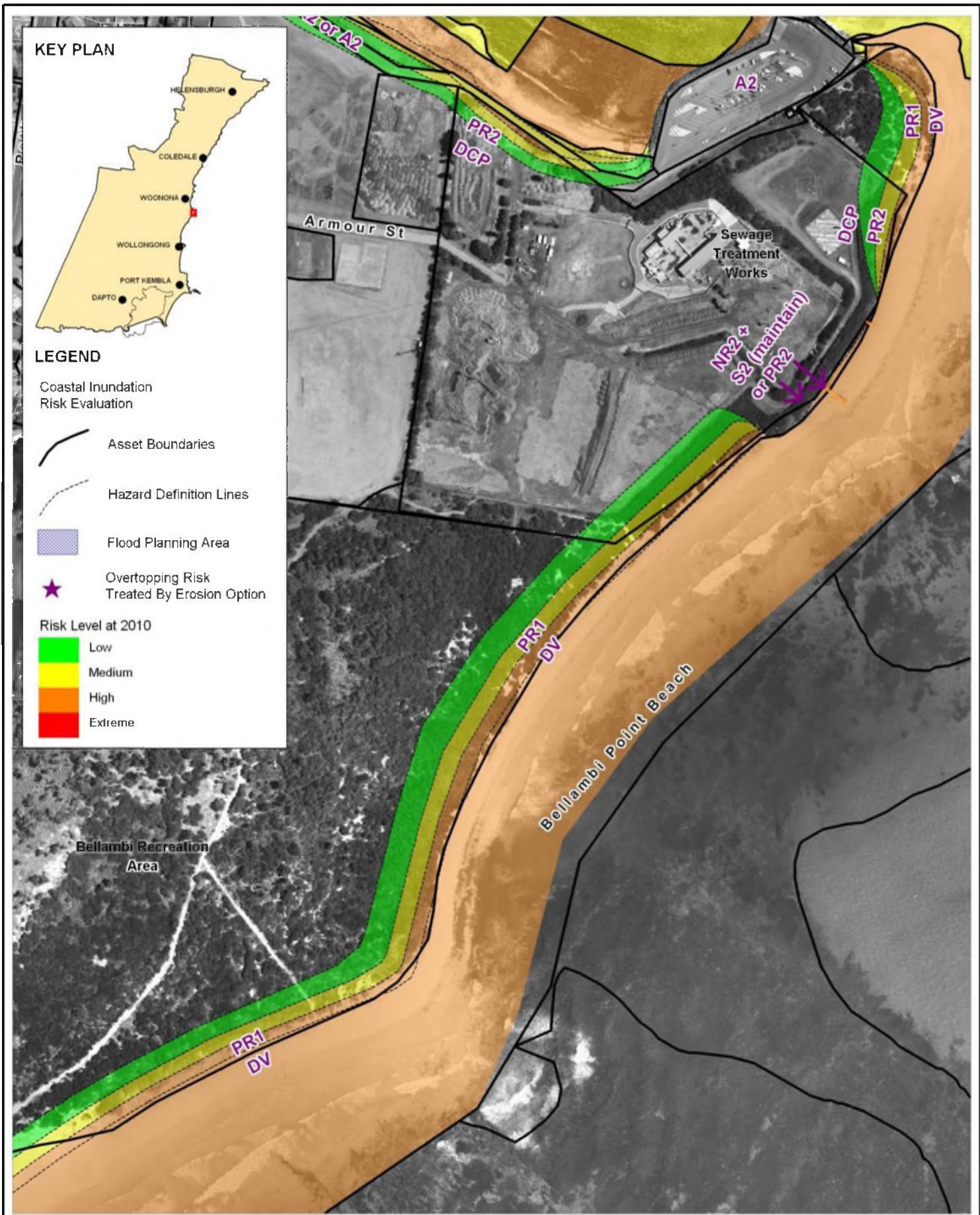
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**Immediate Erosion Risk Levels and Treatment Options  
Bellambi Boat Harbour**

Drawing:  
**6-30**

Rev:  
**A**

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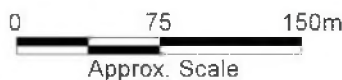


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
Bellambi Point Beach**

Drawing:  
**6-31**

Rev:  
**A**

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

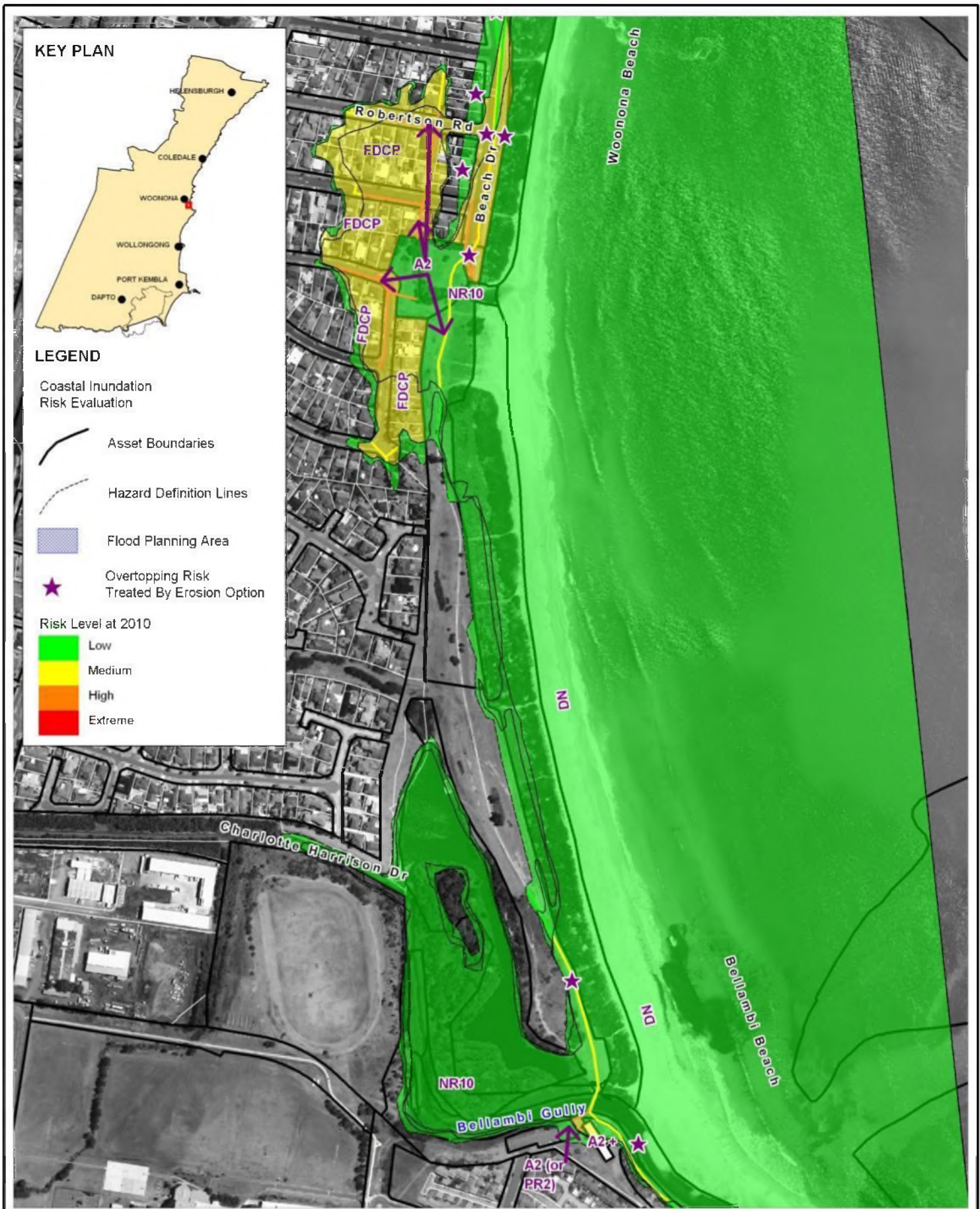
Bellambi Beach (Bellambi Pt in next table)	Inundation Risk Level			Inundation Risk Treatments					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate		No Regrets	
<b>Parks, Beaches and open space</b>					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						✓
<b>Community Infrastructure</b>									
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						✓
<b>Transport Infrastructure</b>									
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	✓					
<b>Water and sewage infrastructure</b>									
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	

Symbol	
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					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					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						✓
<b>Community Infrastructure</b>									
Heritage Sites: Bellambi (Sandpit) Point	Medium	High	Extreme	✓					✓
Cycleway / Shared Pathway (W of Bellambi Lagoon, along Dobbie & Murray Ave)	Medium	Medium	High			✓✓	✓	NR14	
<b>Transport Infrastructure</b>									
Local roads (Dobbie Ave)	Medium	High	Extreme			✓✓		NR14	✓
Local car park at Lagoon entrance (off Murray Rd)	Medium	High	Extreme			✓✓		NR14	✓
<b>Water and sewage infrastructure</b>									
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	✓					
<b>Residential Development</b>									
Existing Residences (10 adjacent to Bellambi Lagoon)	Medium	Medium	High			✓✓	✓	NR10	

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

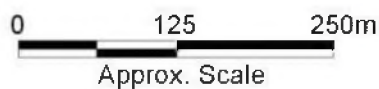


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
Bellambi Beach**

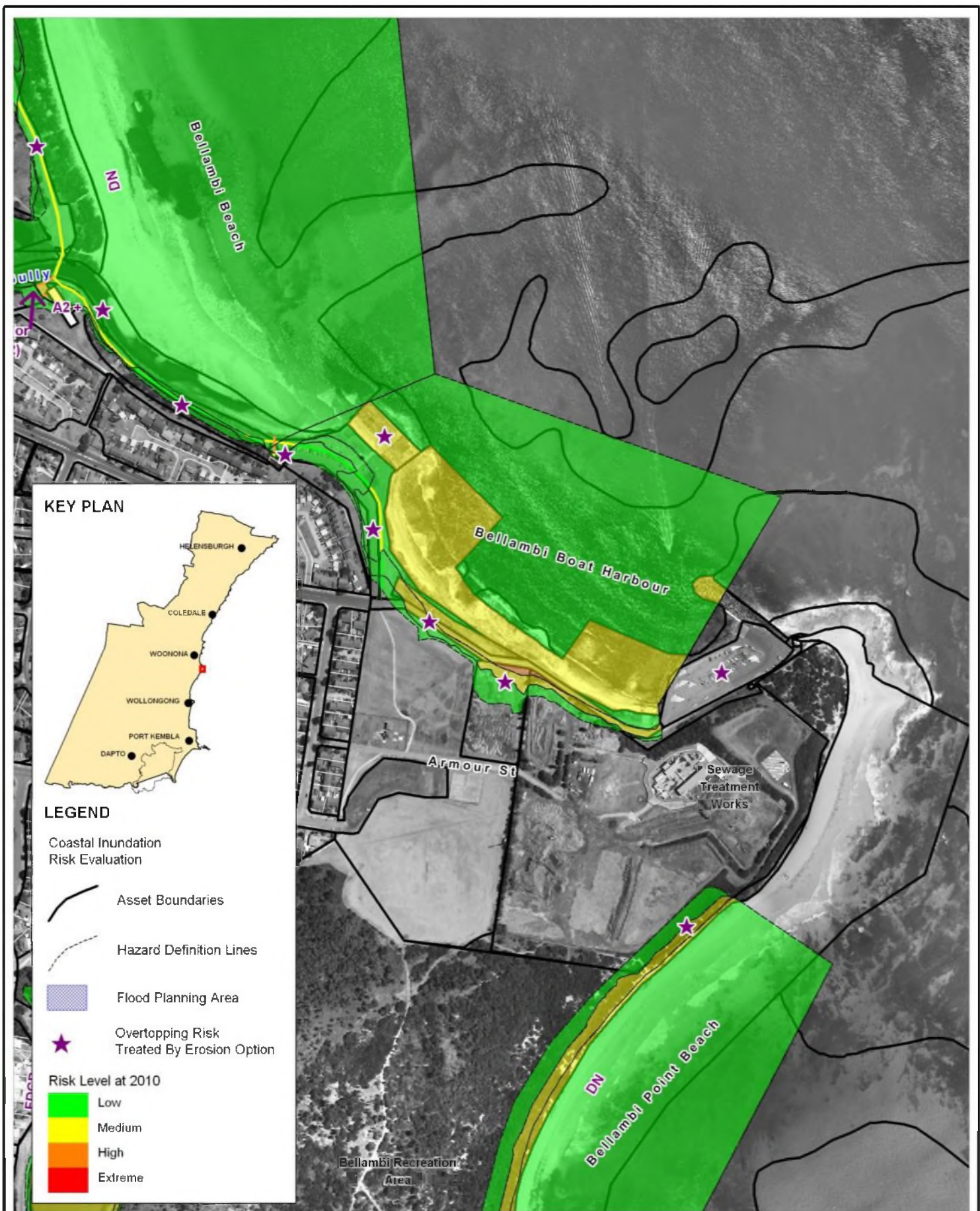
Drawing:  
**6-32**

Rev:  
**A**

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**KEY PLAN**



**LEGEND**

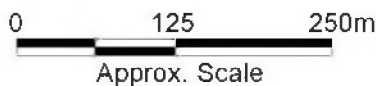
- Coastal Inundation Risk Evaluation
- Asset Boundaries
  - Hazard Definition Lines
  - Flood Planning Area
  - Overtopping Risk Treated By Erosion Option
- Risk Level at 2010
- Low
  - Medium
  - High
  - Extreme

Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Bellambi Boat Harbour**

Drawing:  
**6-33**

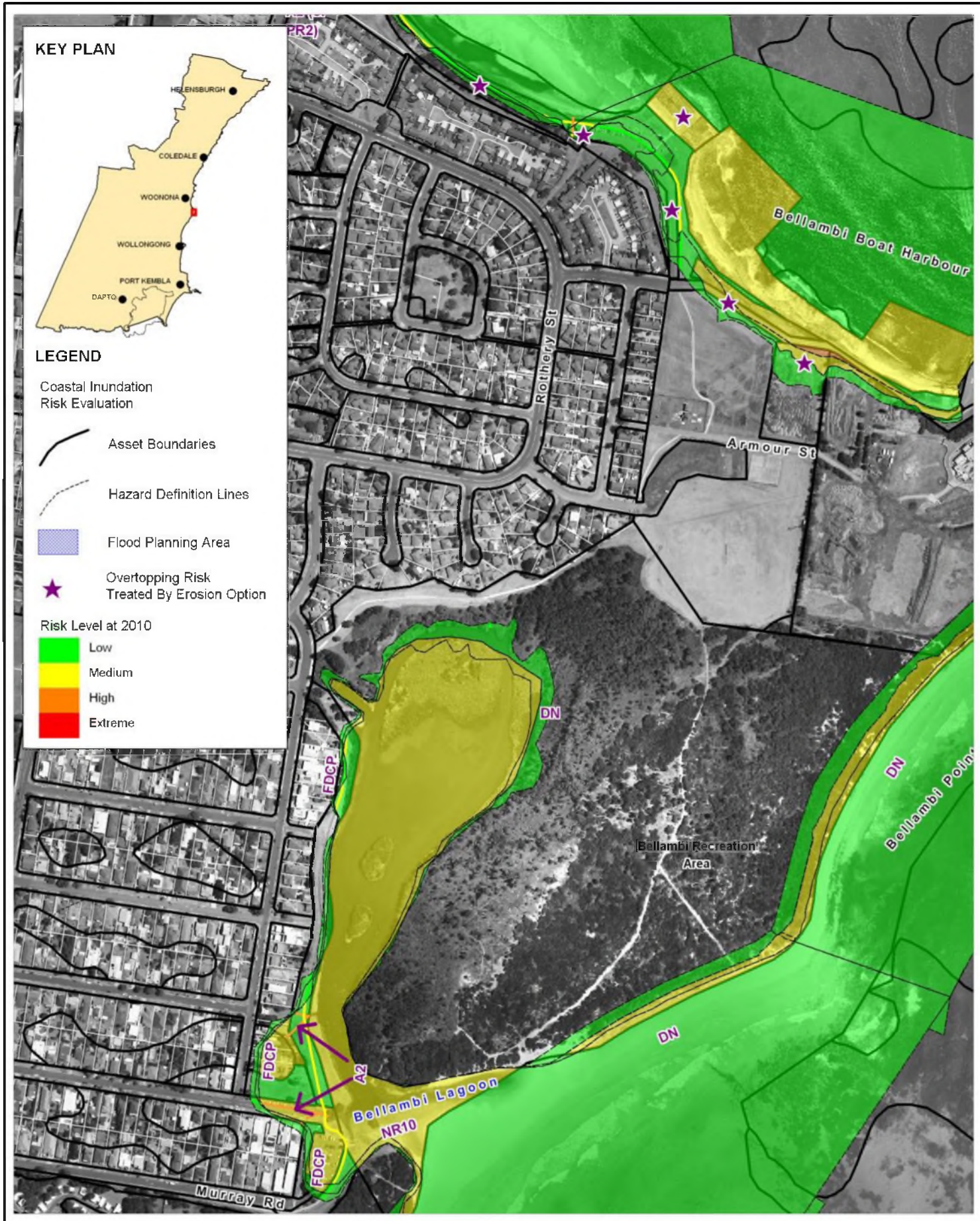
Rev:  
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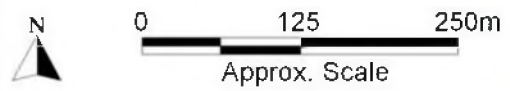




Title:  
**Immediate Inundation Risk Levels and Treatment Options  
Bellambi Point Beach**

Drawing: **6-34** Rev: **A**

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

Bellambi															
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 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.	✓	✓	x								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). <i>Refer to Protect Options Table for further cost benefit details for S2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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								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). <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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 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). <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	<b>Current Action:</b> NR5, NR8 <b>Trigger:</b> When ZRFC measured from erosion escarpment encroaches roadway	✓	✓	x								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 roadway. 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 <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs), Sydney Water (at site) <input checked="" type="checkbox"/> Council (new levies or increased rates) N/A Private landholders who directly benefit from option	Marginal

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 PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
PR2	Relocate cycleway outside of hazard zone	<b>Current Action:</b> NR6 <b>Trigger:</b> When ZRFC measured from erosion escarpment encroaches cycleway	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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	✓	✓	x								This option applies proposed Coastal DCP controls to any redevelopments on the Sewage Treatment Works site. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? 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.	<b>Current Action:</b> NR3 <b>Trigger:</b> At scheduled time for asset maintenance OR when ZRFC measured from erosion escarpment encroaches onto building foundations, whichever is sooner	✓	✓	x								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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? 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.	<b>Trigger:</b> As asset maintenance to revetment and boat ramp is required over time, or following storm damage	✓	✓	x								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 <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) N/A Private landholders who directly benefit from option	Recommended

Symbol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overlapping 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.	<b>Current Action:</b> NR4 <b>Trigger:</b> When damage to pool shell occurs <u>OR</u> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR7 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR3 <b>Trigger:</b> When structure is refurbished or re-built.	x	x	✓								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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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 the surf club at the "low flood risk" level, until a Flood Study for Bellambi Gully is conducted (refer NR10). <i>Refer to Accommodate Options Table for further cost benefit details for FDCP.</i>	N/A State Government (external funding unlikely to be needed) <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Marginal
NR	NR1, NR2, NR4, NR5, NR6, NR7, NR8, NR10, NR11, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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															
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 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.	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details for S2.</i>	? 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	✓	✓	x								The existing vegetation coverage should be maintained, particularly managing weed species (e.g. bitou). <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? 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 option allows reserve or public open space to naturally recede, for continued provision of a beach over the long term. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? 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	<b>Trigger:</b> Move activities as erosion impacts manifest	✓	✓	x								There appears to be sufficient vacant land within the Plant to relocate activities within the site to allow retreat. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) ? Sydney Water ☑ Council (Current Programs, new levies or increased rates?) N/A Private landholders who directly benefit from option	Marginal

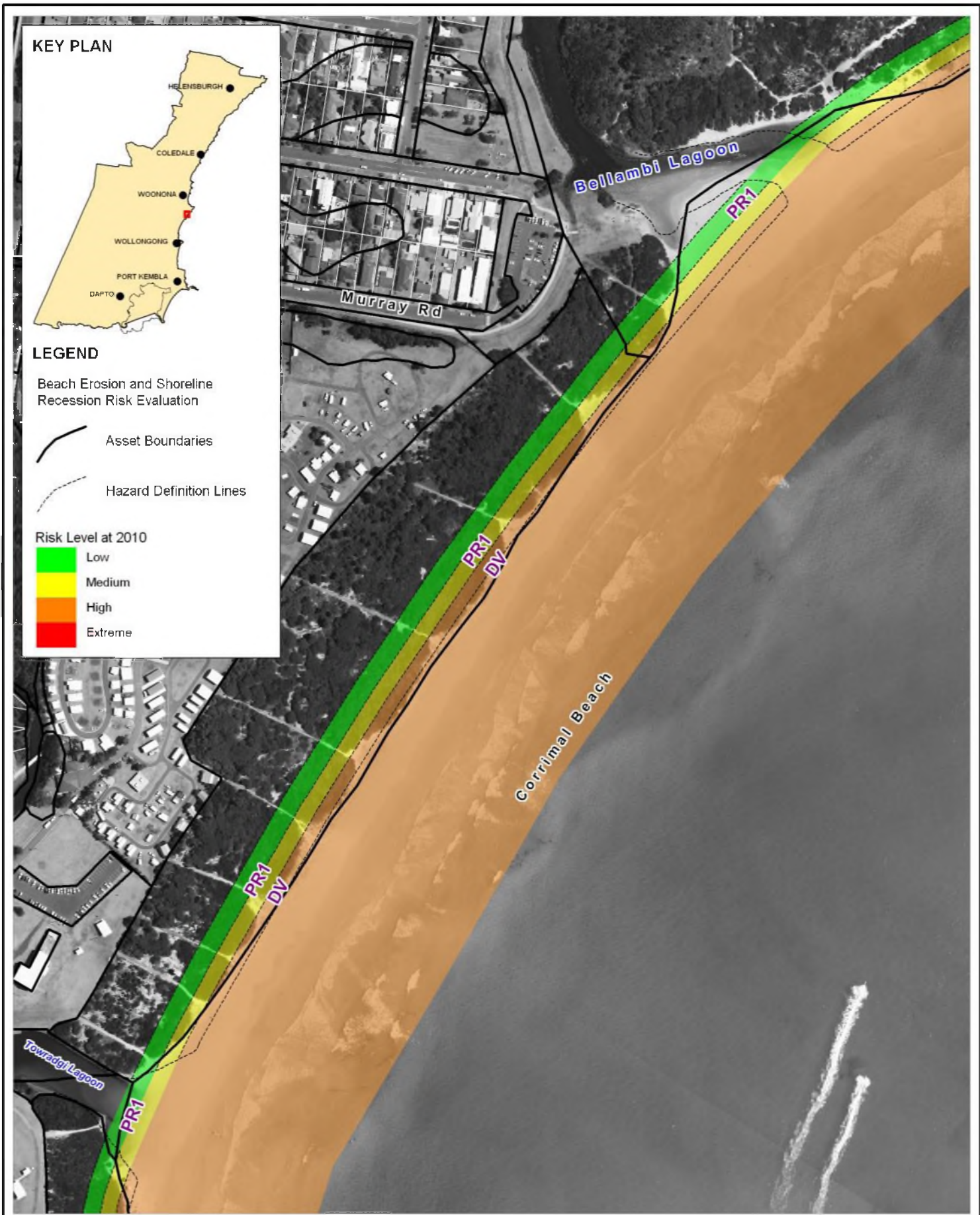
Symbol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overtopping Option	Backwater Inundation Option	Capital Cost	Recurrent Costs	Environmental or Social Impact	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Specific Cost Benefit Considerations for 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. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) <input checked="" type="checkbox"/> Council (Current Programs) - cost to prepare DCP <input checked="" type="checkbox"/> Sydney Water - cost to implement DCP	Recommended
A2	Redesign or retrofit stormwater structures W of Bellambi Lagoon in current location to withstand impacts.	<b>Current Action:</b> NR7 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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). <i>Refer to Accommodate Options Table for further cost benefit details for FDCP.</i>	N/A State Government (external funding unlikely to be needed) <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> 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, particularly where community services are impacted. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Not Recommended
NR	NR1, NR2, NR7, NR8, NR10, NR11, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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														"Do Nothing" (Accept Risk)
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	
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						✓✓									✓
<b>Community Infrastructure</b>																		
Towradgi Rock Pool amenities mens	Low	Low	Medium											✓✓				✓
Towradgi Rock Pool amenities womens	Low	Low	Medium											✓✓				✓

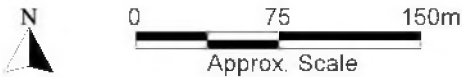
Sym- bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	Apply development controls (future devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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: <b>6-35</b>	Rev: <b>A</b>
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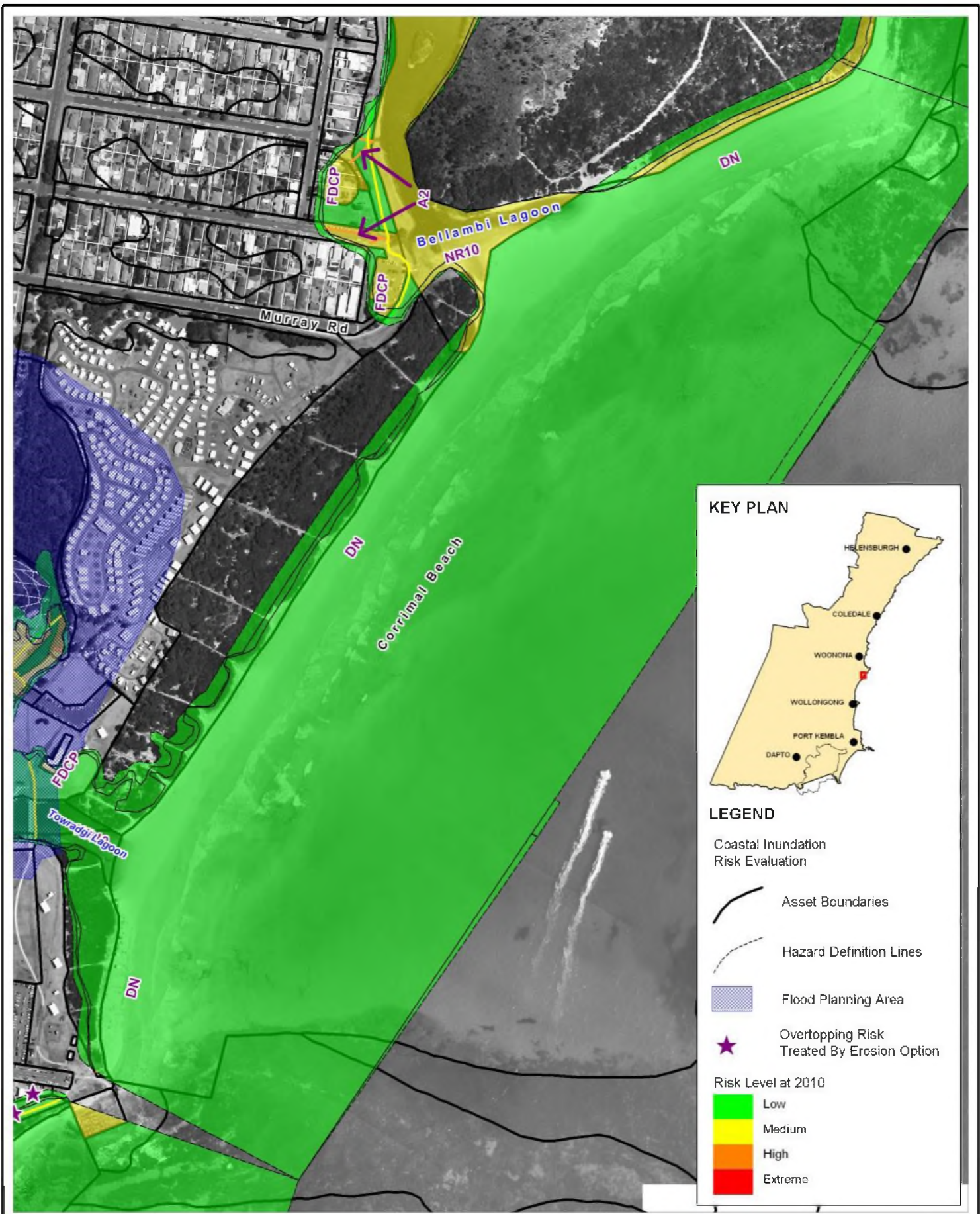
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### 6.13.2 Coastal Inundation Risk Level and Treatment Options

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	Accommodate	No Regrets	"Do Nothing" (Accept Risk)	
<b>Parks, Beaches and open space</b>					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						✓
<b>Community Infrastructure</b>									
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	
<b>Transport Infrastructure</b>									
Local roads (Lake Pde)	Medium	High	Extreme			✓✓		NR14	✓
<b>Water and sewage infrastructure</b>									
Stormwater outlets and pipes	High	Extreme	Extreme			✓✓	✓✓	NR7, NR14	
<b>Residential Development</b>									
Existing Residences (37 adjacent to Towradgi Lagoon / Creek)	Medium	High	High			✓✓	✓	NR10	

Symbol	
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

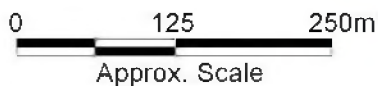


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Corrimal Beach**

Drawing:  
**6-36**

Rev:  
**A**

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6.13.3 Assessment of Treatment Options

Corrimal															
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 Corrimal Beach	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓	✓	x								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. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) <input checked="" type="checkbox"/> Council (Current Programs) - cost to prepare DCP <input checked="" type="checkbox"/> Private landholders - cost to implement DCP	Recommended
A2	Redesign or retrofit stormwater structures in current location to withstand impacts.	<b>Current Action:</b> NR7 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs, new levies or increased rates?) N/A Private landholders who directly benefit from option	Recommended

Symbol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overlapping 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.	<b>Current Action:</b> NR3 <b>Trigger:</b> When structure is refurbished or re-built.	x	x	✓								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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓								The majority of land and assets within the coastal inundation area are within the Flood Planning Area for Towradgi Lagoon. These properties will already 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. <i>Refer to Accommodate Options Table for further cost benefit details for FDCP.</i>	N/A State Government (external funding unlikely to be needed) <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Not Recommended
NR	NR1, NR3, NR5, NR7, NR9, NR10, NR11, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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													"Do Nothing" (Accept Risk)	
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate				No Regrets
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				✓✓		✓✓									
<b>Community Infrastructure</b>																		
Cycleway / Shared Pathway	Medium	High	High							✓				✓			NR6, NR14	
Towradgi Pool	High	Extreme	Extreme						✓						✓		NR4, NR14	
Towradgi Beach Lifeguard Tower	Low	Low	Medium							✓				✓				✓
<b>Transport Infrastructure</b>																		
Local Roads: Marine Parade (N end of beach)	Low	Medium	Medium							✓				✓✓			NR5	
<b>Water and sewage infrastructure</b>																		
Stormwater outlet / pipe (N end)	Medium	High	High							✓✓				✓			NR7, NR14	
<b>Residential Development</b>																		
Existing Residences (3 at N end)	Low	Medium	Medium										✓	✓	✓✓		NR14	
Existing Residences (1 at N end)	Medium	Medium	High									✓	✓	✓✓			NR14	

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

**KEY PLAN**

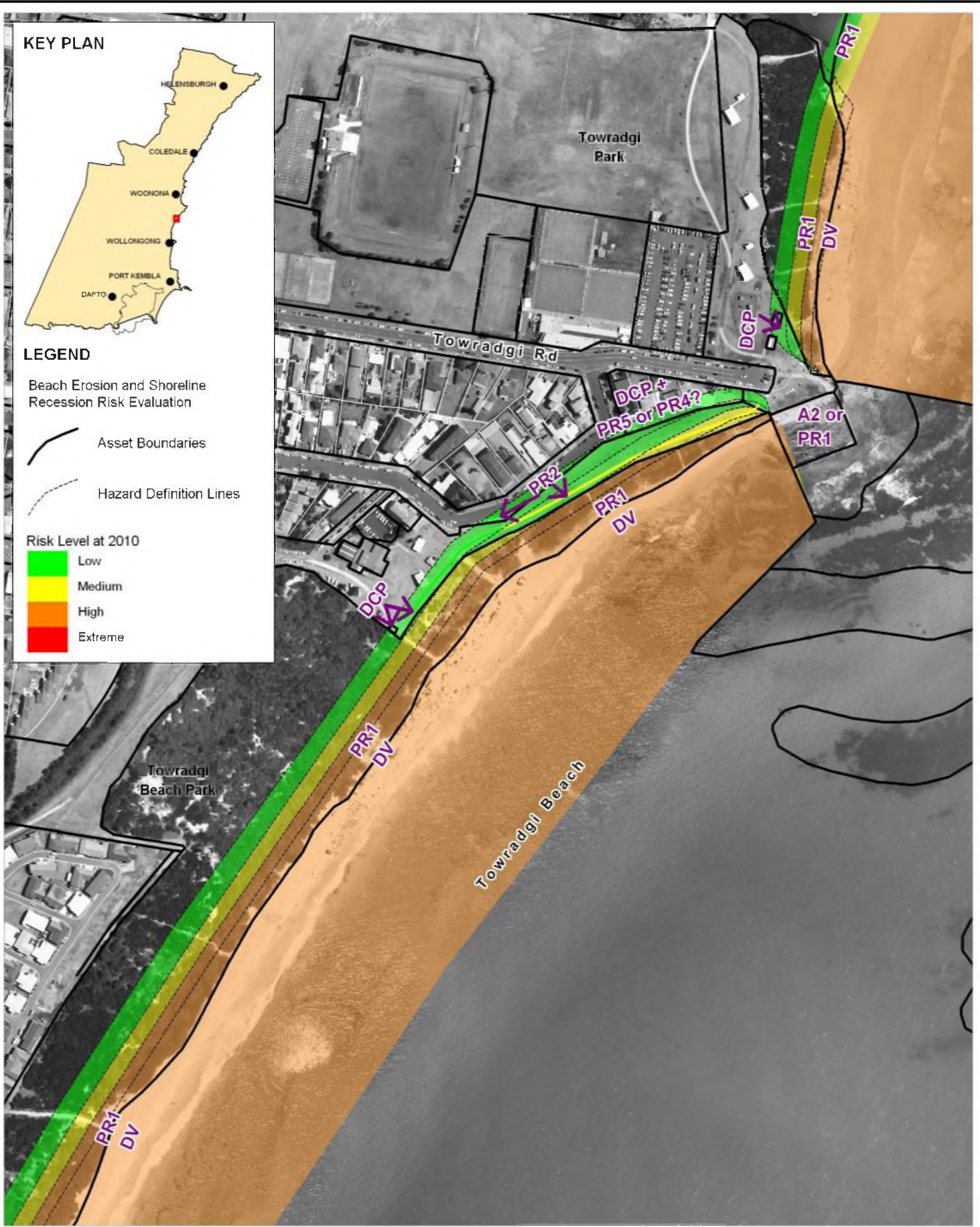


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



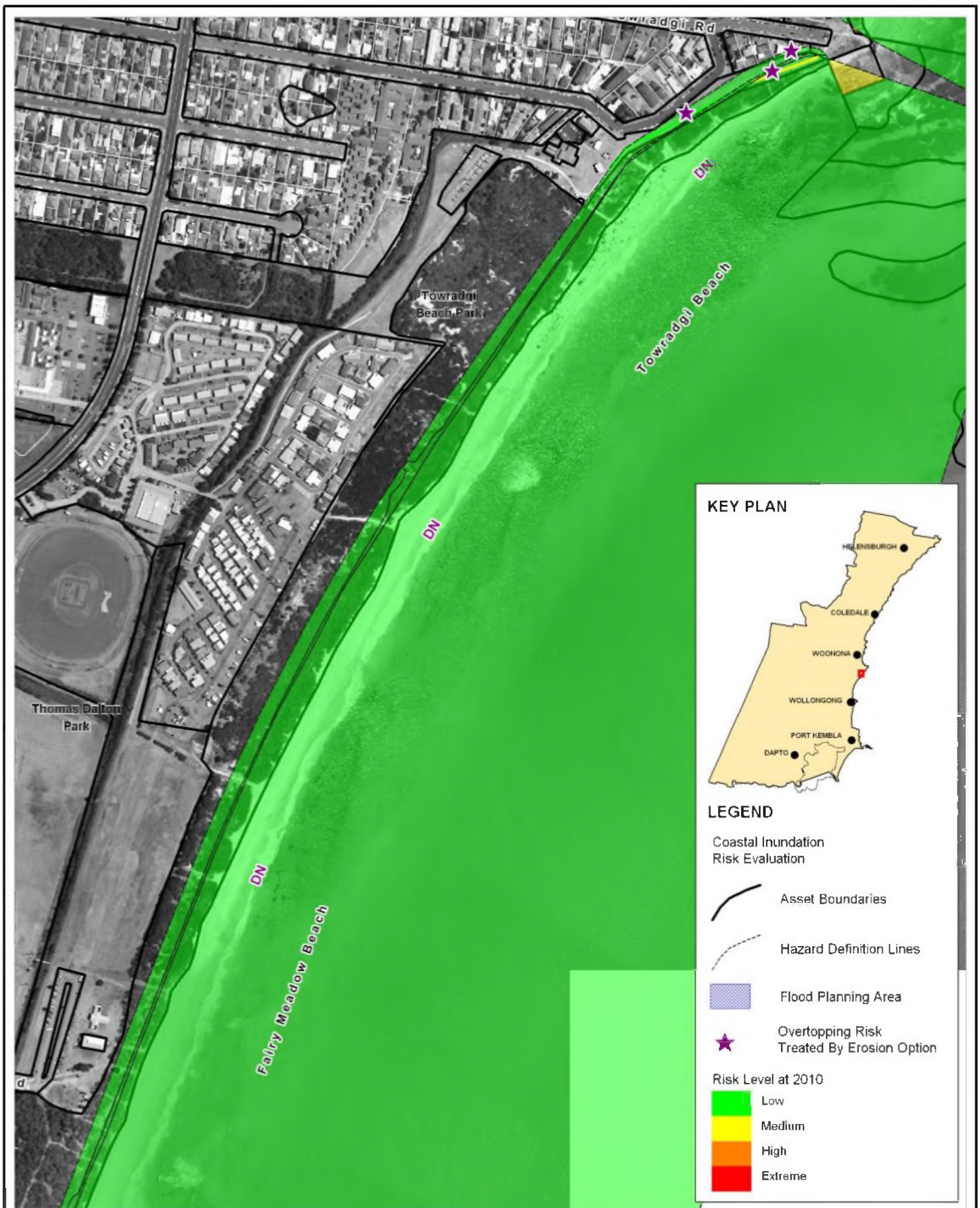
Title: <b>Immediate Erosion Risk Levels and Treatment Options Towradgi Beach</b>		Drawing: <b>6-37</b>	Rev: <b>A</b>
<p>BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.</p>		<p>Approx. Scale</p>	
		<p><b>BMT WBM</b> www.wbmpl.com.au</p>	

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**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				"Do Nothing" (Accept Risk)	
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					PR2	FDCP	A2	Investigate*	DN
Towradgi Beach	Low	Low	Medium						✓
Coastal Dune Systems	Low	Low	Medium						✓
<b>Community Infrastructure</b>									
Cycleway / Shared Pathway	Medium	Medium	High	✓					
Towradgi Pool	Medium	Medium	High	✓					
<b>Transport Infrastructure</b>									
Local Roads: Towradgi Road, Marine Parade (N end of beach)	Low	Low	Low	✓					
<b>Water and sewage infrastructure</b>									
Stormwater outlet / pipe (N end)	High	Extreme	Extreme	✓					
<b>Residential Development</b>									
Existing Residences (3 at N end)	Low	Low	Low	✓					
Existing Residences (1 at N end)	Low	Medium	Medium	✓					

Symbol	
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
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DCP	Apply development controls (future devt and re-devt)
A2	Redesign / retrofit in current location
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FDCP	Apply existing flood development controls (future devt and re-devt)
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



**KEY PLAN**

**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines
- Flood Planning Area
- Overtopping Risk Treated By Erosion Option

Risk Level at 2010

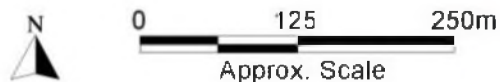
- Low
- Medium
- High
- Extreme

Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Towradgi Beach**

Drawing:  
**6-38**

Rev:  
**A**

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6.14.3 Assessment of Treatment Options

Towradgi															
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 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 maintained including to manage weeds (e.g. bitou). <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? 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). <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? 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	<b>Current Action:</b> NR3 <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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	<b>Current Action:</b> NR7 <b>Trigger:</b> 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 <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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	<b>Current Action:</b> NR6 <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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.	<b>Current Action:</b> NR4 <b>Trigger:</b> 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). <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) ☑ Council (Current Programs, new levies or increased rates?) N/A Private landholders who directly benefit from option	Recommended

RISK LEVELS AND TREATMENT OPTIONS

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 PR2 Beach	Potential Funding Sources (Who may pay)	Conclusion
PR4	Voluntary acquisition	<b>Current Action:</b> Apply for government funding. <b>Trigger:</b> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR4.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> 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. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> 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. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) <input checked="" type="checkbox"/> Council (Current Programs) - cost to prepare DCP and implement for public assets <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Not Recommended
NR	NR1, NR4, NR5, NR6, NR7, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended

## 6.15 Fairy Meadow Beach

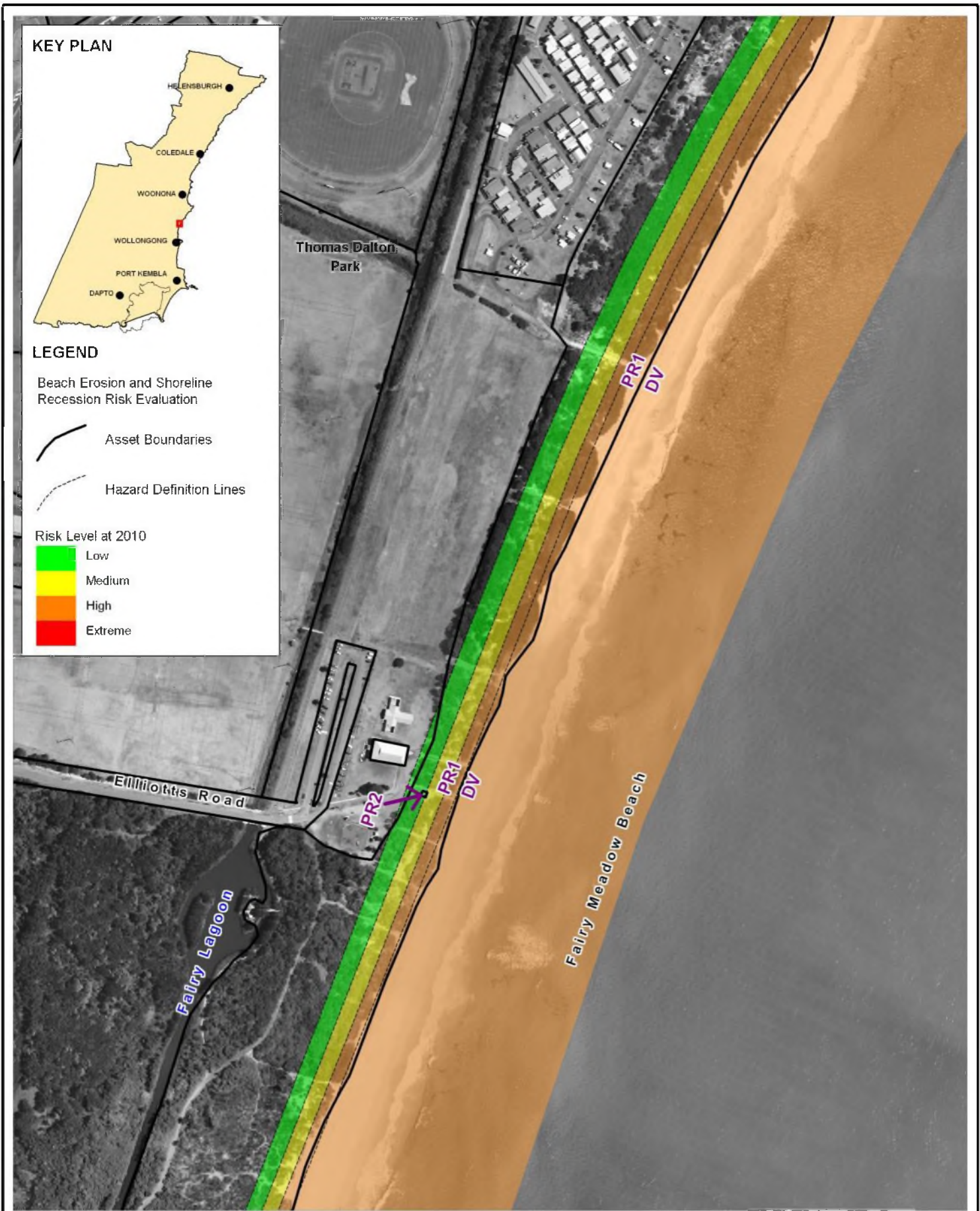
### 6.15.1 Erosion and Recession Risk Level and Treatment Options

Fairy Meadow Beach (extends to immediately north of Fairy Lagoon at boundary to Puckeys Estate)	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments													"Do Nothing" (Accept Risk)	
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate				No Regrets
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						"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets	Investigate*		
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						✓	

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

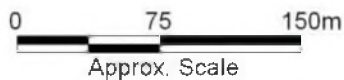


Title:  
**Immediate Erosion Risk Levels and Treatment Options  
Fairy Meadow Beach (north)**

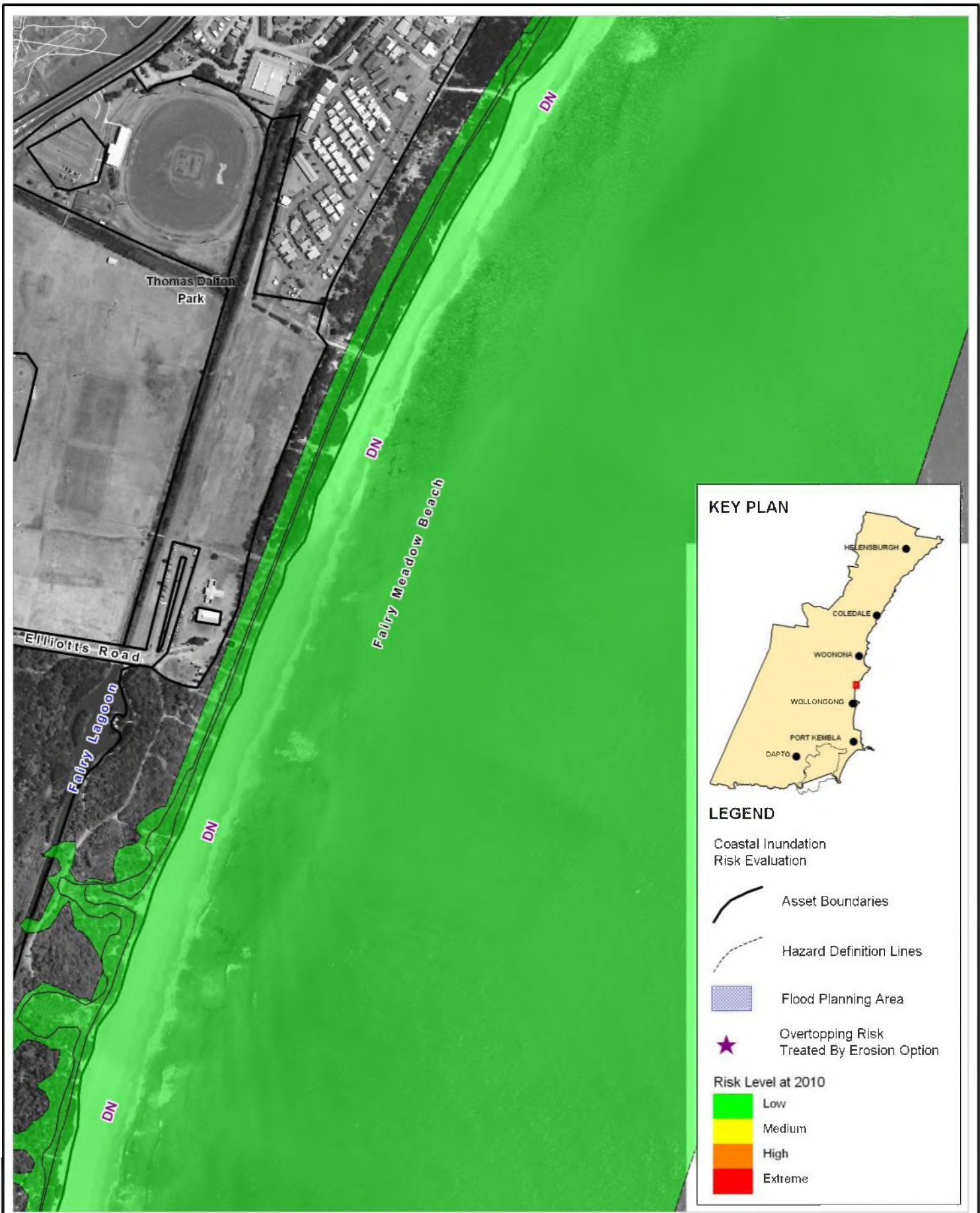
Drawing:  
**6-39**

Rev.:  
**A**

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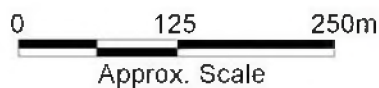


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Fairy Meadow Beach (north)**

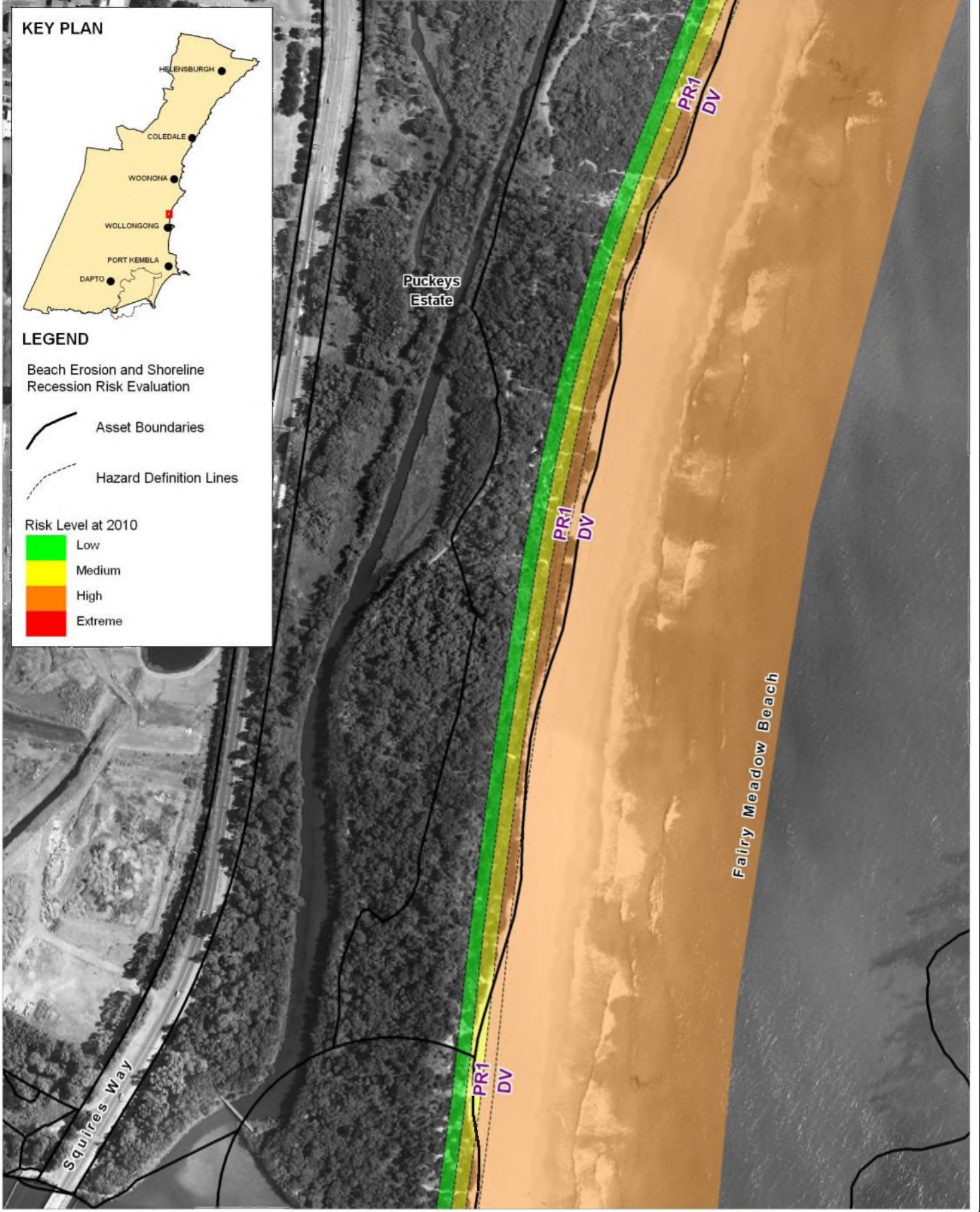
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**6-40**

Rev:  
**A**

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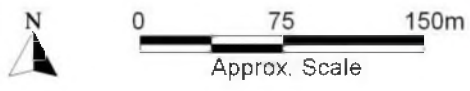


Title:  
**Immediate Erosion Risk Levels and Treatment  
Fairy Meadow Beach (south)**

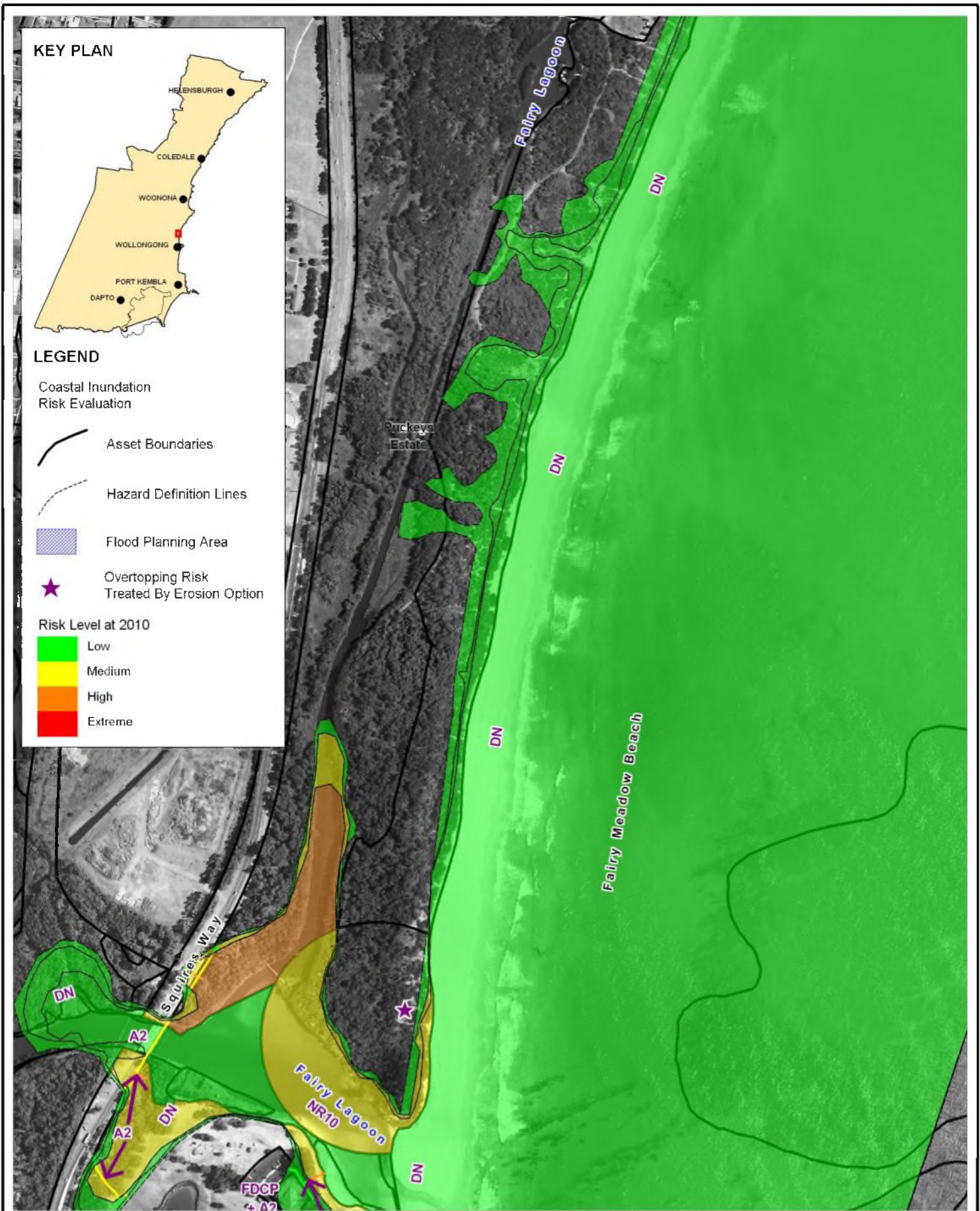
Drawing:  
**6-41**

Rev:  
**A**

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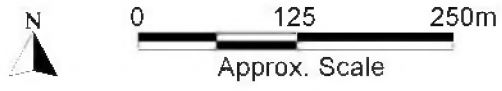
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Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Fairy Meadow Beach (south)**

Drawing: <b>6-42</b>	Rev: <b>A</b>
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6.15.2 Assessment of Treatment Options

Fairy															
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 Fairy Beach	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	x								Dune care programs must be considerate of sightline requirements for SLSC activities. Existing vegetation coverage is good and should be maintained and managed for weeds (e.g. bitou bush). <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended
PR2	Relocate lifeguard tower structure outside of hazard zone	<b>Trigger:</b> when ZRFC measured from erosion escarpment encroaches onto building foundations	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓	✓	x								Coastal DCP controls should apply to any future re-development of the lifeguard tower or other recreational facility. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) N/A Private landholders in Future Generations	Recommended
NR	NR1, NR11, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended

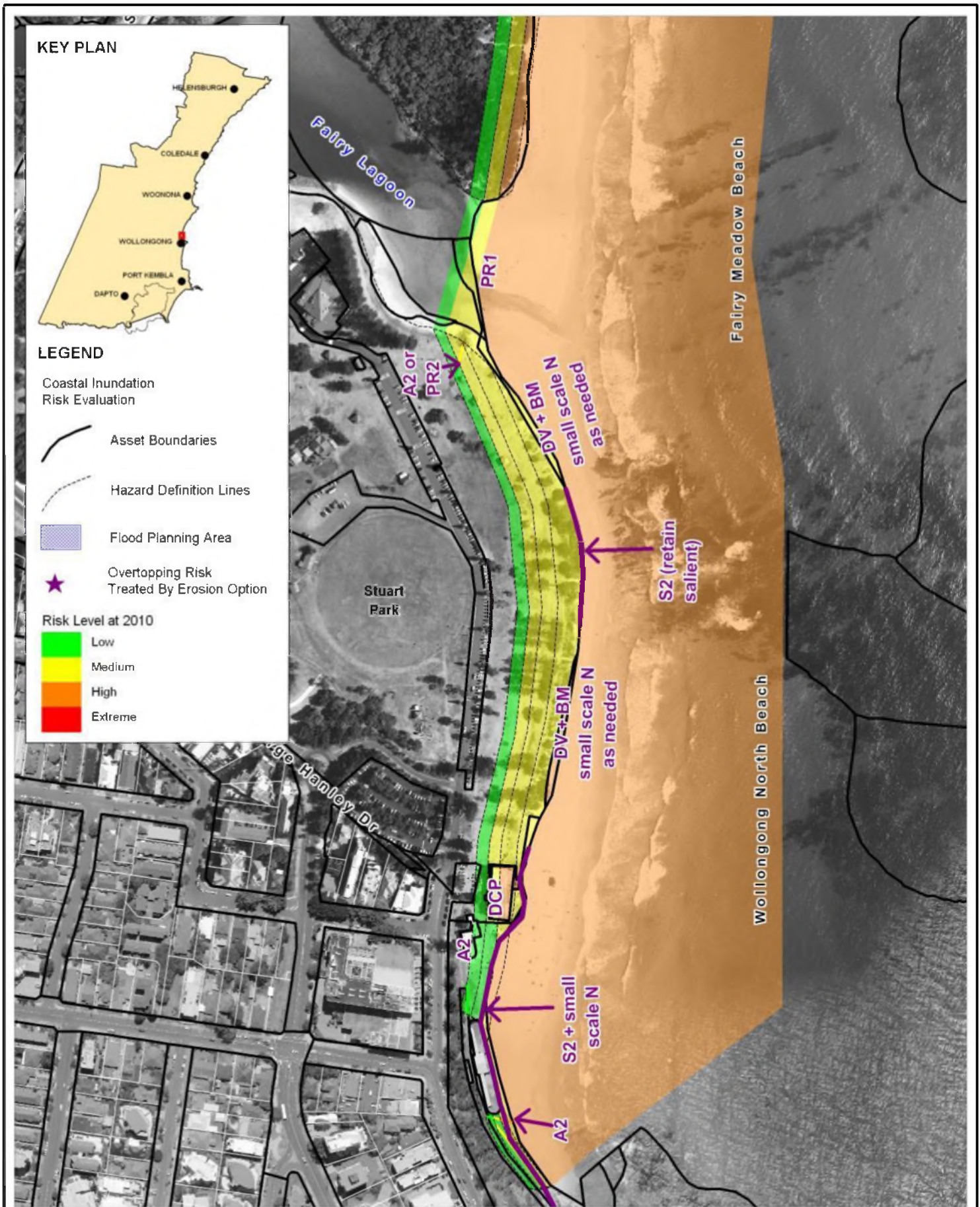


## 6.16 North Beach

### 6.16.1 Erosion and Recession Risk Level and Treatment Options

North Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														"Do Nothing" (Accept Risk)
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	
				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
<b>Parks, Beaches and open space</b>																		
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
<b>Community Infrastructure</b>																		
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
<b>Water and sewage infrastructure</b>																		
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	Revitalse 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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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**

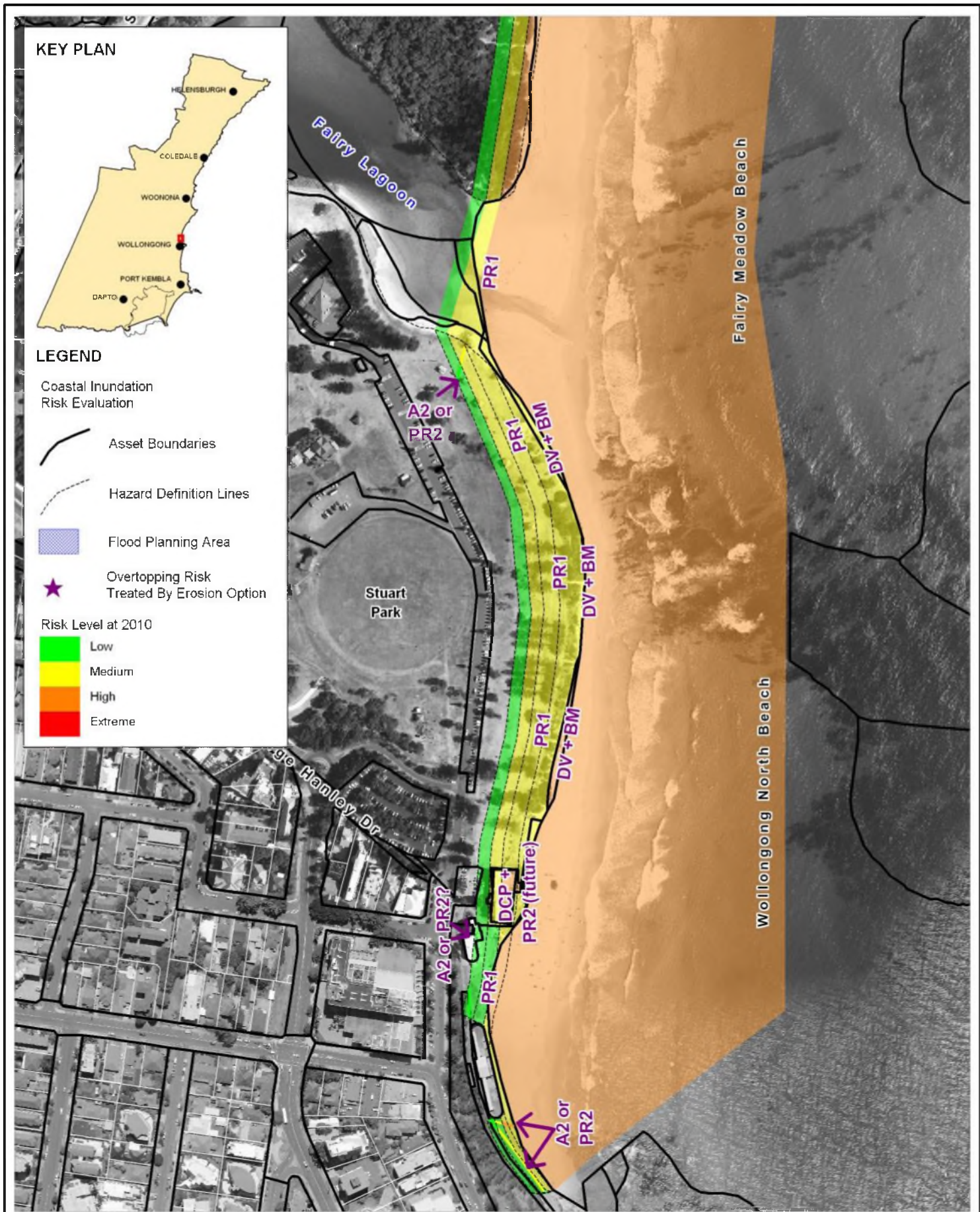
Drawing:  
**6-43**

Rev:  
**A**

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

Drawing:  
**6-44**

Rev:  
**A**

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Approx. Scale

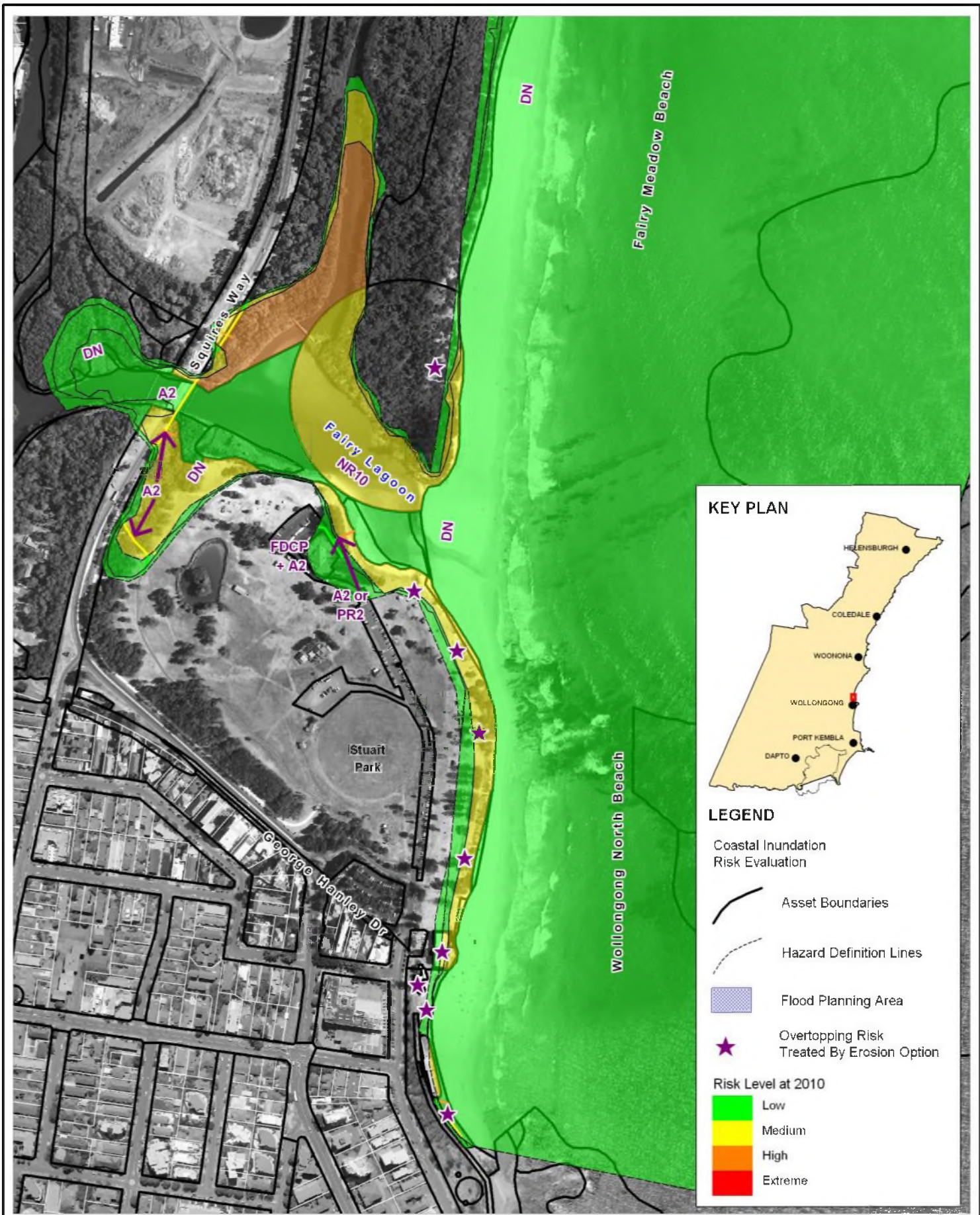


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**6.16.2 Coastal Inundation Risk Level and Treatment Options**

North Beach	Inundation Risk Level			Inundation Risk Treatments					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					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						✓
<b>Community Infrastructure</b>									
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	✓
<b>Water and sewage infrastructure</b>									
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	✓		✓			
<b>Transport Infrastructure</b>									
Major roads (Pioneer Road)	Medium	High	High			✓	✓	NR14	
Local road (beach access into Lagoon restaurant and car park)	Low	Low	Medium			✓			✓

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

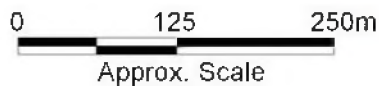


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Wollongong North Beach**

Drawing:  
**6-45**

Rev:  
**A**

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6.16.3 Assessment of Treatment Options

North Beach															
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 North Beach Beach	Potential Funding Sources (Who may pay)	Conclusion
S2	Construct seawall along specified alignments to protect specific assets	<b>Current Action:</b> NR2, detailed designs and planning approvals <b>Trigger:</b> 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 Pavilion 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	<b>Current Action:</b> Determine requirements in combinations with S2 (above) <b>Trigger:</b> 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. <i>Refer to Protect Options Table for further cost benefit details for N.</i>	? 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. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? 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. <i>Refer to Protect Options Table for further cost benefit details for BM.</i>	? State Government (Grant Programs) ☑ Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended

RISK LEVELS AND TREATMENT OPTIONS

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 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	✓	✓	x								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) <input checked="" type="checkbox"/> 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	<b>Current Action:</b> NR3, DCP <b>Trigger:</b> At scheduled time for asset maintenance OR when ZRFC measured from erosion escarpment encroaches onto building foundations, whichever is sooner	✓	✓	x								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 should 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) <input checked="" type="checkbox"/> 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	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe	✓	✓	x								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) <input checked="" type="checkbox"/> 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	<b>Current Action:</b> NR6 <b>Trigger:</b> When ZRFC measured from erosion escarpment encroaches cycleway	✓	✓	x								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 be relocated with the path. Refer to Planned Retreat Options Table for further cost benefit details for PR2.	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓	✓	x								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) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR6 <b>Trigger:</b> When ZRFC measured from erosion escarpment encroaches cycleway	✓	✓	x								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) <input checked="" type="checkbox"/> Council (new levies or increased rates) N/A Private landholders who directly benefit from option	Marginal

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 DCP Beach	Potential Funding Sources (Who may pay)	Conclusion
A2	Redesign or retrofit kiosk structure and Lagoon Kiosk in current location to withstand impacts.	<b>Current Action:</b> NR3 <b>Trigger:</b> 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). <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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.	<b>Current Action:</b> NR7 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓								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). <i>Refer to Accommodate Options Table for further cost benefit details for FDCP.</i>	N/A State Government (external funding unlikely to be needed) <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Not Recommended
NR	NR1, NR2, NR3, NR6, NR7, NR10, NR11, NR12, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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.

**KEY PLAN**

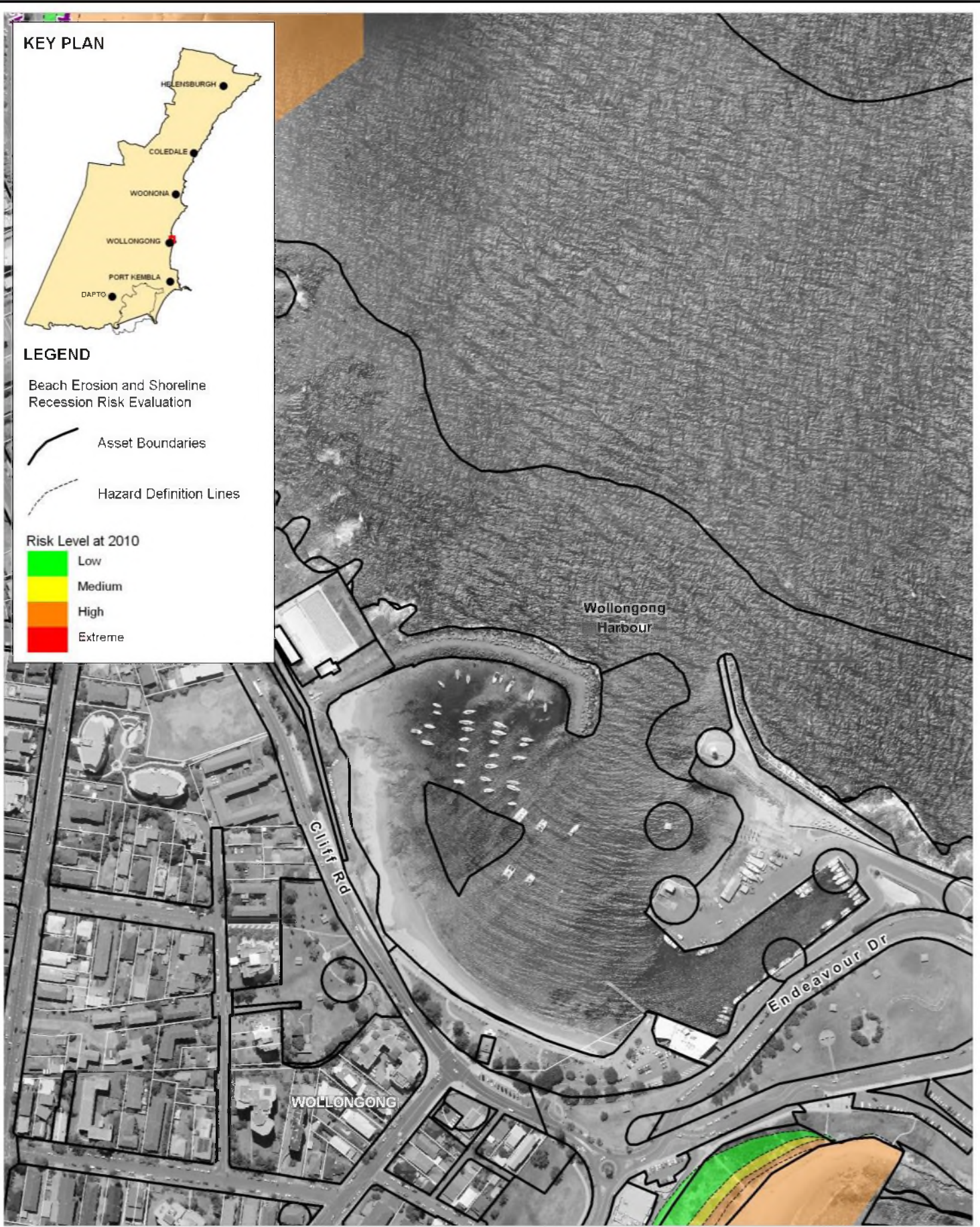


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

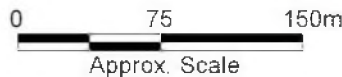


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Immediate Planning Horizon - Wollongong Boat Harbour**

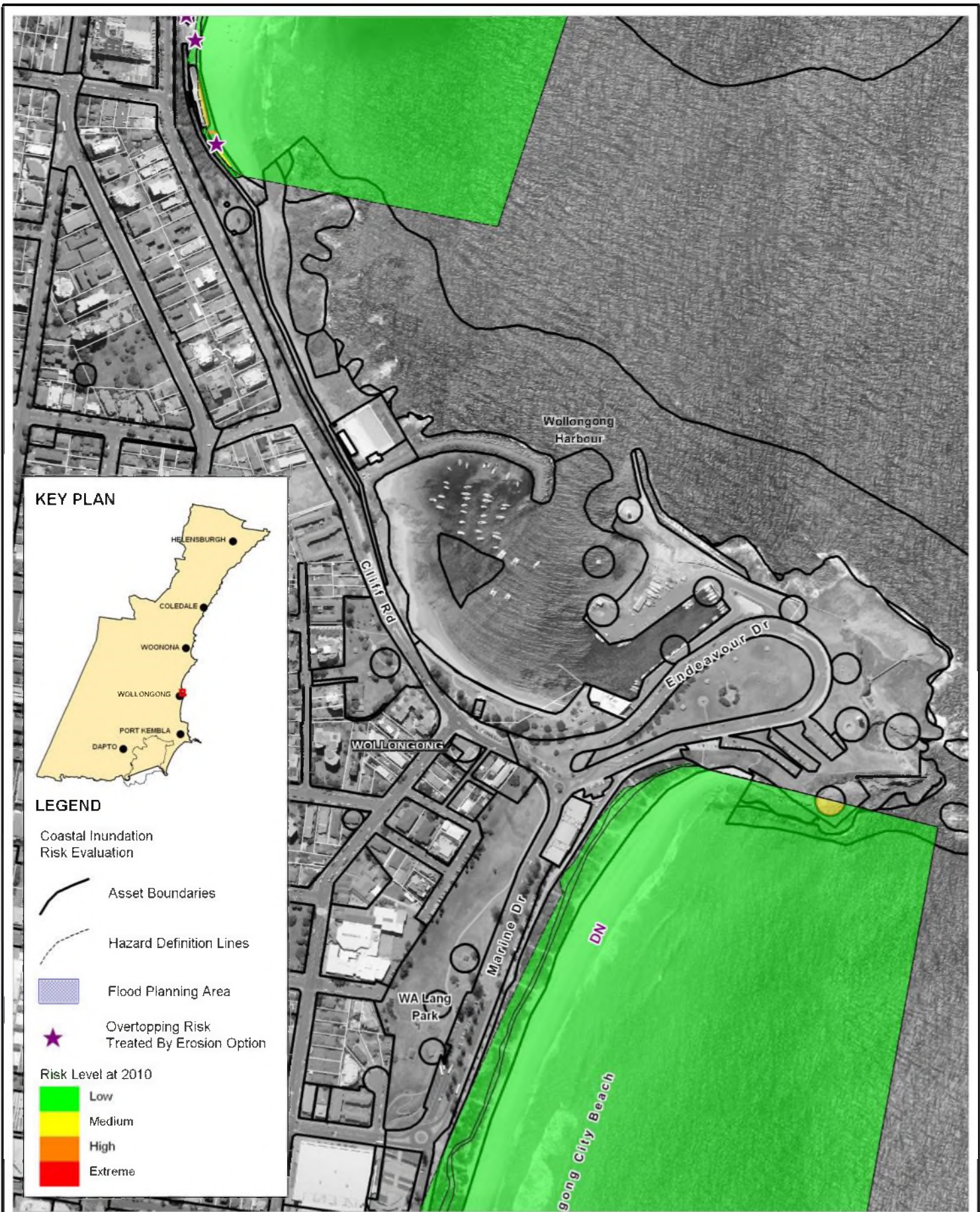
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**6-46**

Rev:  
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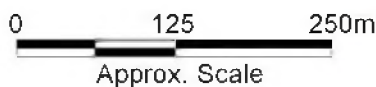


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Wollongong Harbour**

Drawing:  
**6-47**

Rev:  
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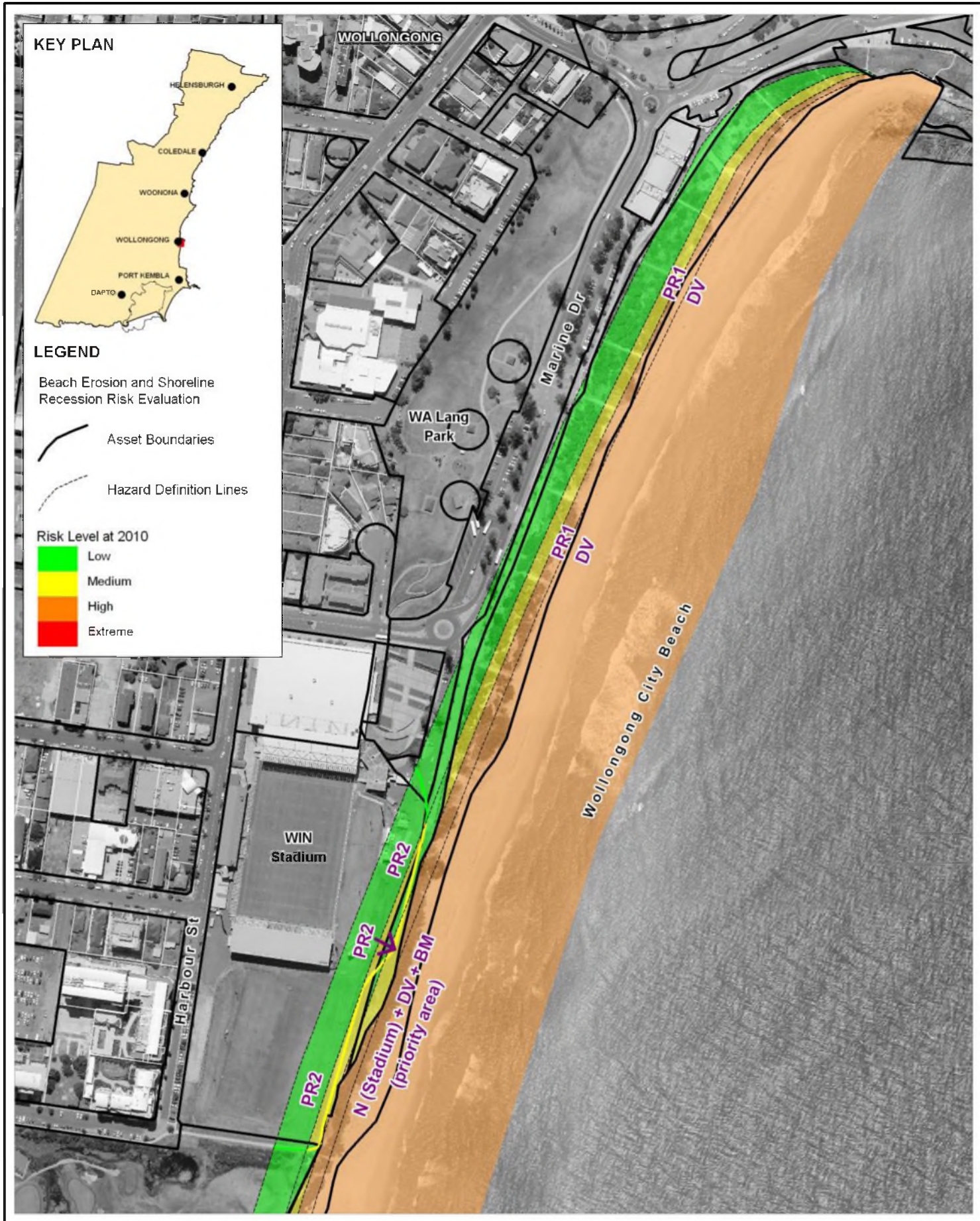
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## 6.18 City Beach

### 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														"Do Nothing" (Accept Risk)	
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect				Planned Retreat					Accommodate			No Regrets			
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				✓✓		✓✓										
<b>Community Infrastructure</b>																			
Cycleway / Shared Pathway	Medium	High	Extreme							✓✓				✓				NR6, NR14	
<b>Transport Infrastructure</b>																			
Local Roads: Beach access car parks	Low	Low	Medium						✓✓										✓

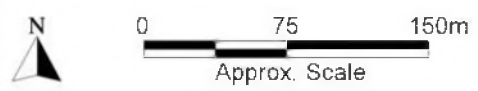
Sym- bol	
N	Nourishment
S1	Seawall - long or majority of beach
S2	Seawall - short sections
DV	Revitalise Dune Care Programs
BM	Manage beach sands
PR1	Accept loss as sacrificial
PR2	Relocate out of hazard zone
PR3	Prohibit development expansion
PR4	Voluntary Acquisition
PR5	Buy back then lease back
DCP	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: <b>6-48</b>	Rev: <b>A</b>
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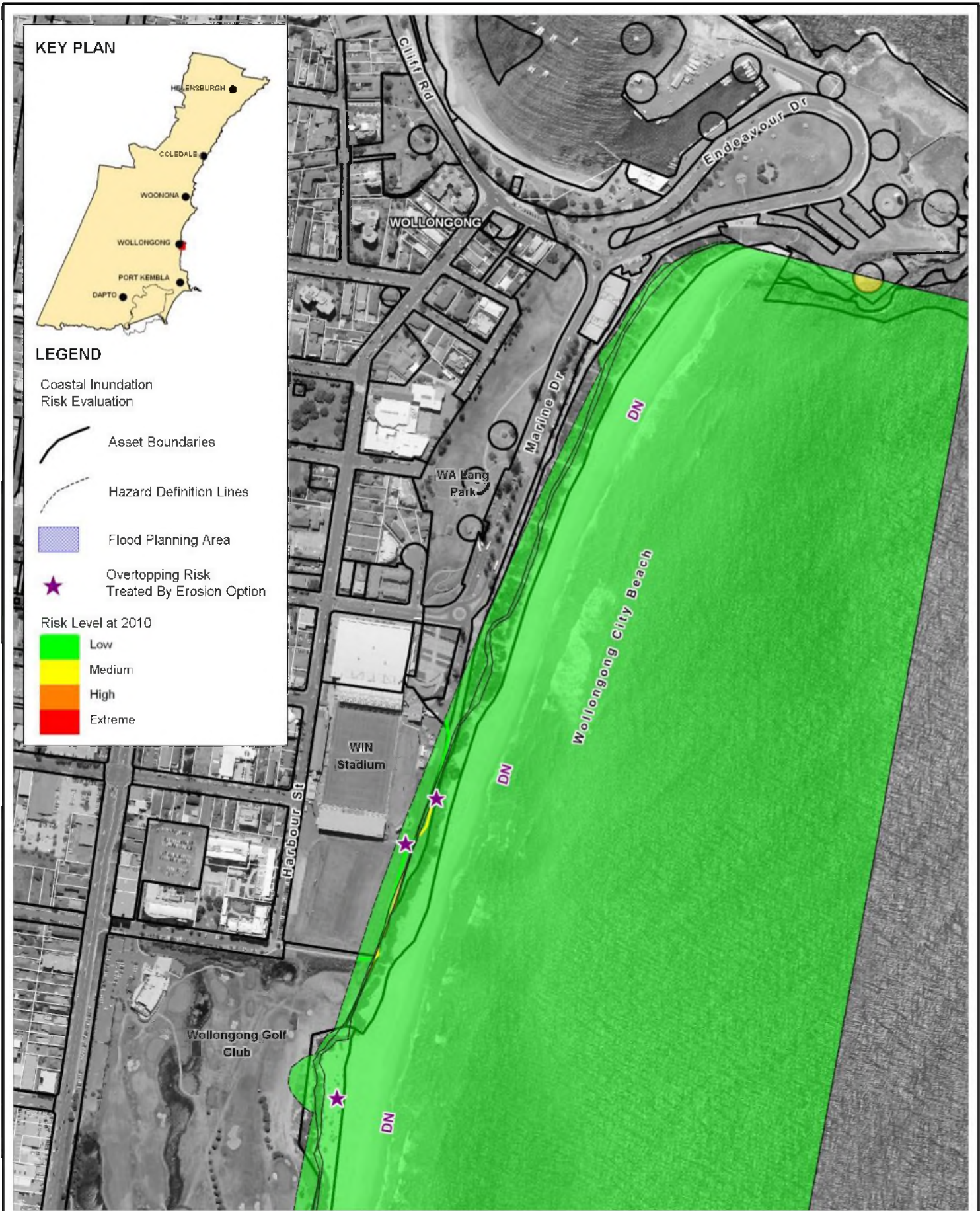


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**6.18.2 Coastal Inundation Risk Level and Treatment Options**

City Beach (extending to northern boundary of golf course)	Inundation Risk Level			Inundation Risk Treatments				"Do Nothing" (Accept Risk)	
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					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						✓
<b>Community Infrastructure</b>									
Cycleway / Shared Pathway	Medium	Medium	High	✓					
<b>Transport Infrastructure</b>									
Local Roads: Beach access car parks	Low	Low	Low						✓
<b>Commercial and Industrial Development</b>									
<i>NB: Nuns Pools and Ladies Pool at rock platform off Flagstaff Hill</i>	Low	Low	Low						✓

Symbol	
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 devt and re-devt)
A2	Redesign / retrofit in current location
A3	Replace with relocatable structure
FDCP	Apply existing flood development controls (future devt and re-devt)
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

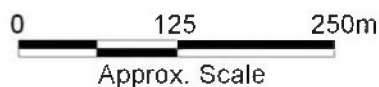


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Wollongong City Beach**

Drawing:  
**6-49**

Rev:  
**A**

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### 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)	✓	✓	x								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). <i>Refer to Protect Options Table for further cost benefit details for N.</i>	? State Government (Grant Programs) - unlikely to fund private property protection <input checked="" type="checkbox"/> Council (new levies or increased rates) <input checked="" type="checkbox"/> Private landholders who directly benefit from option (personal investment or directed by Council)	Marginal		
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details for BM.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	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	<b>Current Action:</b> NR6 <b>Trigger:</b> When ZRFC measured from erosion escarpment encroaches cycleway	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	<b>Trigger:</b> When erosion escarpment encroaches on the assets.	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? State Government (Grant Programs) ? Council (new levies or increased rates) b 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	✓	✓	x								This option shall apply planning controls to re-development of the Stadium and associated grounds to minimise future risk from hazards. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) <input checked="" type="checkbox"/> Council (Current Programs) - cost to prepare DCP and implement for public assets <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Not Recommended
NR	NR1, NR3, NR5, NR7, NR9, NR10, NR11, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended

### 6.19 Coniston Beach

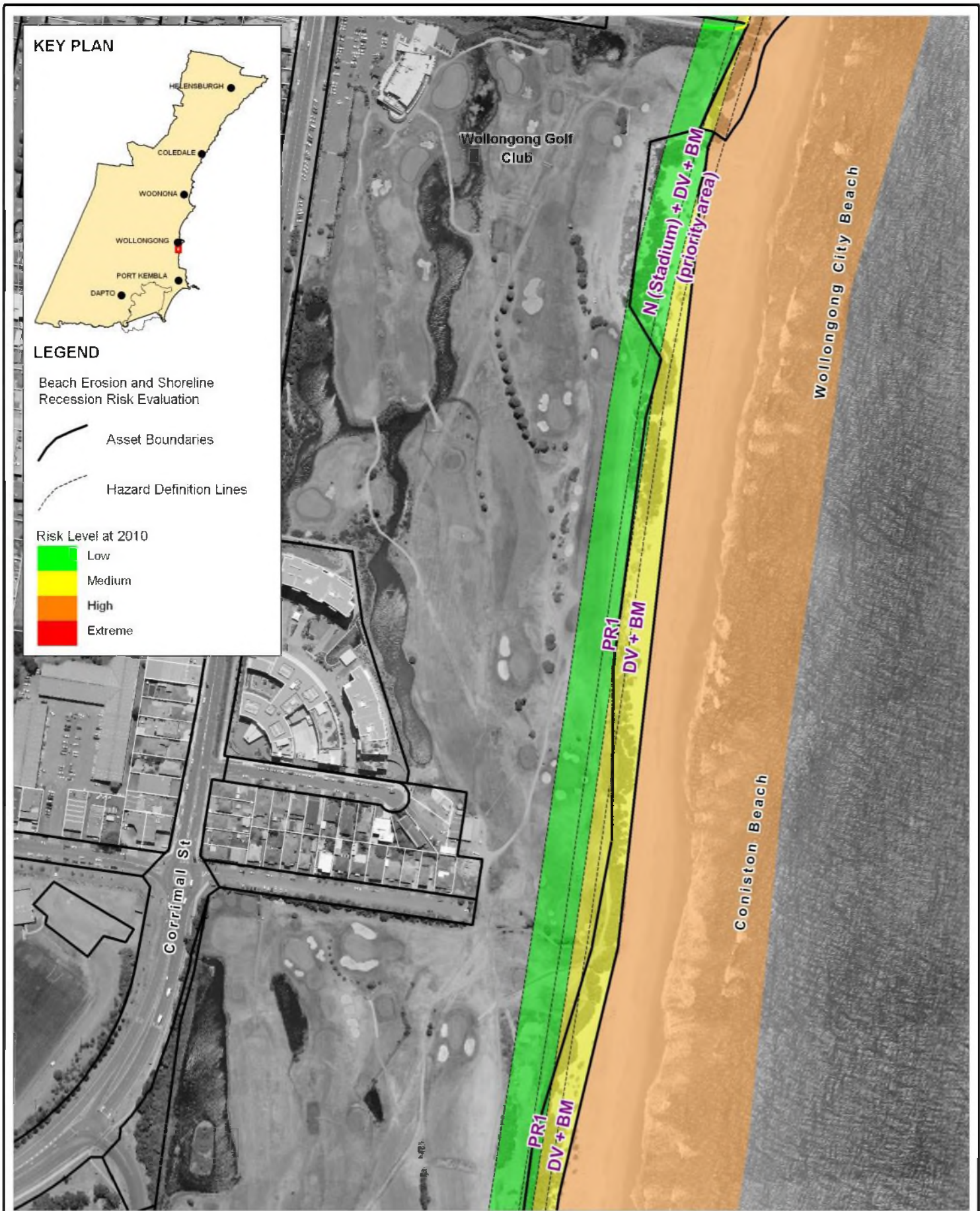
#### 6.19.1 Erosion and Recession Risk Level and Treatment Options

Coniston Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														"Do Nothing" (Accept Risk)
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect				Planned Retreat					Accommodate			No Regrets		
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						"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate		No Regrets		
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						✓	

Symbol	
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
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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

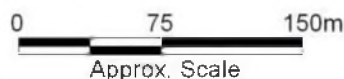


Title:  
**Immediate Erosion Risk Levels and Treatment Options  
Coniston Beach (north)**

Drawing:  
**6-50**

Rev:  
**A**

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**KEY PLAN**

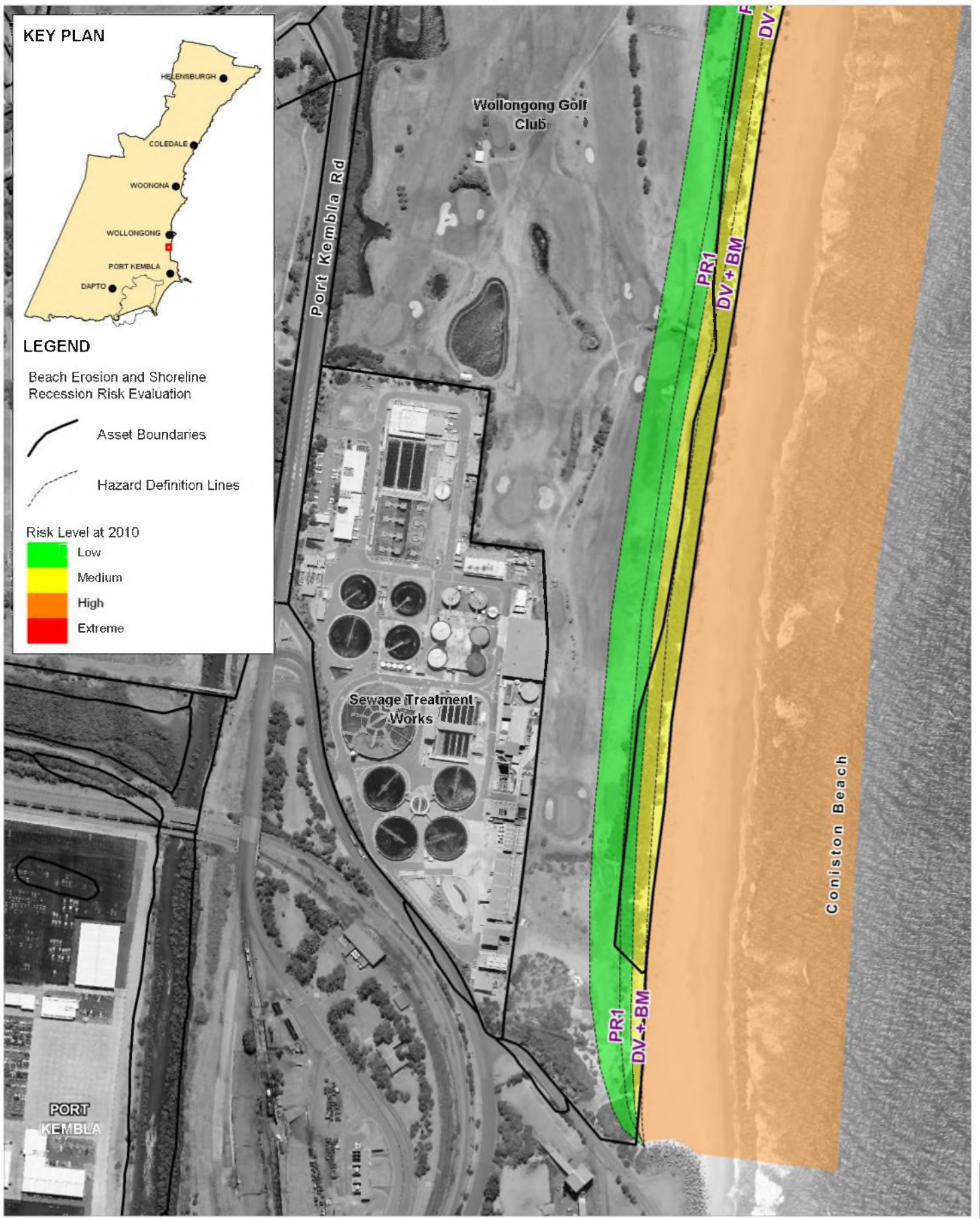
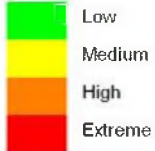


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

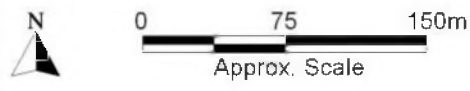
Risk Level at 2010



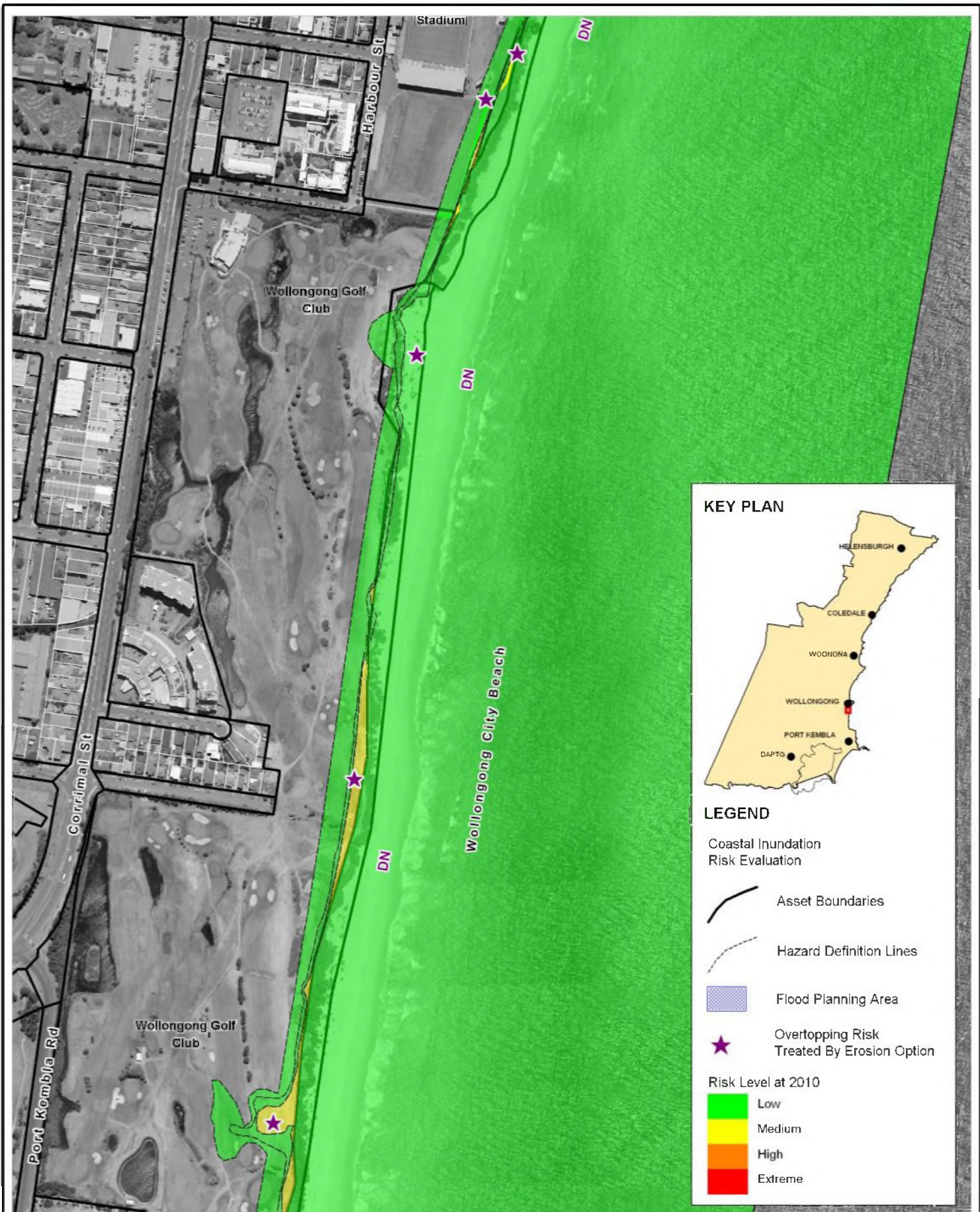
Title:  
**Immediate Erosion Risk Levels and Treatment  
Coniston Beach (south)**

Drawing: <b>6-51</b>	Rev: <b>A</b>
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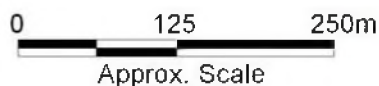


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Coniston Beach (north)**

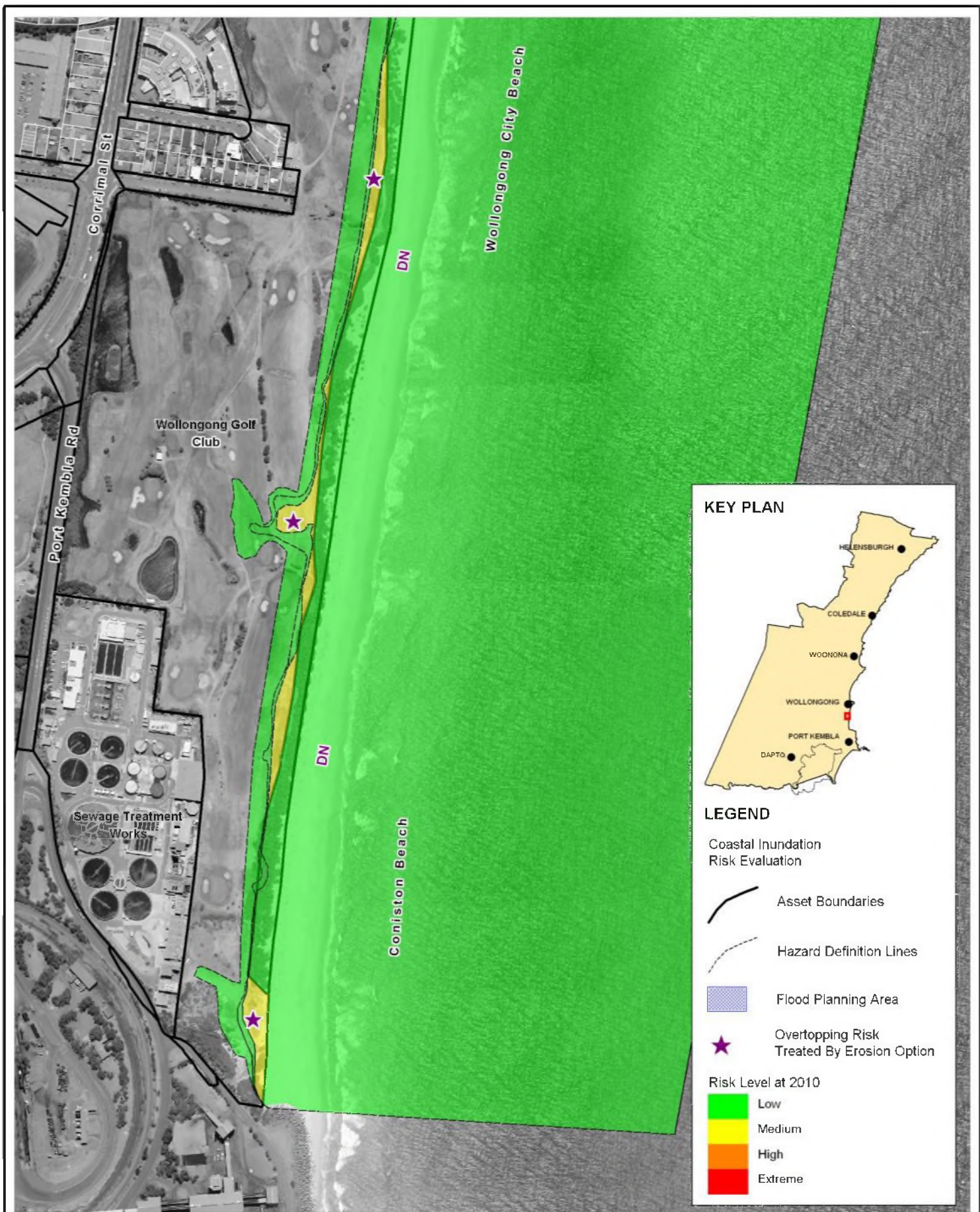
Drawing:  
**6-52**

Rev:  
**A**

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**KEY PLAN**

**LEGEND**

Coastal Inundation Risk Evaluation

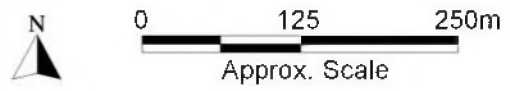
- Asset Boundaries
- Hazard Definition Lines
- Flood Planning Area
- Overtopping Risk Treated By Erosion Option

Risk Level at 2010

- Low
- Medium
- High
- Extreme

<p>Title: <b>Immediate Inundation Risk Levels and Treatment Options Coniston Beach (south)</b></p>	<p>Drawing: <b>6-53</b></p>	<p>Rev: <b>A</b></p>
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6.19.2 Assessment of Treatment Options

Coniston															
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 Coniston Beach	Potential Funding Sources (Who may pay)	Conclusion
DV	Revitalise and undertake Dune Care Programs	Now and continuing	✓	✓	x								This is a priority 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. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓	✓	x								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. <i>Refer to Protect Options Table for further cost benefit details for BM.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓	✓	x								This is an excellent option for retaining the beach. The golf course will remain a viable land use even if after erosion impacts. Dune vegetation works aim to slow the progression of erosion, at least over the short term. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓	✓	x								Coastal DCP development controls shall be applied to Wollongong Golf Course lands, in the case of redevelopments on the site. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? State Government (Grant programs) <input checked="" type="checkbox"/> Council (Current Programs) - cost to prepare DCP and implement for public assets <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Marginal

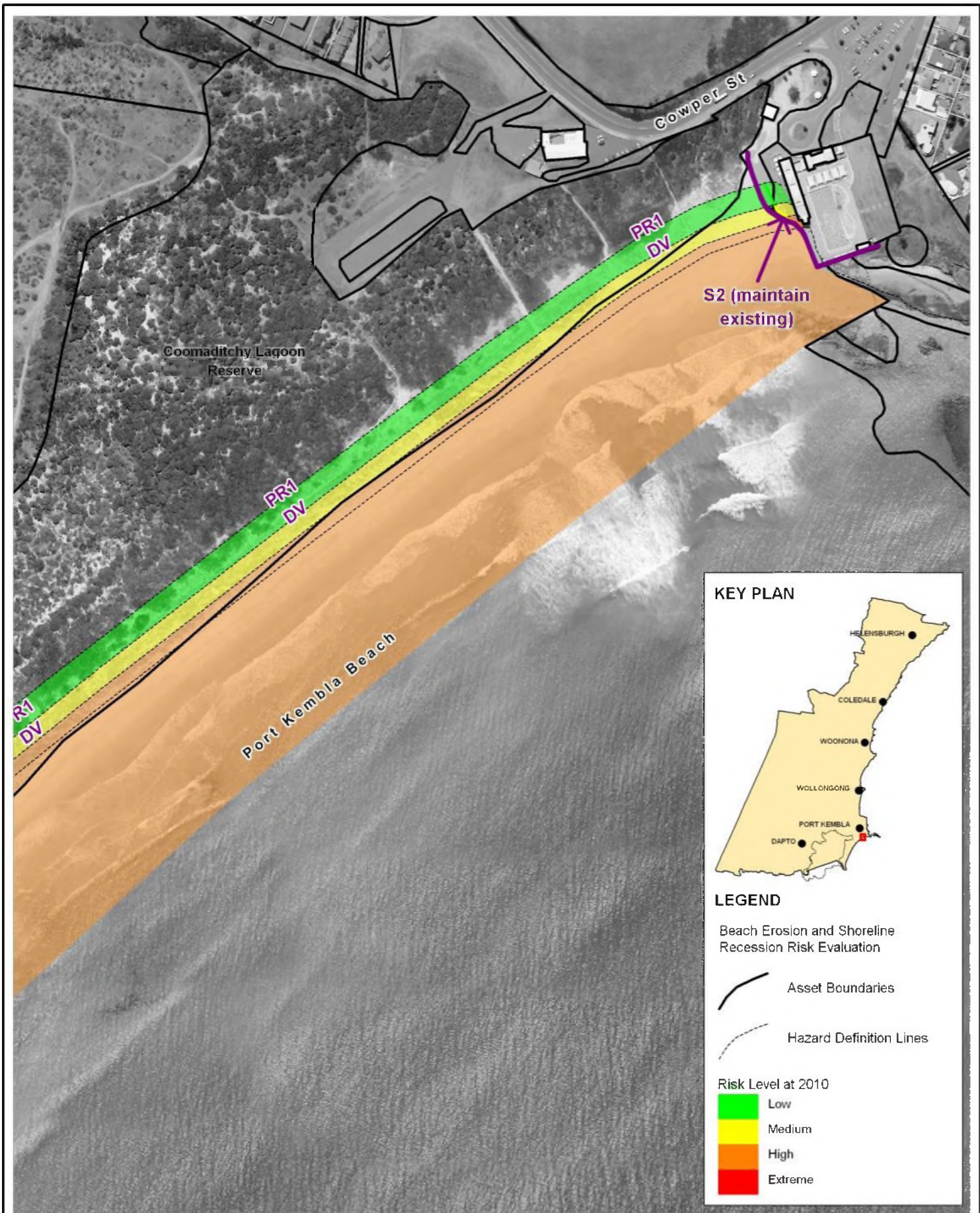
## 6.20 Perkins Beach

### 6.20.1 Erosion and Recession Risk Level and Treatment Options

Perkins Beach	Erosion and Recession Risk Level			Erosion / Recession Risk Treatments														"Do Nothing" (Accept Risk)
	Erosion by 2010	Erosion by 2050	Erosion by 2100	Protect					Planned Retreat					Accommodate			No Regrets	
				N	S1	S2	DV	BM	PR1	PR2	PR3	PR4	PR5	DCP	A2	A3	Investigate*	DN
<b>Parks, Beaches and open space</b>																		
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						✓✓									✓
<b>Community Infrastructure</b>																		
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											✓✓				
<b>Transport Infrastructure</b>																		
Lake Illawarra Training Walls	High	Extreme	Extreme												✓		NR14	
<b>Water and sewage infrastructure</b>																		
Stormwater outlets & pipes (one adjacent to Port Kembla Pool)	High	Extreme	Extreme			✓✓				✓				✓			NR7, NR2, NR14	

Symbol	
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





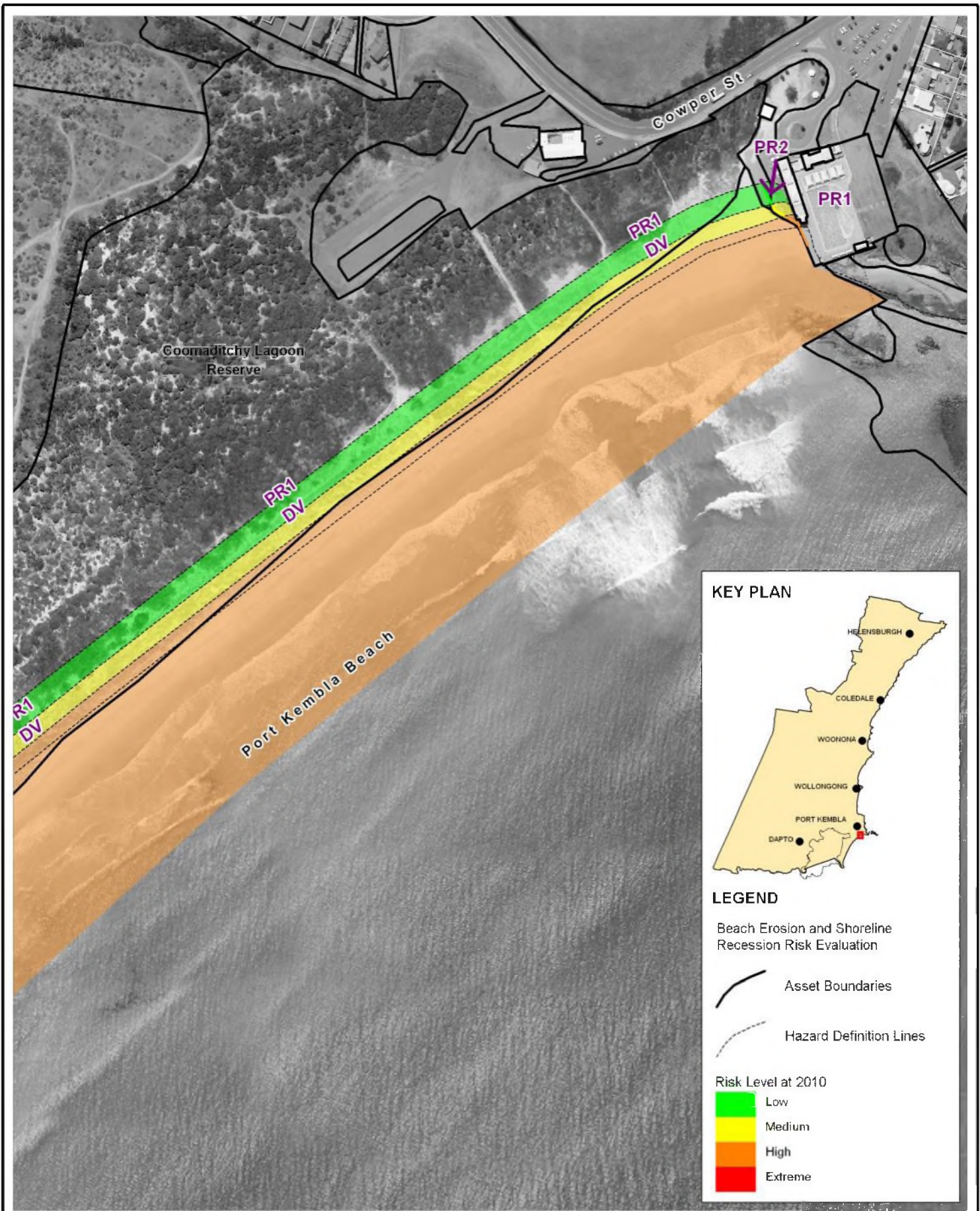
Title:  
**Immediate Erosion Risk Levels and Treatment Options  
 Port Kembla Beach - Seawall S2 Option**

Drawing: **6-54**      Rev: **A**

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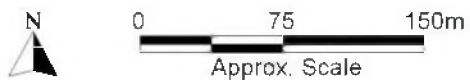
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Title:  
**Immediate Erosion Risk Levels and Treatment Options  
 Port Kembla Beach - Planned Retreat Option**

Drawing: **6-55**      Rev: **A**

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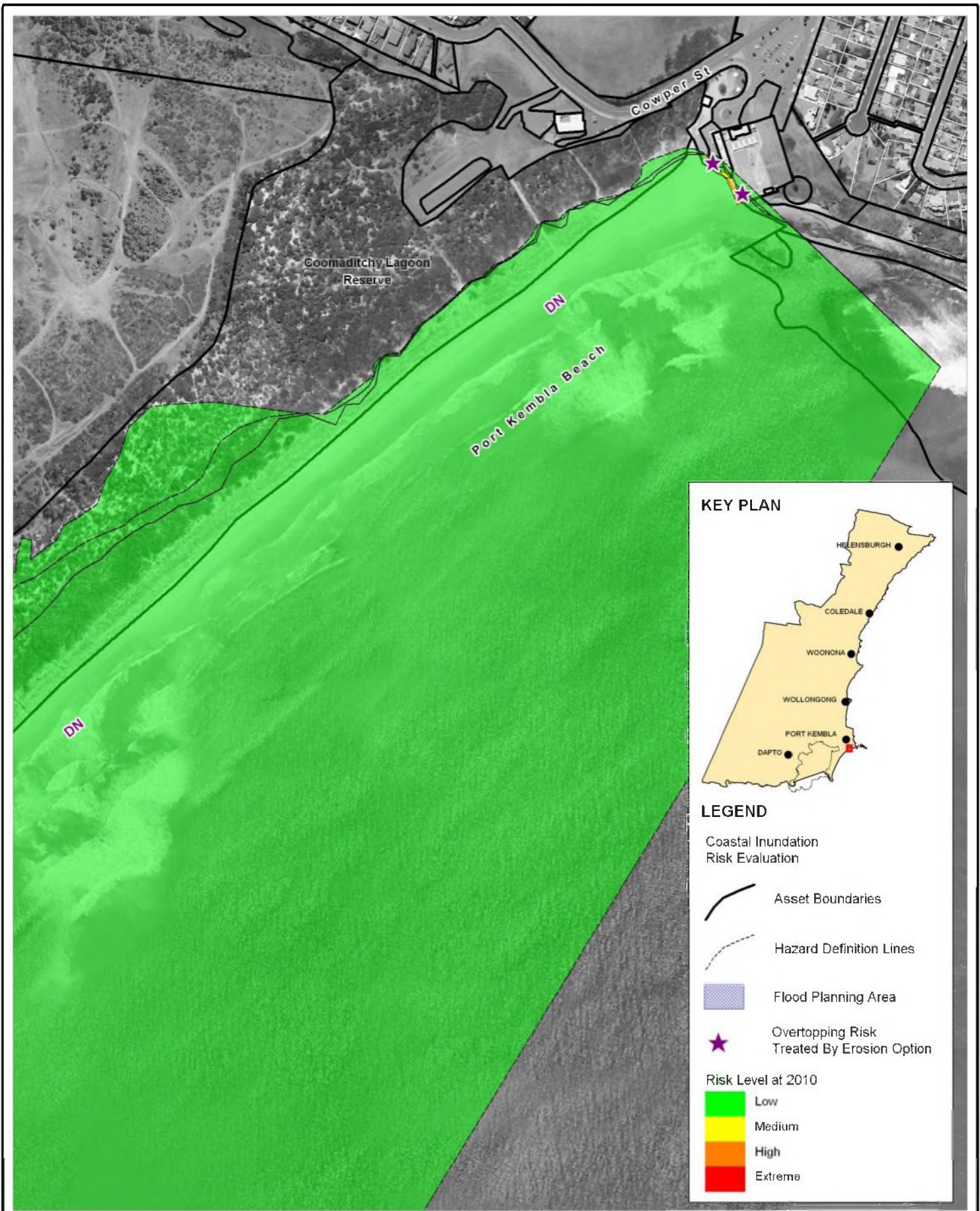


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**6.20.2 Coastal Inundation Risk Level and Treatment Options**

Perkins Beach	Inundation Risk Level			Inundation Risk Treatments				"Do Nothing" (Accept Risk)	
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Overtopping risk treated by erosion option	Planned Retreat	Accommodate	No Regrets		
<b>Parks, Beaches and open space</b>					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						✓
<b>Community Infrastructure</b>									
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	✓					✓
<b>Transport Infrastructure</b>									
Local Roads	Low	Medium	Medium						✓
Lake Illawarra Training Walls	Low	Low	Medium						✓
<b>Water and sewage infrastructure</b>									
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

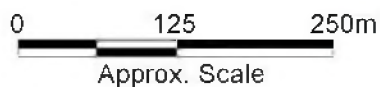


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Port Kembla Beach**

Drawing:  
**6-56**

Rev:  
**A**

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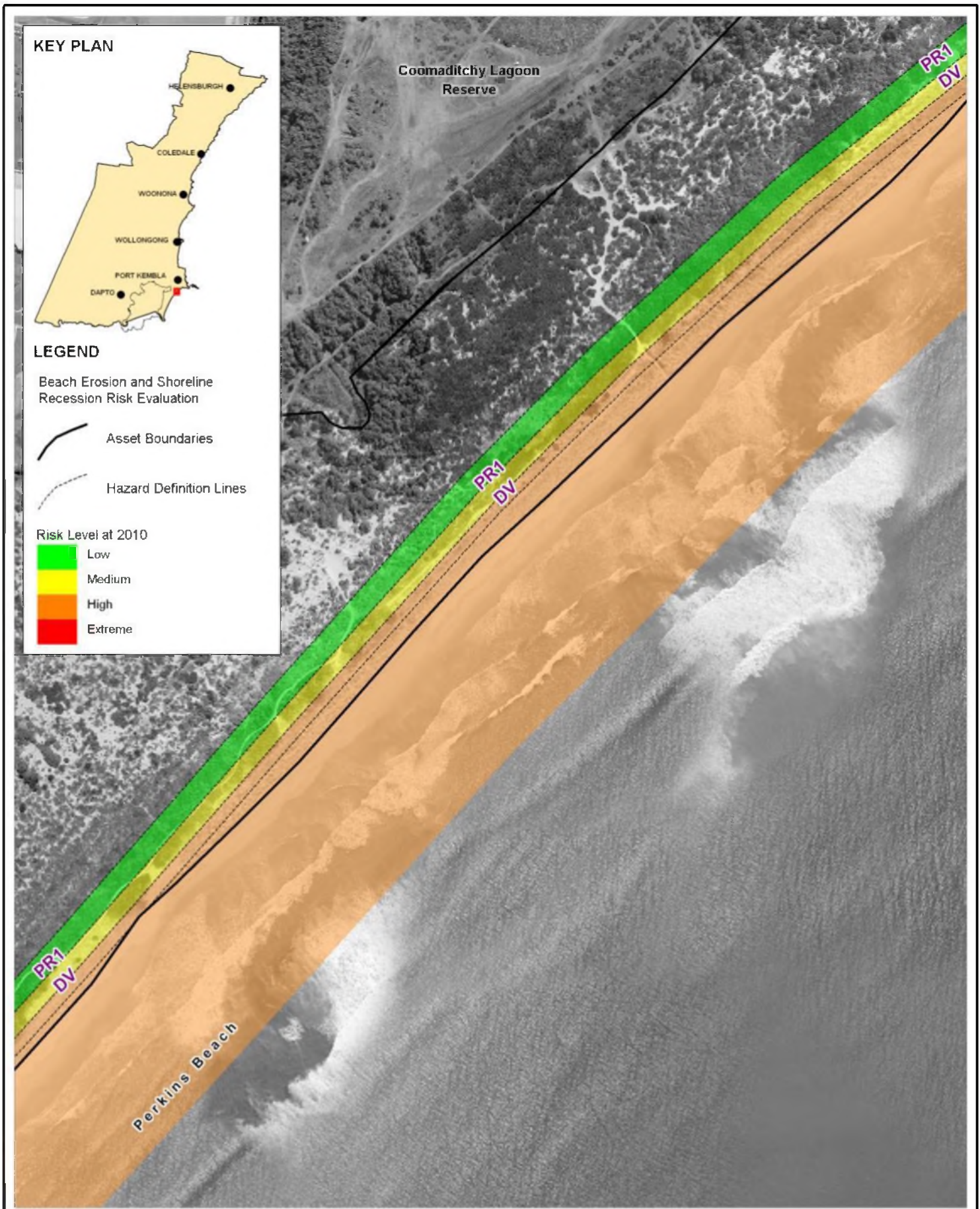


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### 6.20.3 Assessment of Treatment Options

Perkins															
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 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. <i>Refer to Protect Options Table for further cost benefit details for S2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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. <i>Refer to Protect Options Table for further cost benefit details for DV.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR1.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> Council (Current Programs) N/A Private landholders who directly benefit from option	Not Recommended

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 PR1 Beach	Potential Funding Sources (Who may pay)	Conclusion
PR2	Relocate stormwater assets landward of hazard zone	<b>Current Action:</b> NR7 <b>Trigger:</b> When erosion or wave overtopping destabilises outlet or pipe OR the pipe requires replacement, whichever is sooner.	✓	✓	x								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. <i>Refer to Planned Retreat Options Table for further cost benefit details for PR2.</i>	? 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	✓	✓	x								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. <i>Refer to Accommodate Options Table for further cost benefit details for DCP.</i>	? 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.	<b>Current Action:</b> None <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	☑ 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? 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	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) ☑ Council (Current Programs) N/A Private landholders who directly benefit from option	Recommended

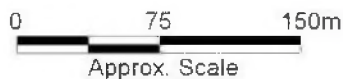


Title:  
**Immediate Erosion Risk Levels and Treatment  
 Perkins Beach (1)**

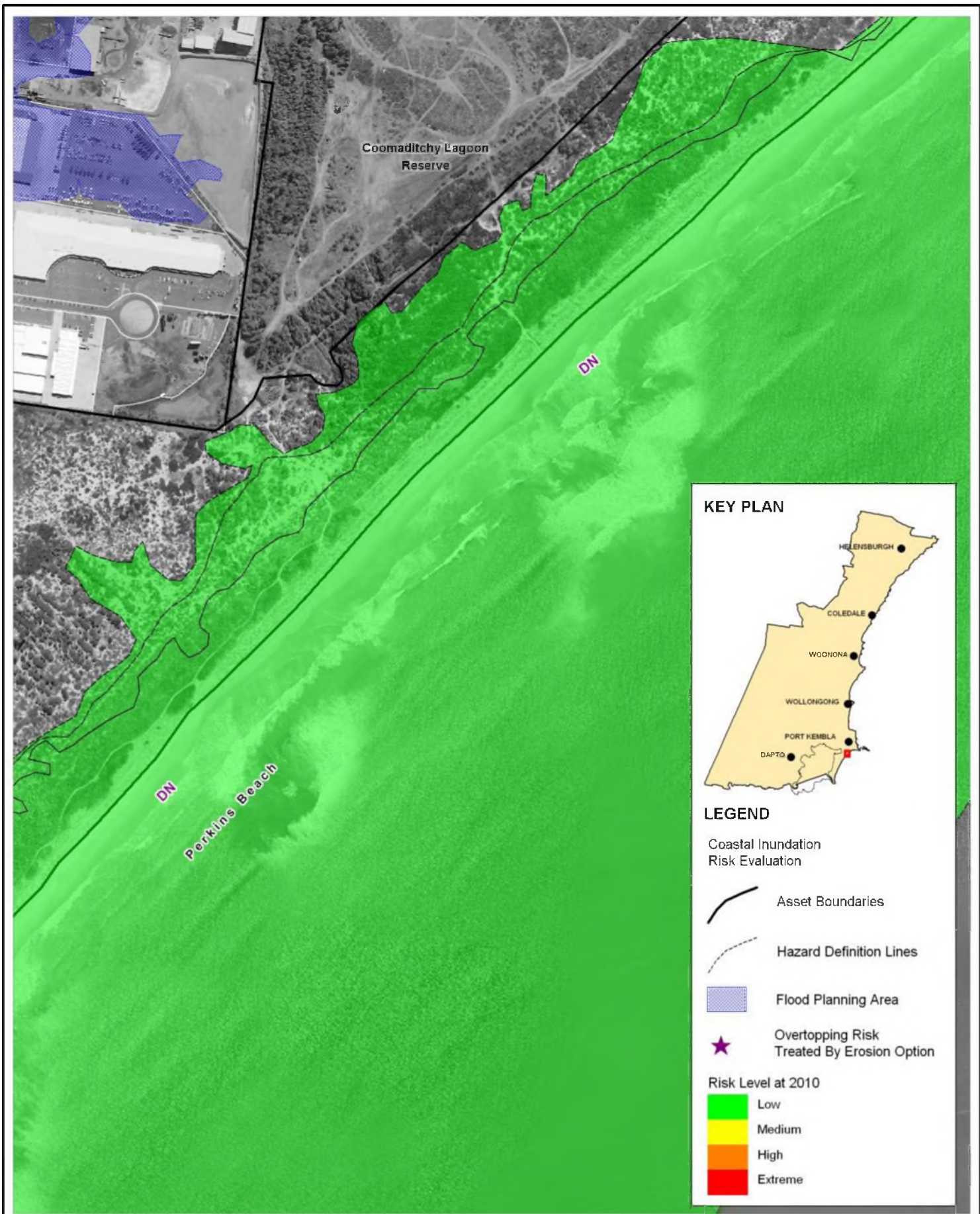
Drawing:  
**6-57**

Rev:  
**A**

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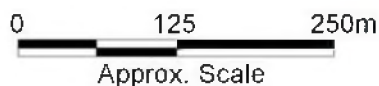


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Perkins Beach (1)**

Drawing:  
**6-58**

Rev:  
**A**

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**KEY PLAN**



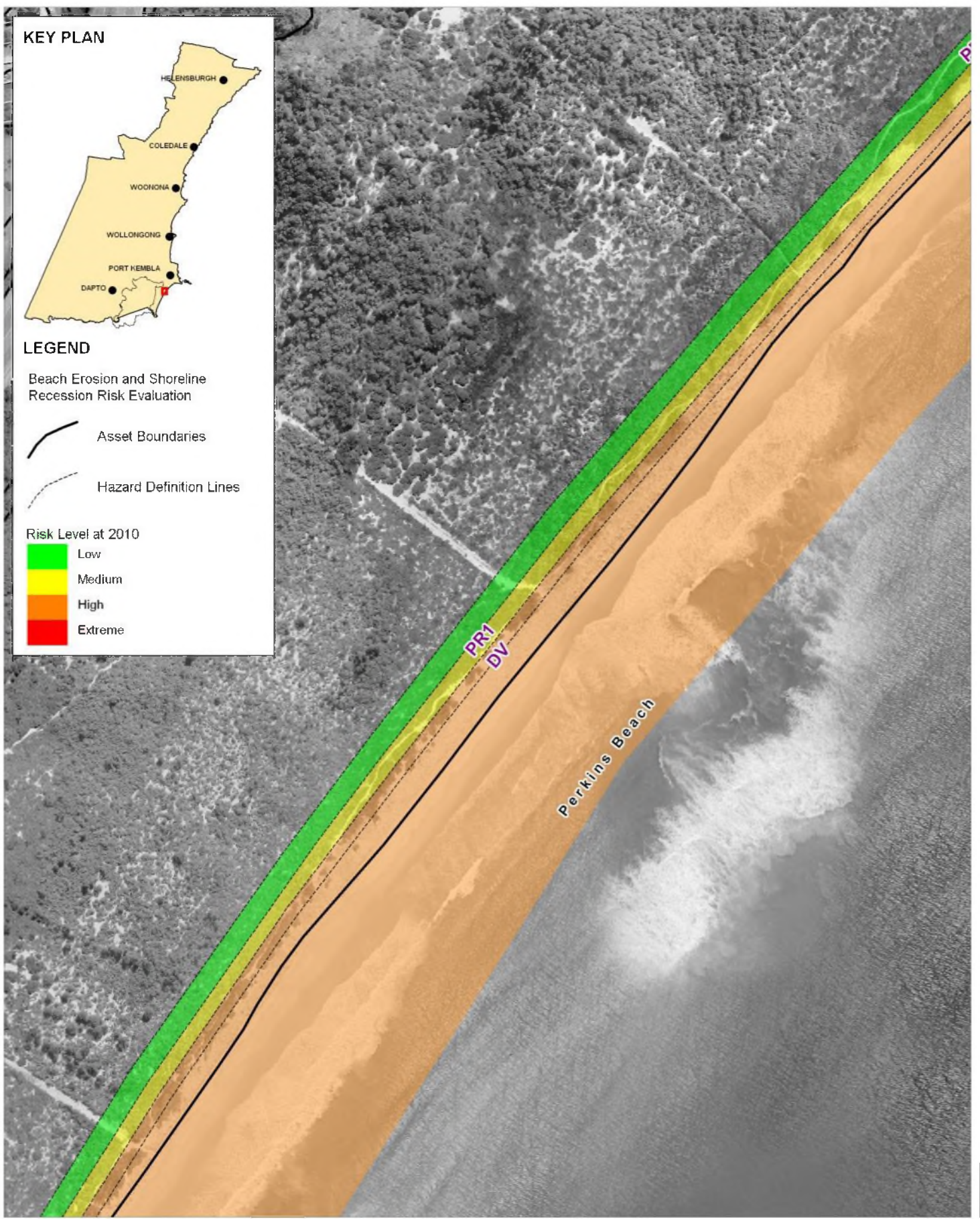
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

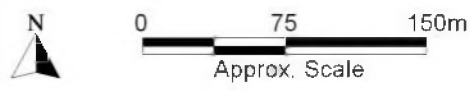
Risk Level at 2010

- Low
- Medium
- High
- Extreme

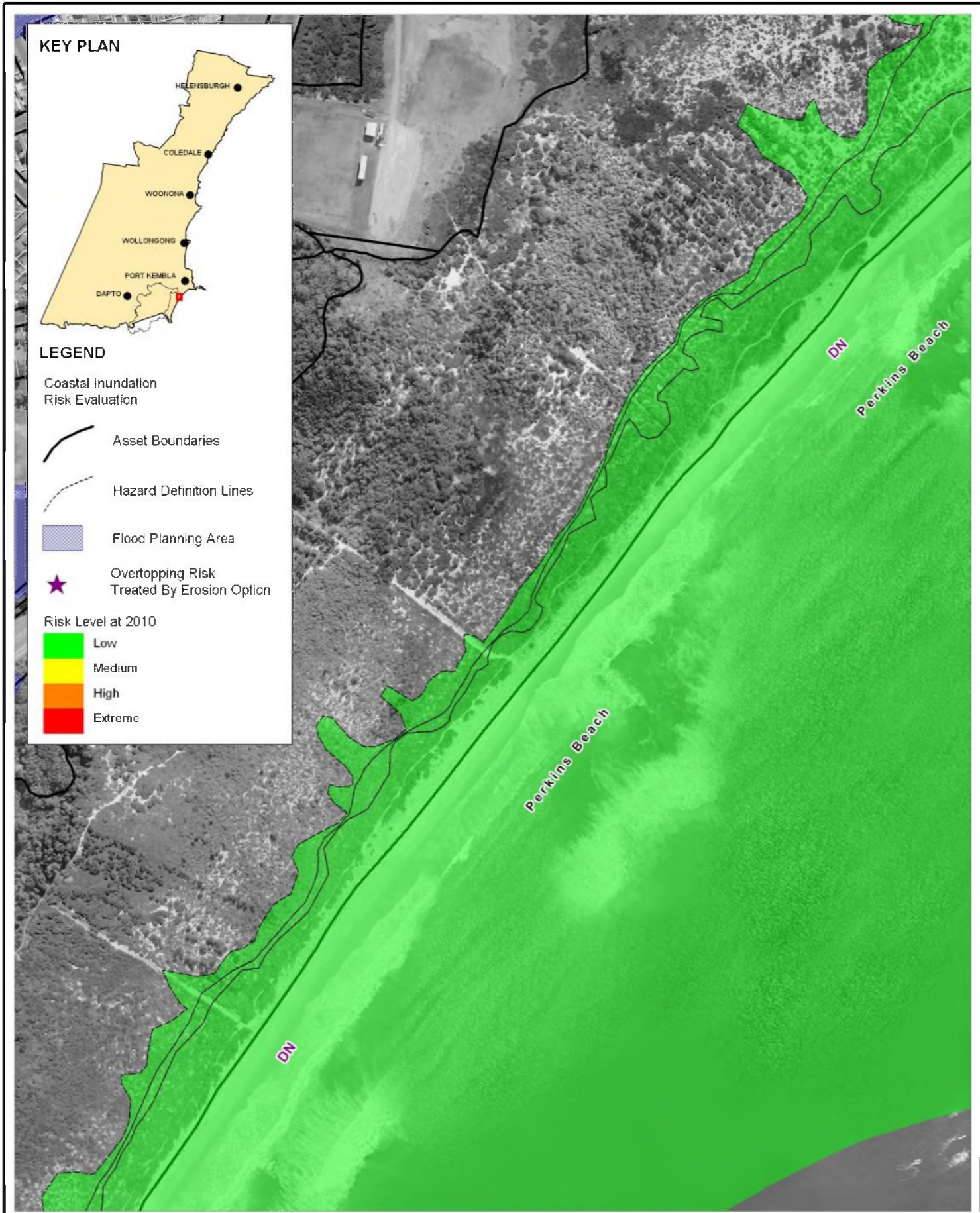


<p>Title: <b>Immediate Erosion Risk Levels and Treatment Perkins Beach (2)</b></p>	<p>Drawing: <b>6-59</b></p>	<p>Rev: <b>A</b></p>
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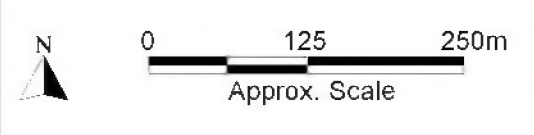
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Title: **Immediate Inundation Risk Levels and Treatment Options Perkins Beach (2)**

Drawing: **6-60** Rev: **A**

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**KEY PLAN**



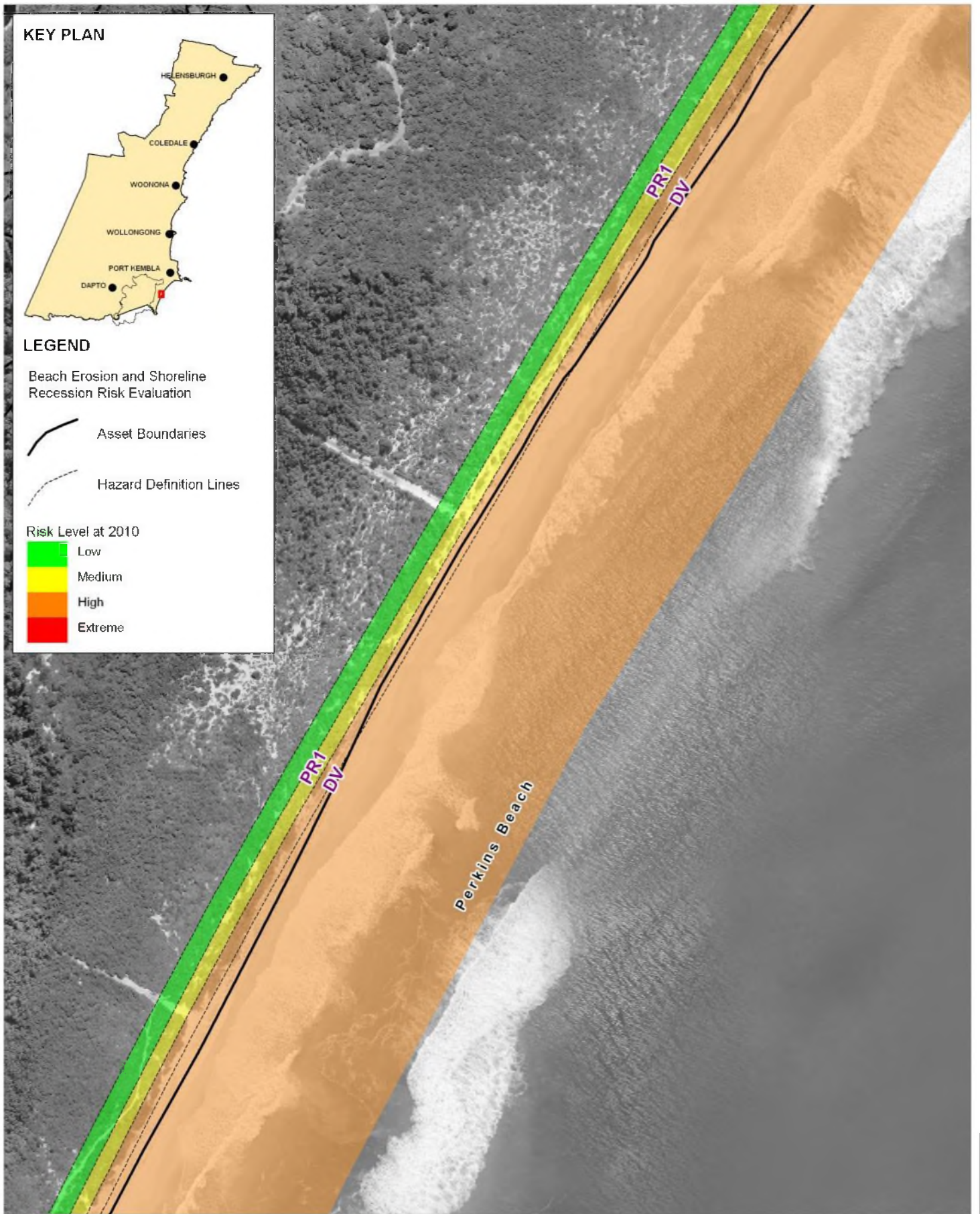
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

- Low
- Medium
- High
- Extreme

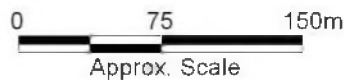


Title:  
**Immediate Erosion Risk Levels and Treatment  
Perkins Beach (3)**

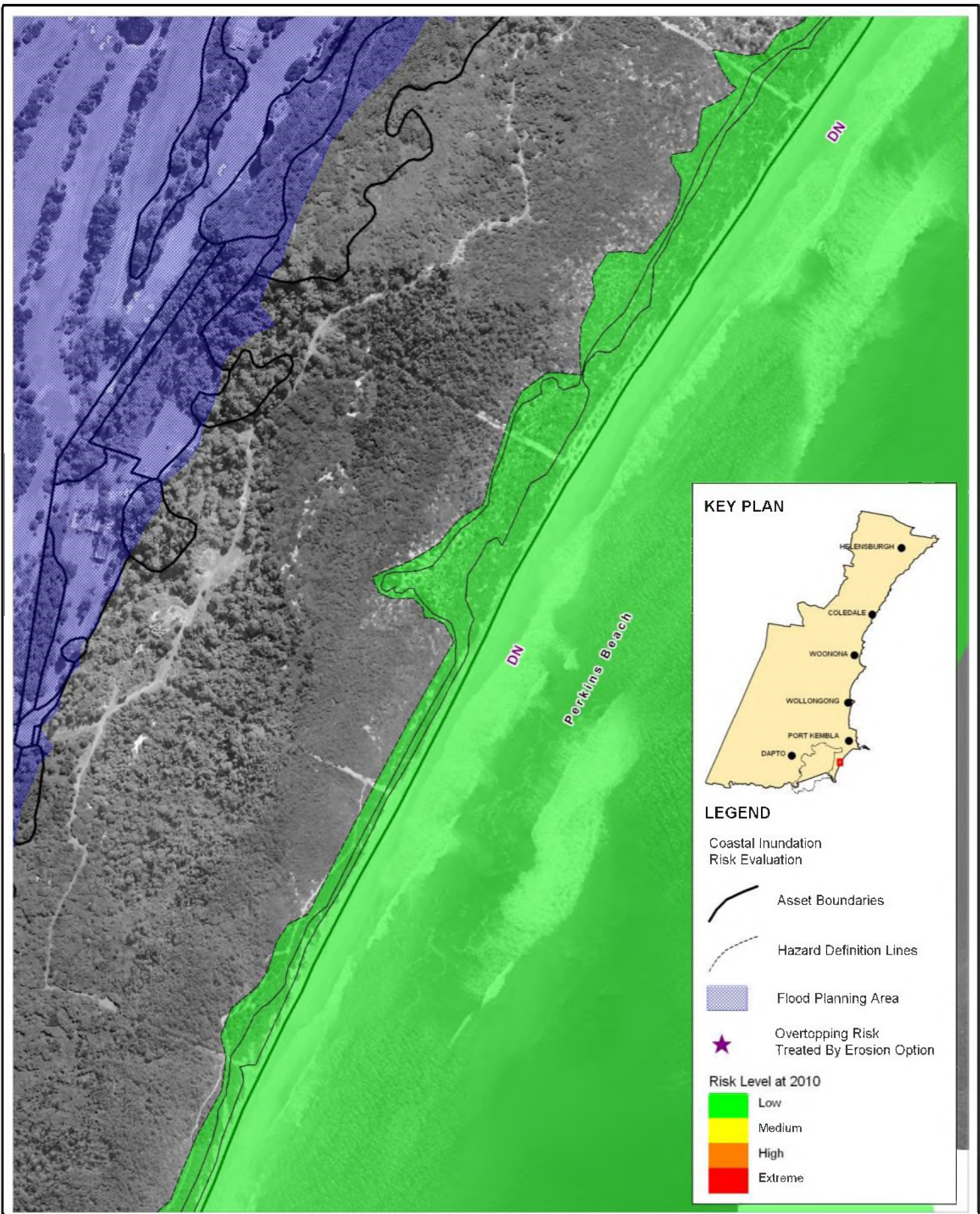
Drawing:  
**6-61**

Rev:  
**A**

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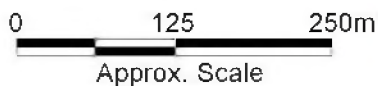


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Perkins Beach (3)**

Drawing:  
**6-62**

Rev:  
**A**

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**KEY PLAN**



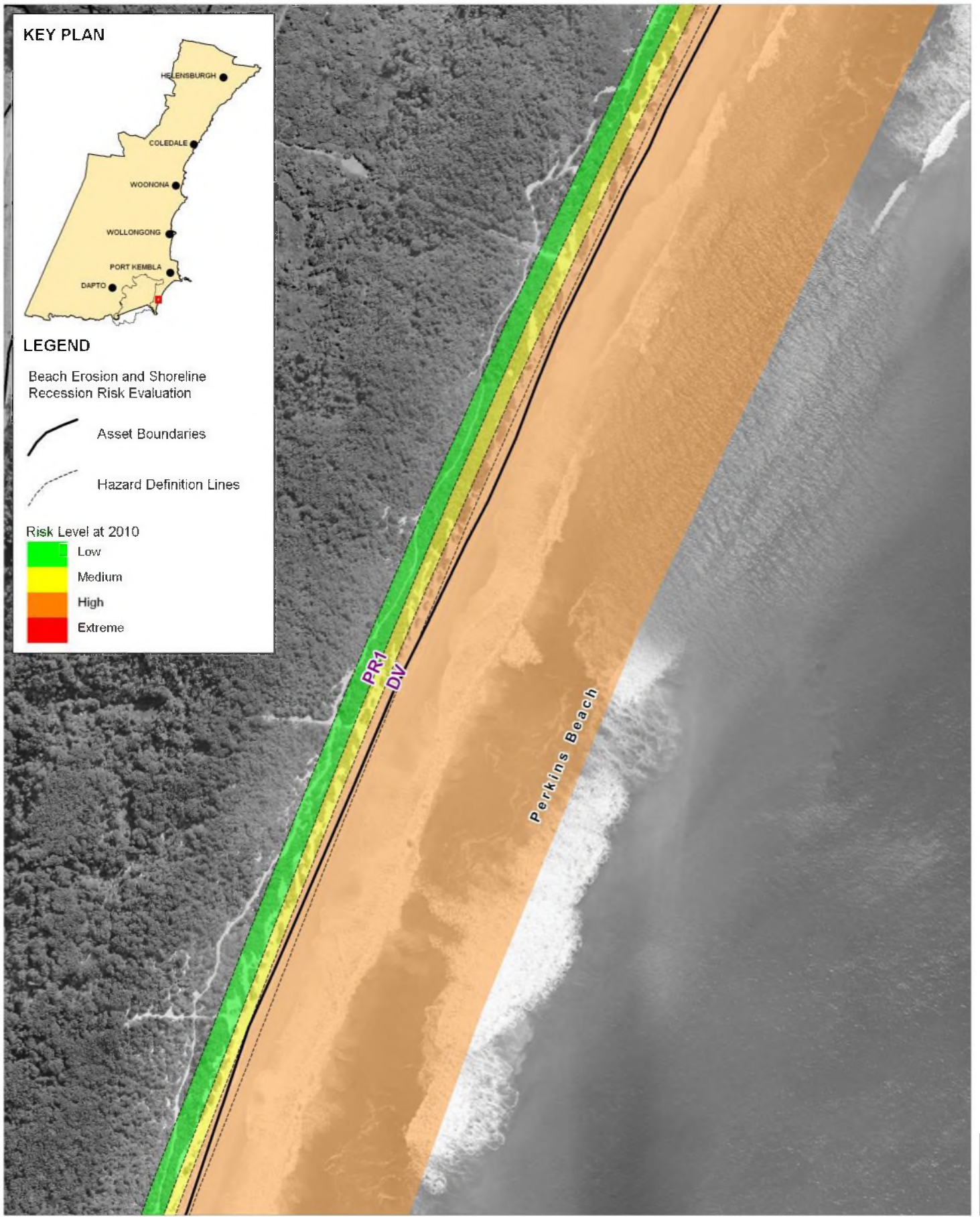
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

- Low
- Medium
- High
- Extreme

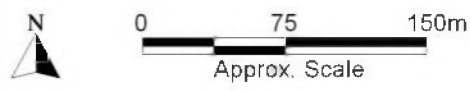


Title:  
**Immediate Erosion Risk Levels and Treatment  
Perkins Beach (4)**

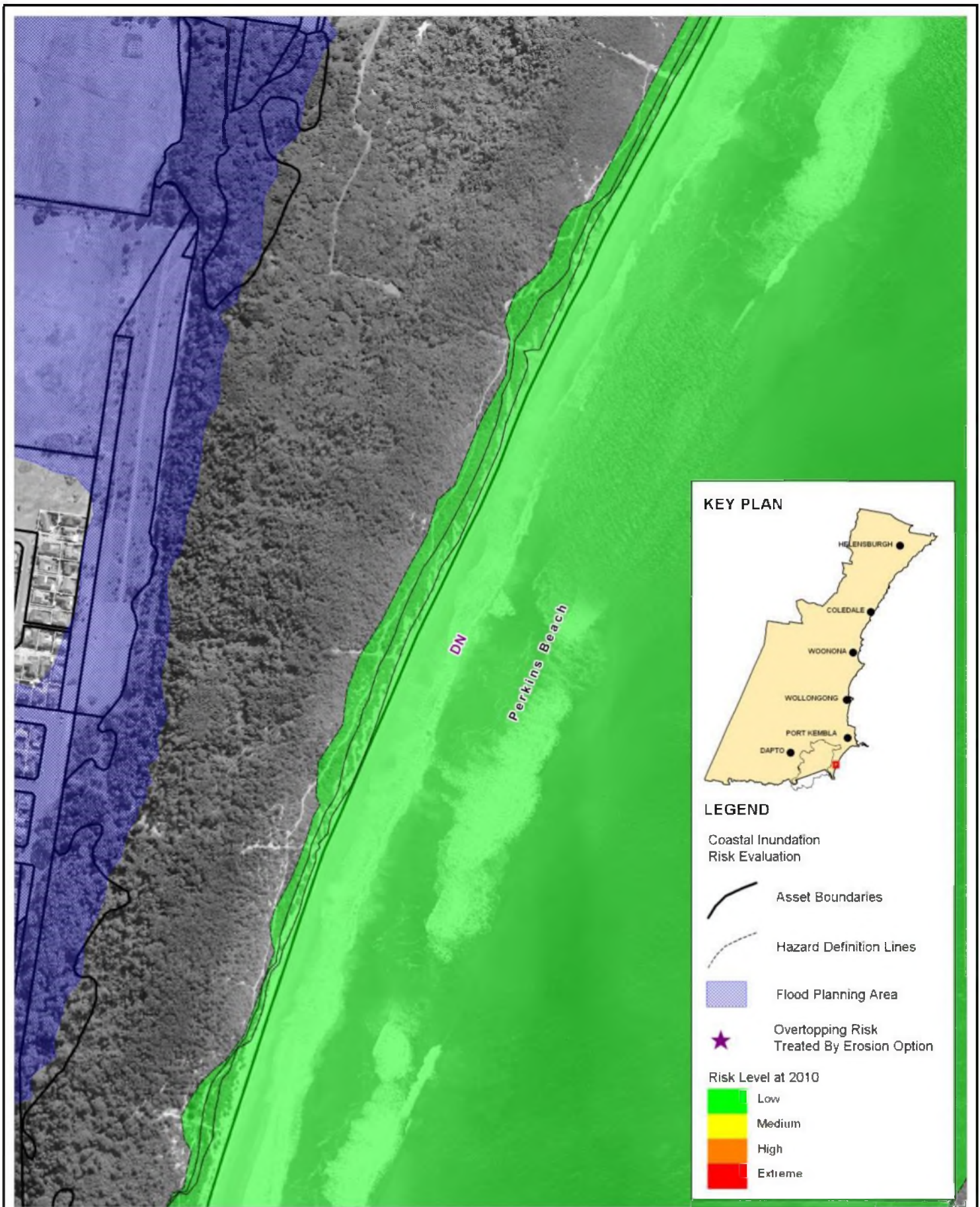
Drawing:  
**6-63**

Rev:  
**A**

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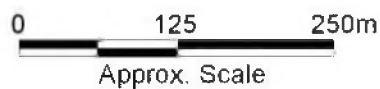


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Perkins Beach (4)**

Drawing:  
**6-64**

Rev:  
**A**

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**KEY PLAN**

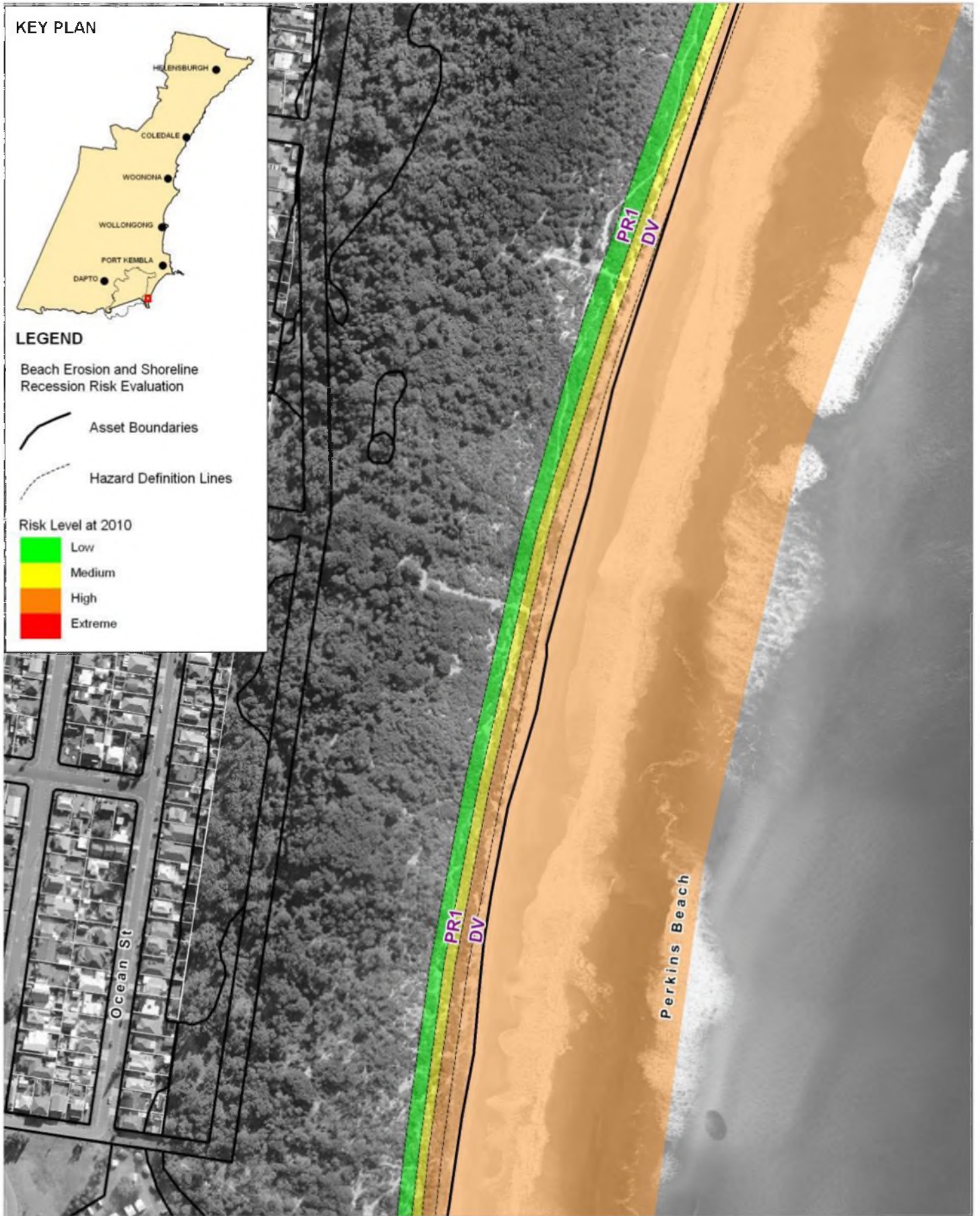


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

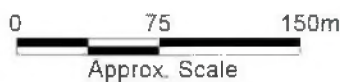


Title:  
**Immediate Erosion Risk Levels and Treatment  
Perkins Beach (5)**

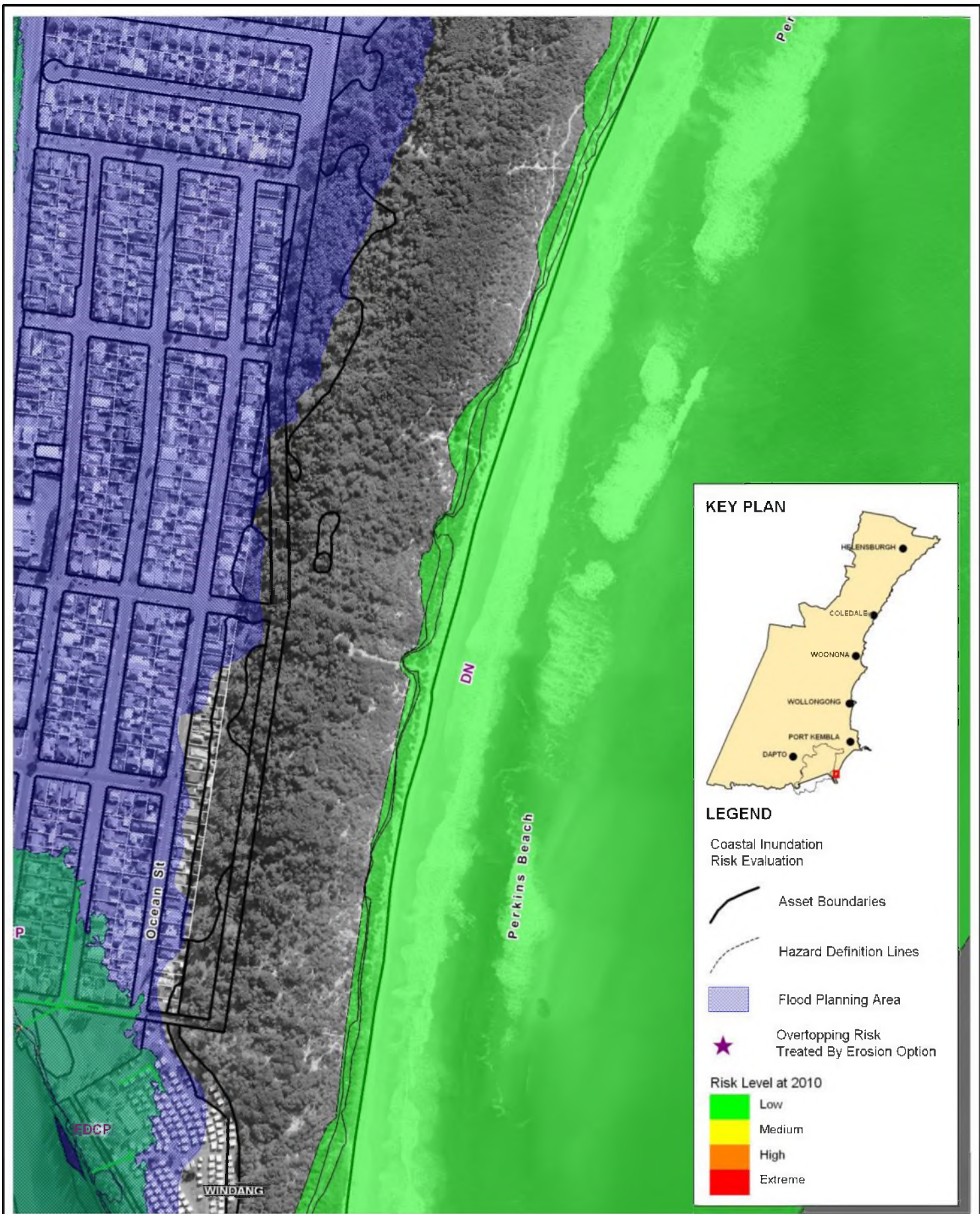
Drawing:  
**6-65**

Rev:  
**A**

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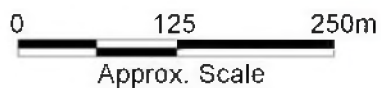


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
 Perkins Beach (5)**

Drawing:  
**6-66**

Rev:  
**A**

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**KEY PLAN**



**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

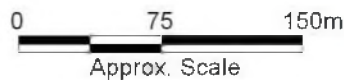


Title:  
**Immediate Erosion Risk Levels and Treatment  
Windang Beach**

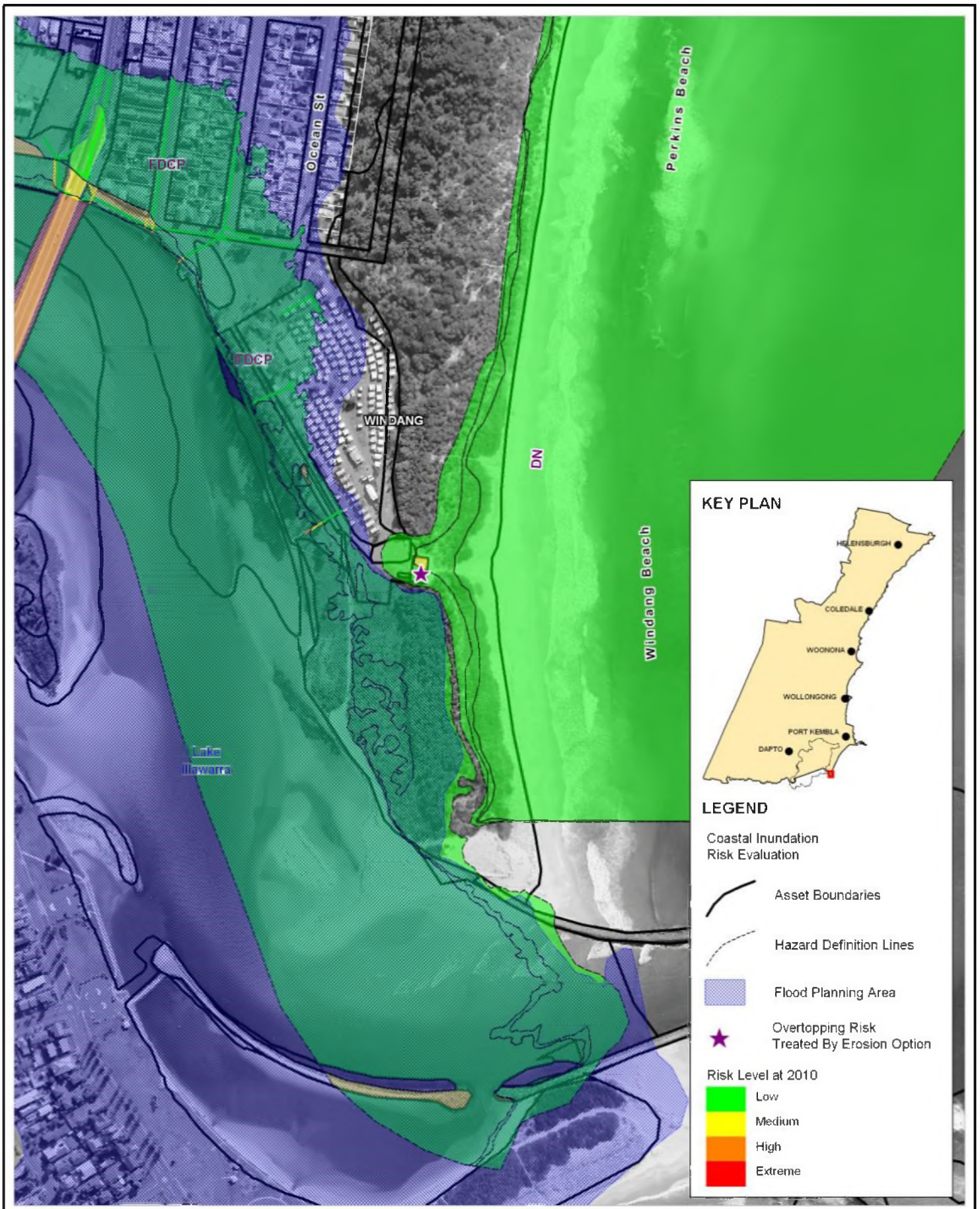
Drawing:  
**6-67**

Rev:  
**A**

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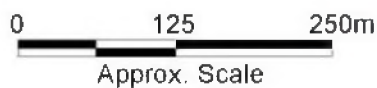


Title:  
**Immediate Inundation Risk Levels and Treatment Options  
Windang Beach**

Drawing:  
**6-68**

Rev:  
**A**

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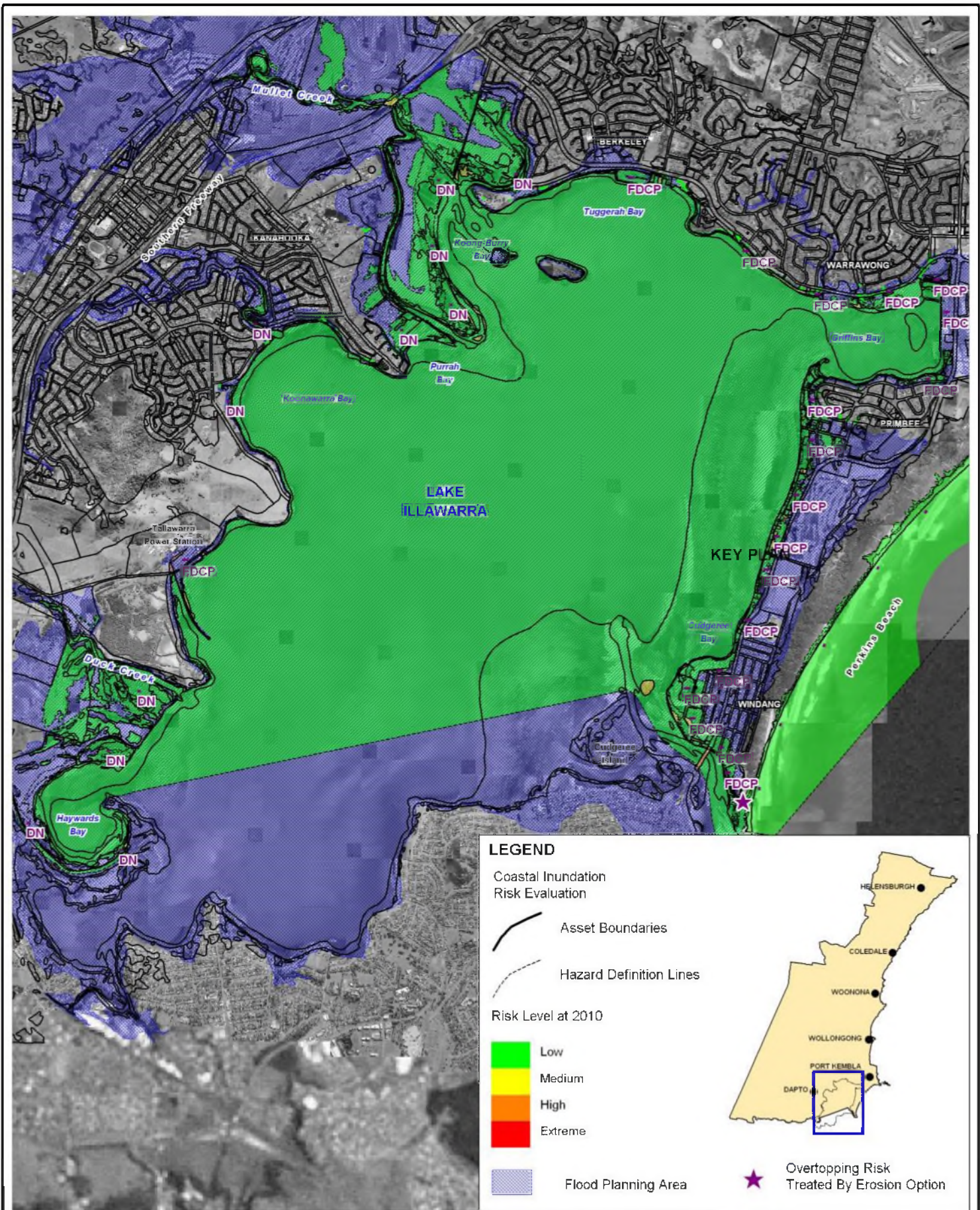
Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_130\_1104129 Drawing 6-68.WOR

## 6.21 Lake Illawarra

### 6.21.1 Coastal Inundation Risk Level and Treatment Options



Lake Illawarra Foreshores	Inundation Risk Level			Inundation Risk Treatments					"Do Nothing" (Accept Risk)
	Inundation by 2010	Inundation by 2050	Inundation by 2100	Treated by erosion option**	Planned Retreat	Accommodate	No Regrets	Investigate*	
<b>Parks, Beaches and open space</b>					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	✓
<b>Community Infrastructure</b>									
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			✓			✓
<b>Transport Infrastructure</b>									
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			✓			
<b>Water and sewage infrastructure</b>									
Stormwater outlets / pipes	Medium	High	High			✓	✓	NR7, NR14	
<b>Residential Development</b>									
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			✓			
<i>Note: 674 land parcels affected</i>									
<b>Commercial and Industrial Development</b>									
Oasis Resort and Caravan Park	Low	Low	Medium			✓			✓
Tru Energy Gas Powered Station	High	Extreme	Extreme			✓		NR14	
<b>Institutional Infrastructure</b>									
Windang Public School	Medium	High	High			✓			

Symbol	
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



**LEGEND**

Coastal Inundation Risk Evaluation


-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2010

-  Low
-  Medium
-  High
-  Extreme

 Flood Planning Area



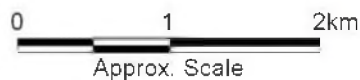
 Overtopping Risk Treated By Erosion Option

Title:  
**Immediate Inundation Risk Levels and Treatment Options  
Lake Illawarra**

Drawing:  
**6-69**

Rev.:  
**A**

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### 6.21.2 Assessment of Treatment Options

Lake Illawarra															
Sym- bol	Option	Trigger for implementation (following relevant planning, approvals, etc)	Erosion Option	Overlapping 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.	<b>Current Action:</b> NR7 <b>Trigger:</b> 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. <i>Refer to Accommodate Options Table for further cost benefit details for A2.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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	✓								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 calculator for use in planning. <i>Refer to Accommodate Options Table for further cost benefit details for FDCP.</i>	N/A State Government (external funding unlikely to be needed) <input checked="" type="checkbox"/> Council (Current Programs) <input checked="" type="checkbox"/> 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. <i>Refer to "Do Nothing" Option Table for further cost benefit details.</i>	? State Government <input checked="" type="checkbox"/> Council (new levies and increased rates) <input checked="" type="checkbox"/> Private landholders in Future Generations	Recommended
NR	NR1, NR7, NR11, NR13, NR14	Now	✓	✓	✓								<i>Refer to "No Regrets" Options Table for cost benefit details.</i>	? State Government (Grant Programs) <input checked="" type="checkbox"/> 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'.

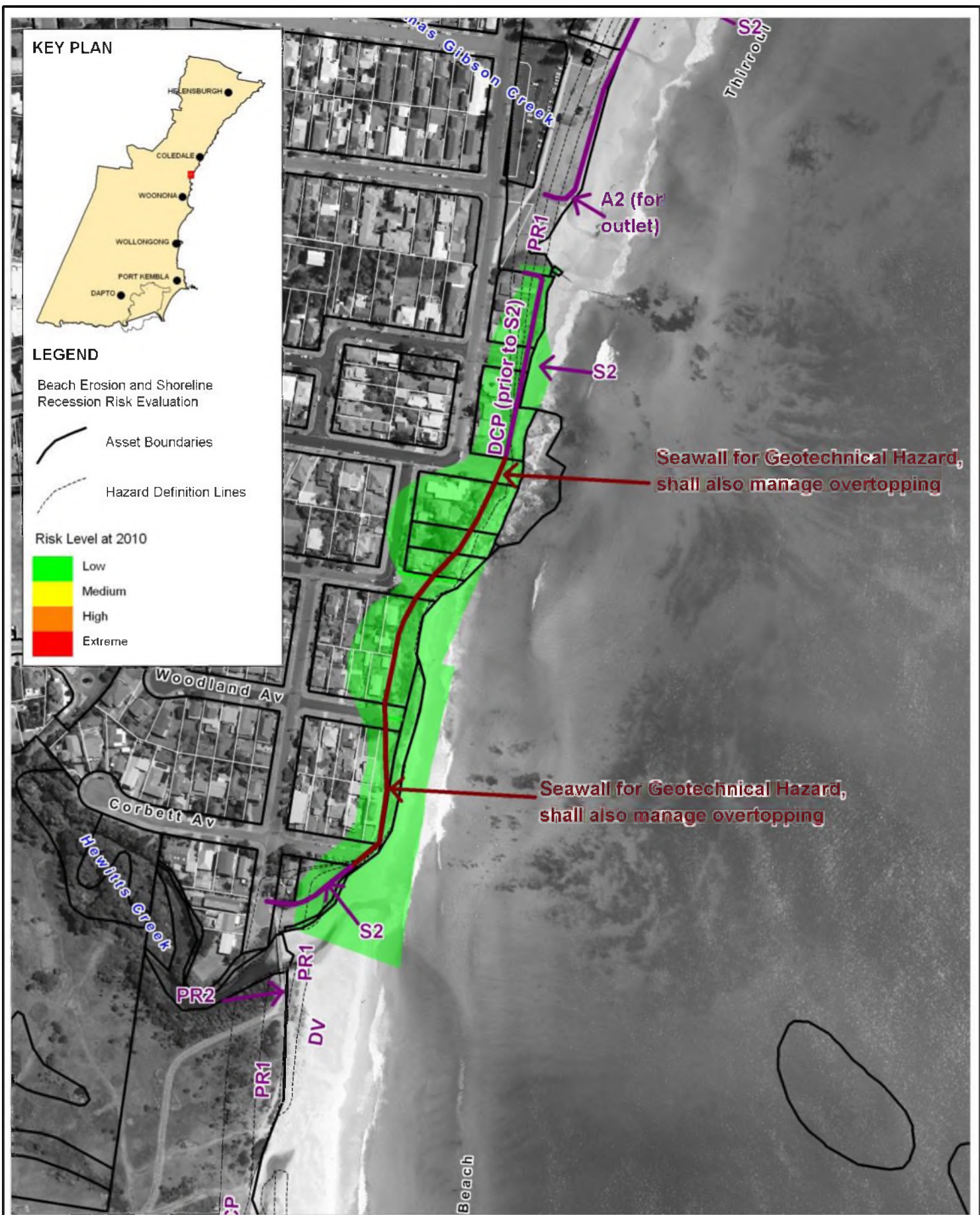
There are very few areas within the Coastal Influenced Geotechnical Hazard Area that are not already within a landslip geotechnical hazard zone, which already have Section 149 notifications provided to landholders by Council. Further, as noted in Section 4.4, there is already a sound process for managing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

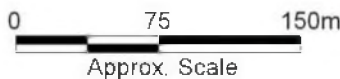
Drawing:

6-70

Rev:

A

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## 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	Scarbw/Wom	Coledale	Sharkies	Little Austin.	Austinmer	Thirroul	McCaulleys	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

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“Where will our knowledge take you?”

# Wollongong Coastal Zone Management Plan: Management Study Appendices

Final Report September 2017



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# Wollongong Coastal Zone Management Plan: Management Study Appendices

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*



## **APPENDIX A: RISK LEVELS MAPS FOR THE IMMEDIATE, 2050 AND 2100 TIMEFRAMES**

**KEY PLAN**

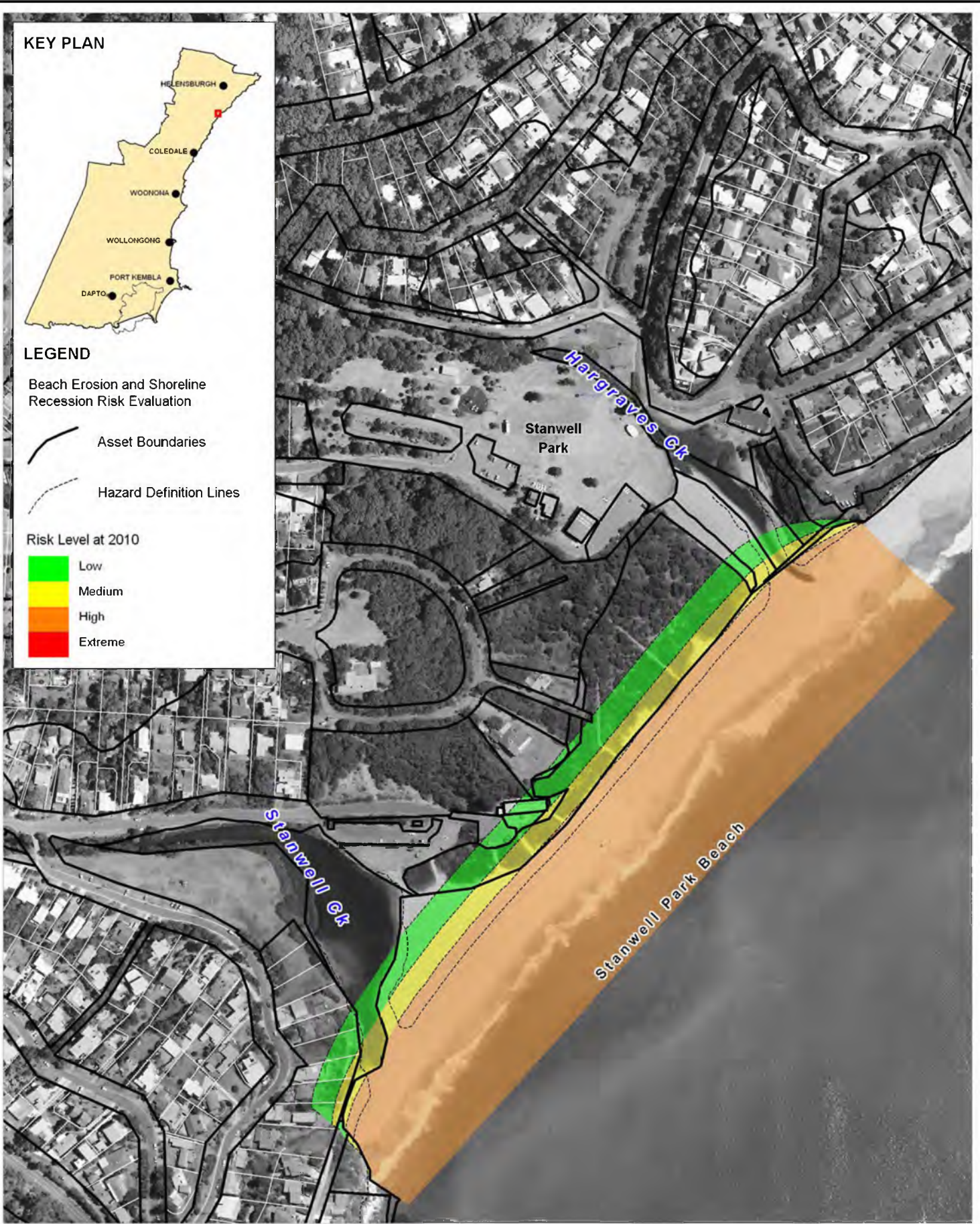


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

**Erosion and Recession Risk Evaluation  
Immediate Horizon Risk - Stanwell Park**

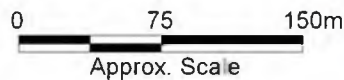
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**A-1**

Rev:

**A**

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**KEY PLAN**

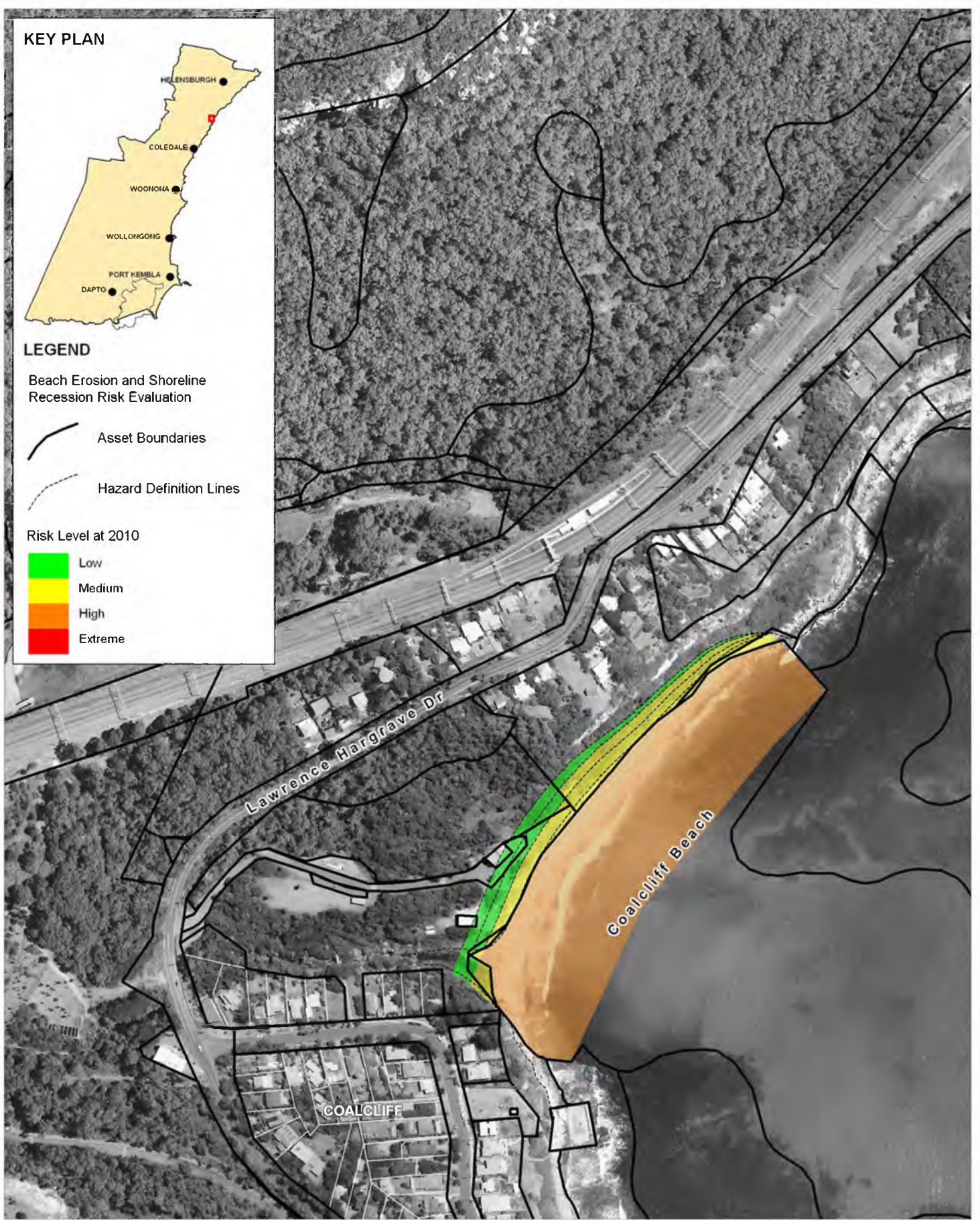


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Coalcliff**

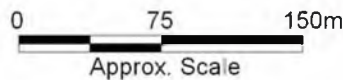
Drawing:

**A-2**

Rev:

**A**

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**KEY PLAN**



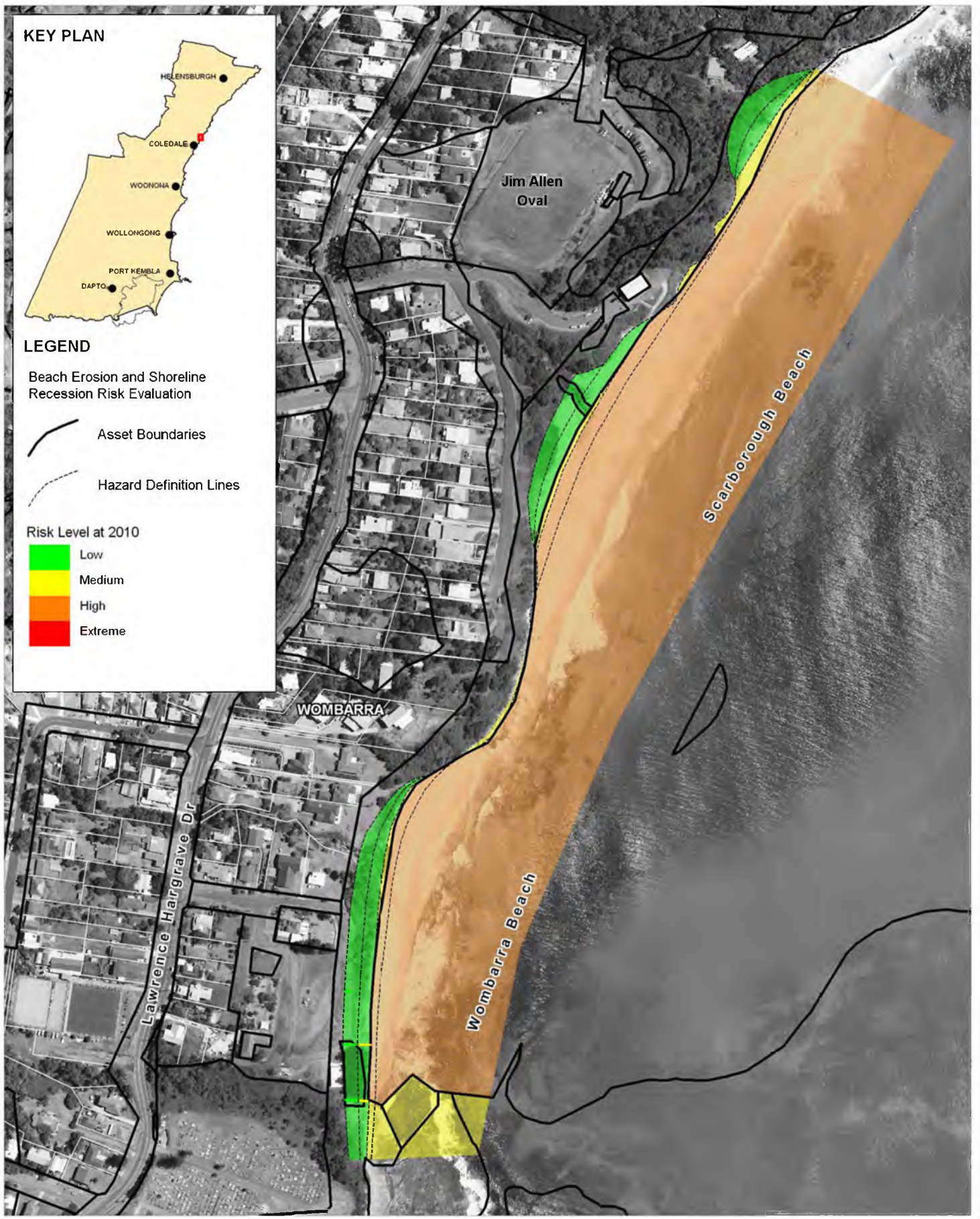
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

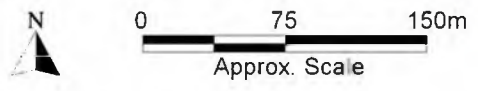
- Low
- Medium
- High
- Extreme



Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Scarborough/Wombarra**

Drawing: <b>A-3</b>	Rev: <b>A</b>
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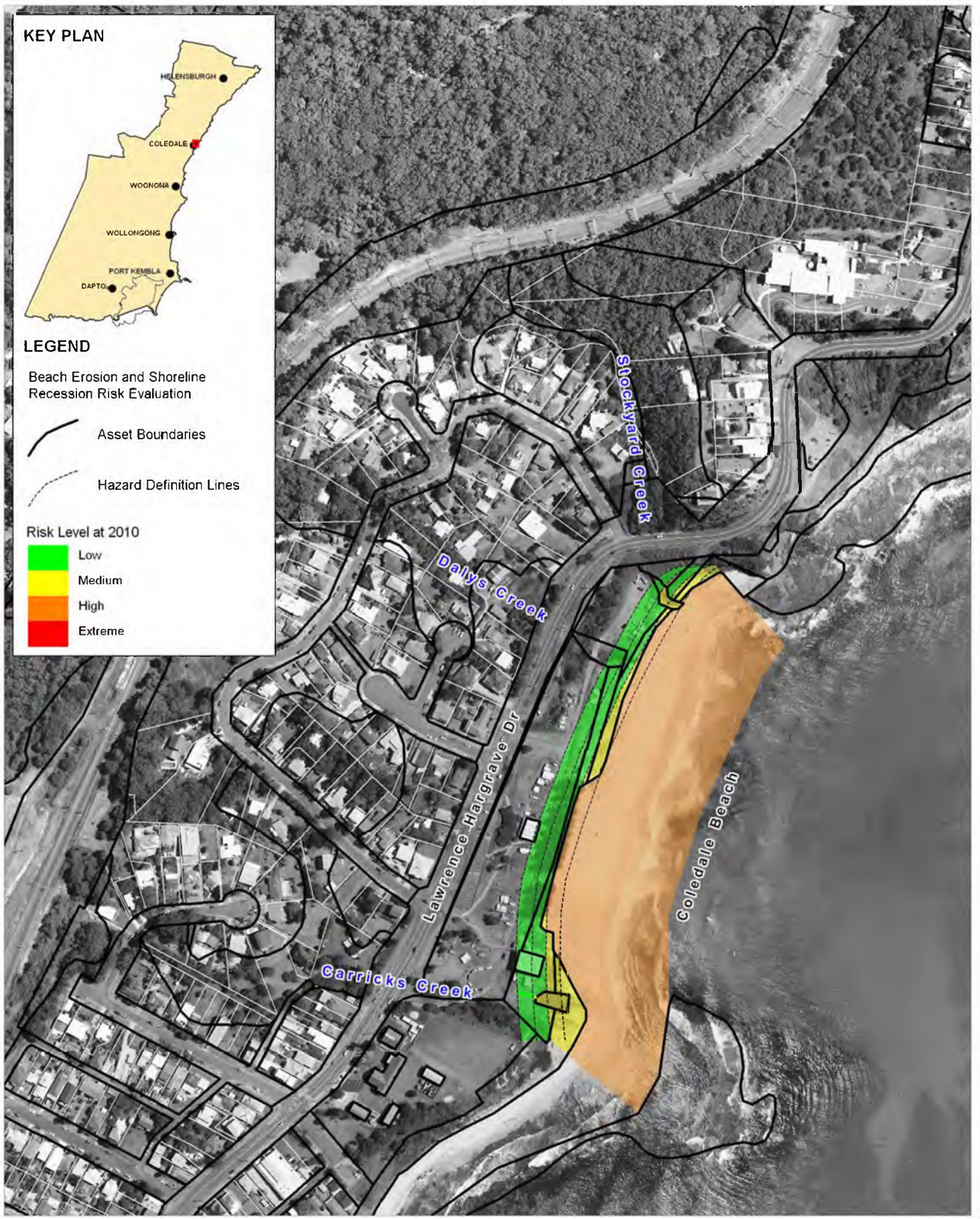


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Coledale**

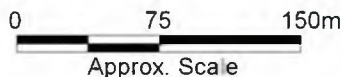
Drawing:

**A-4**

Rev:

**A**

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**KEY PLAN**

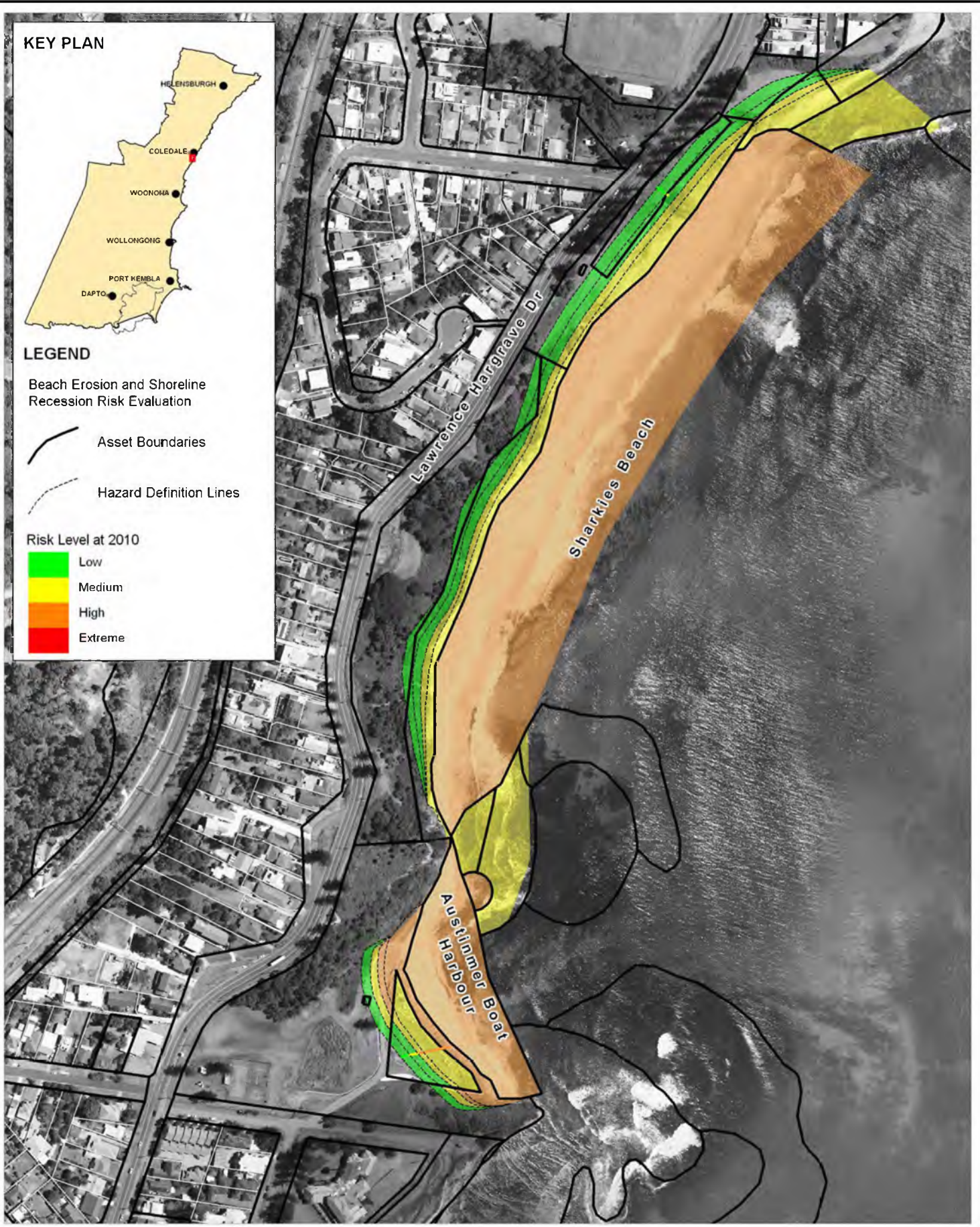


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

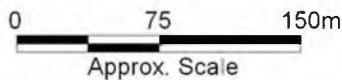


Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Sharkies Beach**

Drawing:  
**A-5**

Rev:  
**A**

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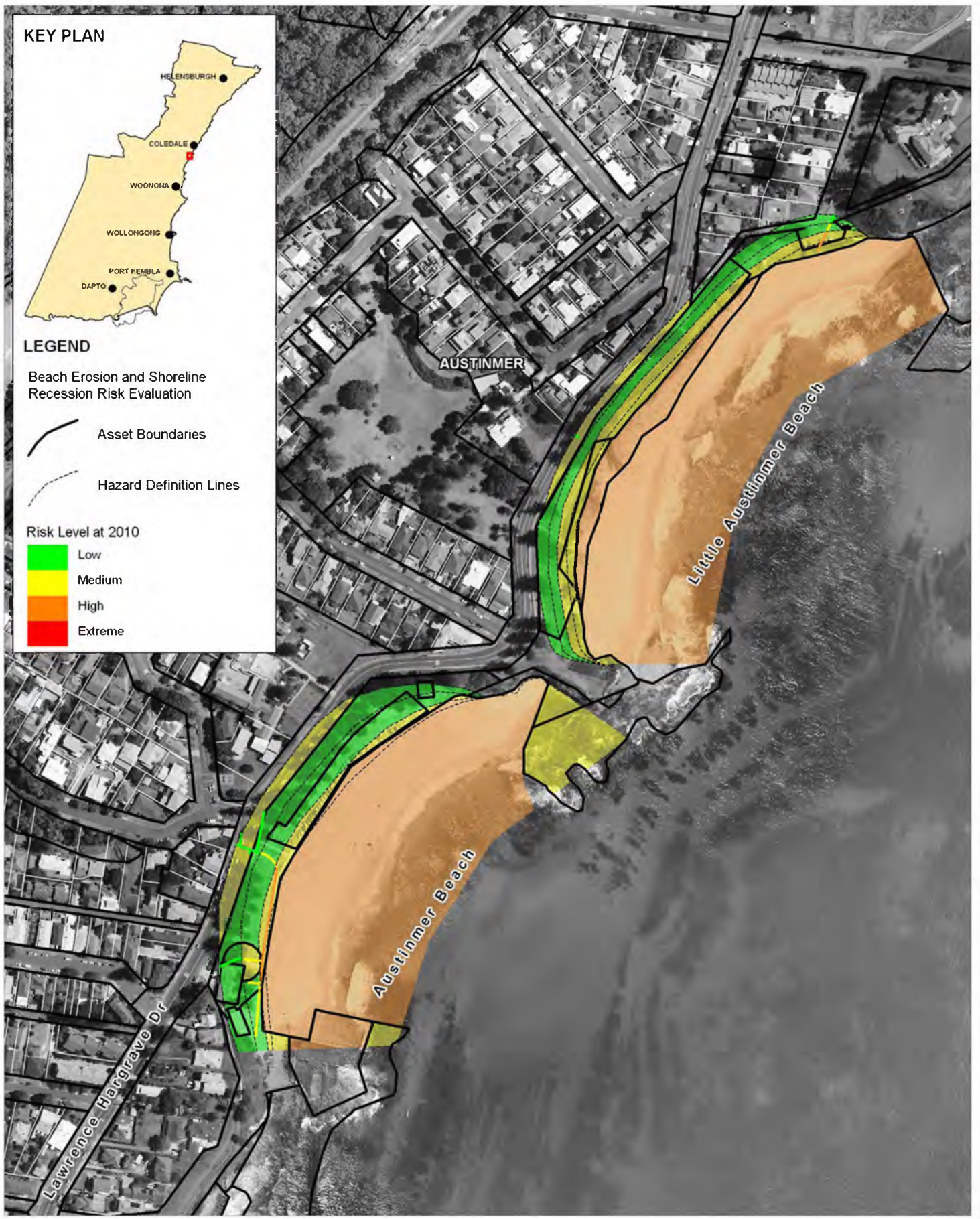


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

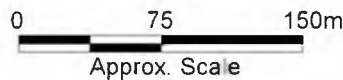


Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Austinmer**

Drawing:  
**A-6**

Rev:  
**A**

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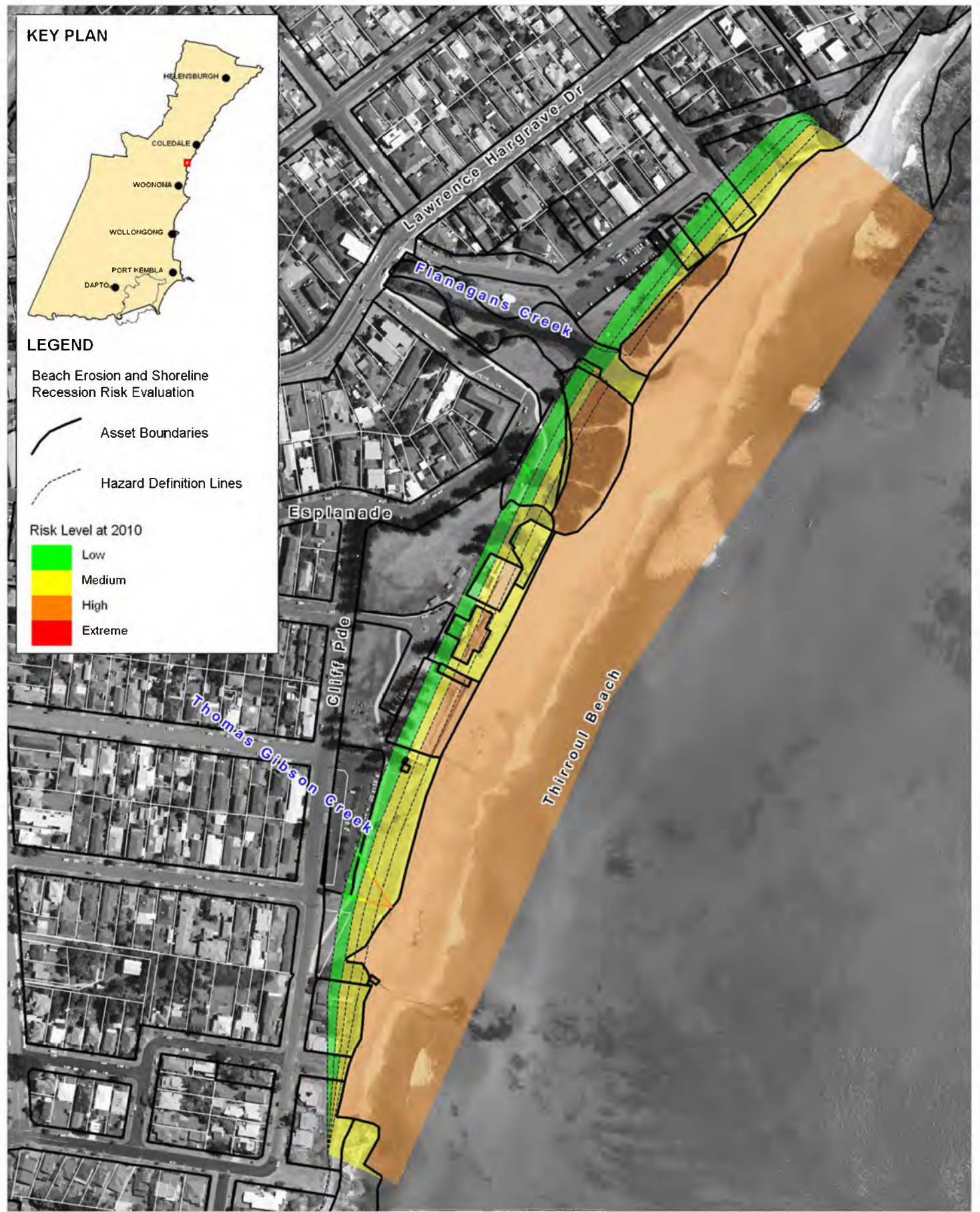


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Thirroul**

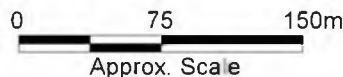
Drawing:

**A-7**

Rev:

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**KEY PLAN**

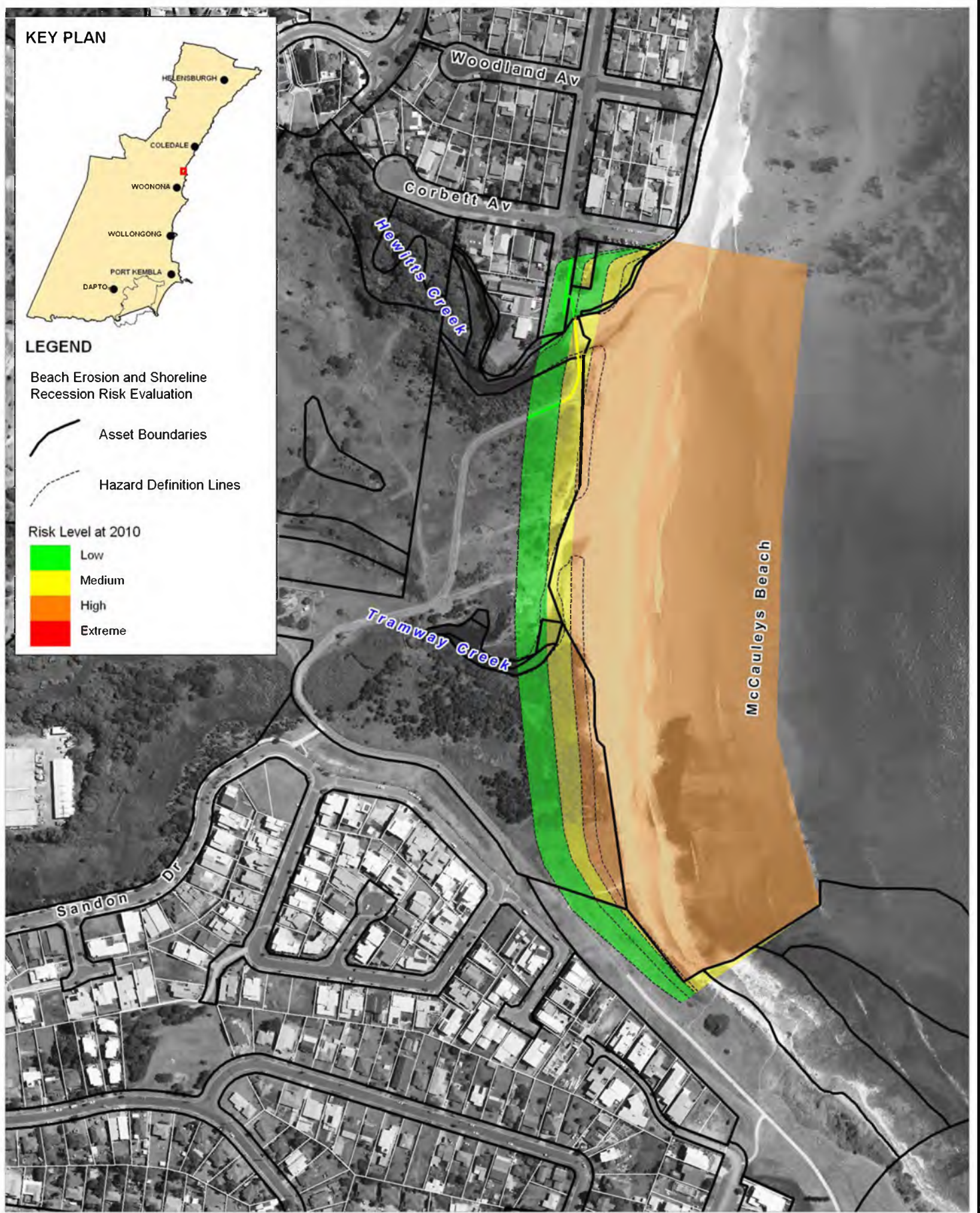


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2010

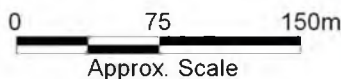


Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - McCauleys Beach**

Drawing:  
**A-8**

Rev:  
**A**

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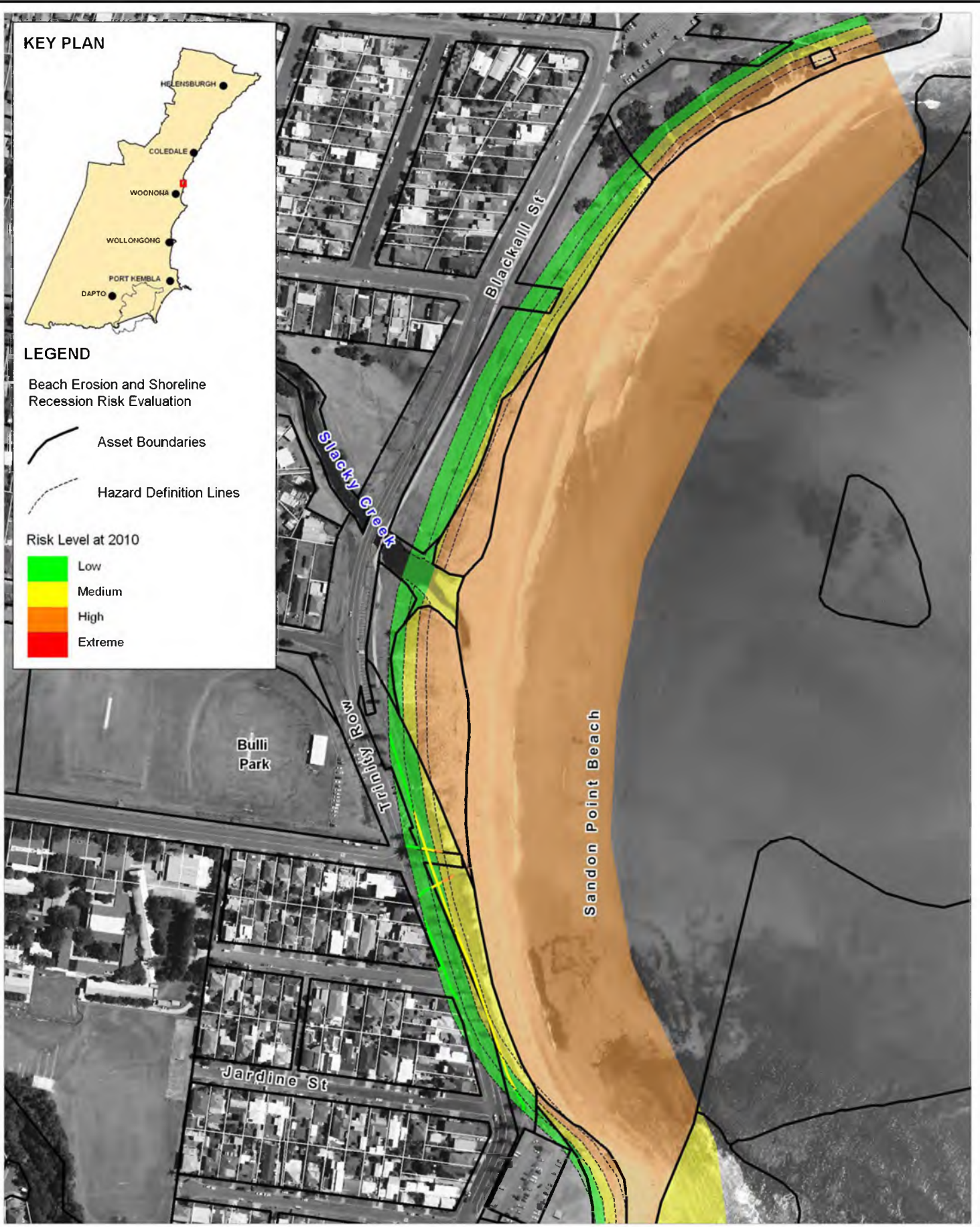


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

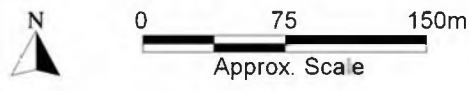
Risk Level at 2010



Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Sandon Point Beach**

Drawing: <b>A-9</b>	Rev: <b>A</b>
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**KEY PLAN**



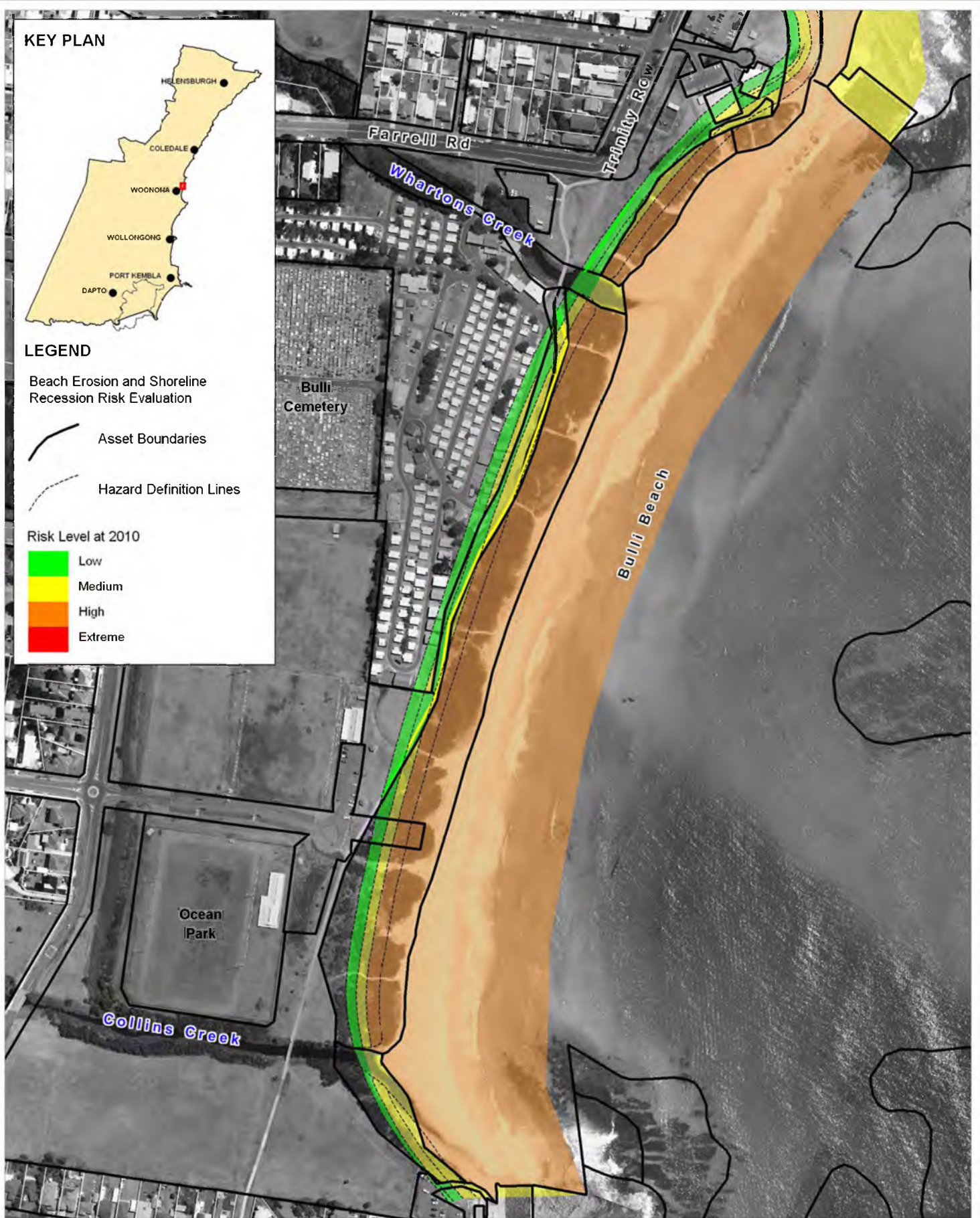
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

- Low
- Medium
- High
- Extreme

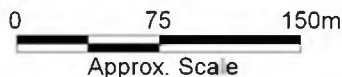


Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Bulli Beach**

Drawing:  
**A-10**

Rev:  
**A**

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**KEY PLAN**

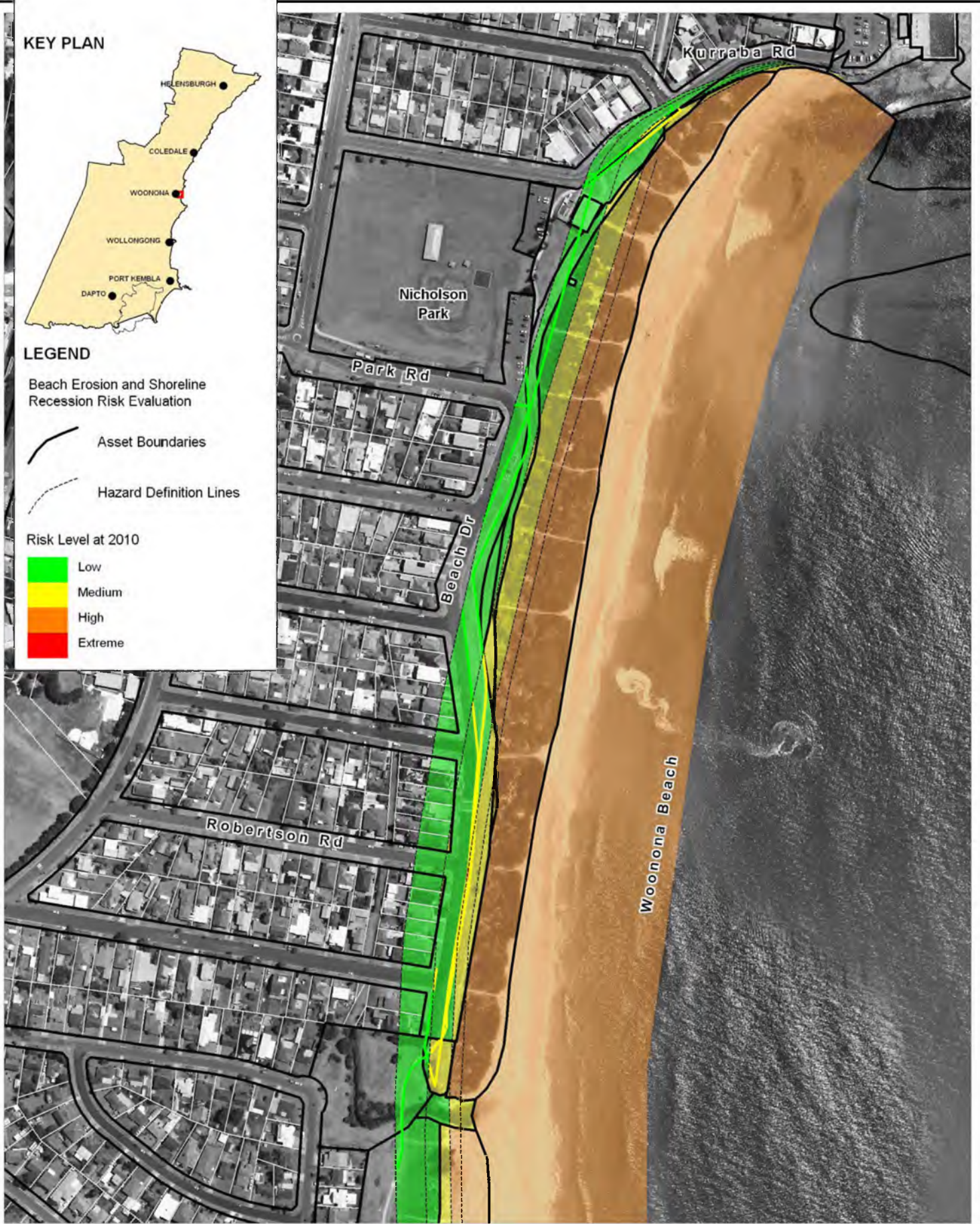


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

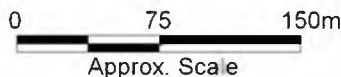


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Immediate Planning Horizon - Woonona Beach**

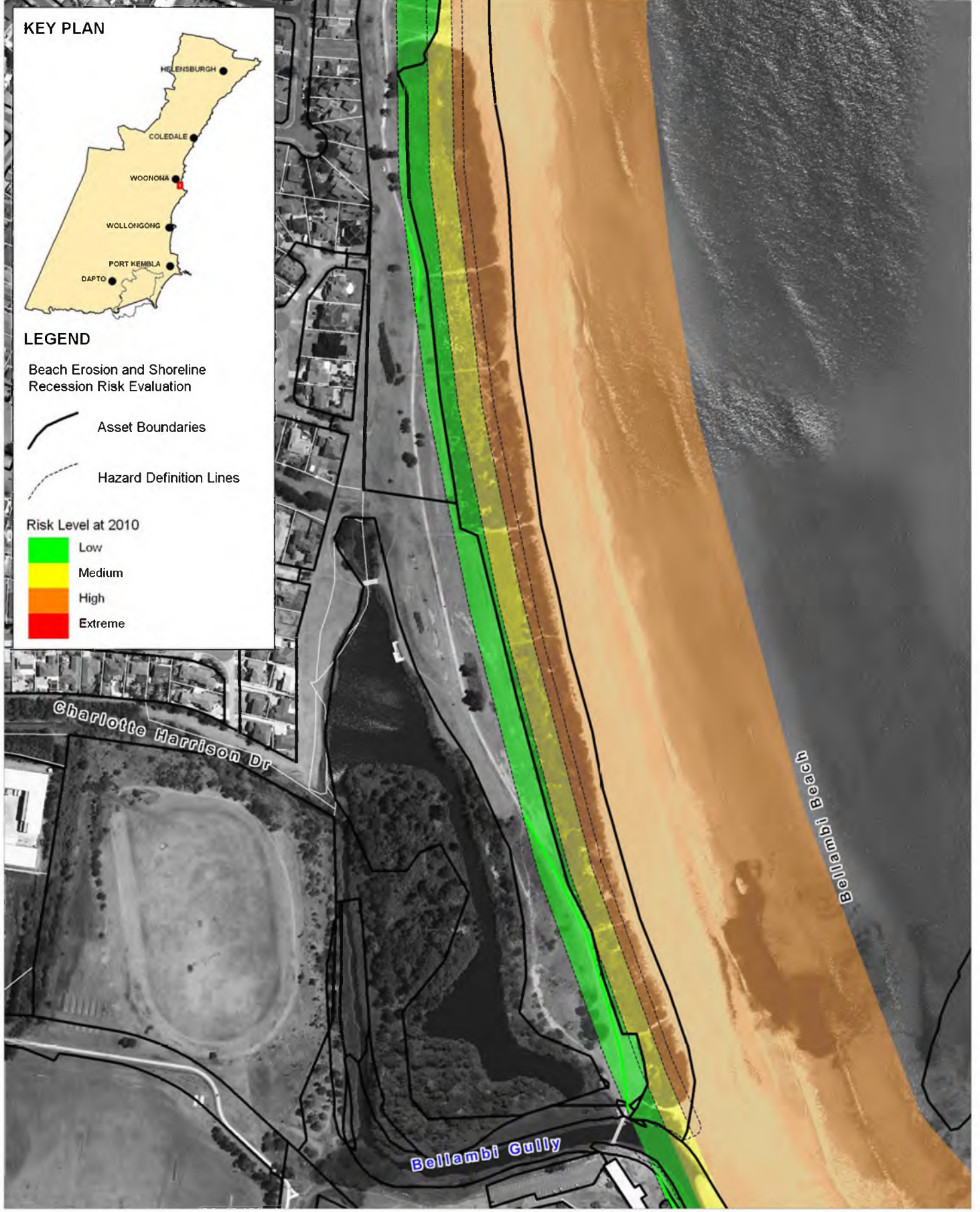
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**A-11**

Rev:  
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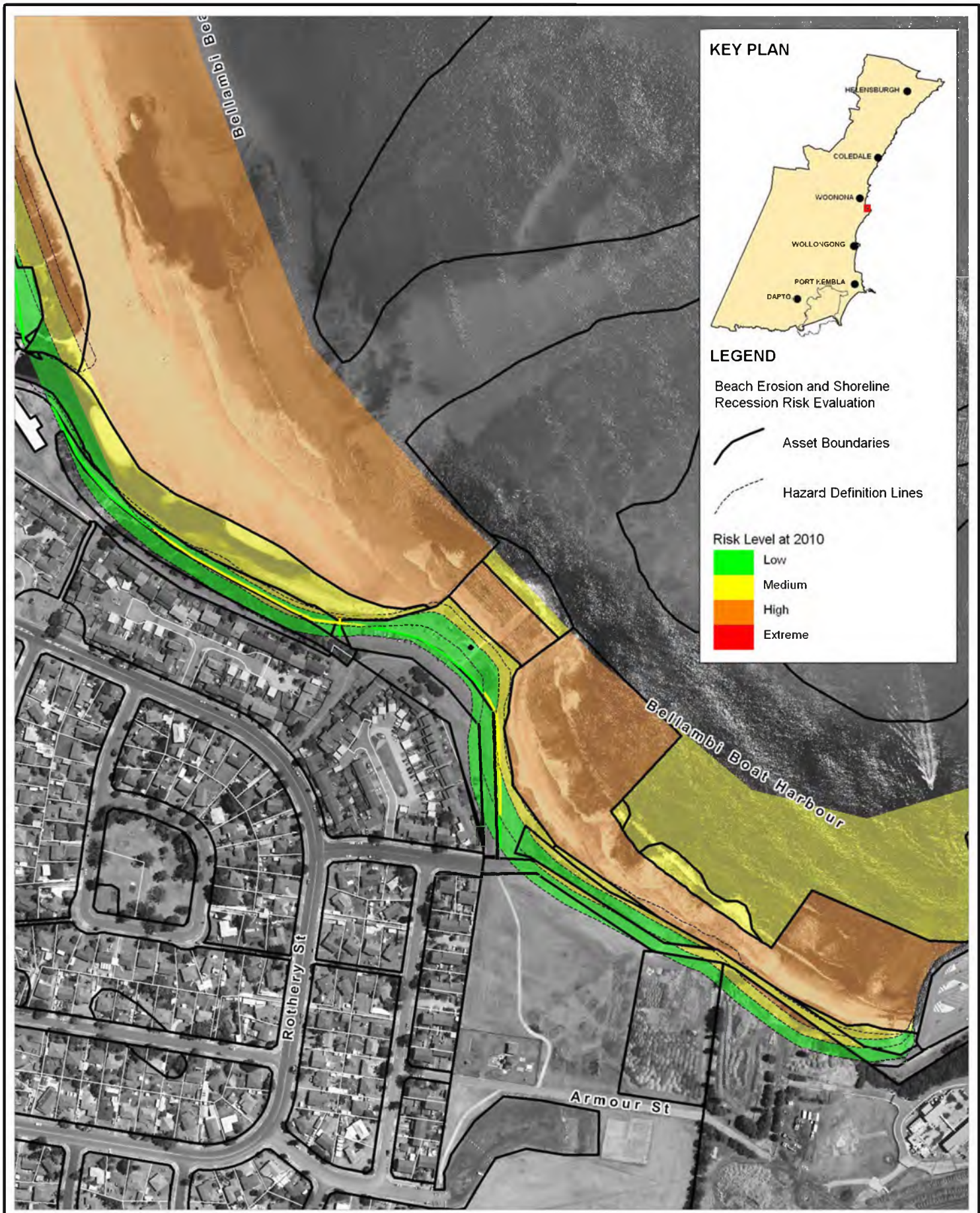


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<b>Title:</b> <b>Erosion and Recession Risk Evaluation</b> <b>Immediate Planning Horizon - Bellambi Beach</b>		<b>Drawing:</b> <b>A-12</b>	<b>Rev:</b> <b>A</b>
<small>BMT WBM endeavours to ensure that the information provided in this map is correct 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.</small>			
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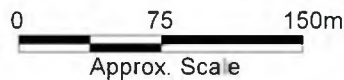


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 Immediate Planning Horizon - Bellambi Boat Harbour**

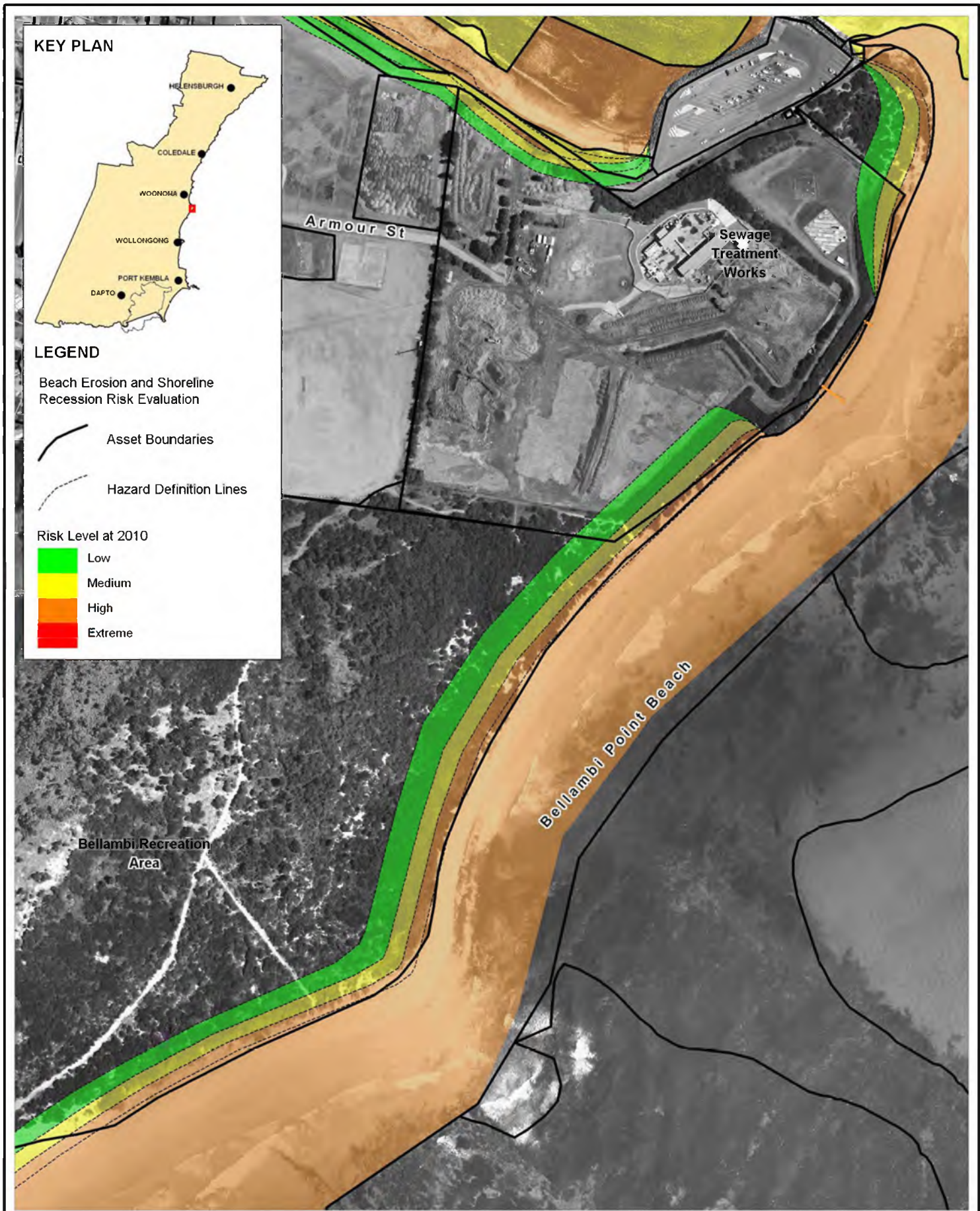
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Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_113\_110414 Drawing A-13.WOR

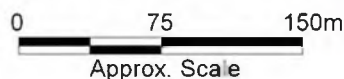


Title:  
**Erosion and Recession Risk Evaluation  
 Immediate Planning Horizon - Bellambi Point Beach**

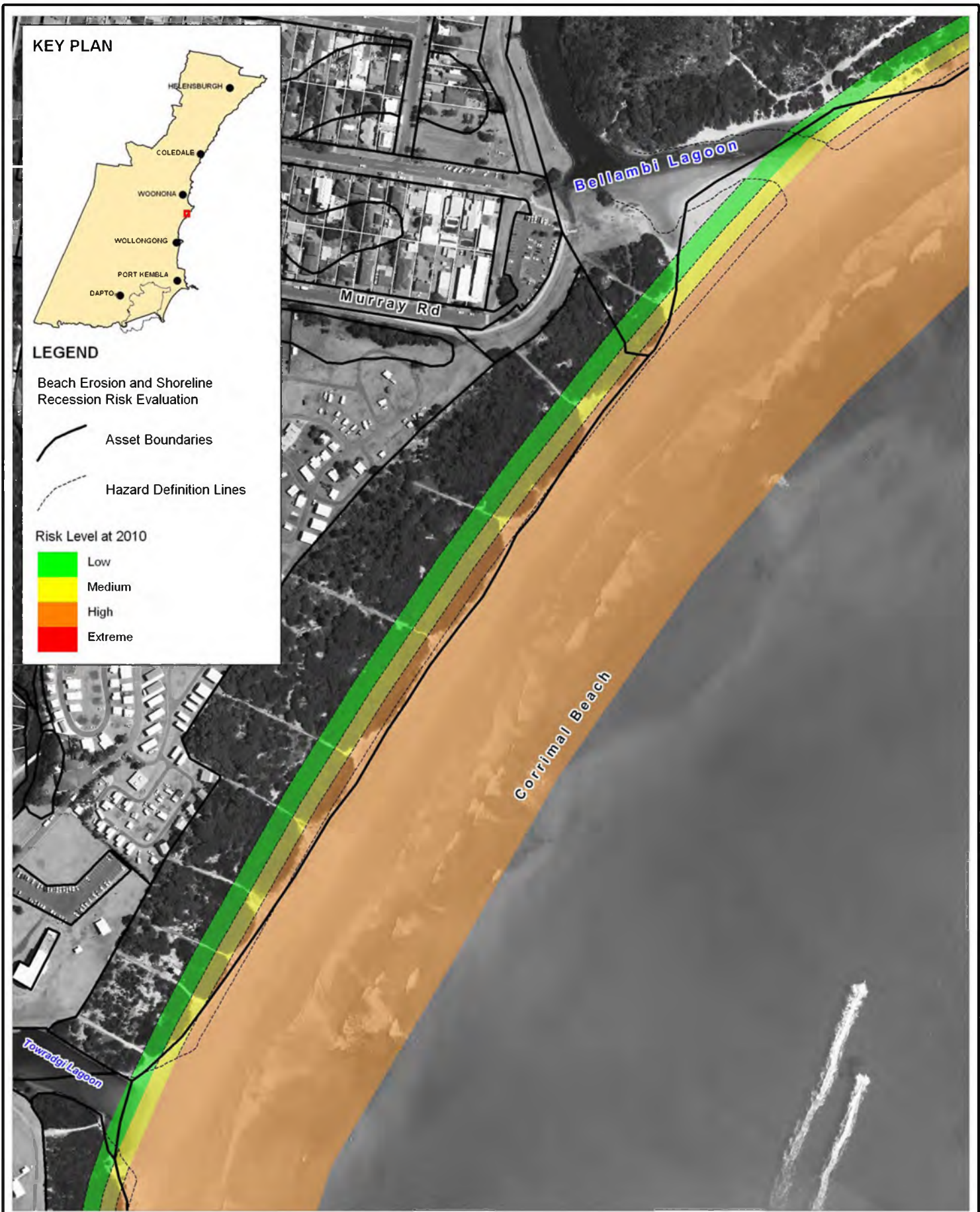
Drawing:  
**A-14**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_114\_110414 Drawing A-14.WOR

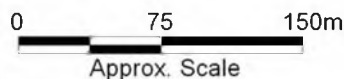


Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Corrimal Beach**

Drawing:  
**A-15**

Rev:  
**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_115\_110414 Drawing A-15.WOR



**KEY PLAN**

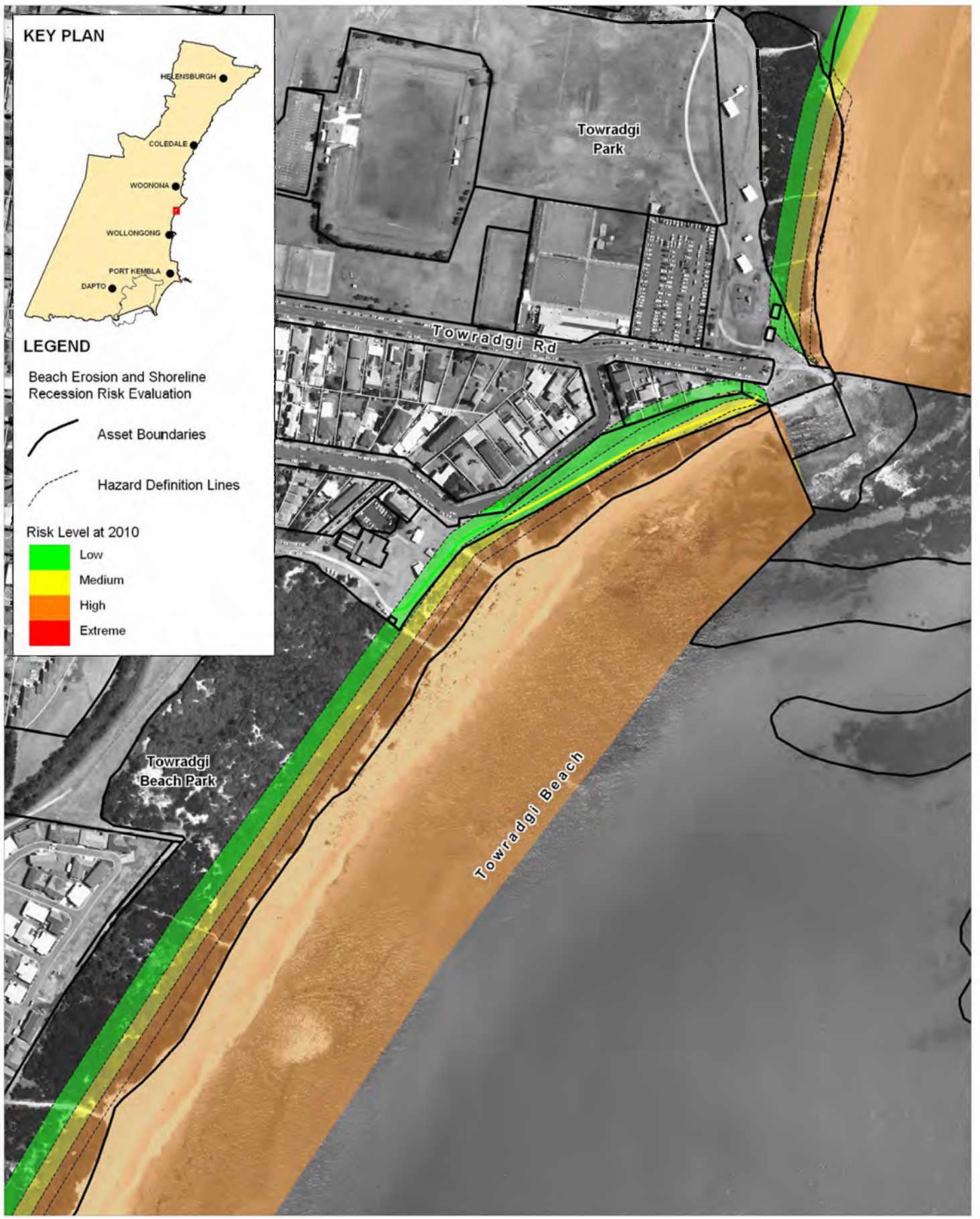


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

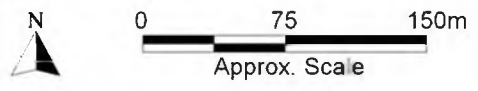
Risk Level at 2010



Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Towradgi Beach**

Drawing: <b>A-16</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_116\_110414 Drawing A-16.WOR

**KEY PLAN**

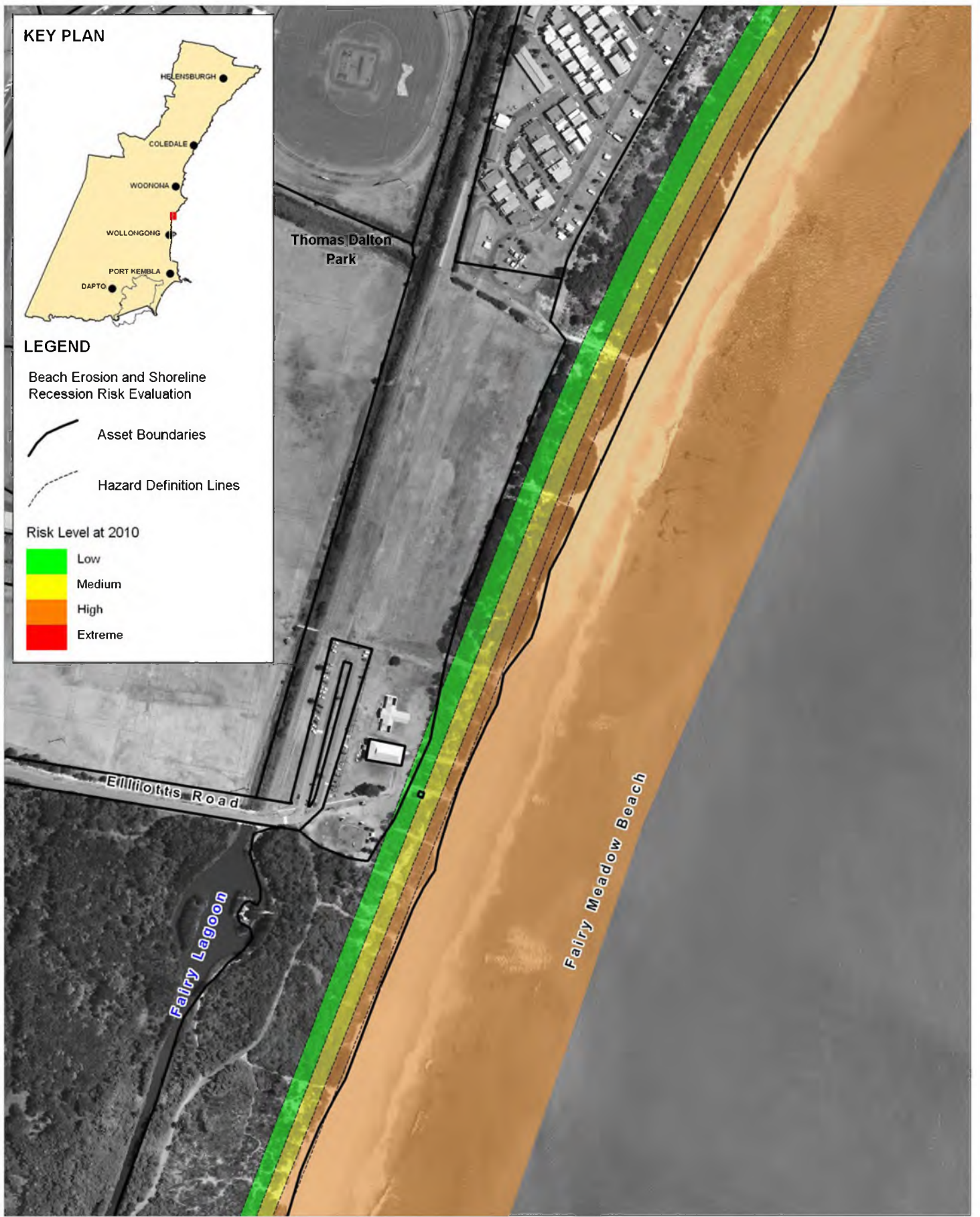


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

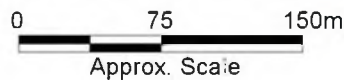


Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Fairy Meadow Beach (north)**

Drawing:  
**A-17**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_117\_110415 Drawing A-17.WOR

**KEY PLAN**



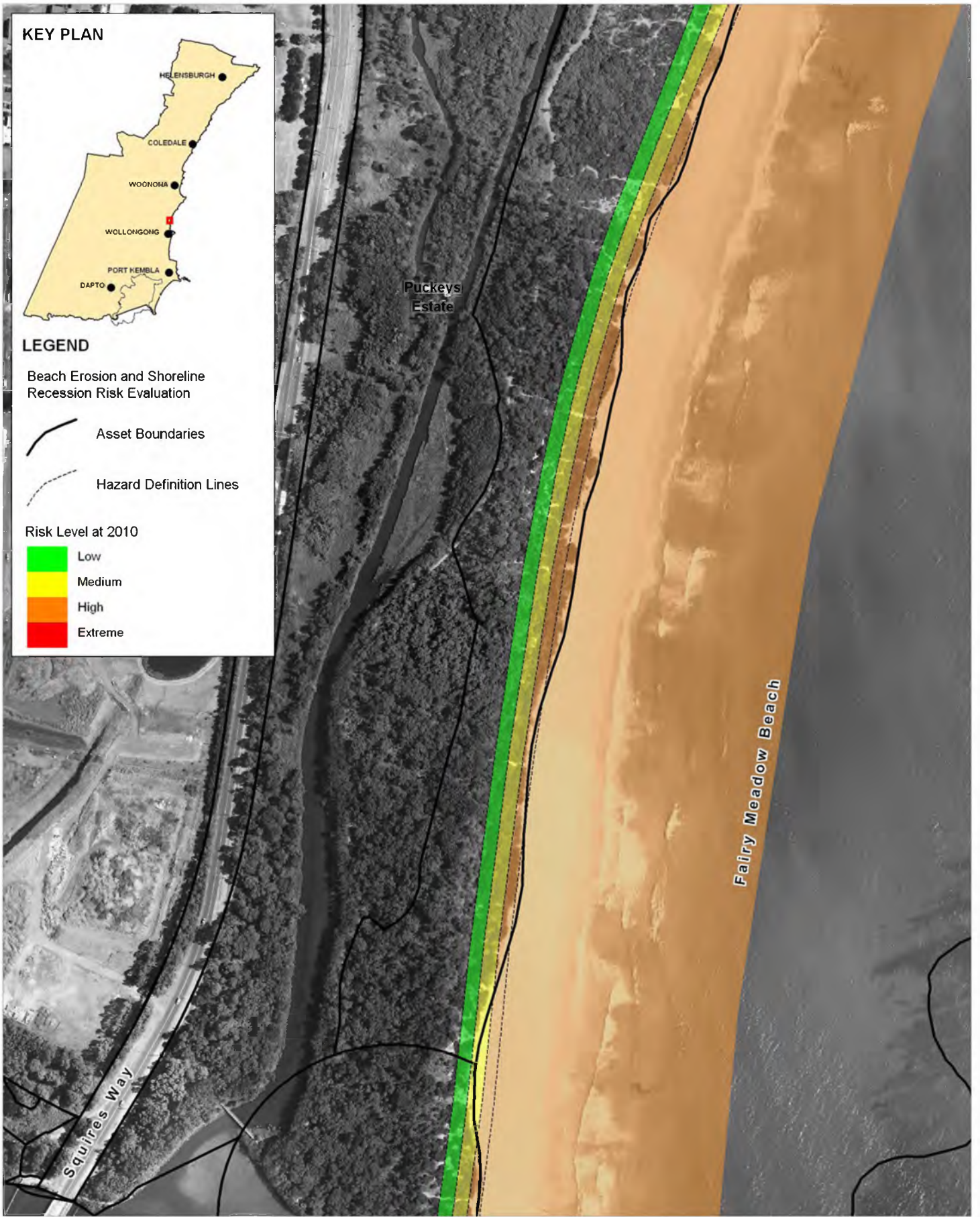
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2010

-  Low
-  Medium
-  High
-  Extreme

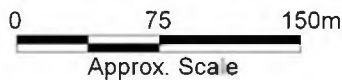


Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Fairy Meadow Beach (south)**

Drawing:  
**A-18**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_118\_110415 Drawing A-18.WOR

**KEY PLAN**

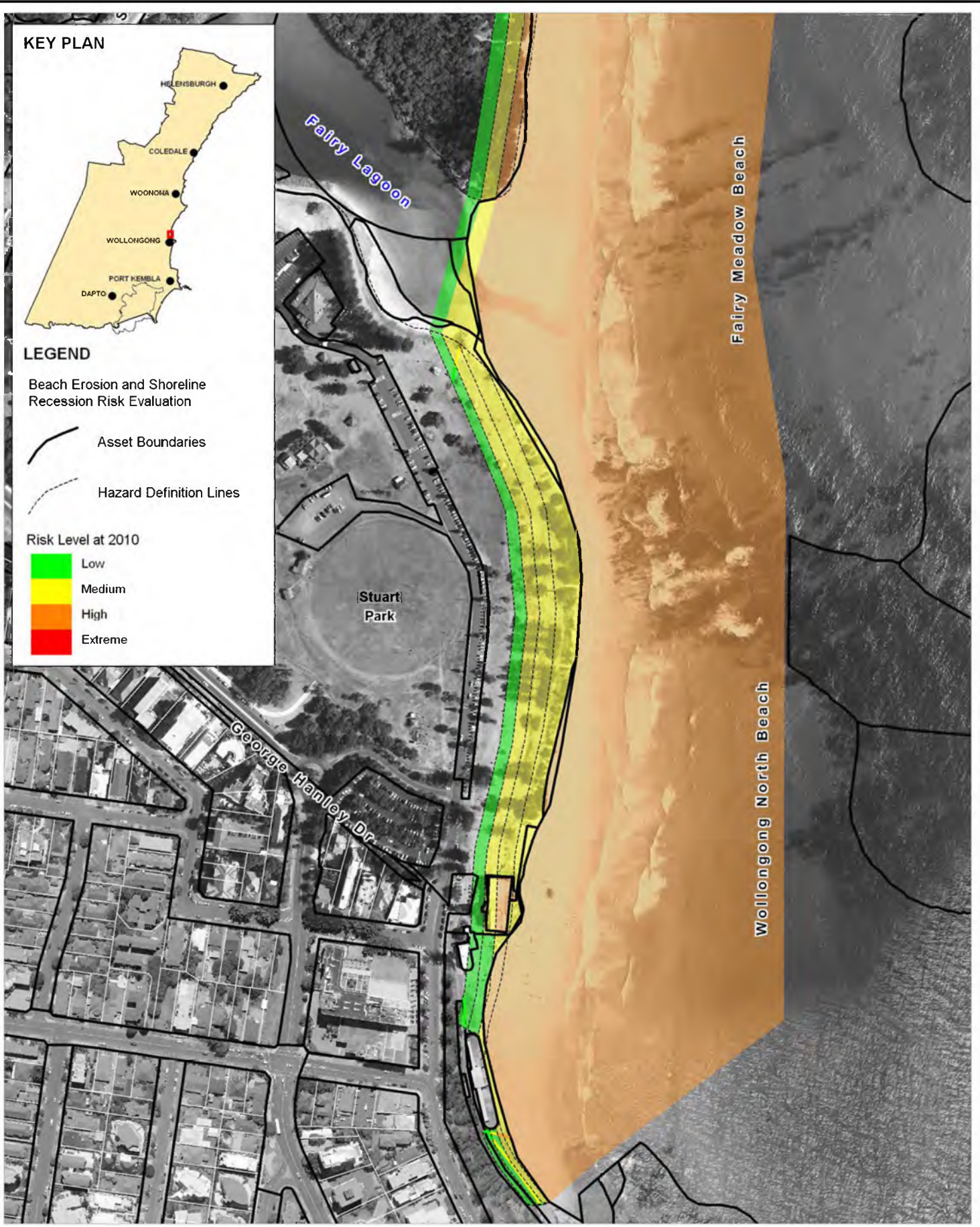


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Wollongong North Beach**

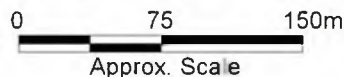
Drawing:

**A-19**

Rev:

**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_119\_110415 Drawing A-19.WOR

**KEY PLAN**

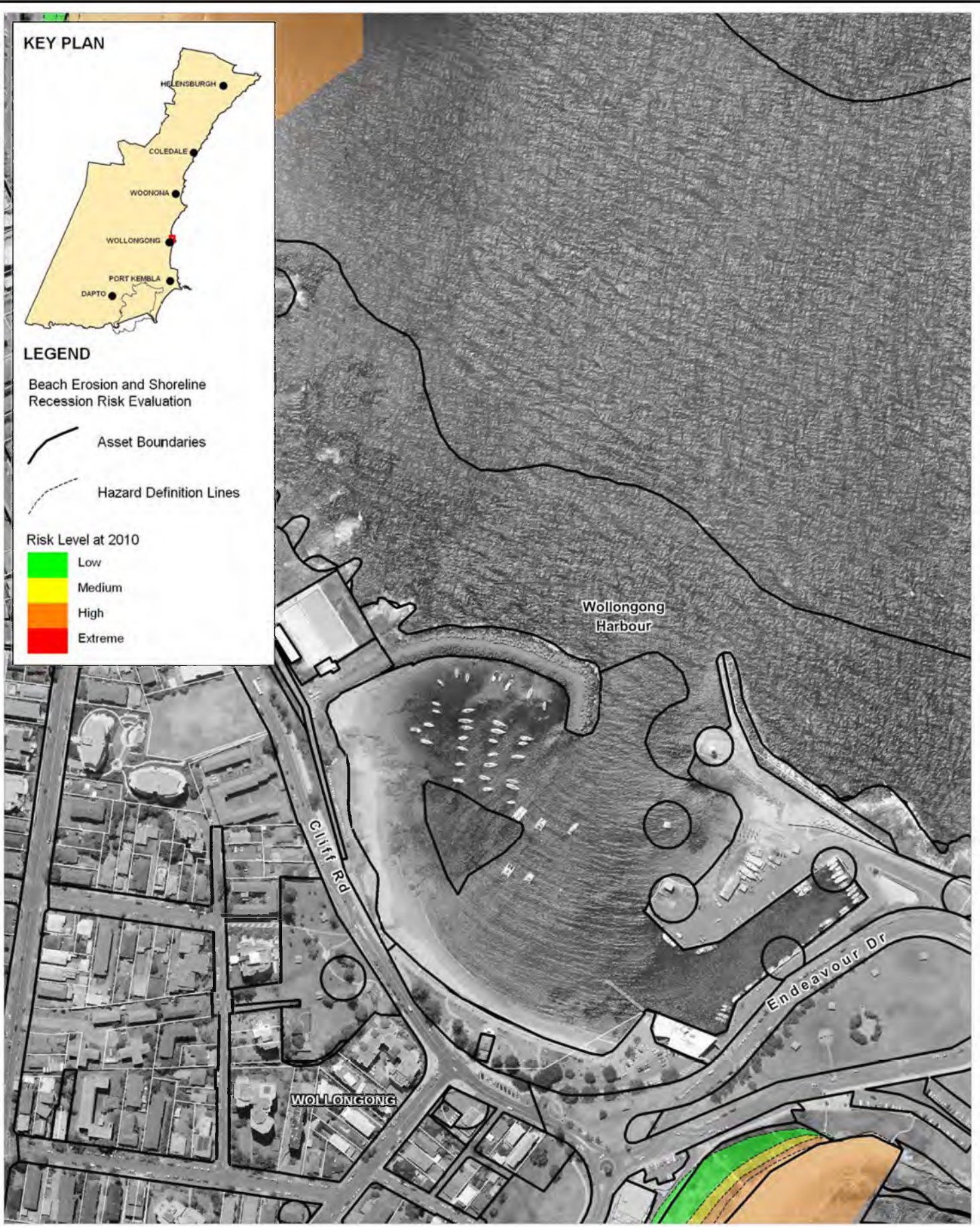


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

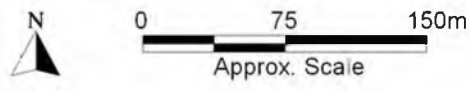
Risk Level at 2010



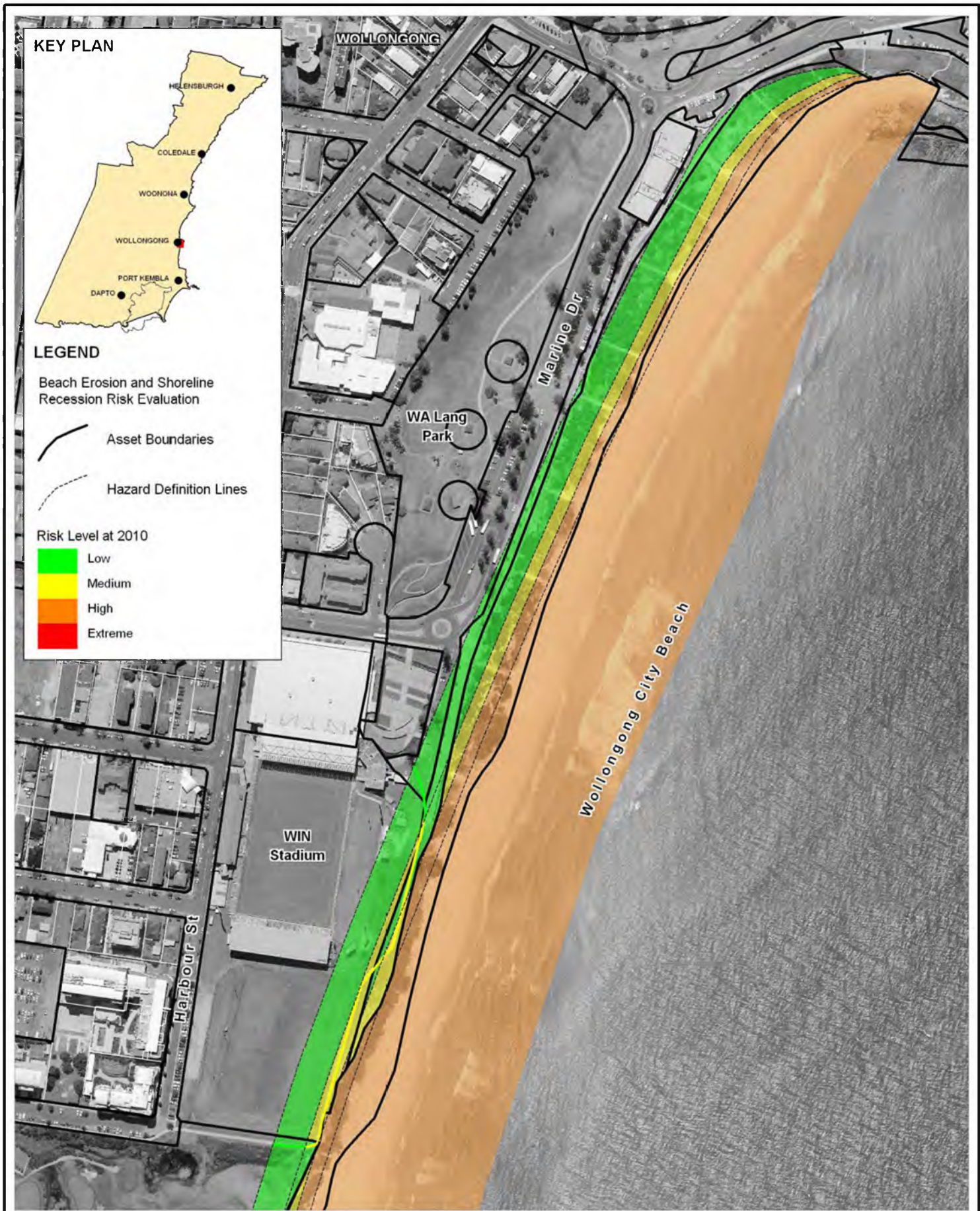
Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Wollongong Harbour**

Drawing: <b>A-20</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_120\_110415 Drawing A-20.WOR

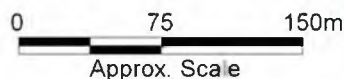


Title:  
**Erosion and Recession Risk Evaluation  
 Immediate Planning Horizon - Wollongong City Beach**

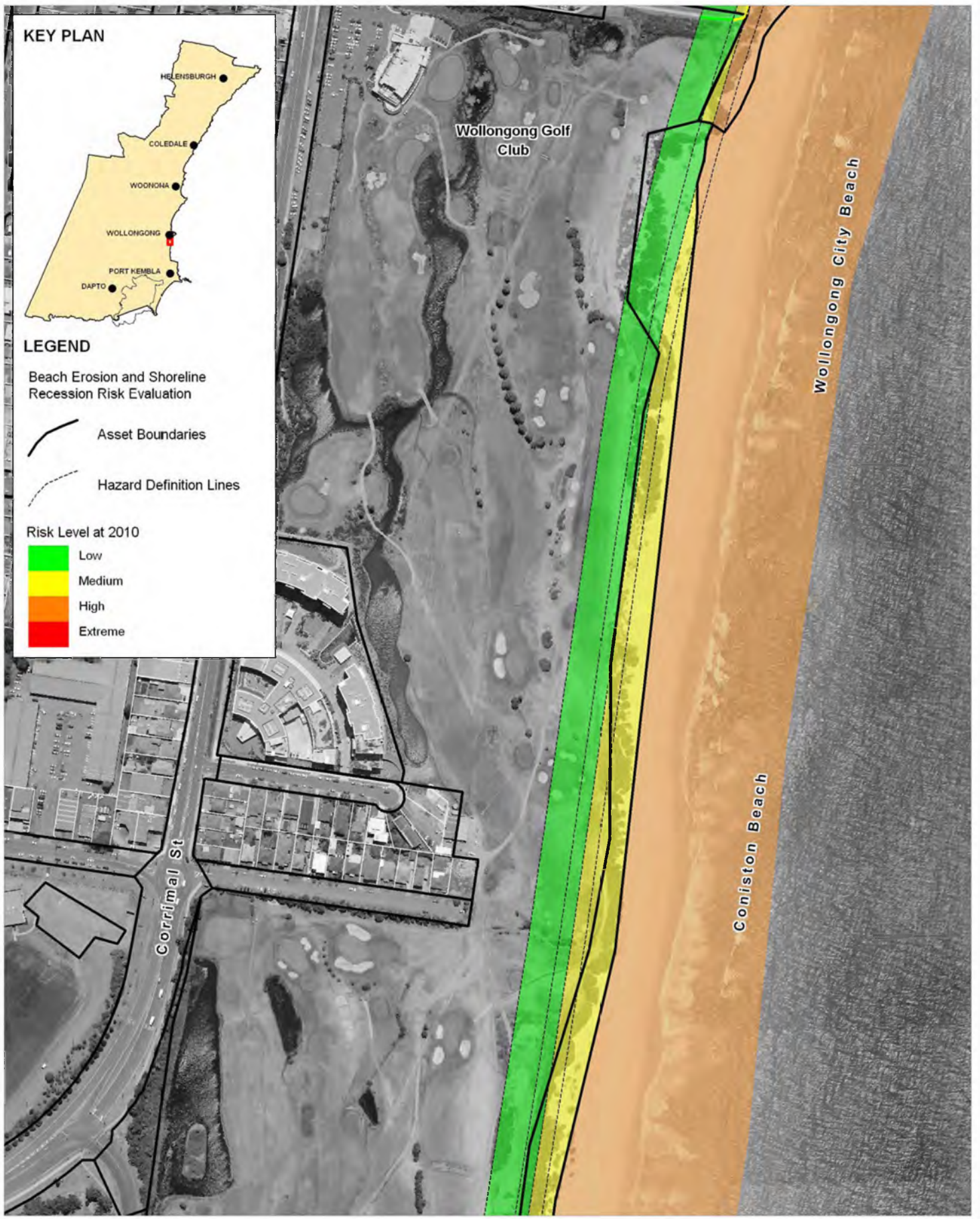
Drawing:  
**A-21**

Rev:  
**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_121\_110415 Drawing A-21.WOR

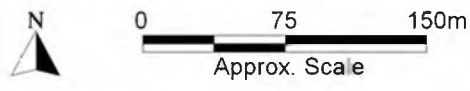


Title: **Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Coniston Beach (north)**

Drawing: **A-22**

Rev: **A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_122\_110415 Drawing A-22.WOR

**KEY PLAN**

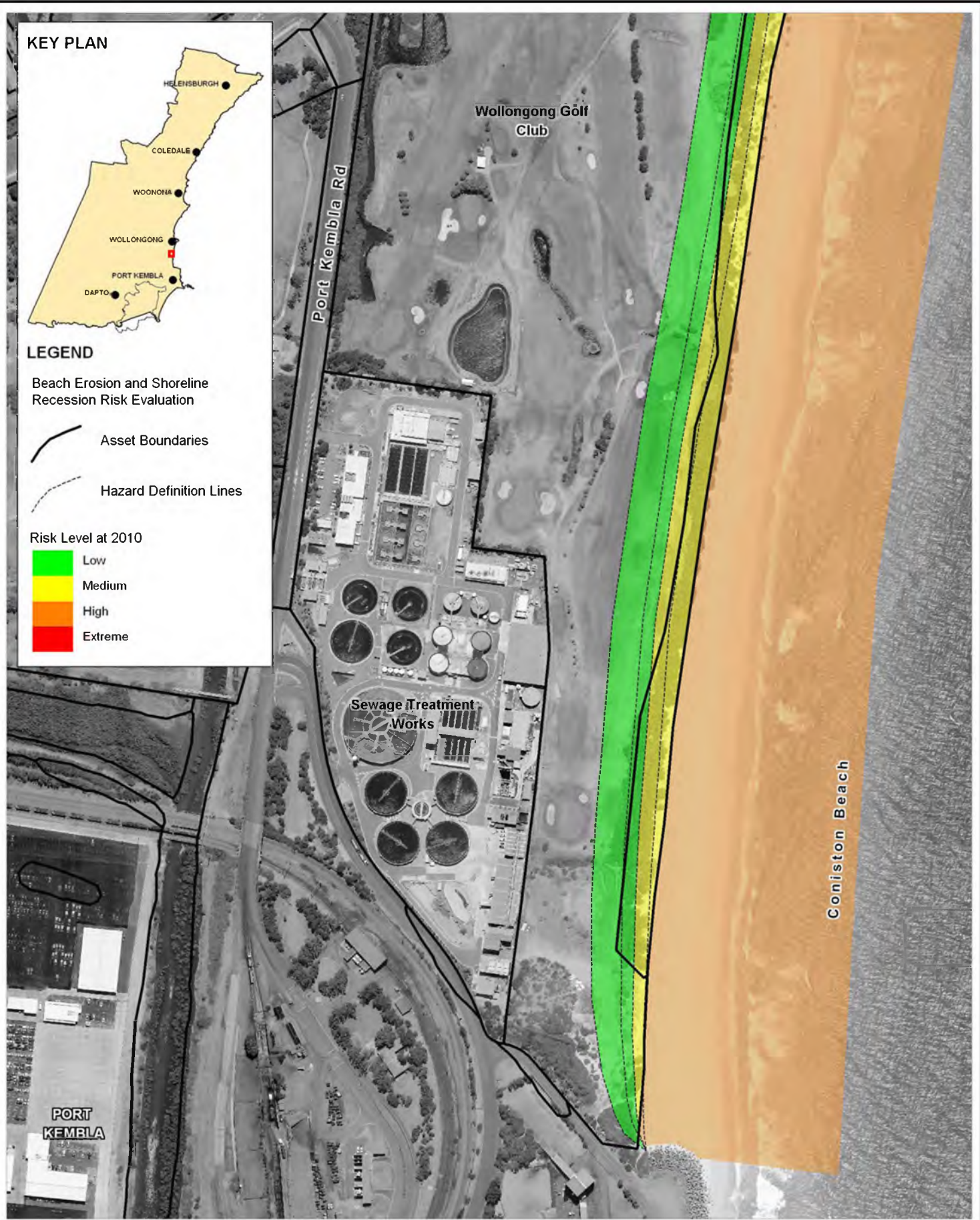
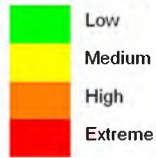


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Coniston Beach (south)**

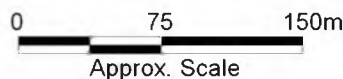
Drawing:

**A-23**

Rev:

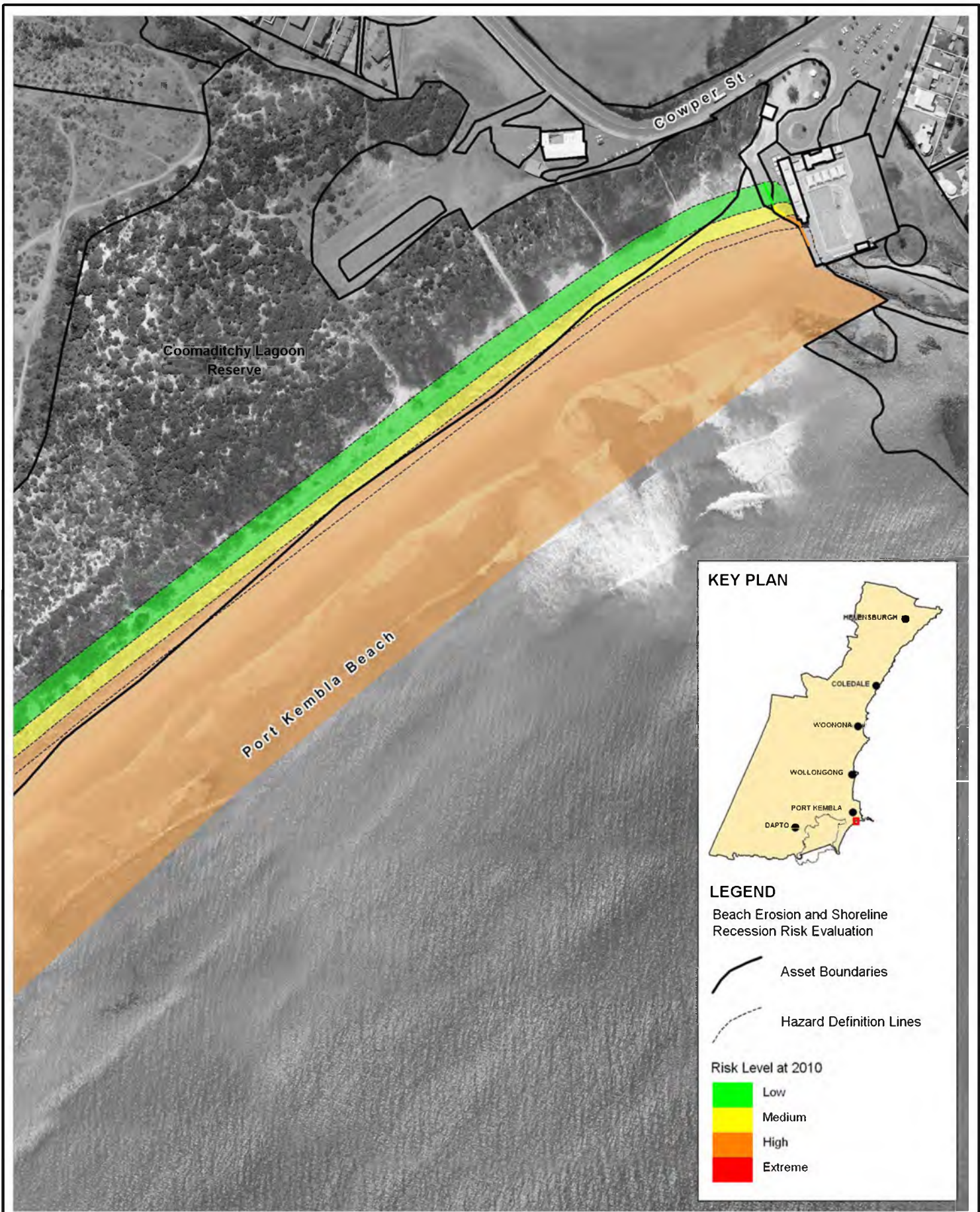
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_123\_110415 Drawing A-23.WOR



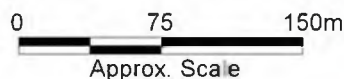


Title:  
**Erosion and Recession Risk Evaluation  
 Immediate Planning Horizon - Port Kembla Beach**

Drawing:  
**A-24**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_124\_110415 Drawing A-24.WOR

**KEY PLAN**



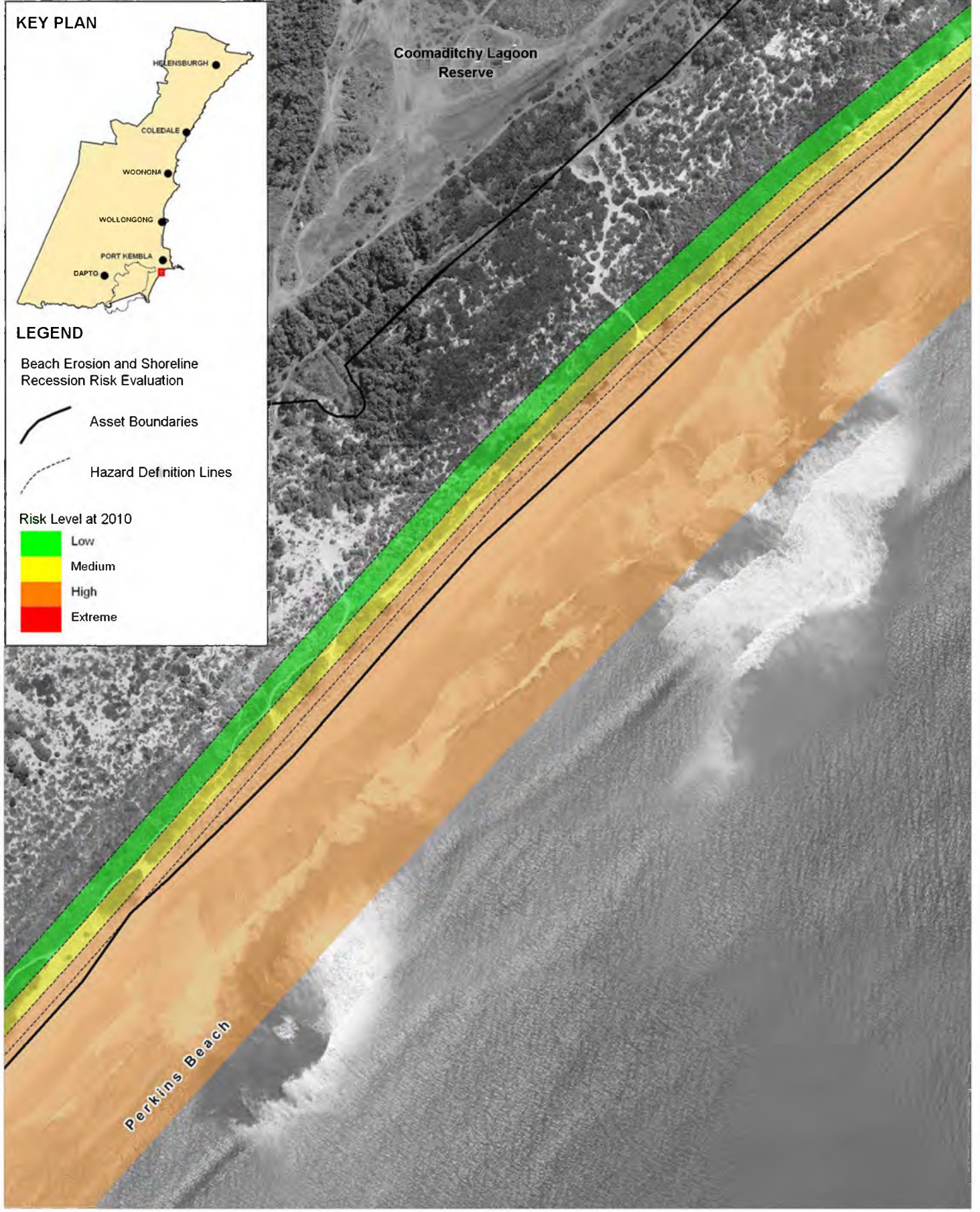
**LEGEND**

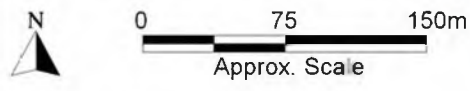

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2010

-  Low
-  Medium
-  High
-  Extreme



<p>Title: <b>Erosion and Recession Risk Evaluation Immediate Planning Horizon - Perkins Beach (1)</b></p>		<p>Drawing: <b>A-25</b></p>	<p>Rev: <b>A</b></p>
<p>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.</p>			
			



Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_125\_110415 Drawing A-25.WOR

**KEY PLAN**

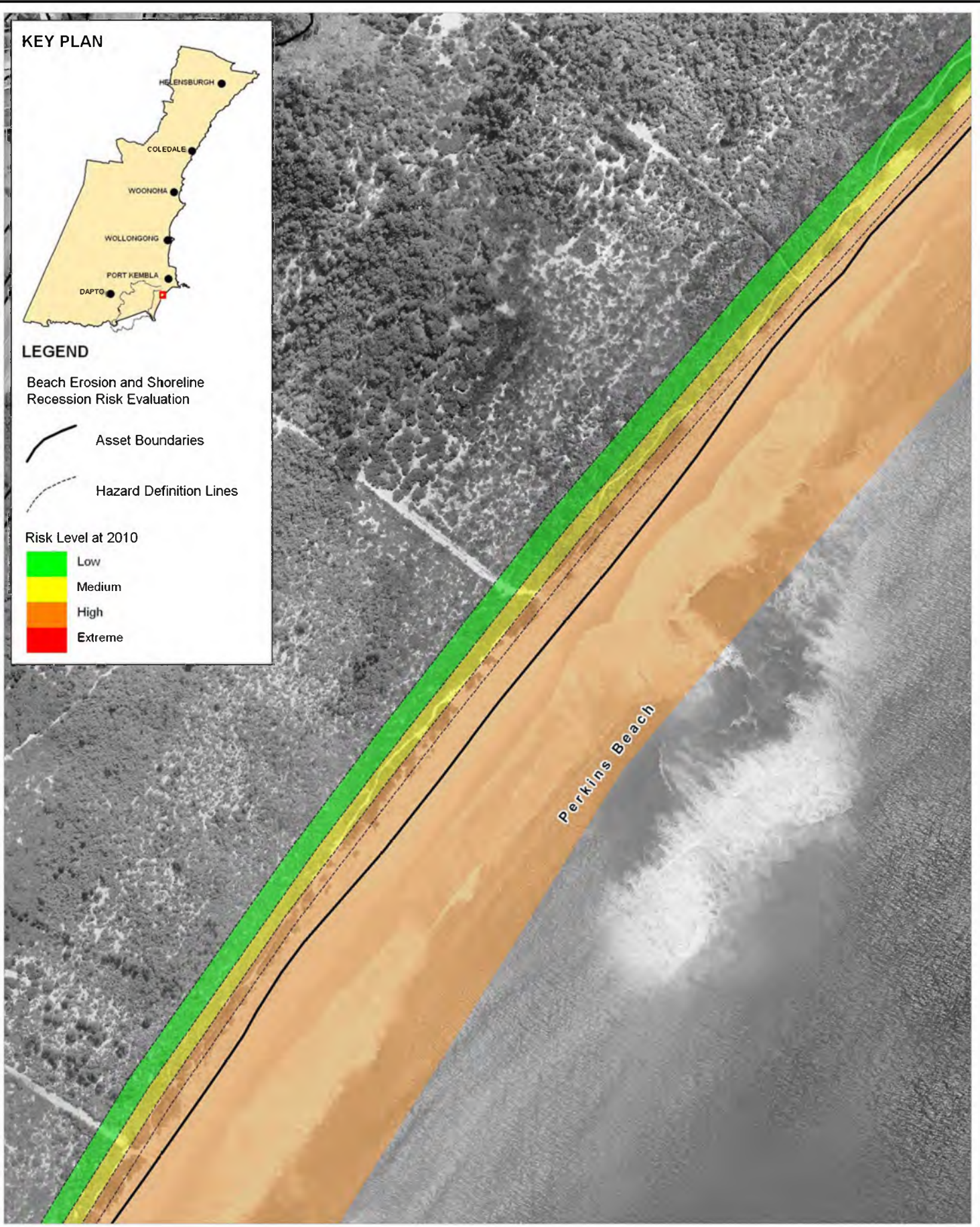


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2010

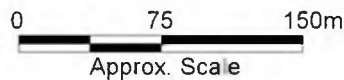


Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Perkins Beach (2)**

Drawing:  
**A-26**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_126\_110415 Drawing A-26.WOR

**KEY PLAN**



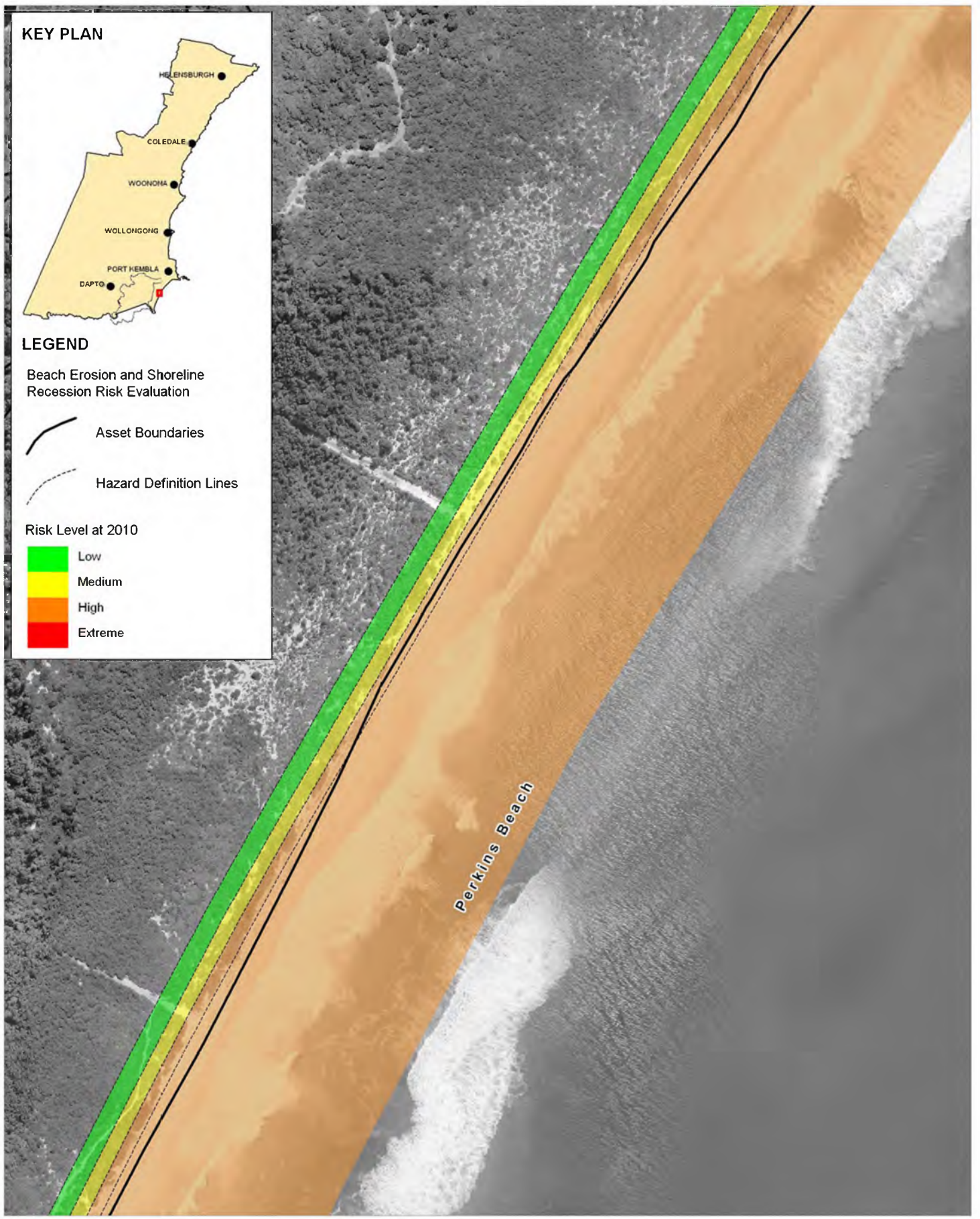
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2010

-  Low
-  Medium
-  High
-  Extreme

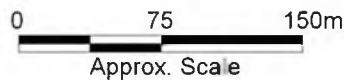


Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Perkins Beach (3)**

Drawing:  
**A-27**

Rev:  
**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_127\_110415 Drawing A-27.WOR

**KEY PLAN**




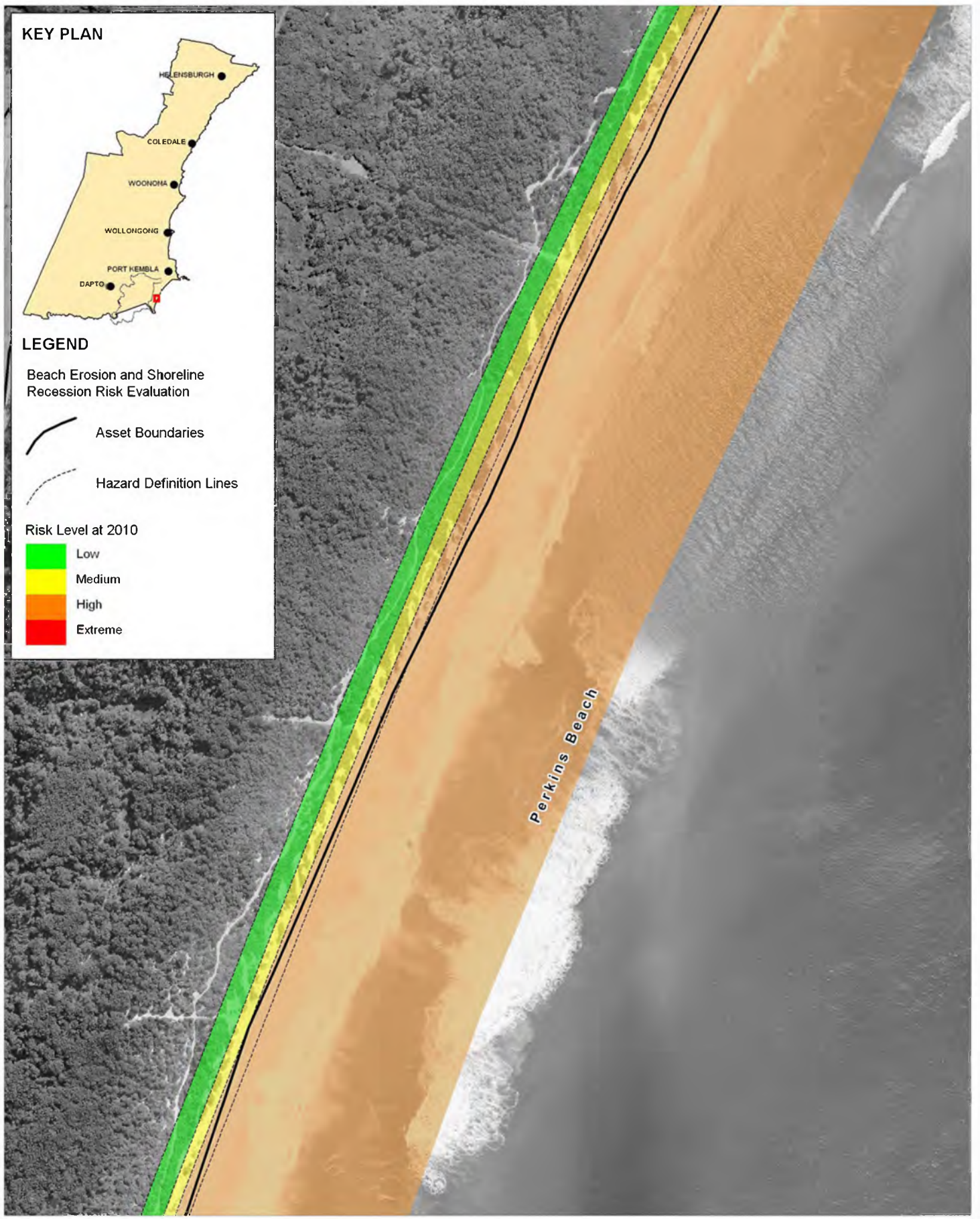
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

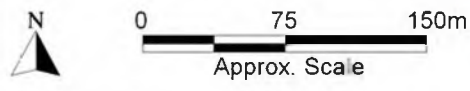
Risk Level at 2010

-  Low
-  Medium
-  High
-  Extreme

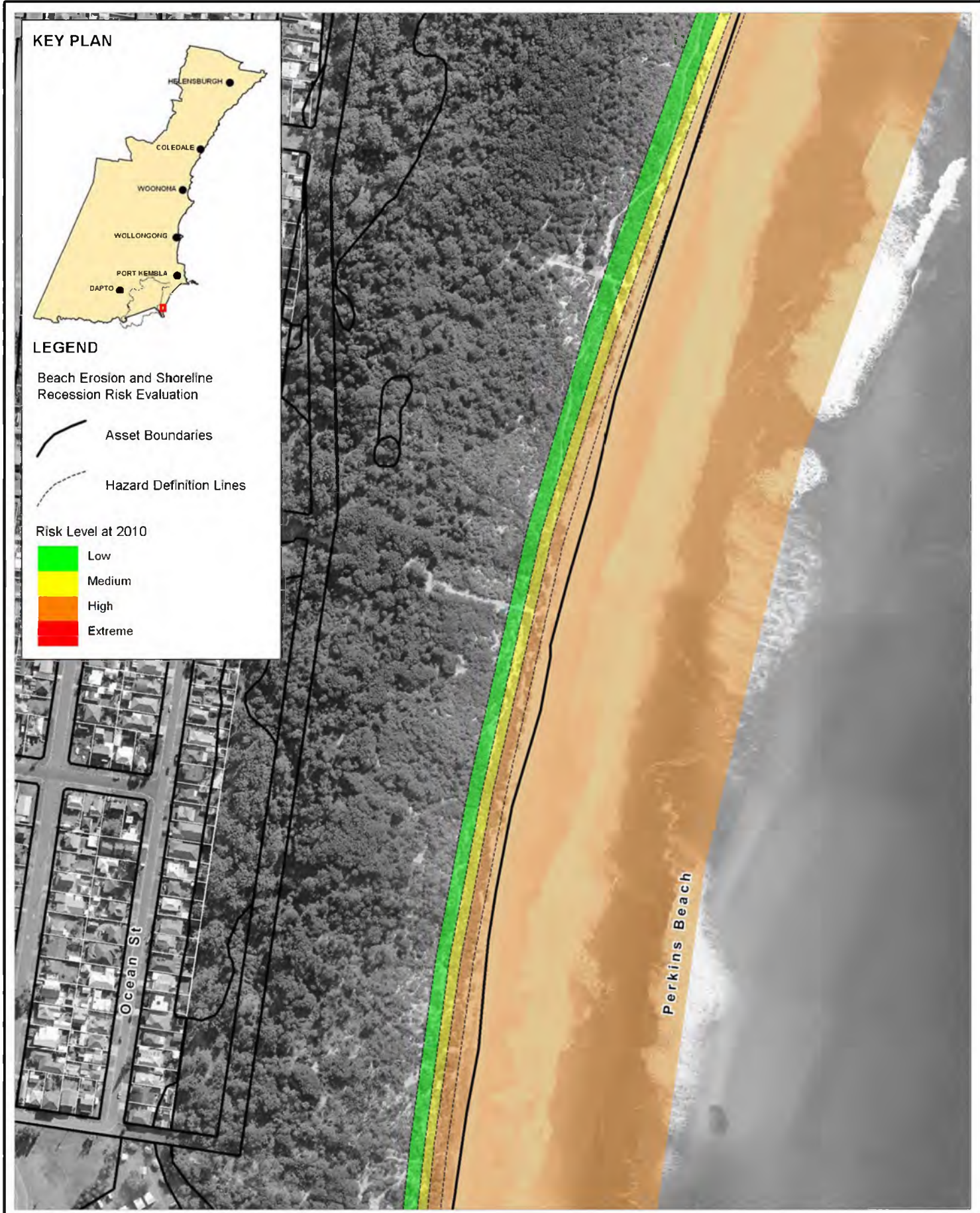


<p>Title: <b>Erosion and Recession Risk Evaluation Immediate Planning Horizon - Perkins Beach (4)</b></p>	<p>Drawing: <b>A-28</b></p>	<p>Rev: <b>A</b></p>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_128\_110415 Drawing A-28.WOR





**KEY PLAN**



**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2010

-  Low
-  Medium
-  High
-  Extreme

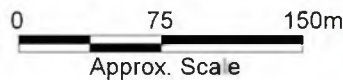


Title:  
**Erosion and Recession Risk Evaluation  
Immediate Planning Horizon - Perkins Beach (5)**

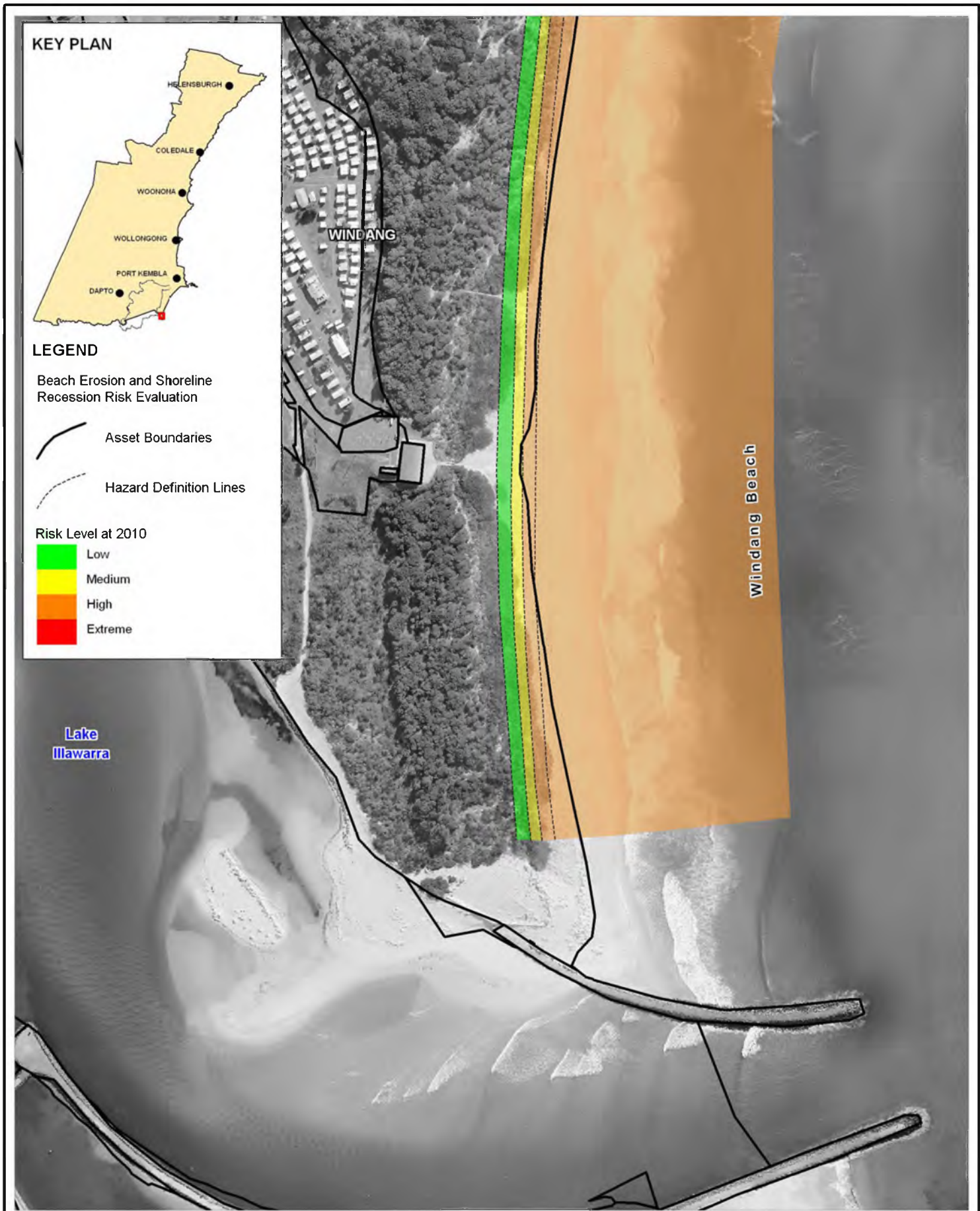
Drawing:  
**A-29**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_129\_110415 Drawing A-29.WOR



Title:  
**Erosion and Recession Risk Evaluation  
 Immediate Planning Horizon - Windang Beach**

Drawing: <b>A-30</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_130\_110415 Drawing A-30.WOR

**KEY PLAN**



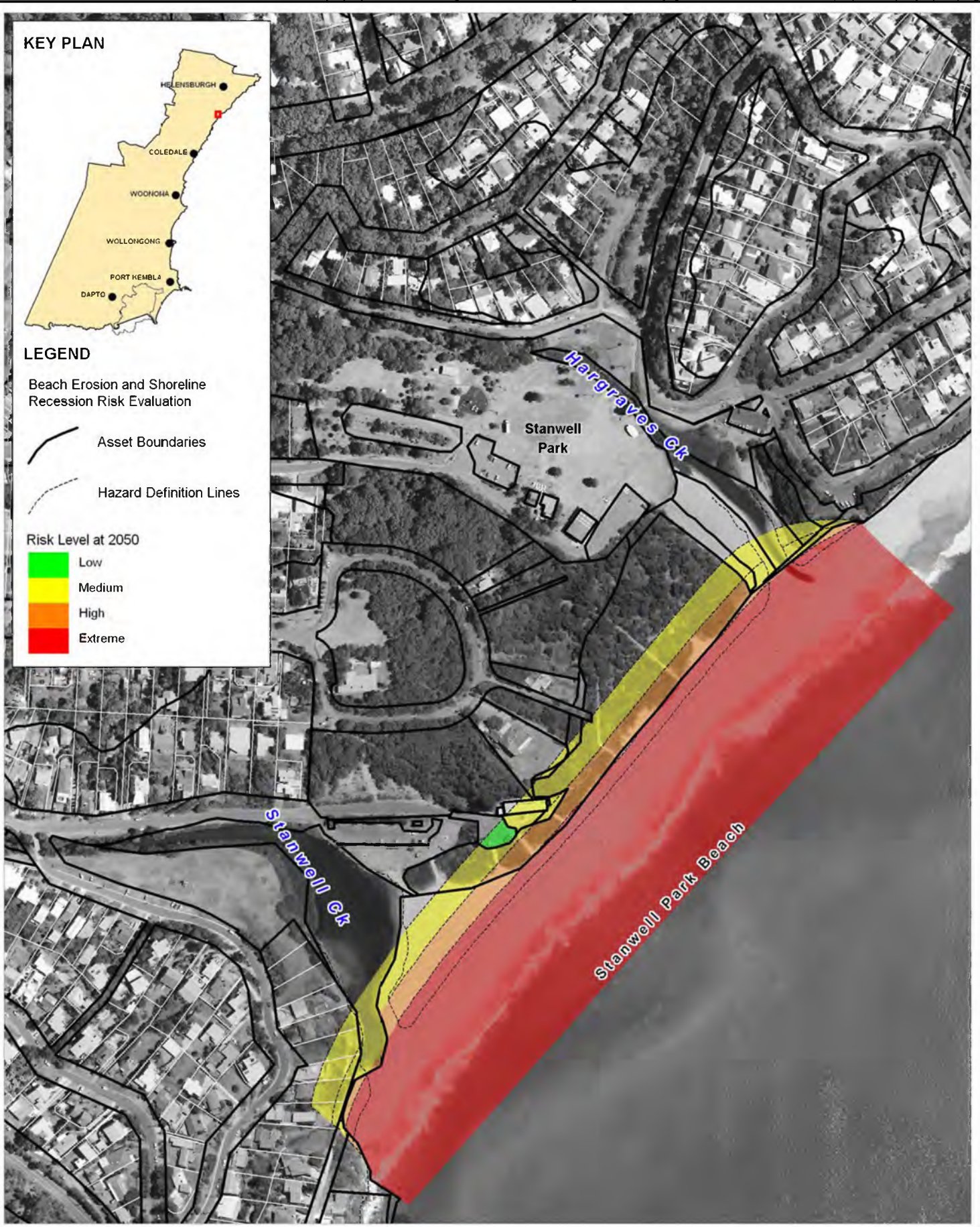
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2050

-  Low
-  Medium
-  High
-  Extreme



Title:

**Erosion and recession Risk Evaluation  
2050 Planning Horizon - Stanwell Park**

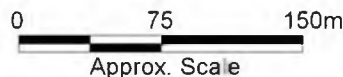
Drawing:

**B-1**

Rev:

**A**

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**KEY PLAN**

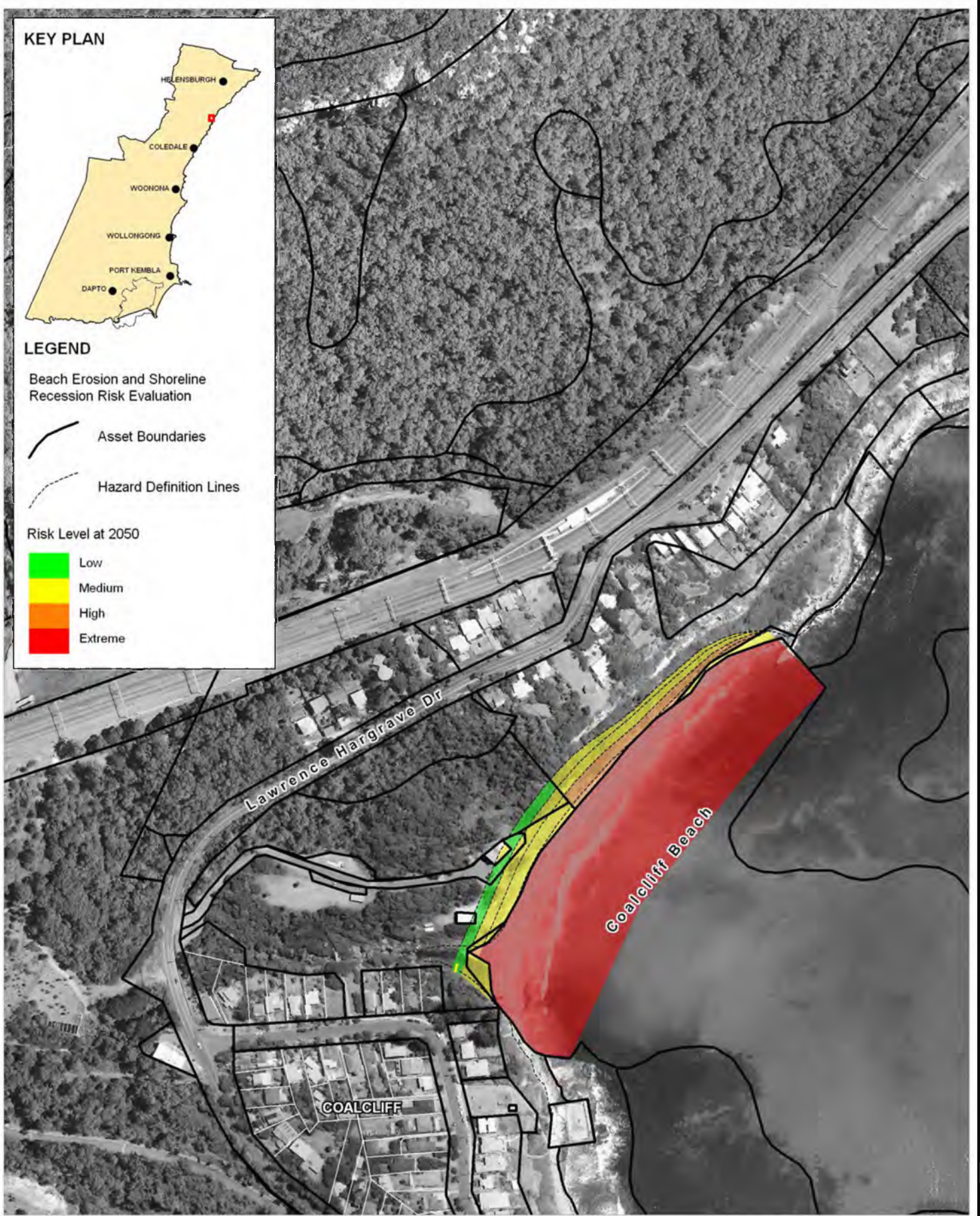


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050



Title:

**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Coalcliff**

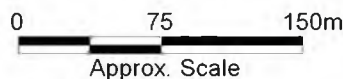
Drawing:

**B-2**

Rev:

**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_132\_110415 Drawing B-2.WOR

**KEY PLAN**

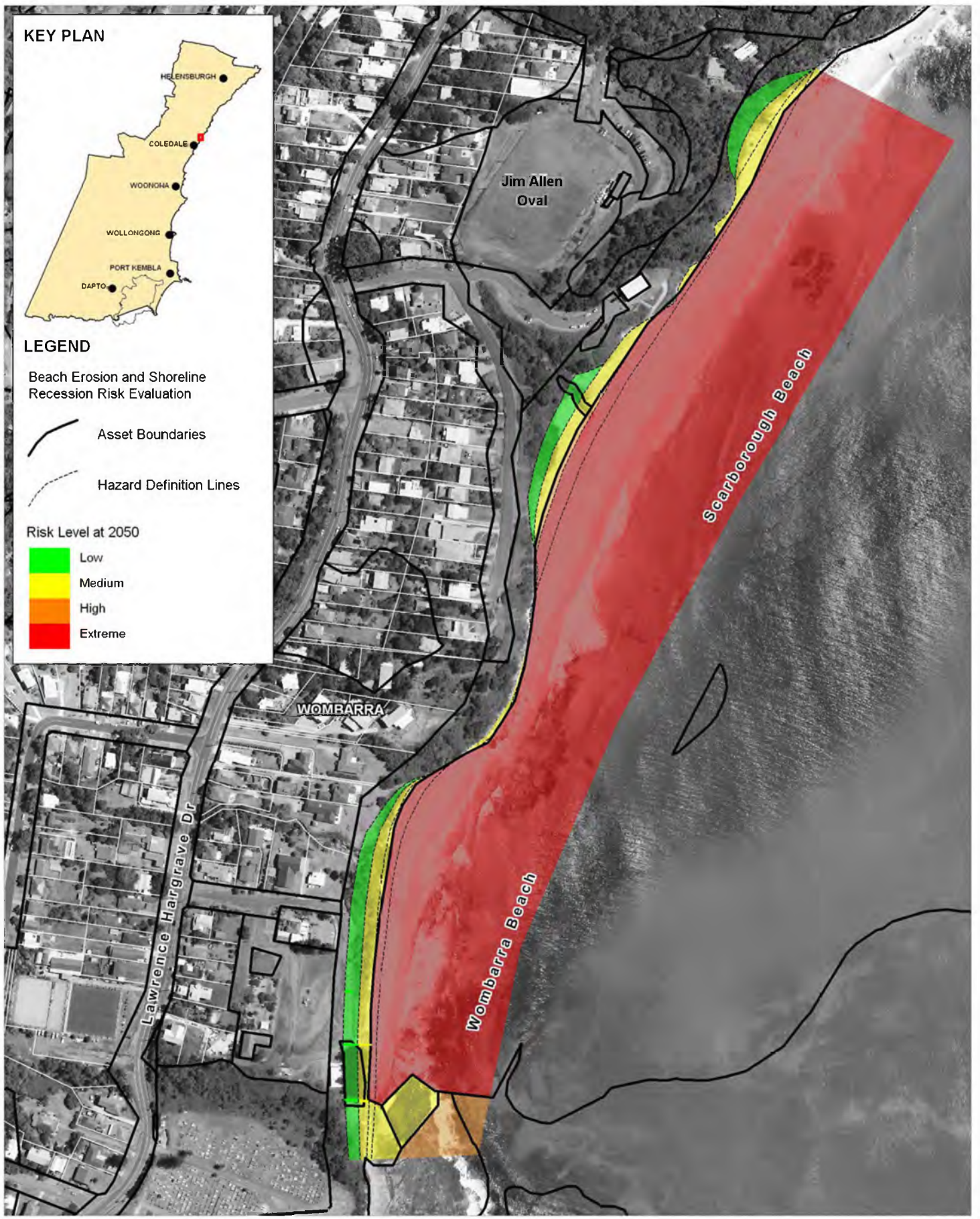


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

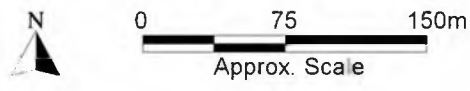
- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050



<p>Title: <b>Erosion and Recession Risk Evaluation 2050 Planning Horizon - Scarborough/Wombarra</b></p>	<p>Drawing: <b>B-3</b></p>	<p>Rev: <b>A</b></p>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_133\_110415 Drawing B-3.WOR

**KEY PLAN**



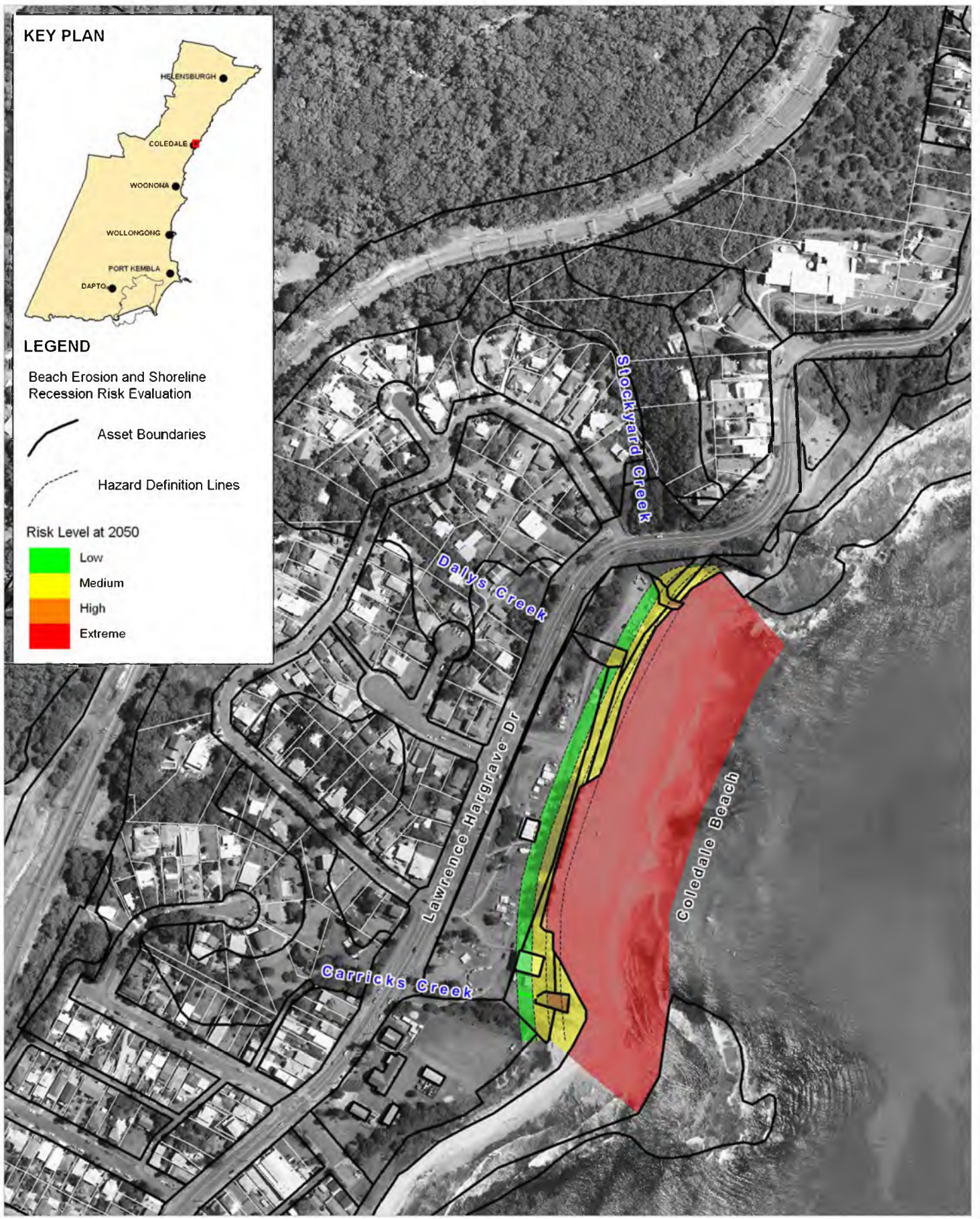
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050

- Low
- Medium
- High
- Extreme



Title:

**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Coledale**

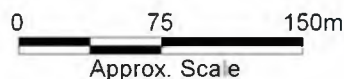
Drawing:

**B-4**

Rev:

**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_134\_110415 Drawing B-4.WOR

**KEY PLAN**






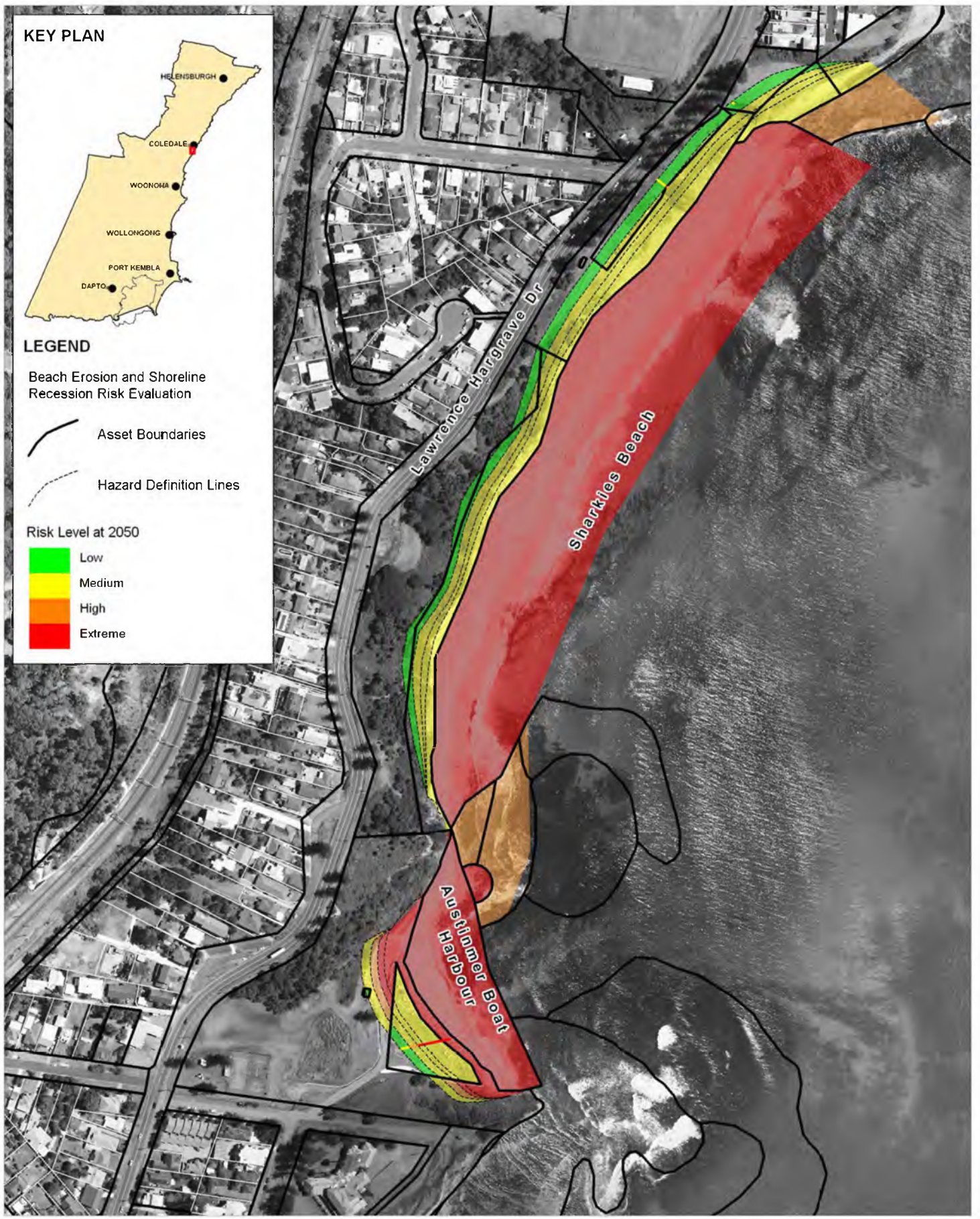
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

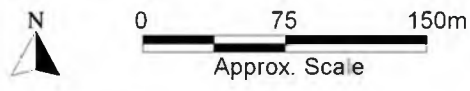
Risk Level at 2050

-  Low
-  Medium
-  High
-  Extreme



<p>Title: <b>Erosion and Recession Risk Evaluation 2050 Planning Horizon - Sharkies Beach</b></p>	<p>Drawing: <b>B-5</b></p>	<p>Rev: <b>A</b></p>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_135\_110415 Drawing B-5.WOR

**KEY PLAN**

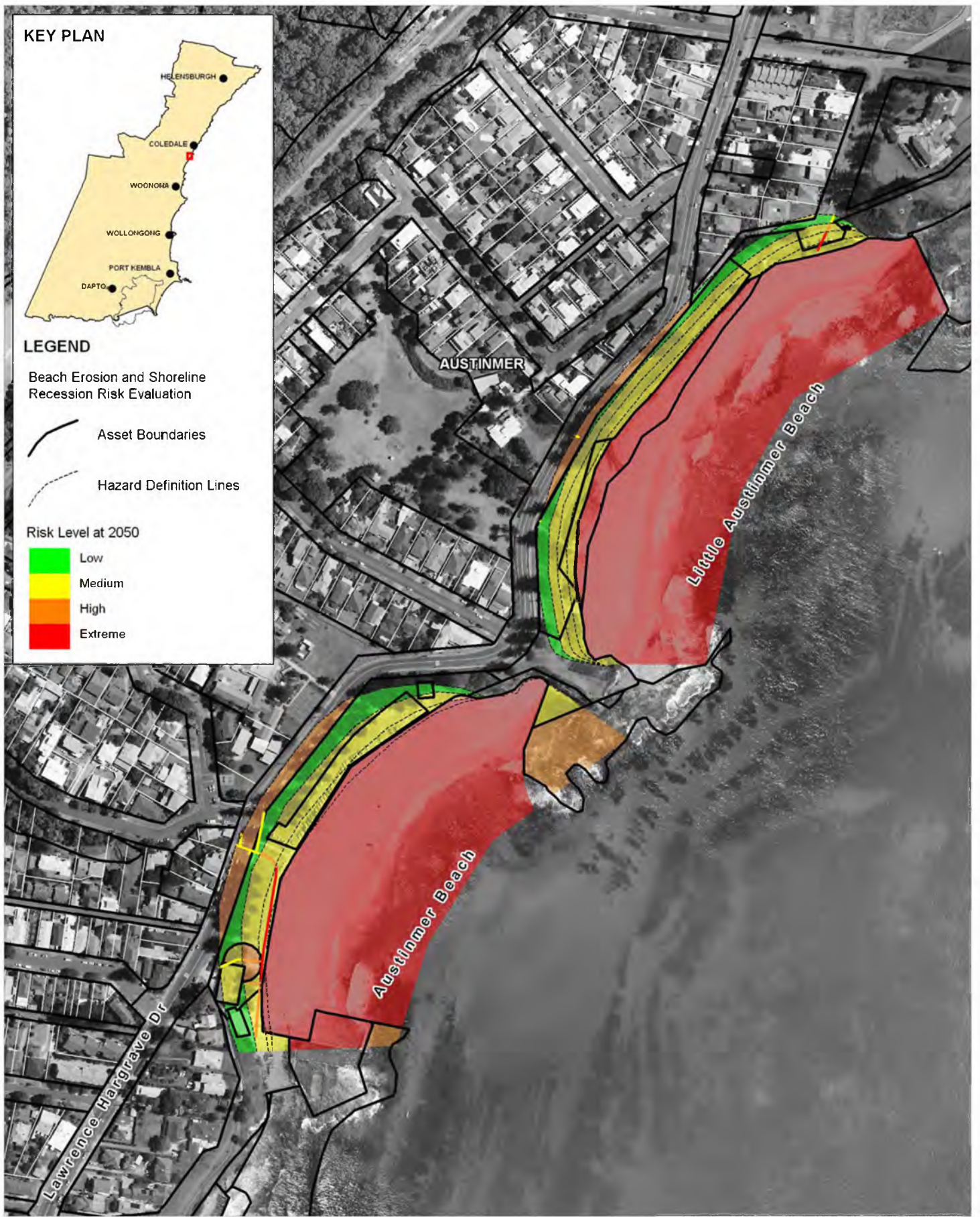


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2050



Title:

**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Austinmer**

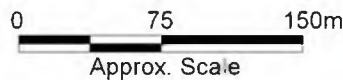
Drawing:

**B-6**

Rev:

**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_136\_110415 Drawing B-6.WOR

**KEY PLAN**

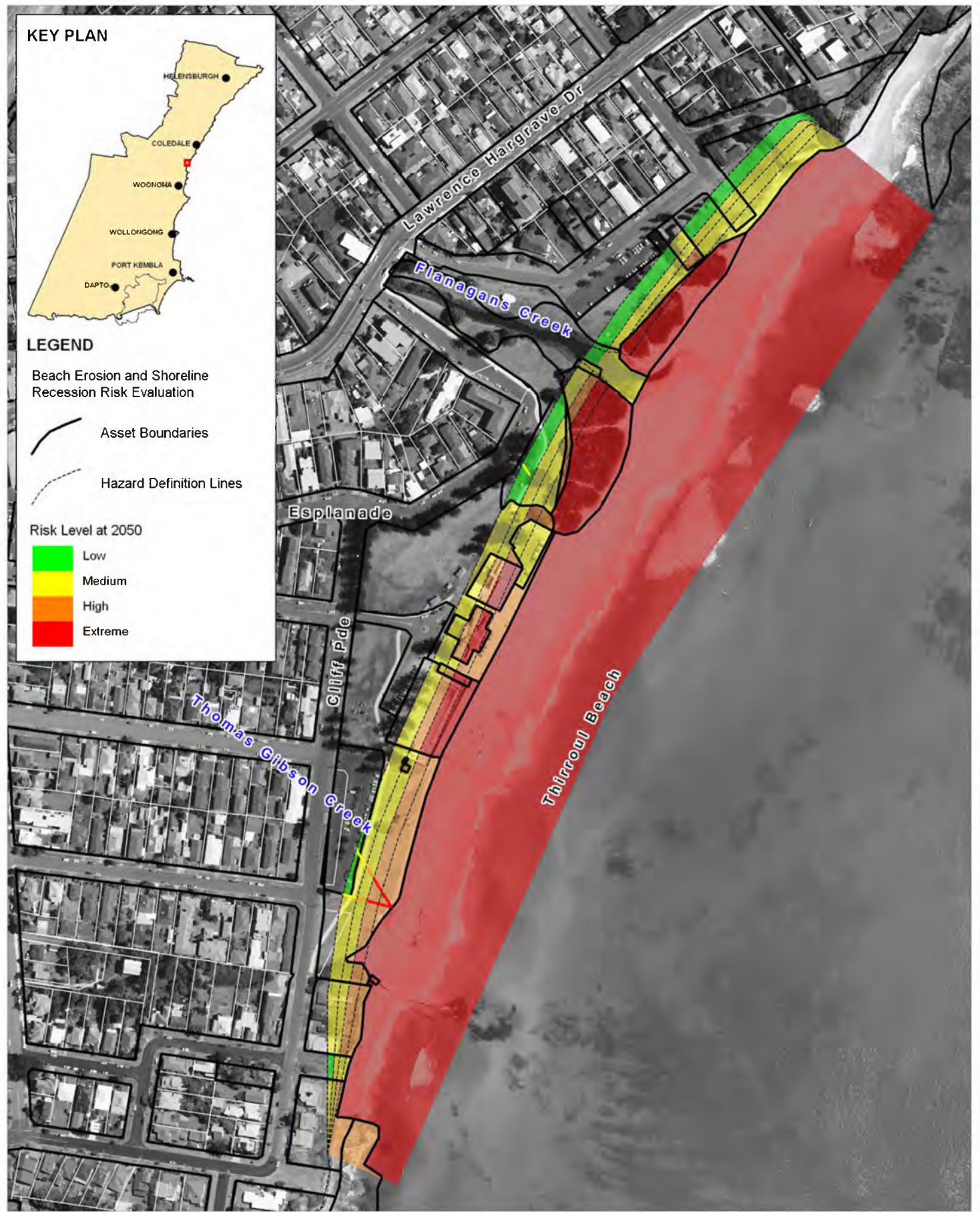
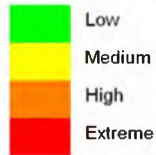


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050



Title:

**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Thirroul**

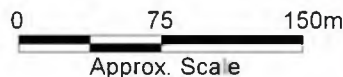
Drawing:

**B-7**

Rev:

**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_137\_110414 Drawing B-7.WOR

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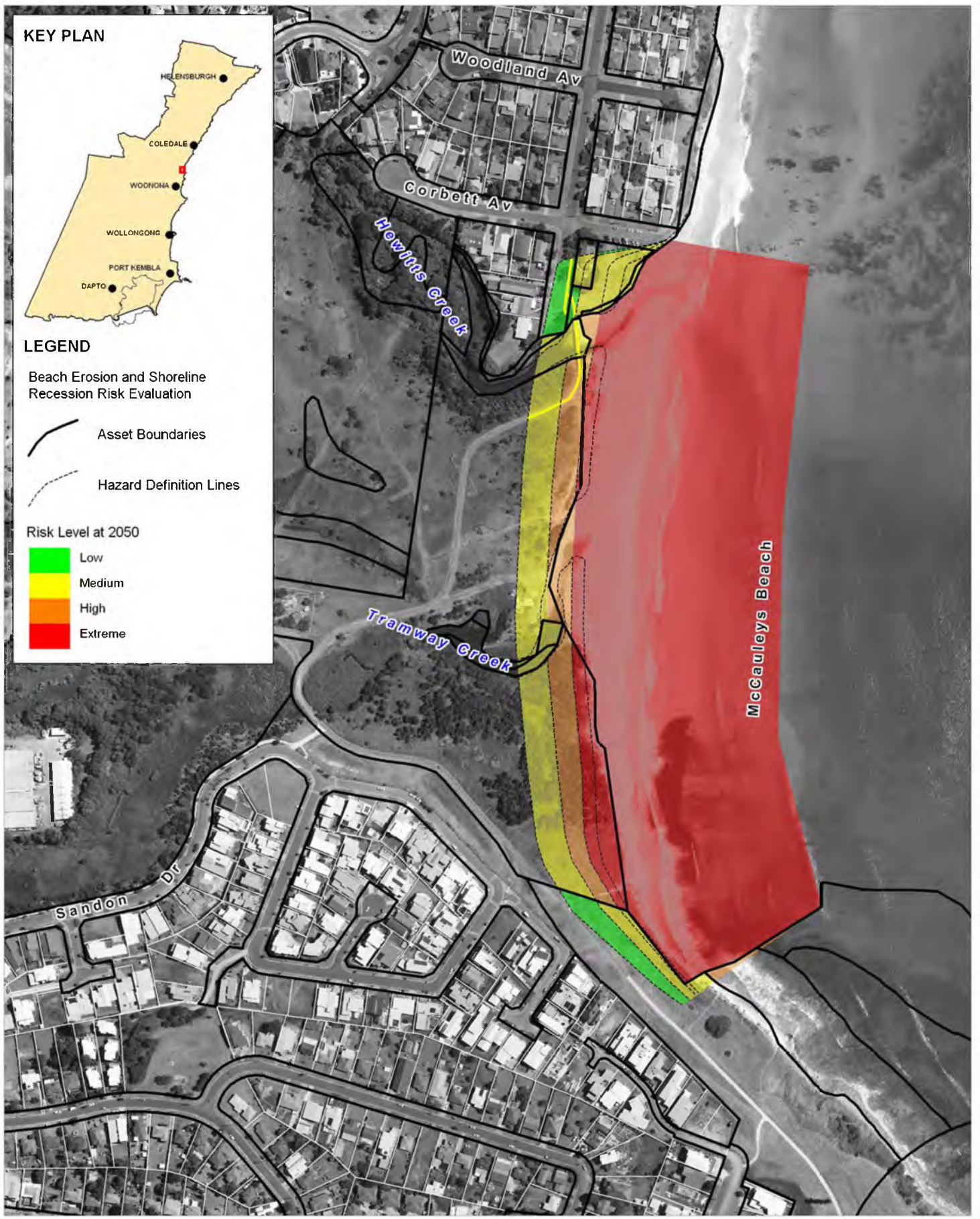
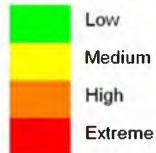


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050

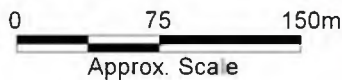


Title:  
**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - McCauleys Beach**

Drawing:  
**B-8**

Rev:  
**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_138\_110415 Drawing B-8.WOR

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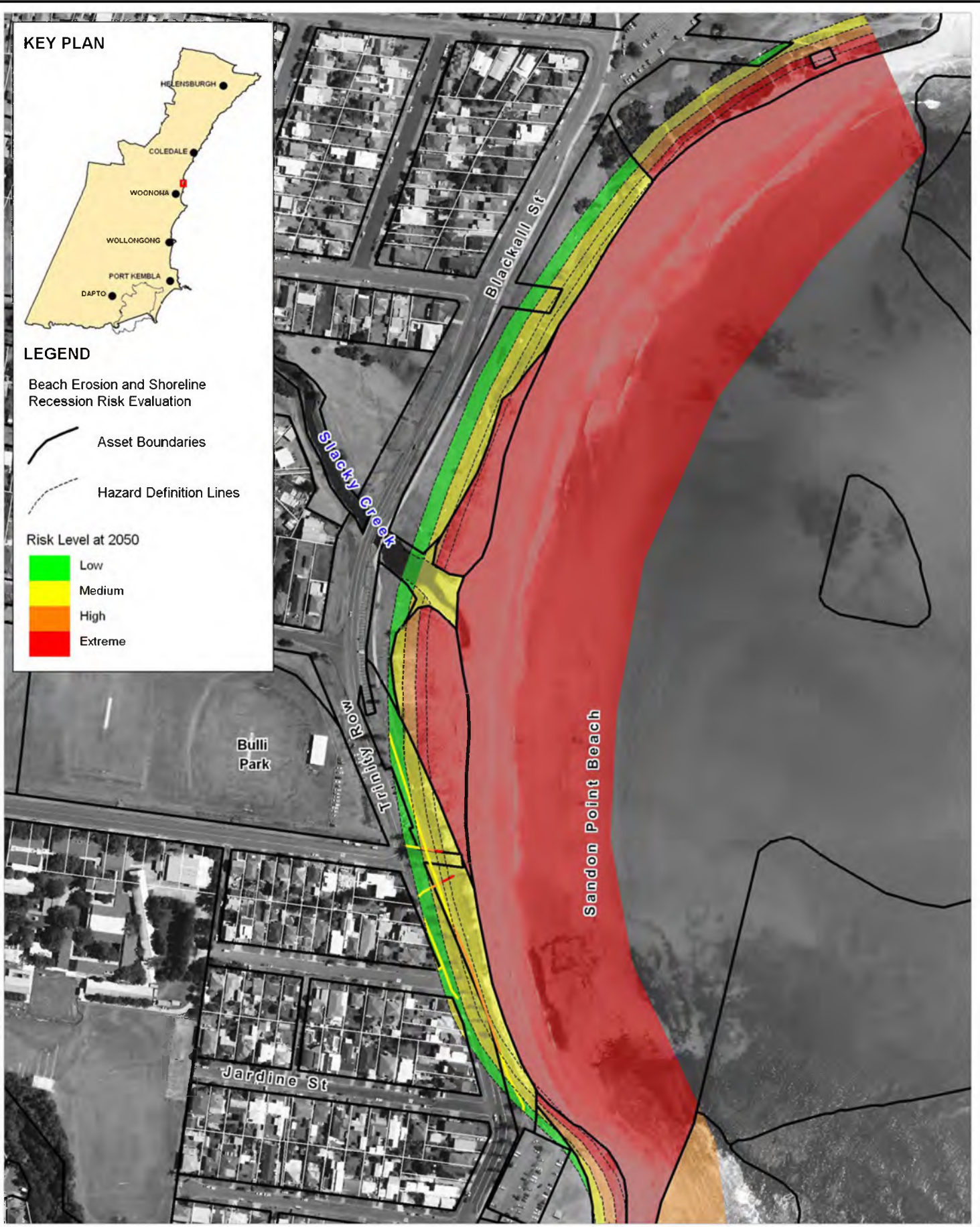


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050



<p>Title:</p> <p><b>Erosion and Recession Risk Evaluation 2050 Planning Horizon - Sandon Point Beach</b></p>	<p>Drawing:</p> <p><b>B-9</b></p>	<p>Rev:</p> <p><b>A</b></p>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_139\_110415 Drawing B-9.WOR





**KEY PLAN**

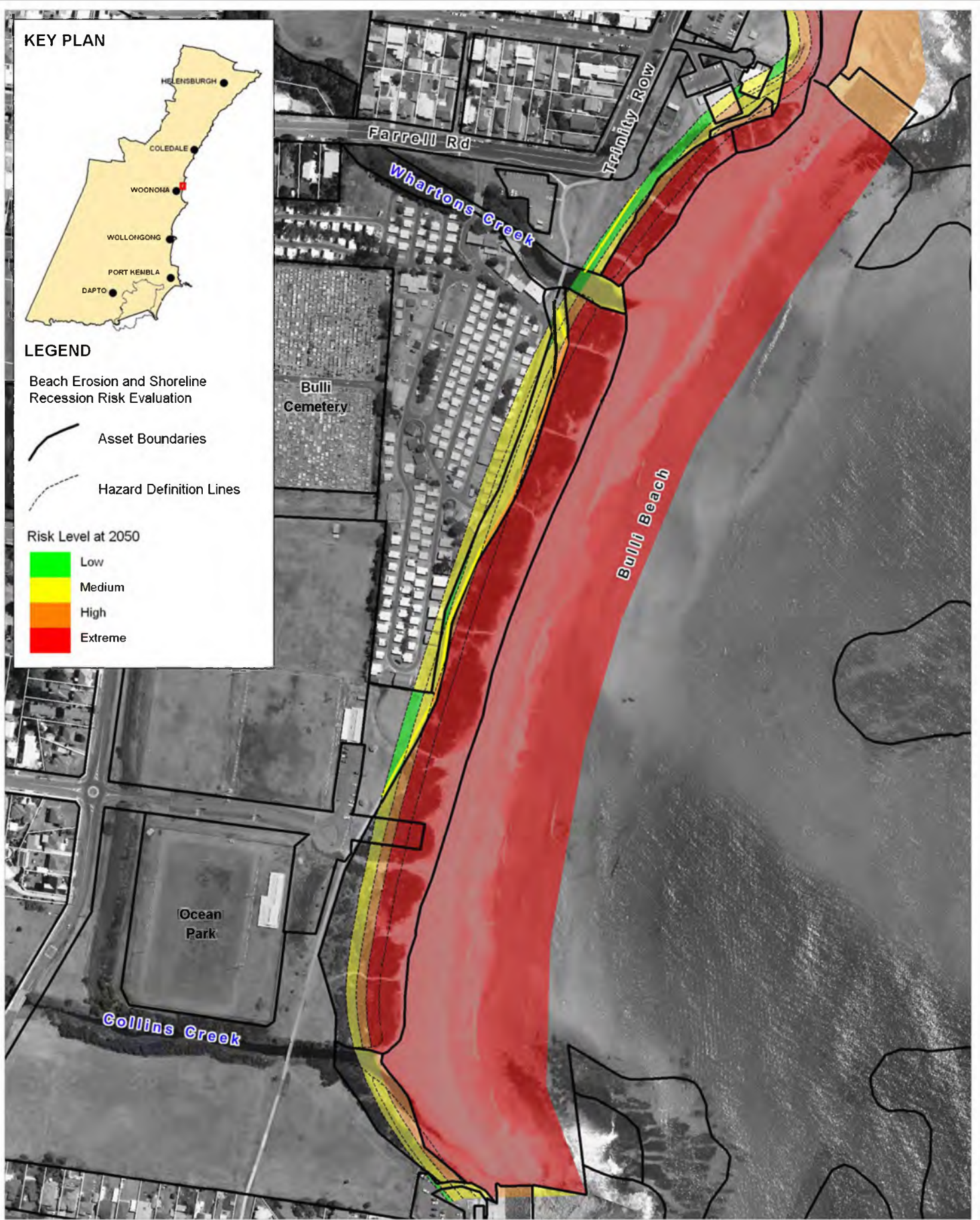


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2050



Title:

**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Bulli Beach**

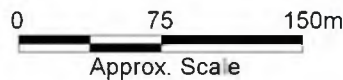
Drawing:

**B-10**

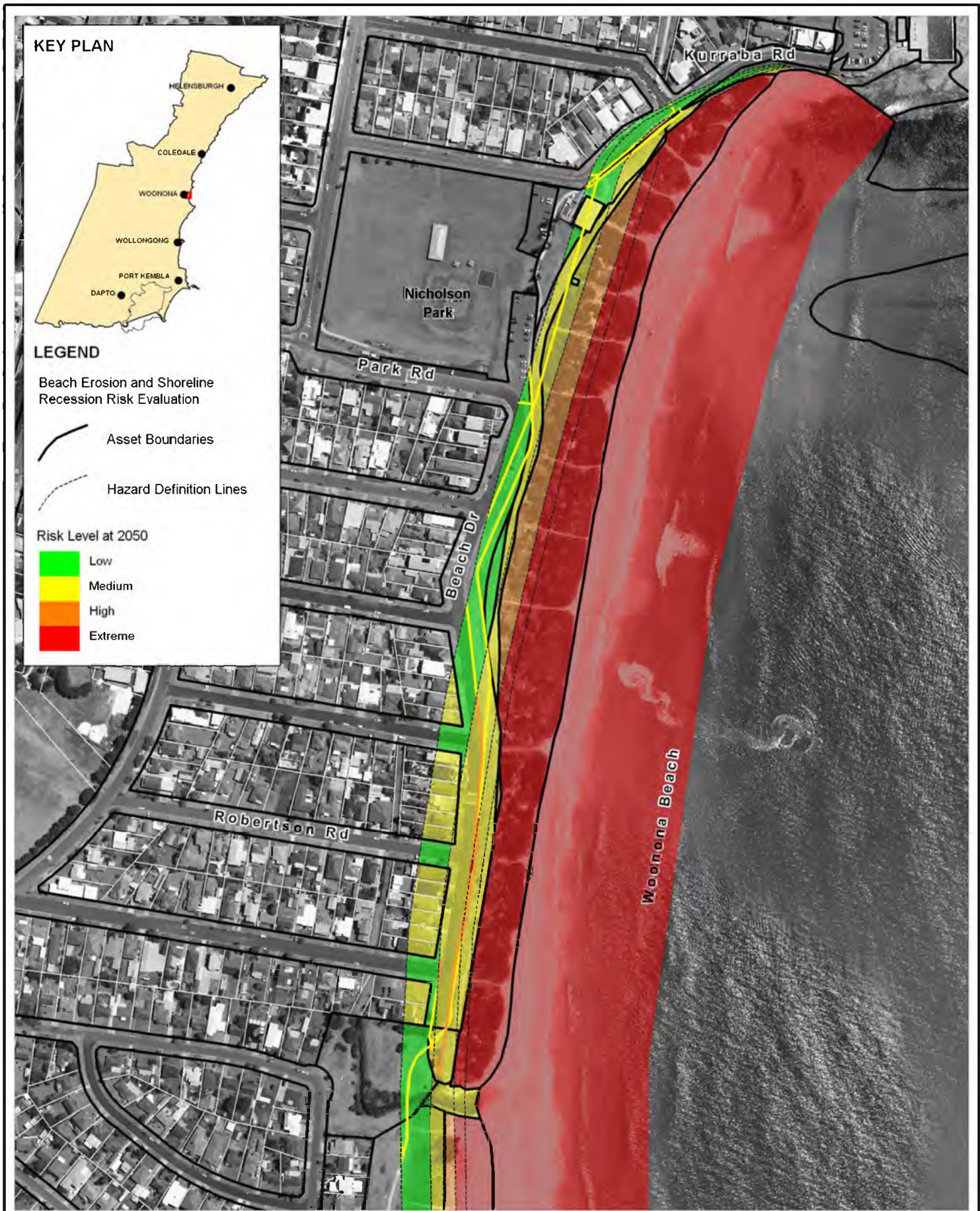
Rev:

**A**

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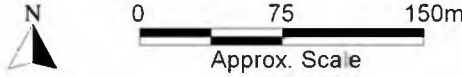
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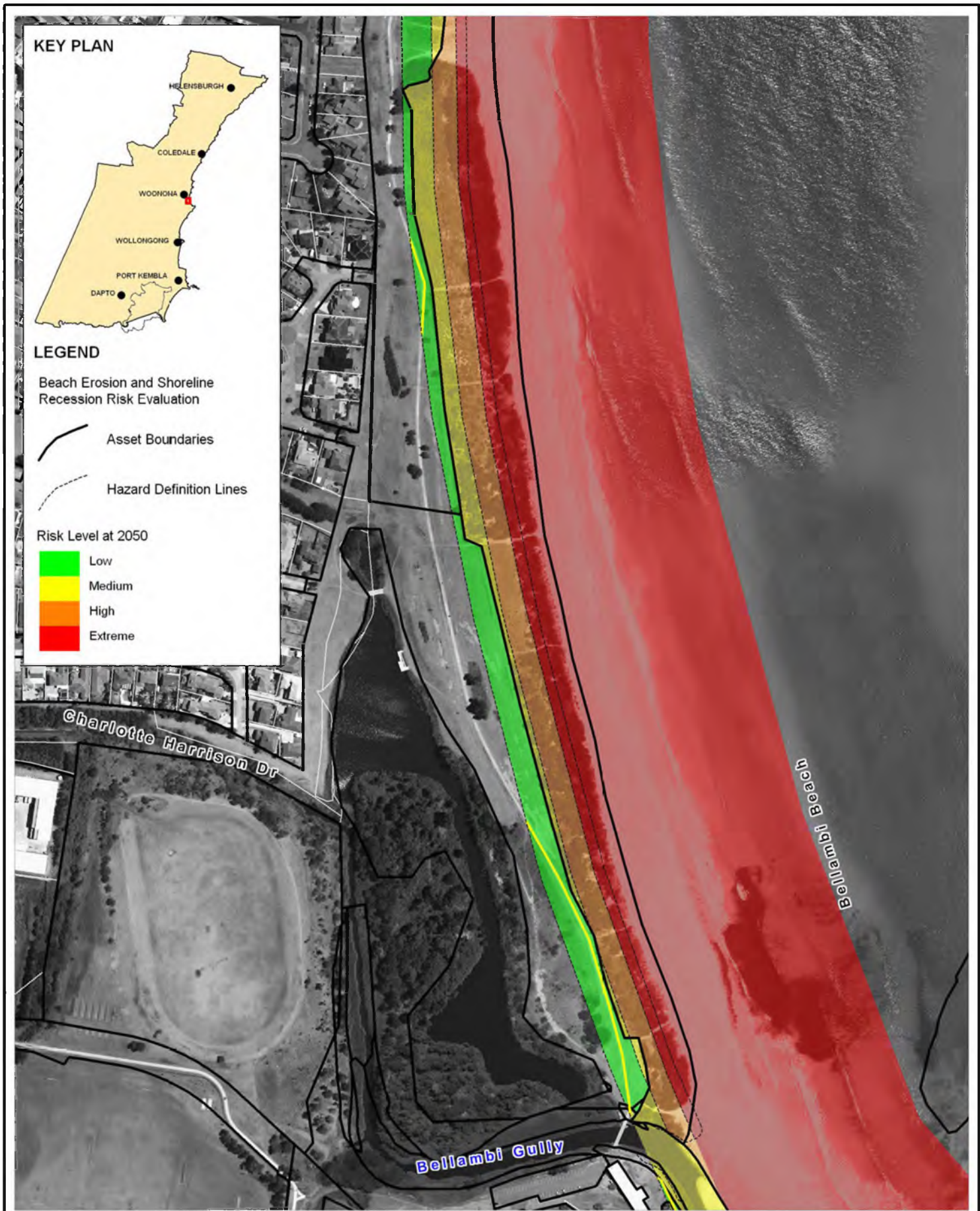
Title:  
**Erosion and Recession Risk Evaluation  
 2050 Planning Horizon - Woonona Beach**

Drawing: <b>B-11</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_141\_110415 Drawing B-11.WOR



Title:  
**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Bellambi Beach**

Drawing:  
**B-12**

Rev:  
**A**

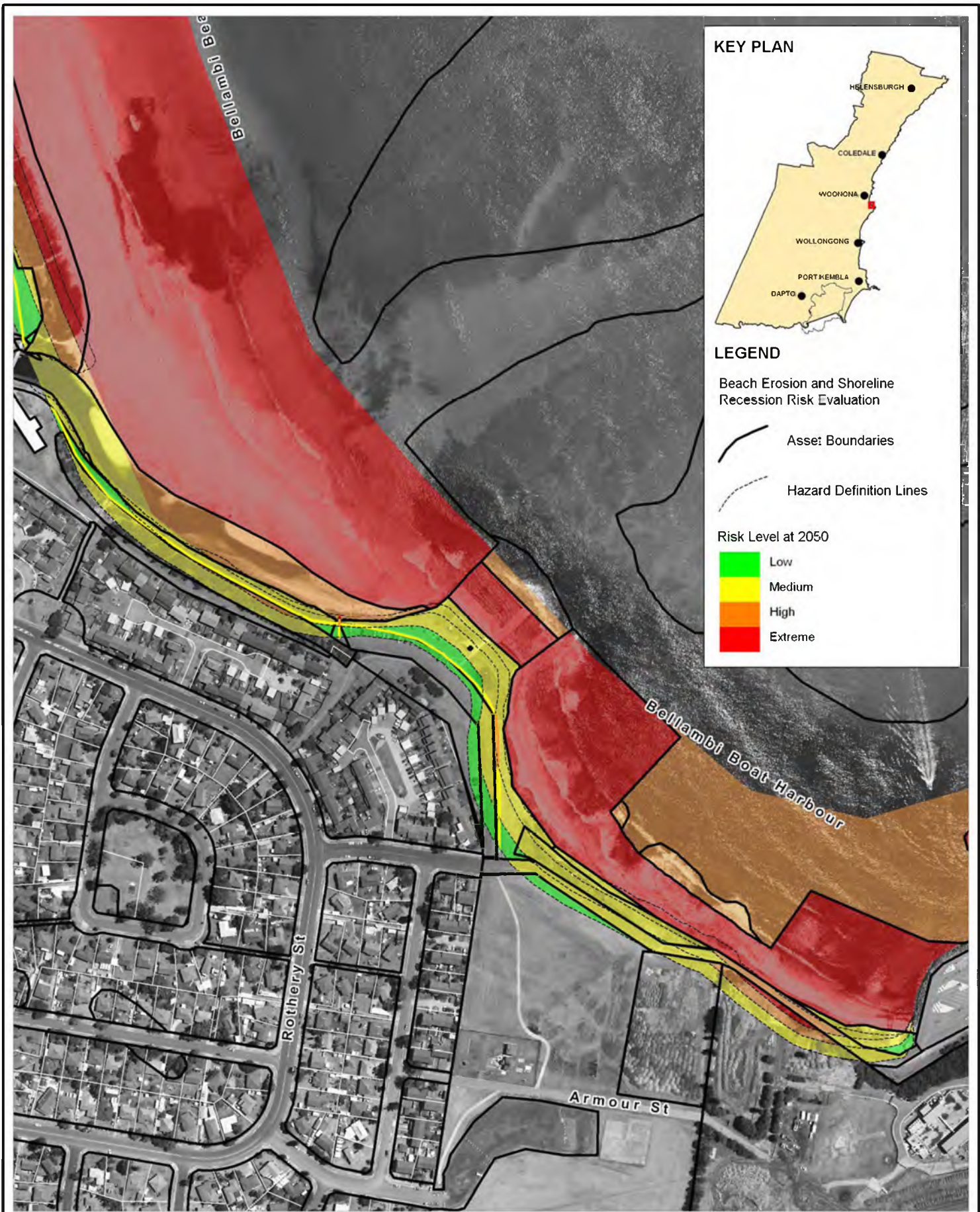
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0 75 150m  
Approx. Scale



Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_142\_110414 Drawing B-12.WOR

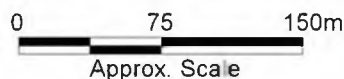


Title:  
**Erosion and Recession Risk Evaluation  
 2050 Planning Horizon - Bellambi Boat Harbour**

Drawing:  
**B-13**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_143\_110415 Drawing B-13.WOR

**KEY PLAN**



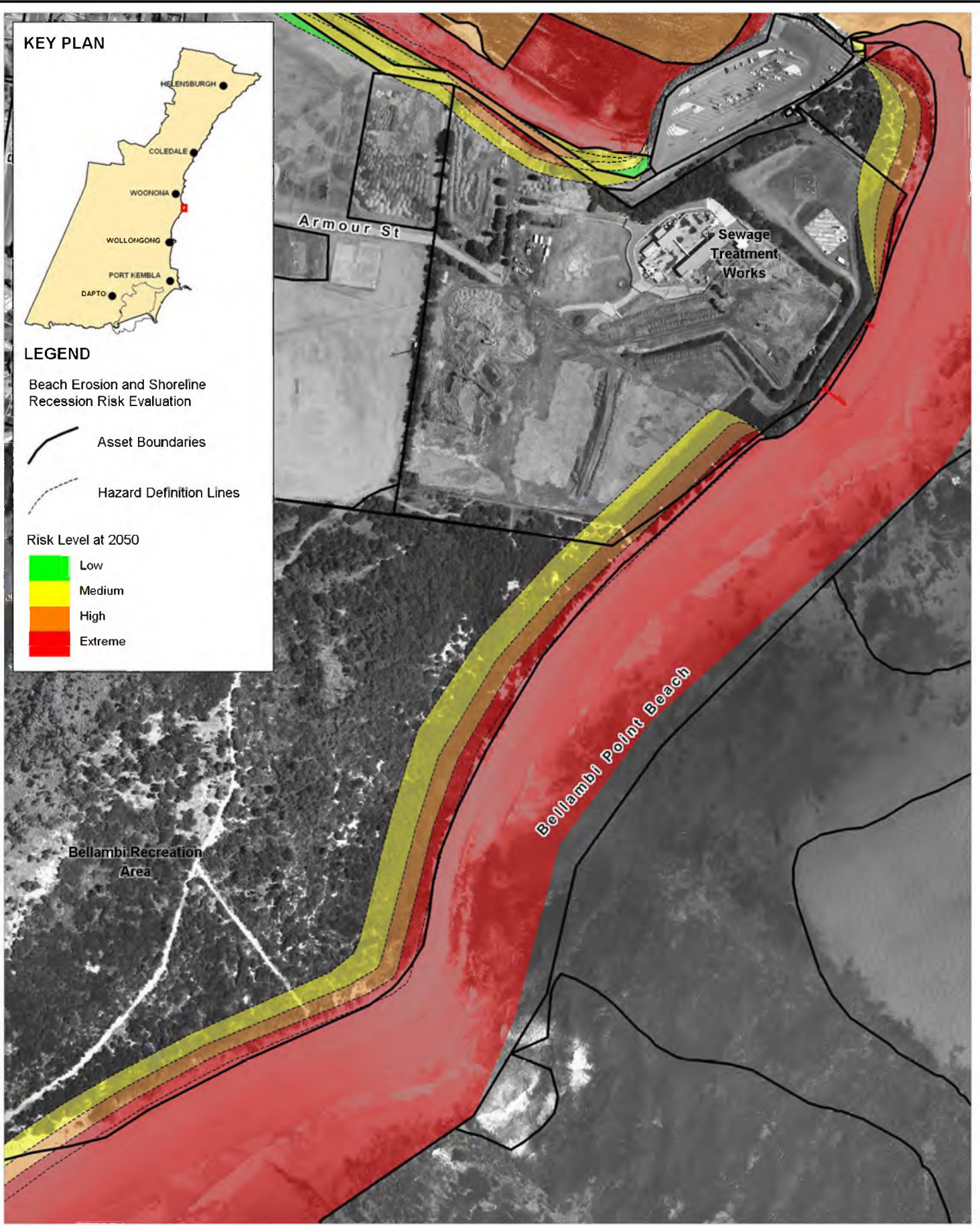
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050

- Low
- Medium
- High
- Extreme



Title:  
**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Bellambi Point Beach**

Drawing: <b>B-14</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_144\_110415 Drawing B-14.WOR

**KEY PLAN**

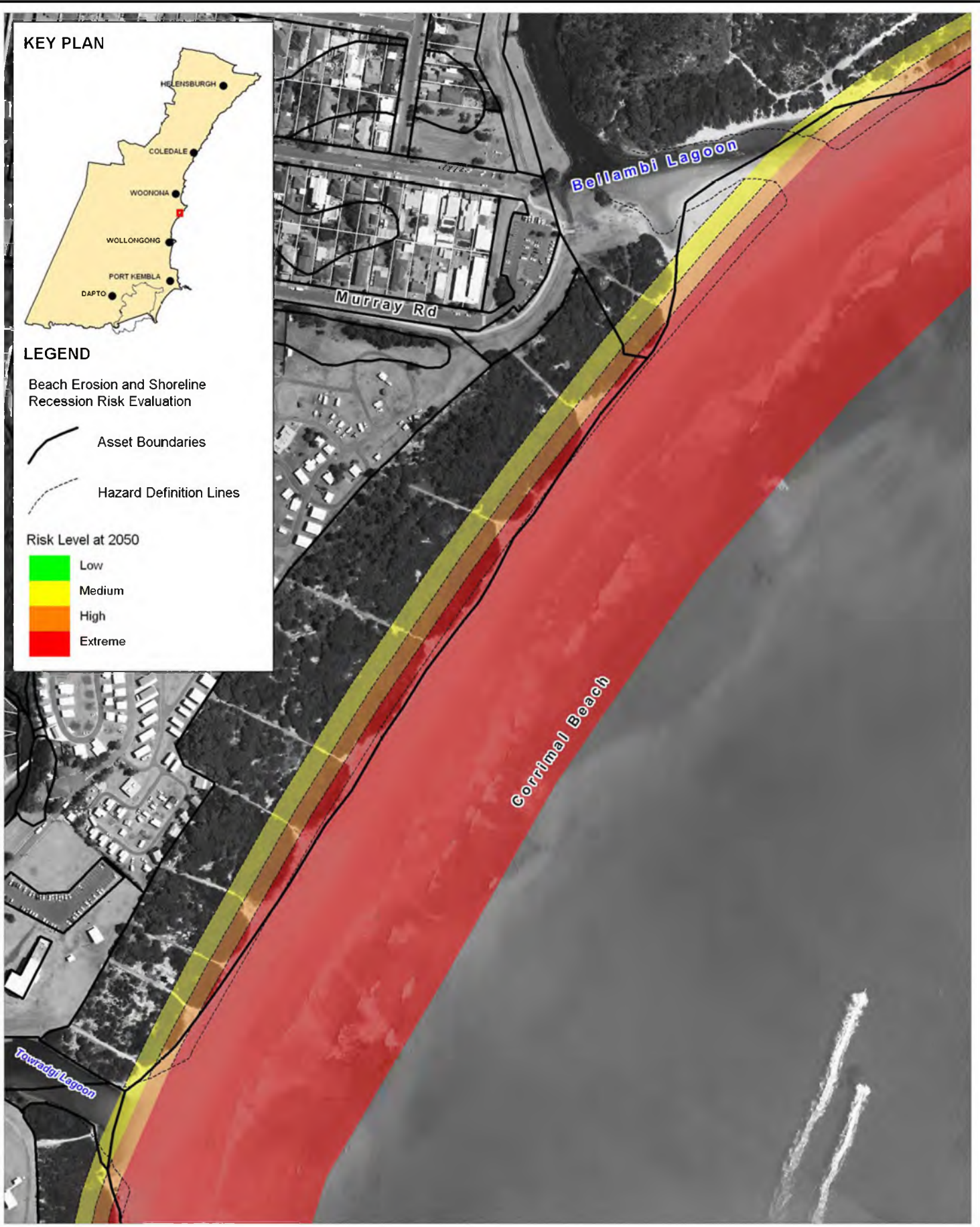


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

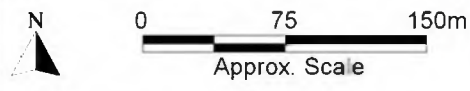
-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2050



<p>Title: <b>Erosion and Recession Risk Evaluation 2050 Planning Horizon - Corrimal Beach</b></p>	<p>Drawing: <b>B-15</b></p>	<p>Rev: <b>A</b></p>
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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_145\_110415 Drawing B-15.WOR

**KEY PLAN**

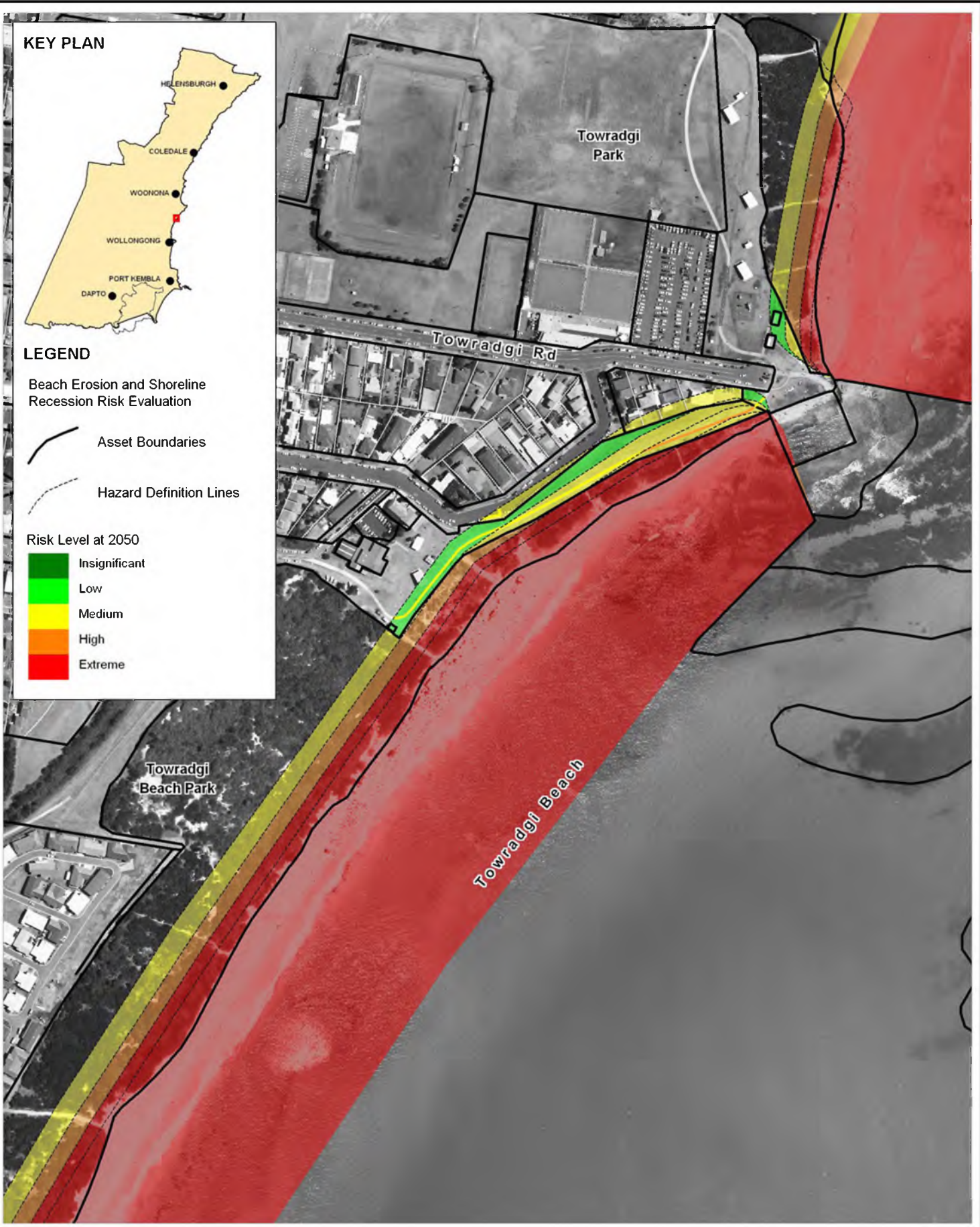
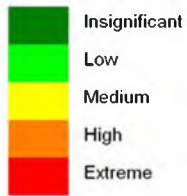


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050



<p>Title: <b>Coastal Hazard Risk Evaluation 2050 Planning Horizon - Towradgi Beach</b></p>	<p>Drawing: <b>B-16</b></p>	<p>Rev: <b>A</b></p>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_146\_110415 Drawing B-16.WOR

**KEY PLAN**



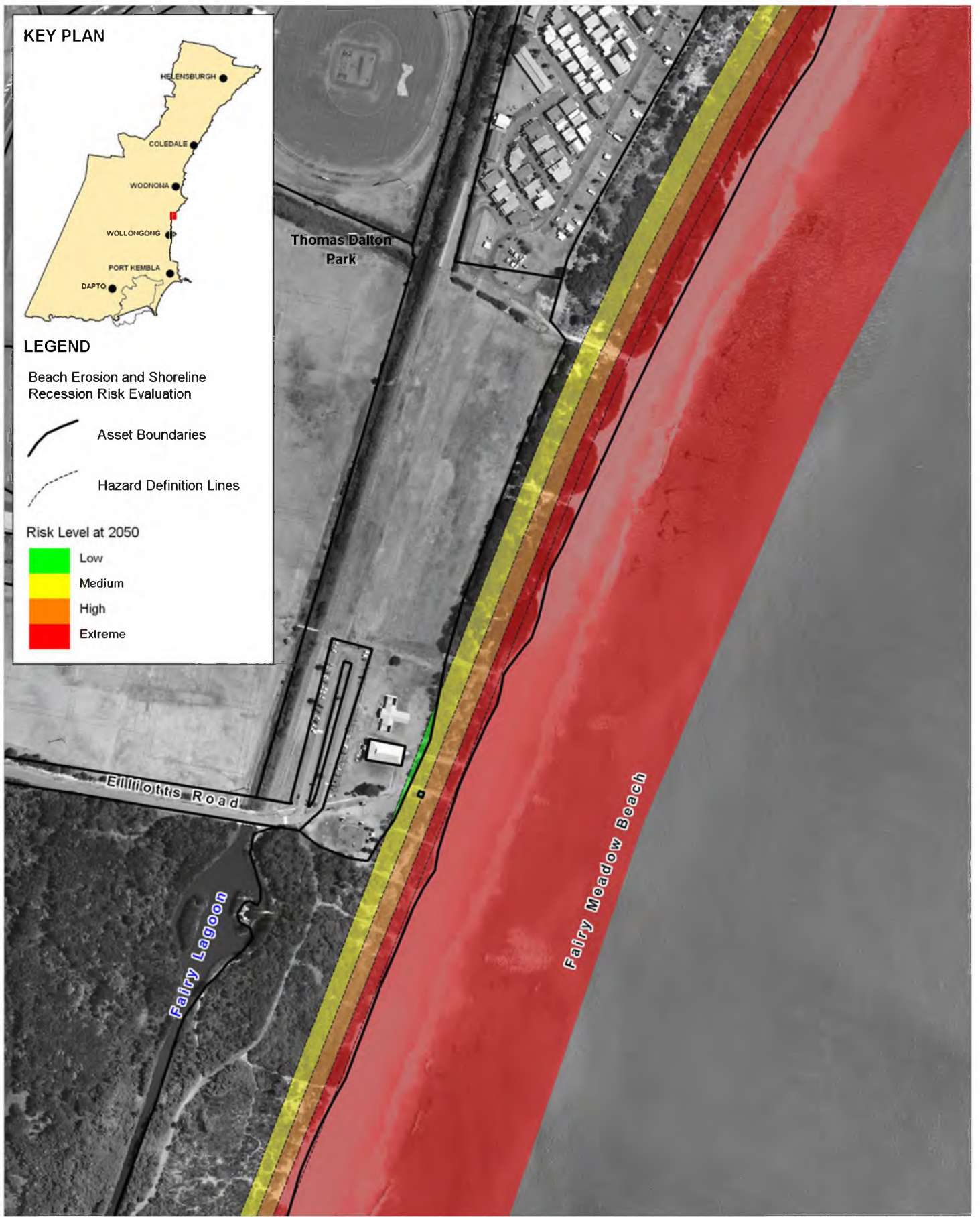
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2050

-  Low
-  Medium
-  High
-  Extreme

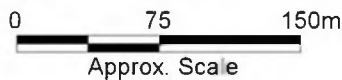


Title:  
**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Fairy Meadow Beach (north)**

Drawing:  
**B-17**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_147\_110415 Drawing B-17.WOR



**KEY PLAN**

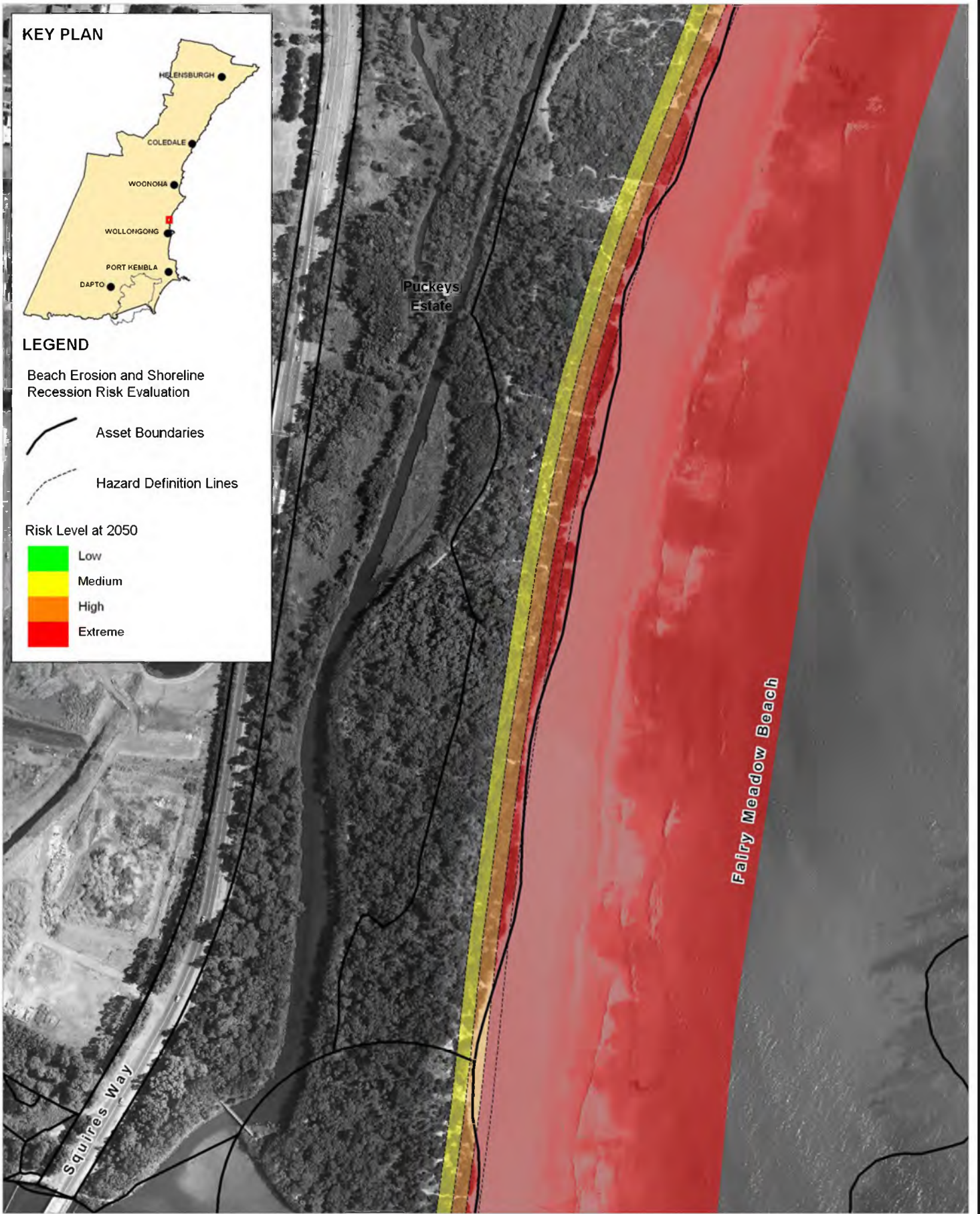


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

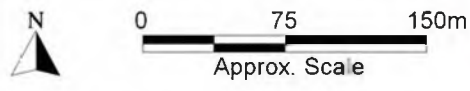
Risk Level at 2050



Title:  
**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Fairy Meadow Beach (south)**

Drawing: <b>B-18</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_148\_110415 Drawing B-18.WOR

**KEY PLAN**



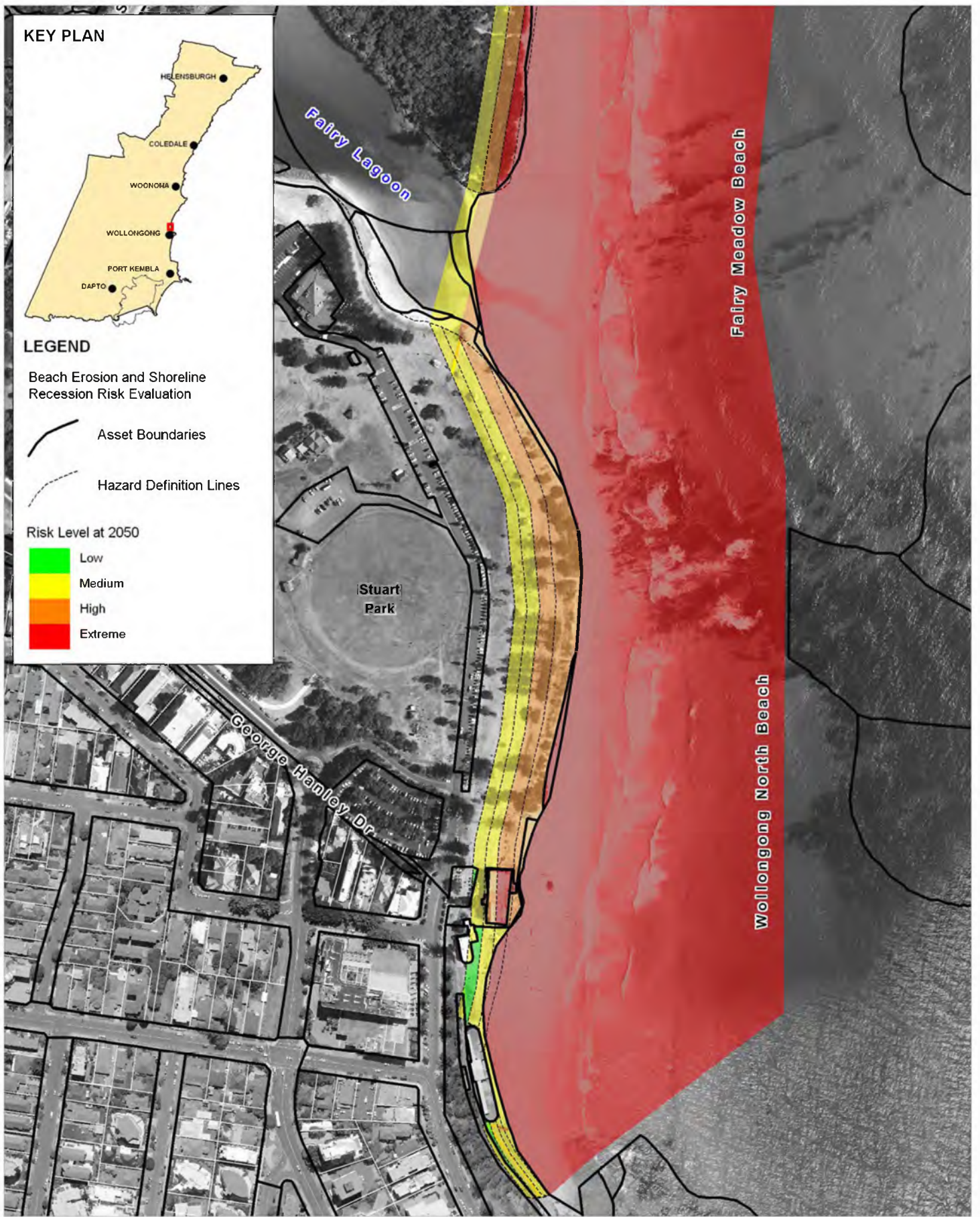
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050

- Low
- Medium
- High
- Extreme

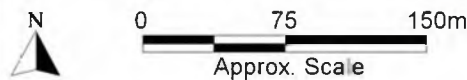


Title:  
**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Wollongong North Beach**

Drawing:  
**B-19**

Rev:  
**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_149\_110415 Drawing B-19.WOR

**KEY PLAN**



**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

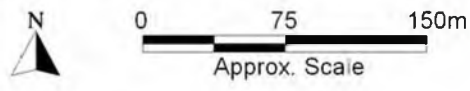
- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050

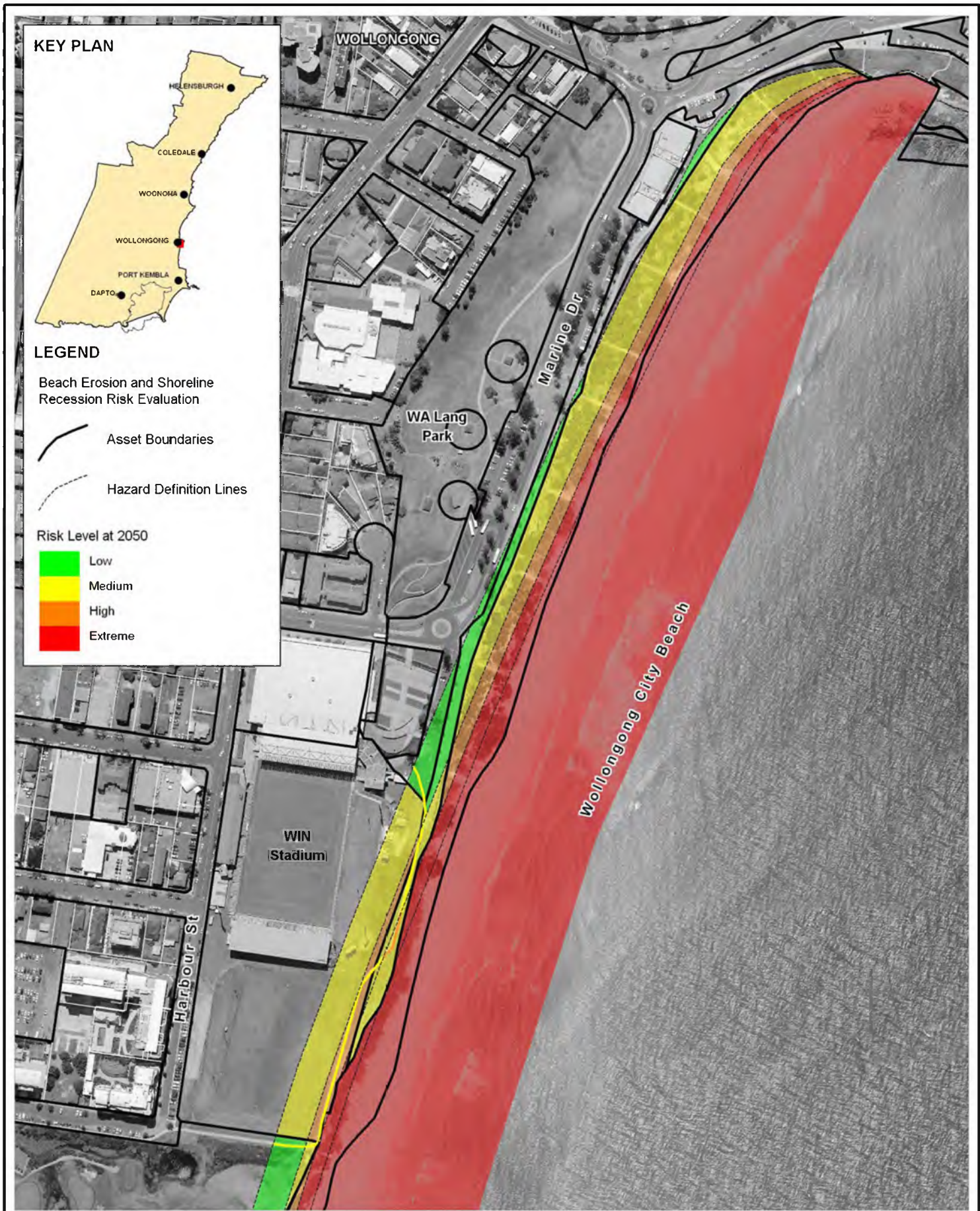


Title: <b>Erosion and Recession Risk Evaluation 2050 Planning Horizon - Wollongong Harbour</b>		Drawing: <b>B-20</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_150\_110415 Drawing B-20.WOR



**KEY PLAN**



**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050

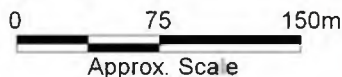
- Low
- Medium
- High
- Extreme

Title:  
**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Wollongong City Beach**

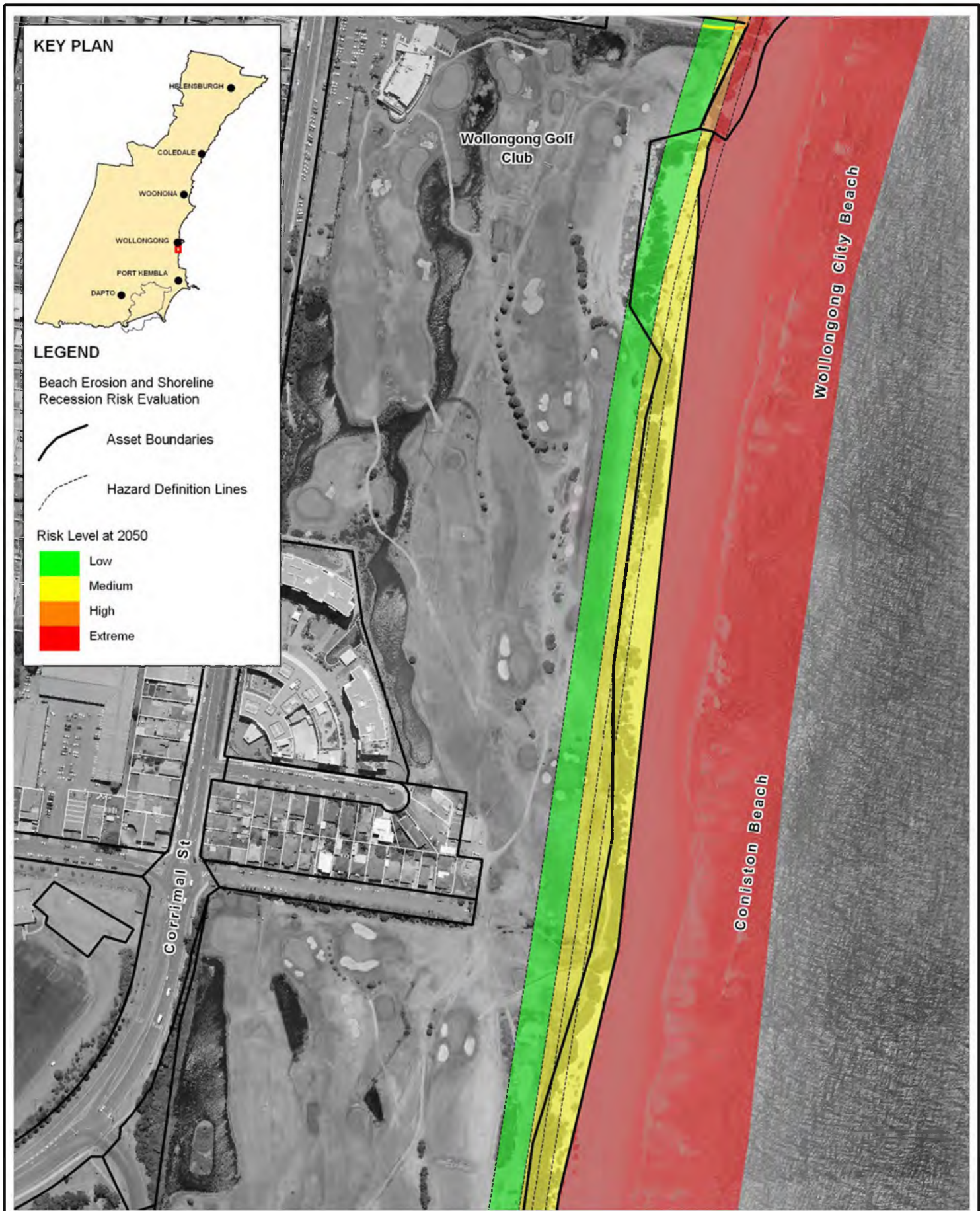
Drawing:  
**B-21**

Rev:  
**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_151\_110418 Drawing B-21.WOR

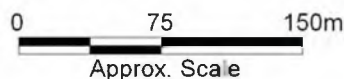


Title:  
**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Coniston Beach (north)**

Drawing:  
**B-22**

Rev:  
**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_152\_110418 Drawing B-22.WOR

**KEY PLAN**



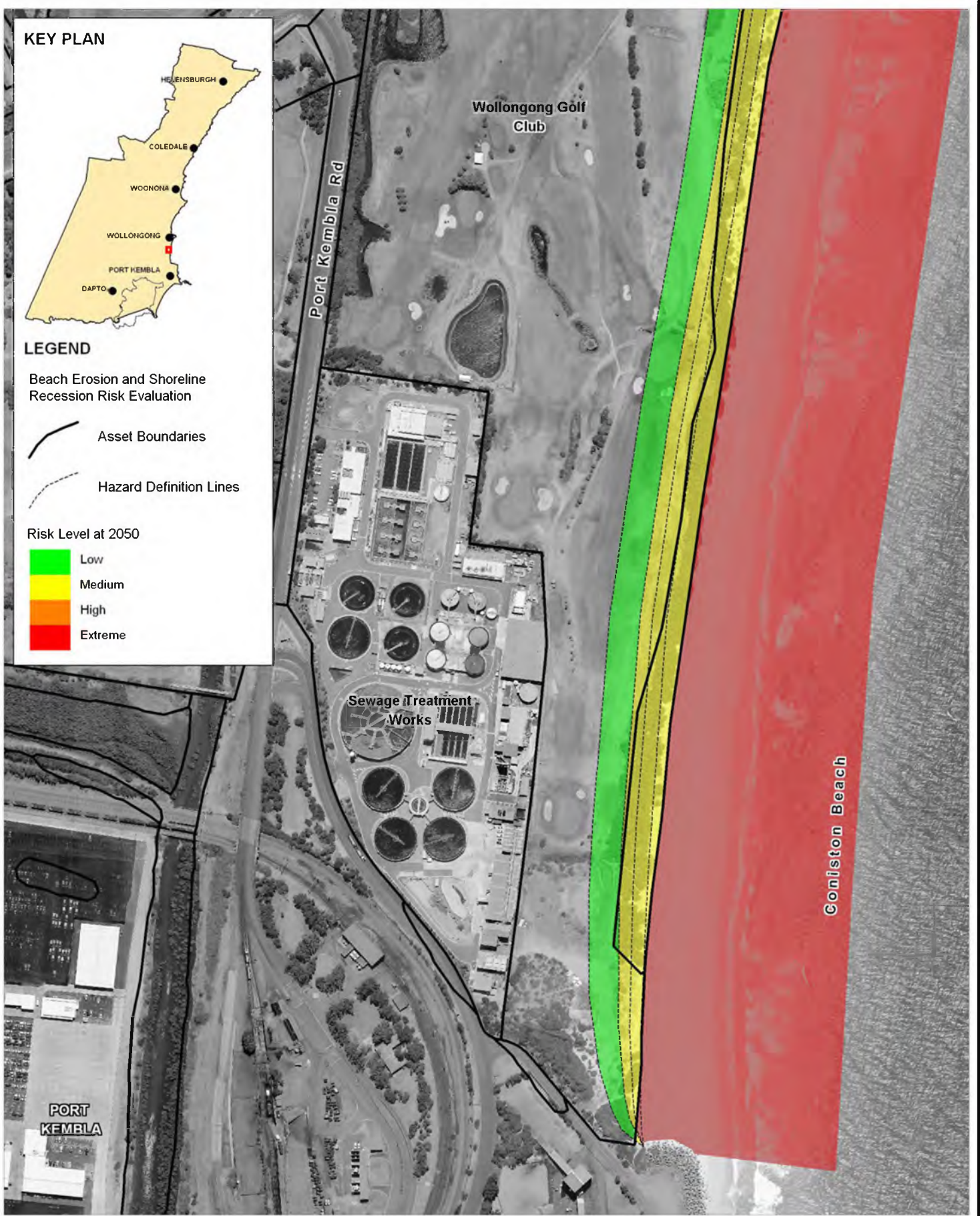
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2050

-  Low
-  Medium
-  High
-  Extreme

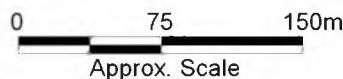


Title:  
**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Coniston Beach (south)**

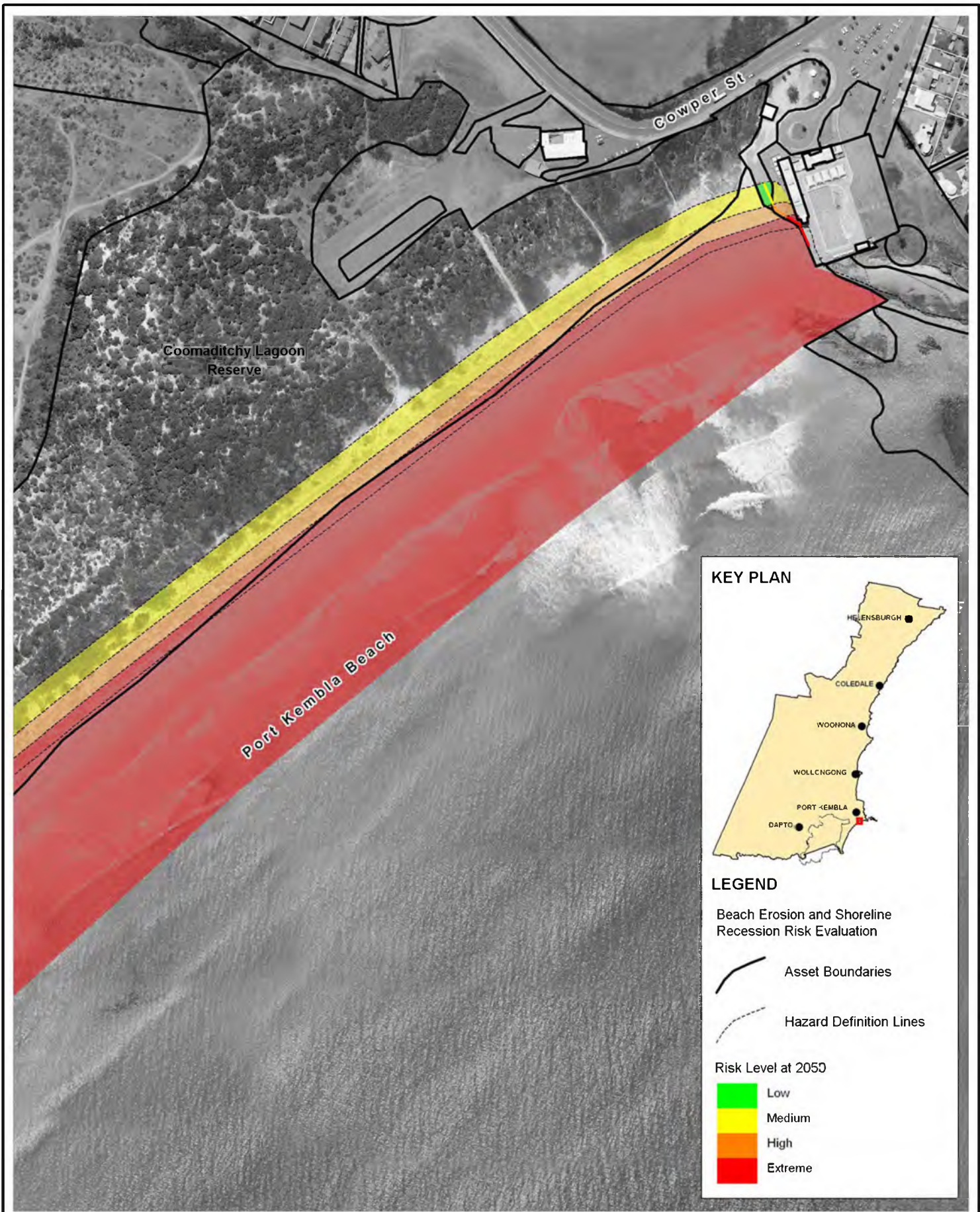
Drawing:  
**B-23**

Rev:  
**A**

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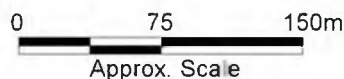


Title:  
**Erosion and Recession Risk Evaluation  
 2050 Planning Horizon - Port Kembla Beach**

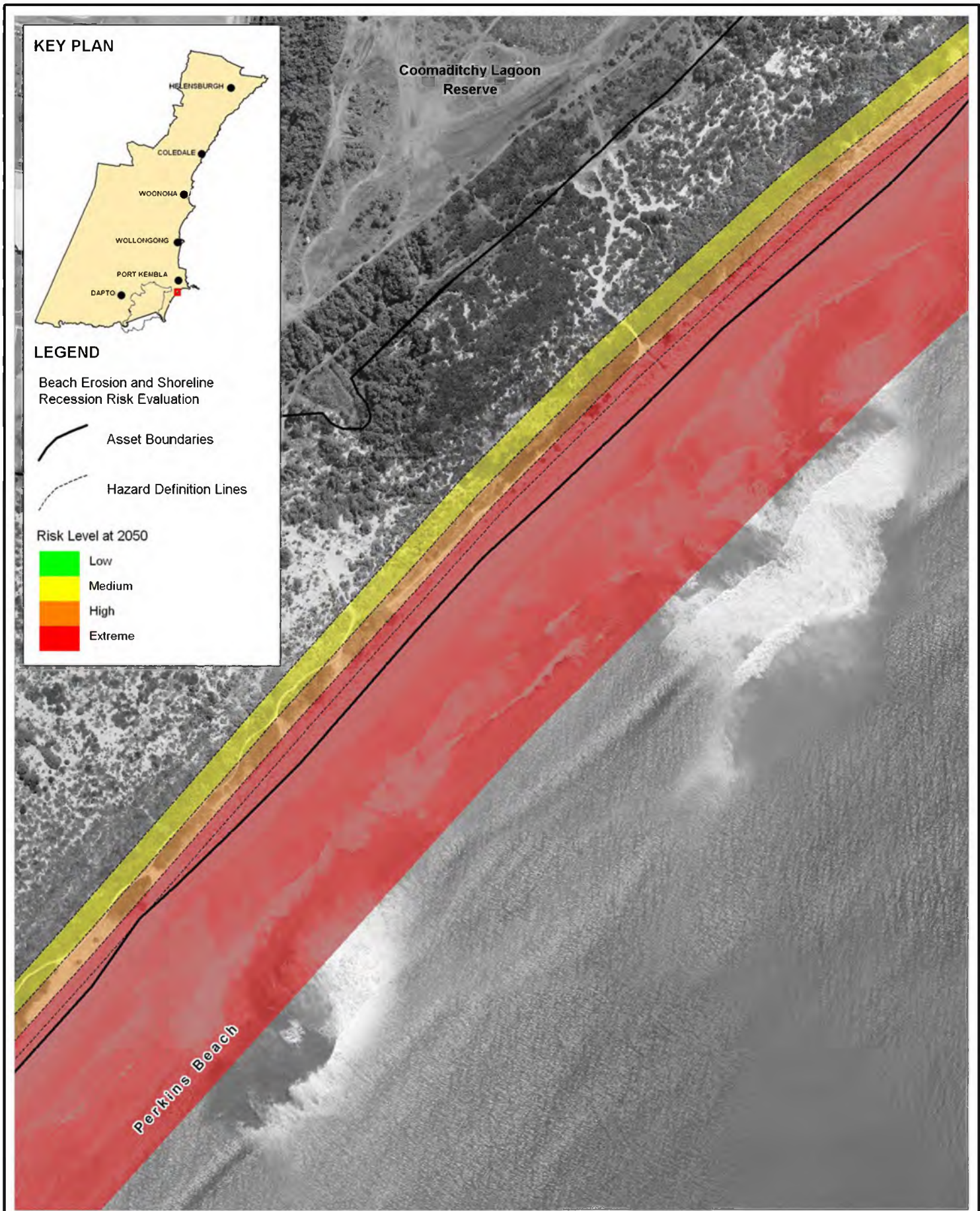
Drawing:  
**B-24**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_154\_110418 Drawing B-24.WOR





**KEY PLAN**




**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

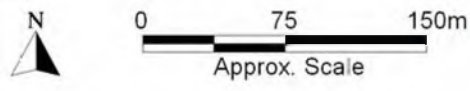
-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2050

-  Low
-  Medium
-  High
-  Extreme

Title: <b>Erosion and Recession Risk Evaluation 2050 Planning Horizon - Perkins Beach (1)</b>		Drawing: <b>B-25</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_155\_110418 Drawing B-25.WOR





**KEY PLAN**



**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2050

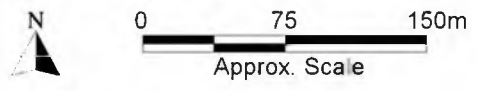
-  Low
-  Medium
-  High
-  Extreme

*Perkins Beach*

Title:  
**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Perkins Beach (2)**

Drawing: <b>B-26</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_156\_110418 Drawing B-26.WOR

**KEY PLAN**



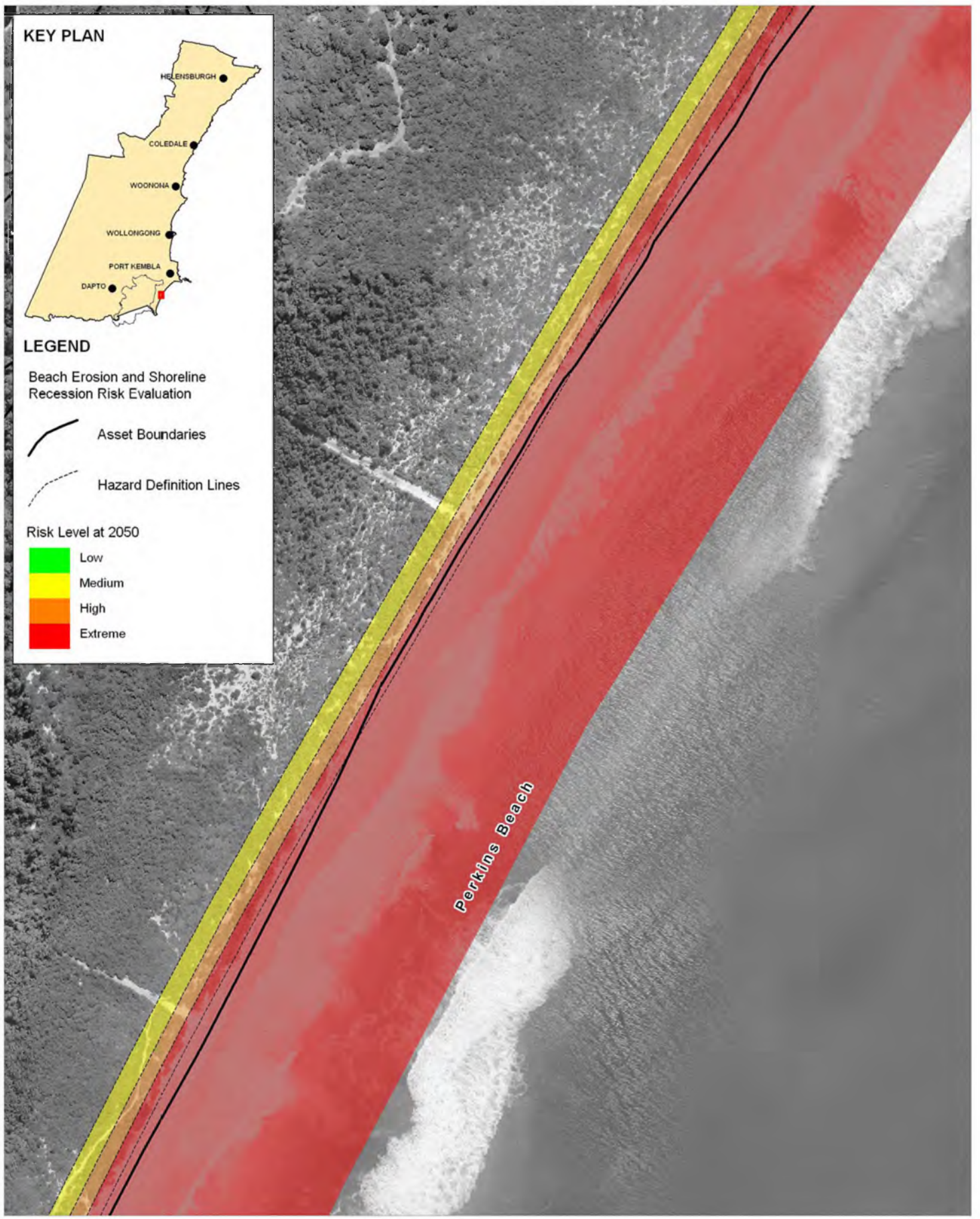
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2050

-  Low
-  Medium
-  High
-  Extreme

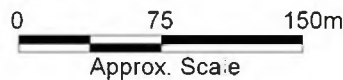


Title:  
**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Perkins Beach (3)**

Drawing:  
**B-27**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_157\_110418 Drawing B-27.WOR

**KEY PLAN**



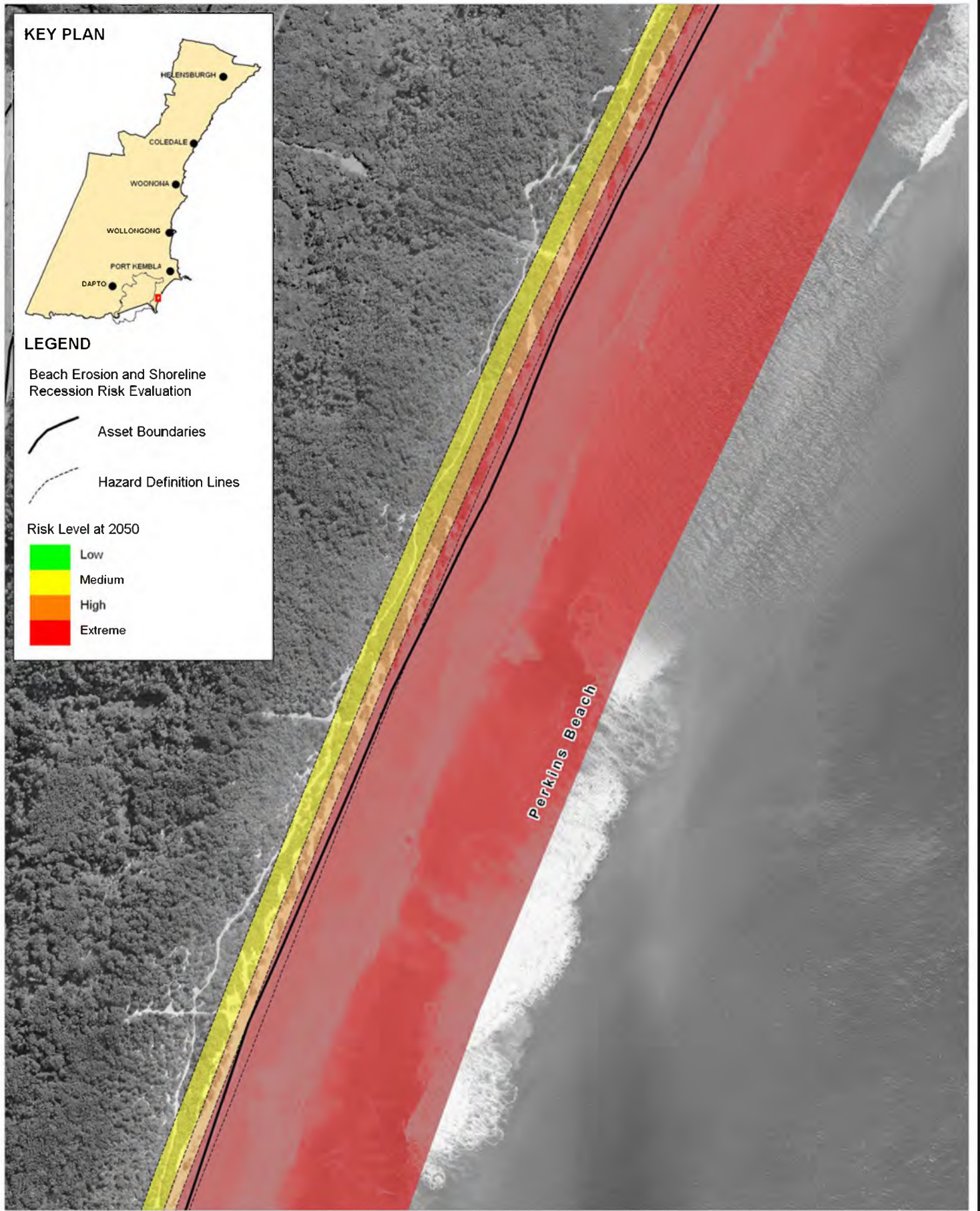
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2050

-  Low
-  Medium
-  High
-  Extreme



Title:

**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Perkins Beach (4)**

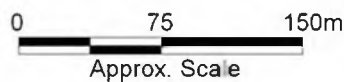
Drawing:

**B-28**

Rev:

**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_158\_110418 Drawing B-28.WOR

**KEY PLAN**

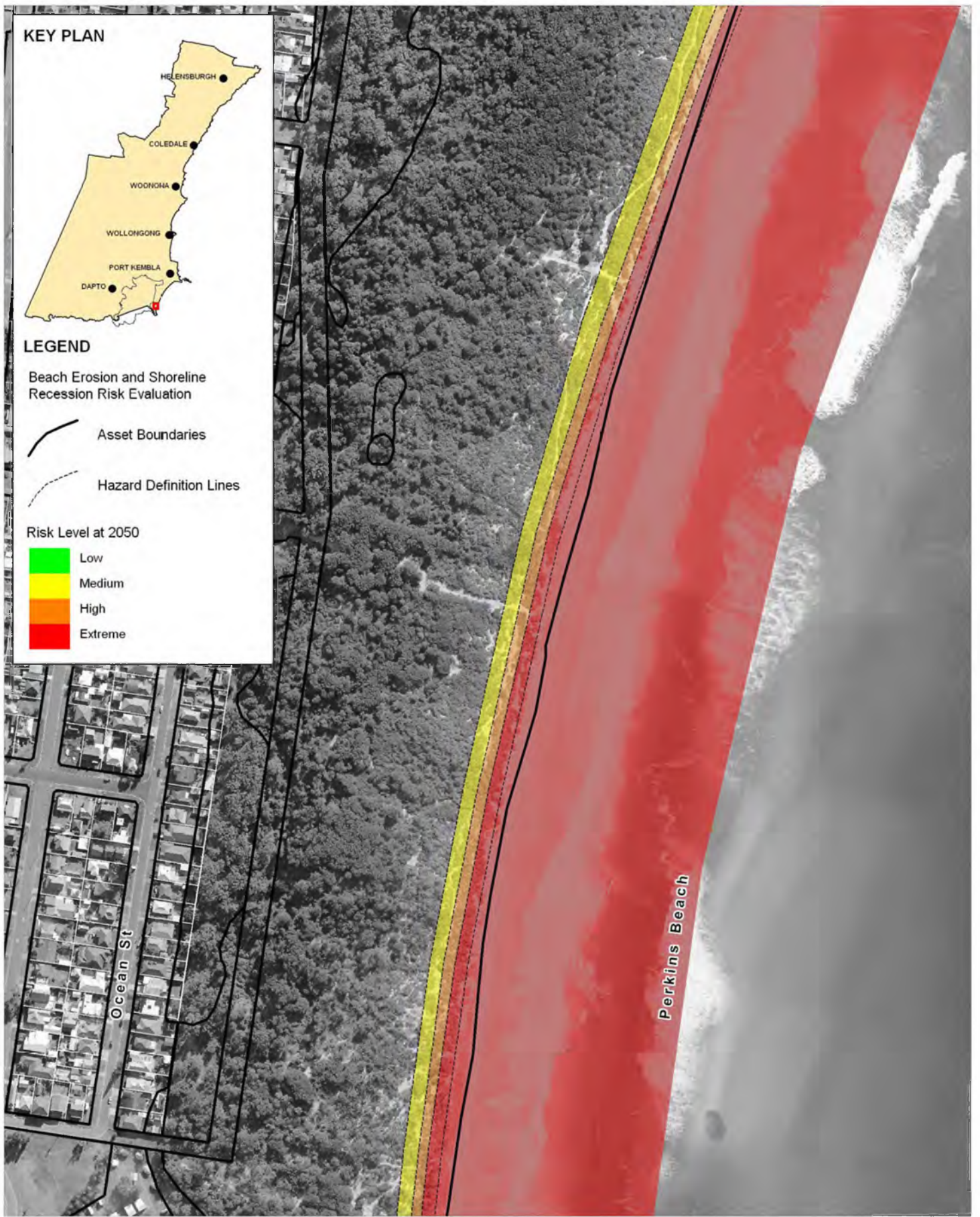


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

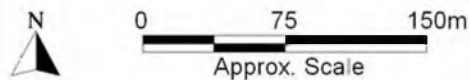
Risk Level at 2050



Title:  
**Erosion and Recession Risk Evaluation  
2050 Planning Horizon - Perkins Beach (5)**

Drawing: <b>B-29</b>	Rev: <b>A</b>
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**KEY PLAN**

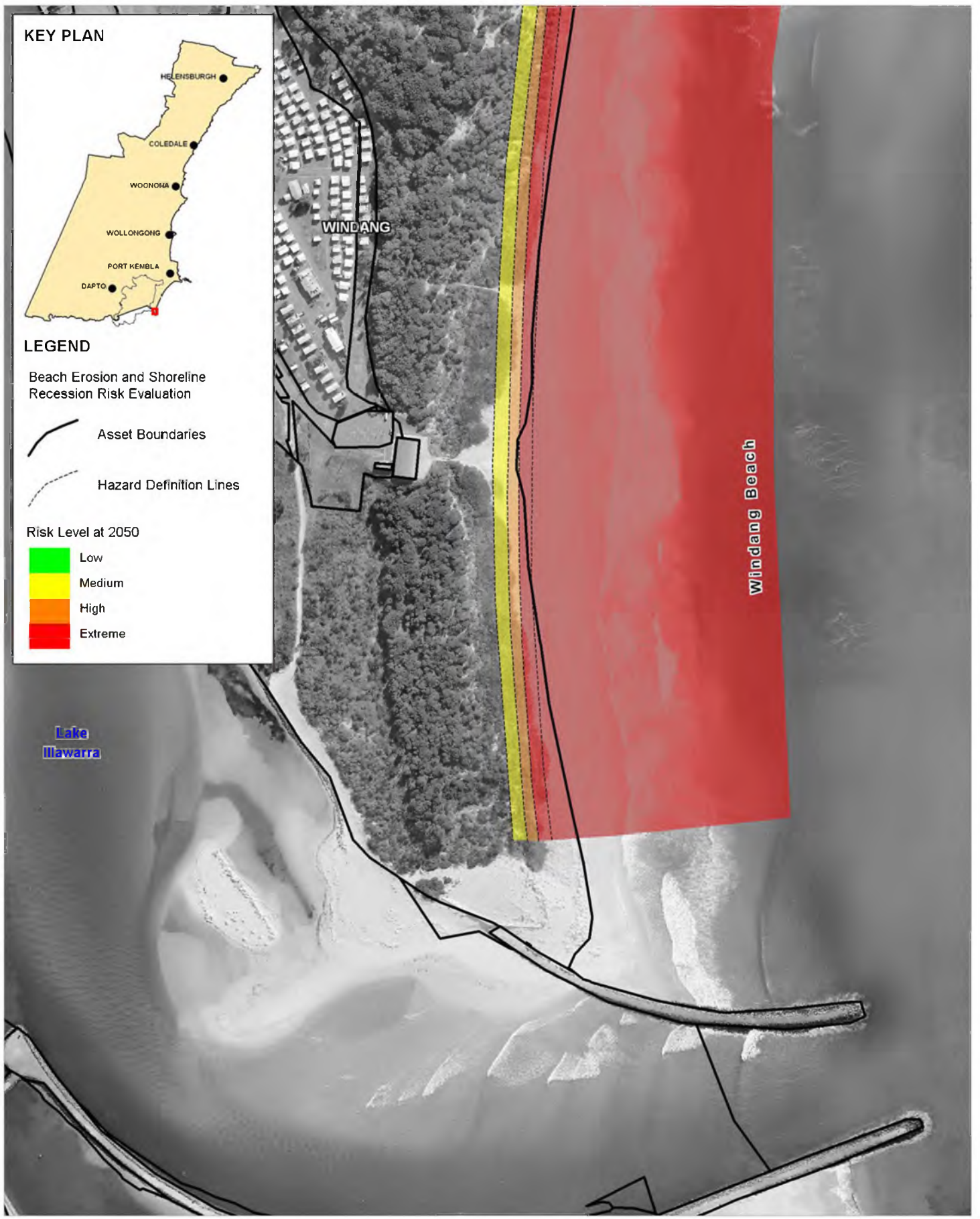


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

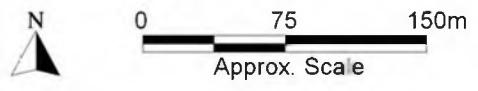
Risk Level at 2050



Lake Illawarra

<p>Title:</p> <p><b>Erosion and Recession Risk Evaluation 2050 Planning Horizon - Windang Beach</b></p>	<p>Drawing:</p> <p><b>B-30</b></p>	<p>Rev:</p> <p><b>A</b></p>
	<p><b>BMT WBM</b> www.wbmpl.com.au</p>	

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**KEY PLAN**

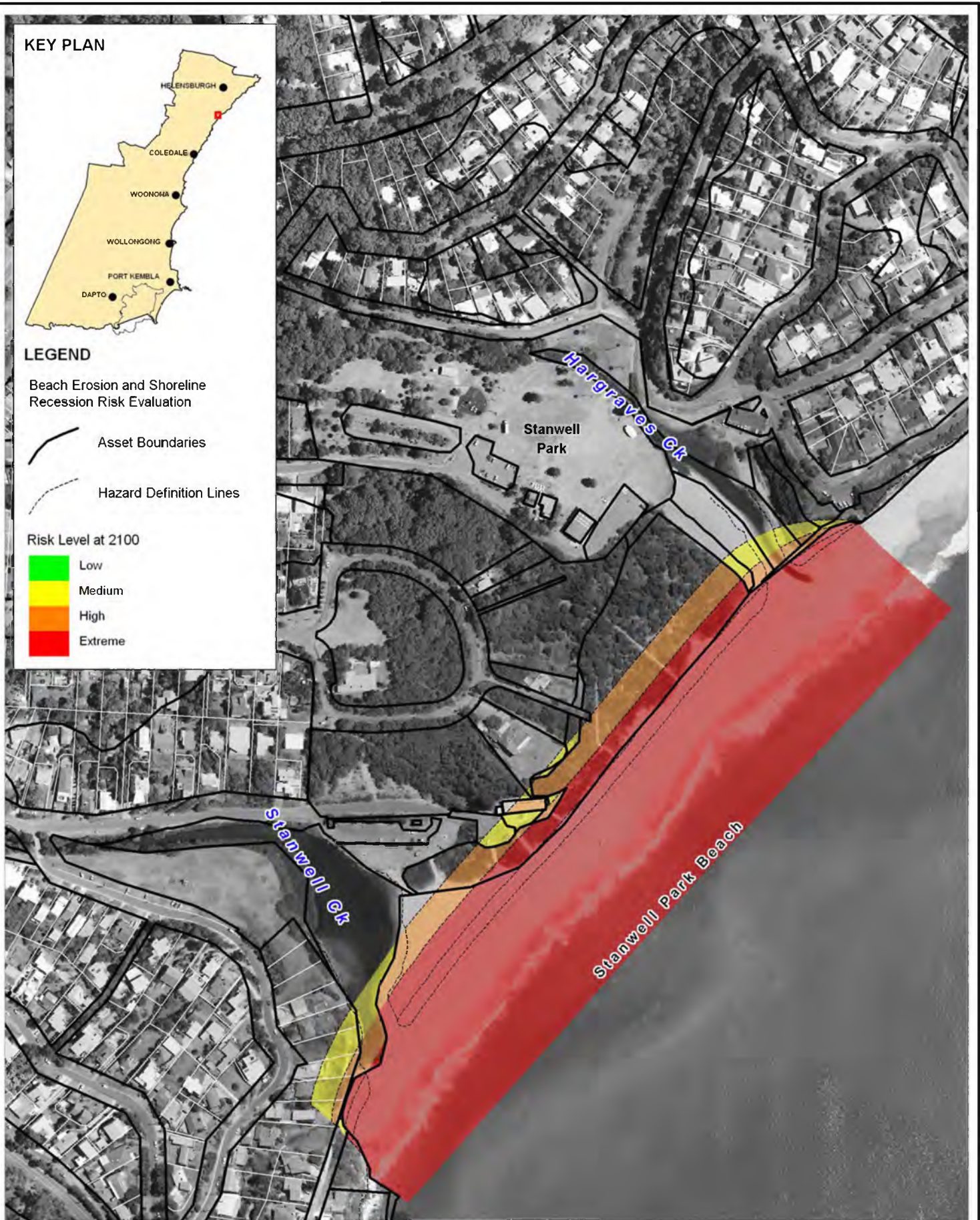


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100



Title:

**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Stanwell Park**

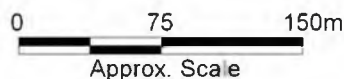
Drawing:

**C-1**

Rev:

**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_161\_110415 Drawing C-1.WOR

**KEY PLAN**

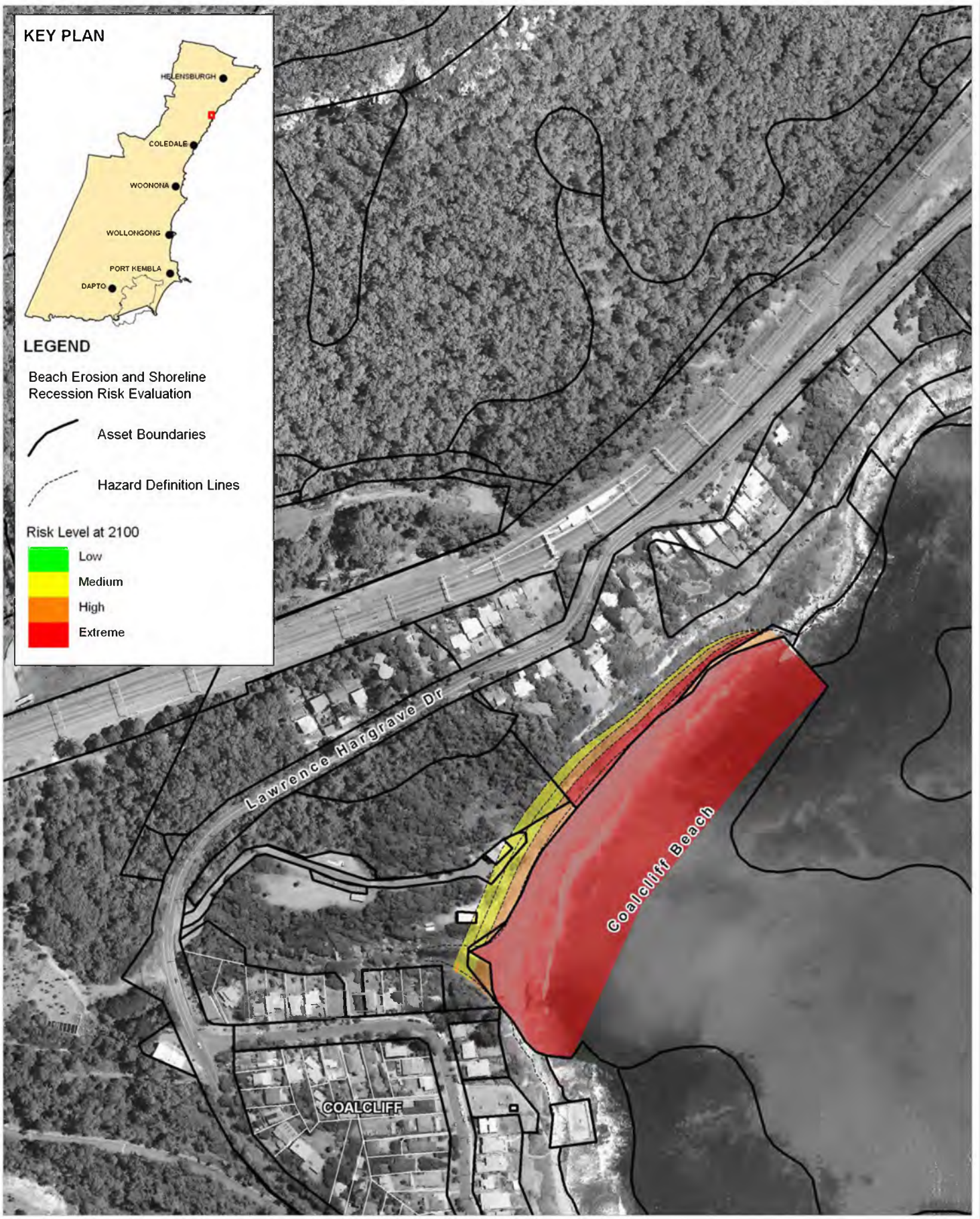


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100



Title:

**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Coalcliff**

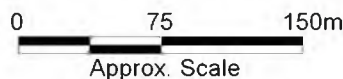
Drawing:

**C-2**

Rev:

**A**

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**KEY PLAN**



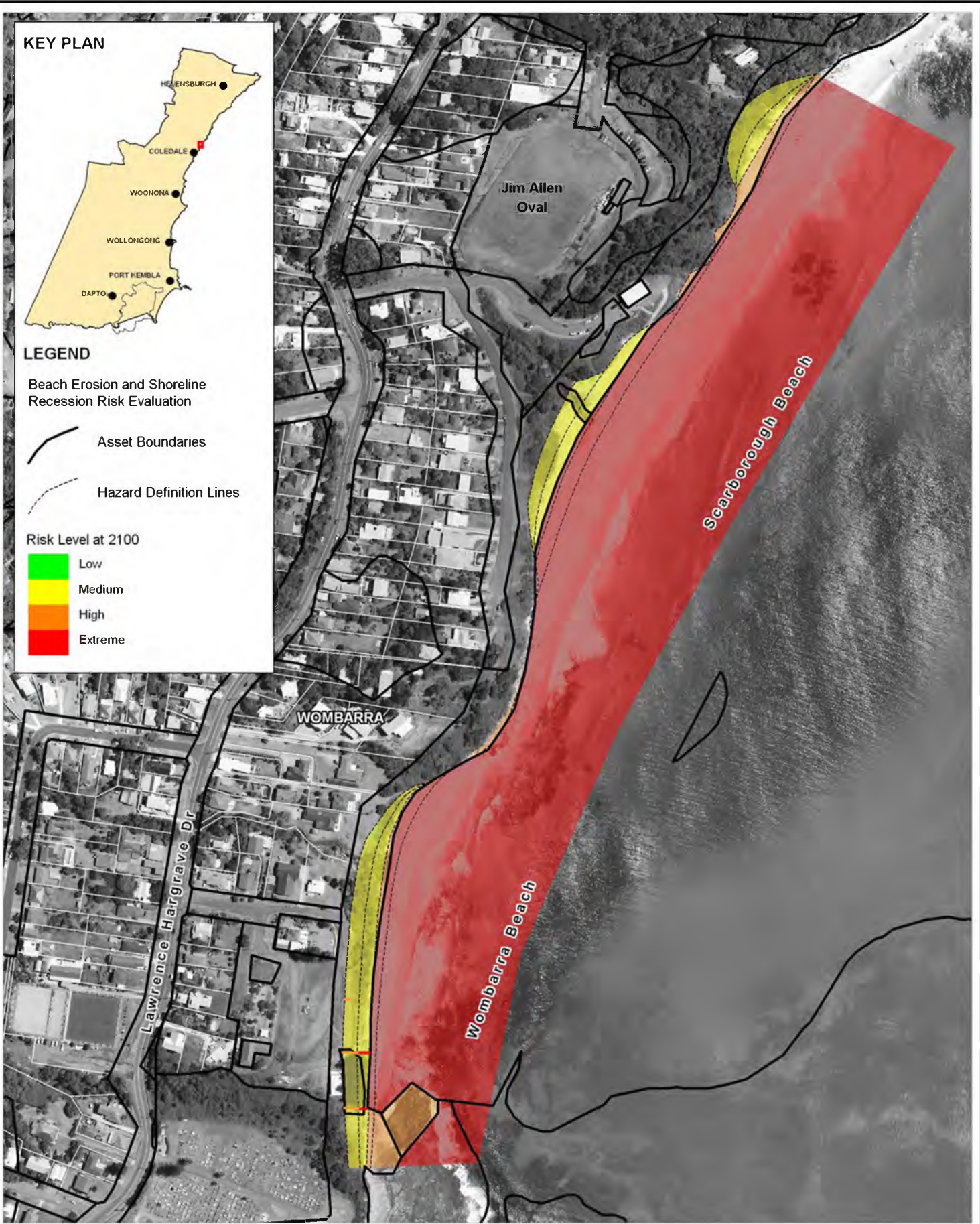
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100

- Low
- Medium
- High
- Extreme



Title:

**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Scarborough/Wombarra**

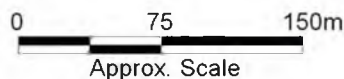
Drawing:

**C-3**

Rev:

**A**

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**KEY PLAN**



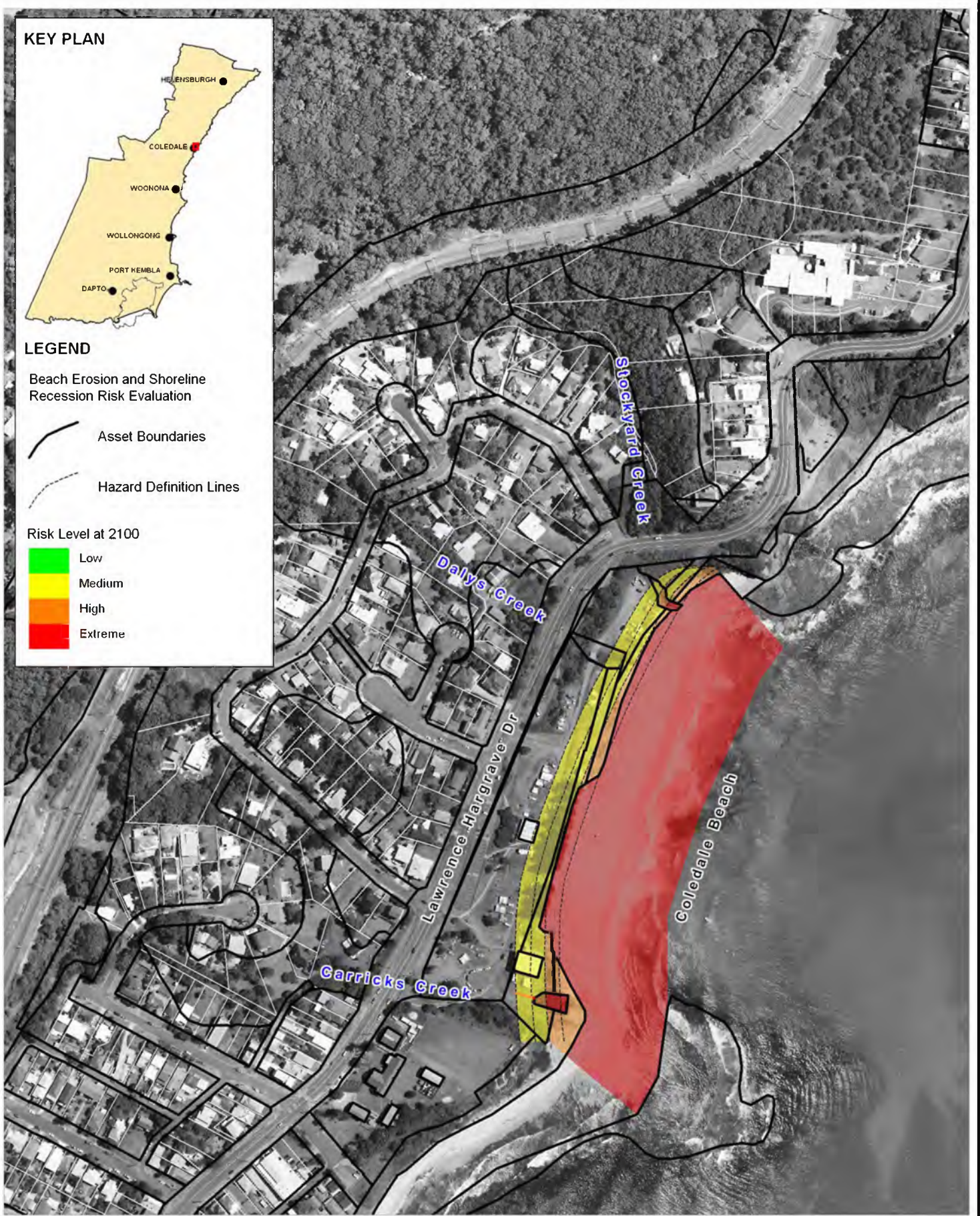
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100

- Low
- Medium
- High
- Extreme



Title:

**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Coledale**

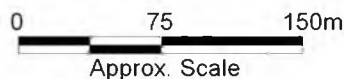
Drawing:

**C-4**

Rev:

**A**

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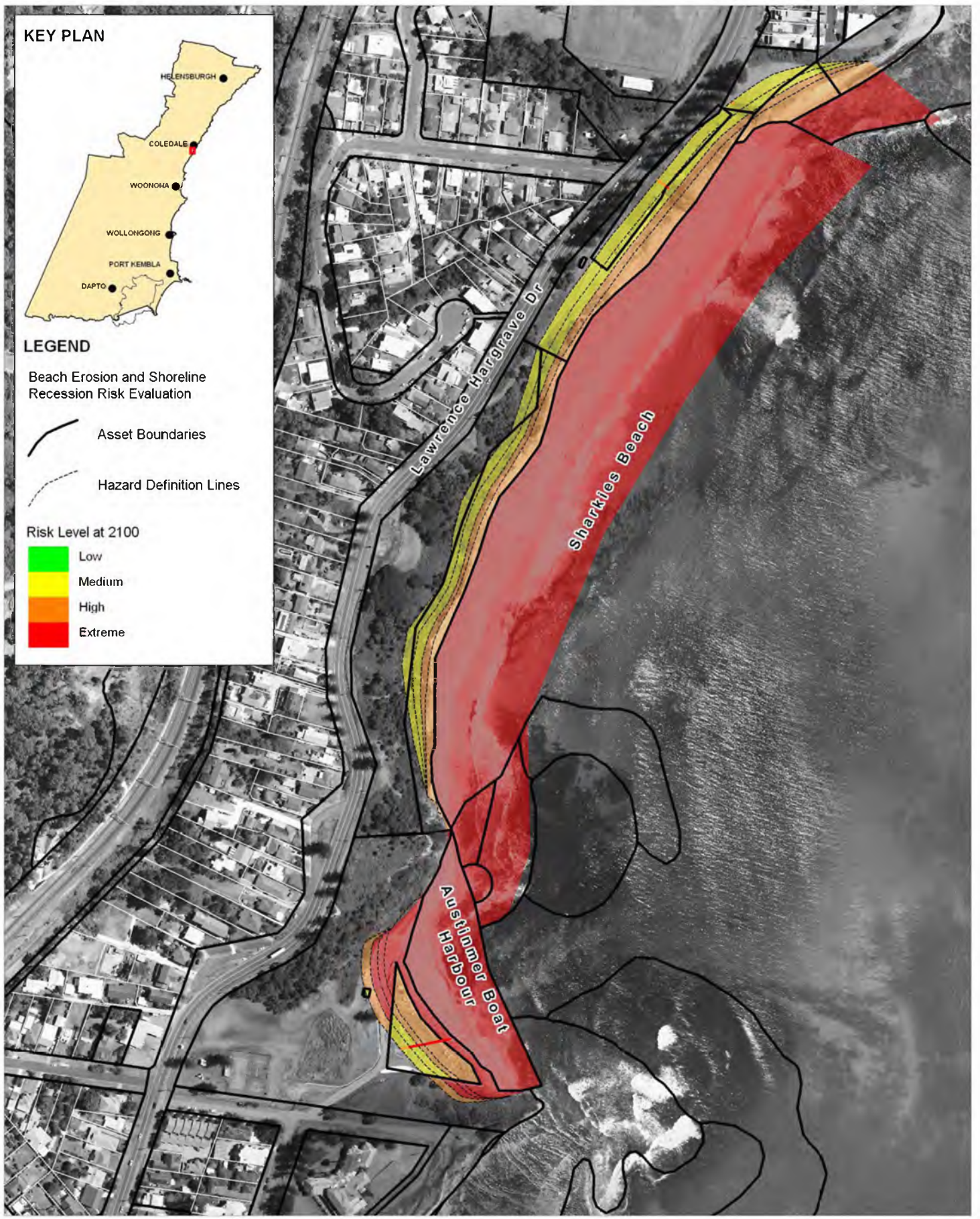


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100



Title:

**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Sharkies Beach**

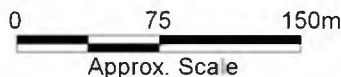
Drawing:

**C-5**

Rev:

**A**

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**KEY PLAN**

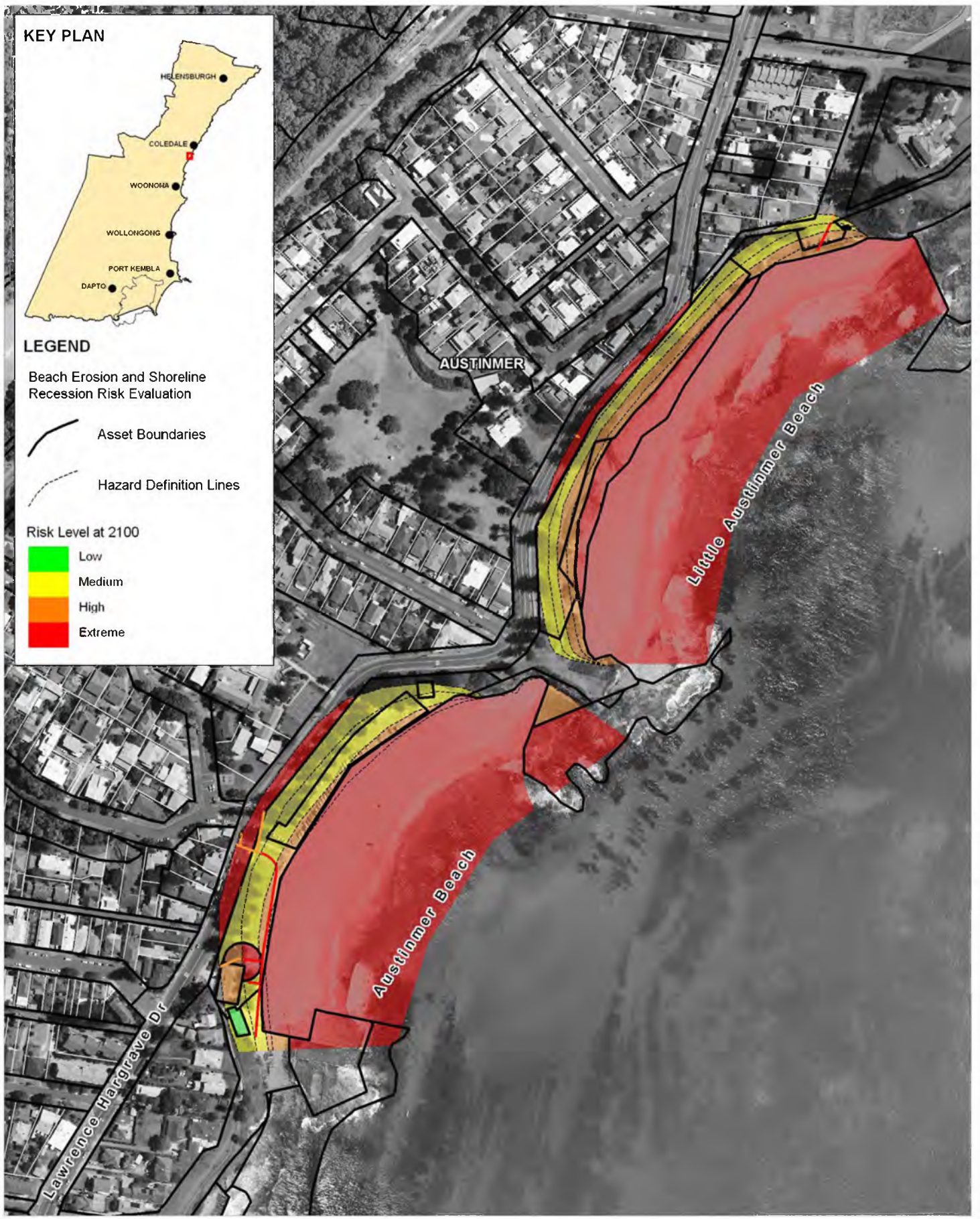


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100



Title:

**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Austinmer**

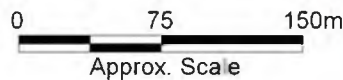
Drawing:

**C-6**

Rev:

**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_166\_110415 Drawing C-6.WOR

**KEY PLAN**



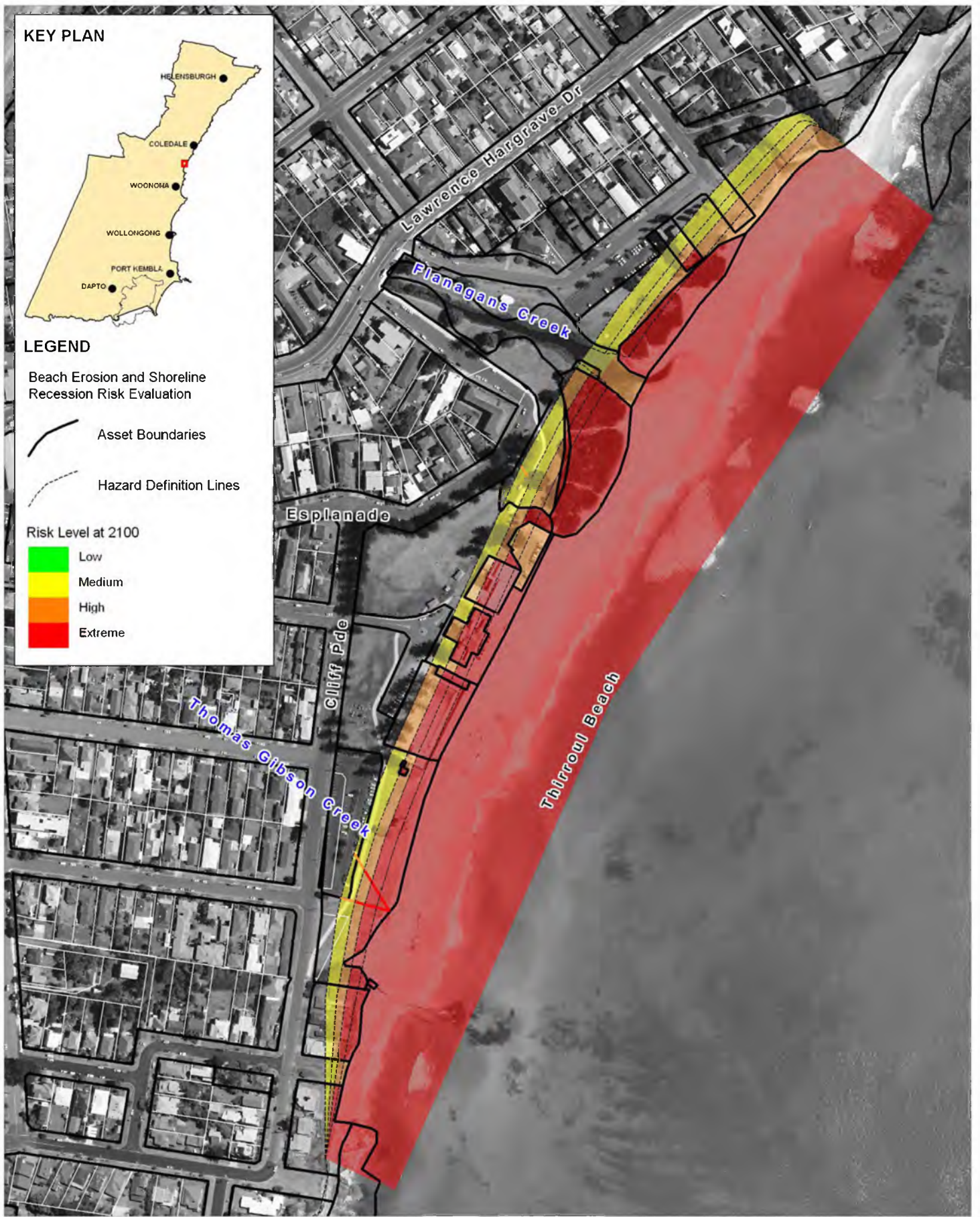
**LEGEND**



Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100

-  Low
-  Medium
-  High
-  Extreme



<p>Title: <b>Erosion and Recession Risk Evaluation 2100 Planning Horizon - Thirroul</b></p>		<p>Drawing: <b>C-7</b></p>	<p>Rev: <b>A</b></p>
<p>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.</p>			
<p>Filepath : K:\N1965_Wollongong\CZMP\MapInfo\Workspaces\DRG_167_110414 Drawing C-7.WOR</p>			

**KEY PLAN**

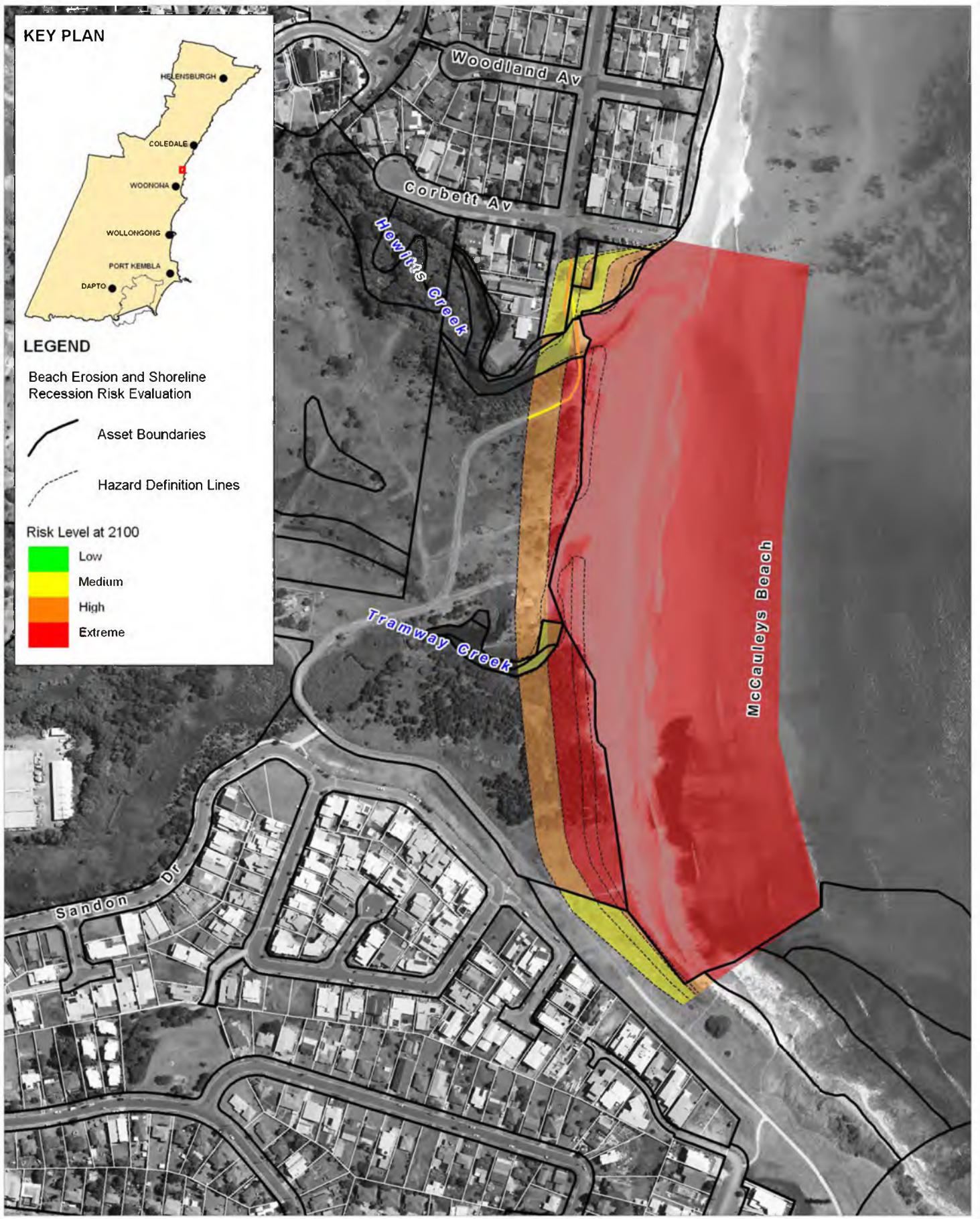


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100

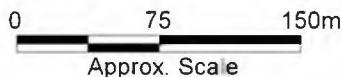


Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - McCauleys Beach**

Drawing:  
**C-8**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_168\_110415 Drawing C-8.WOR

**KEY PLAN**

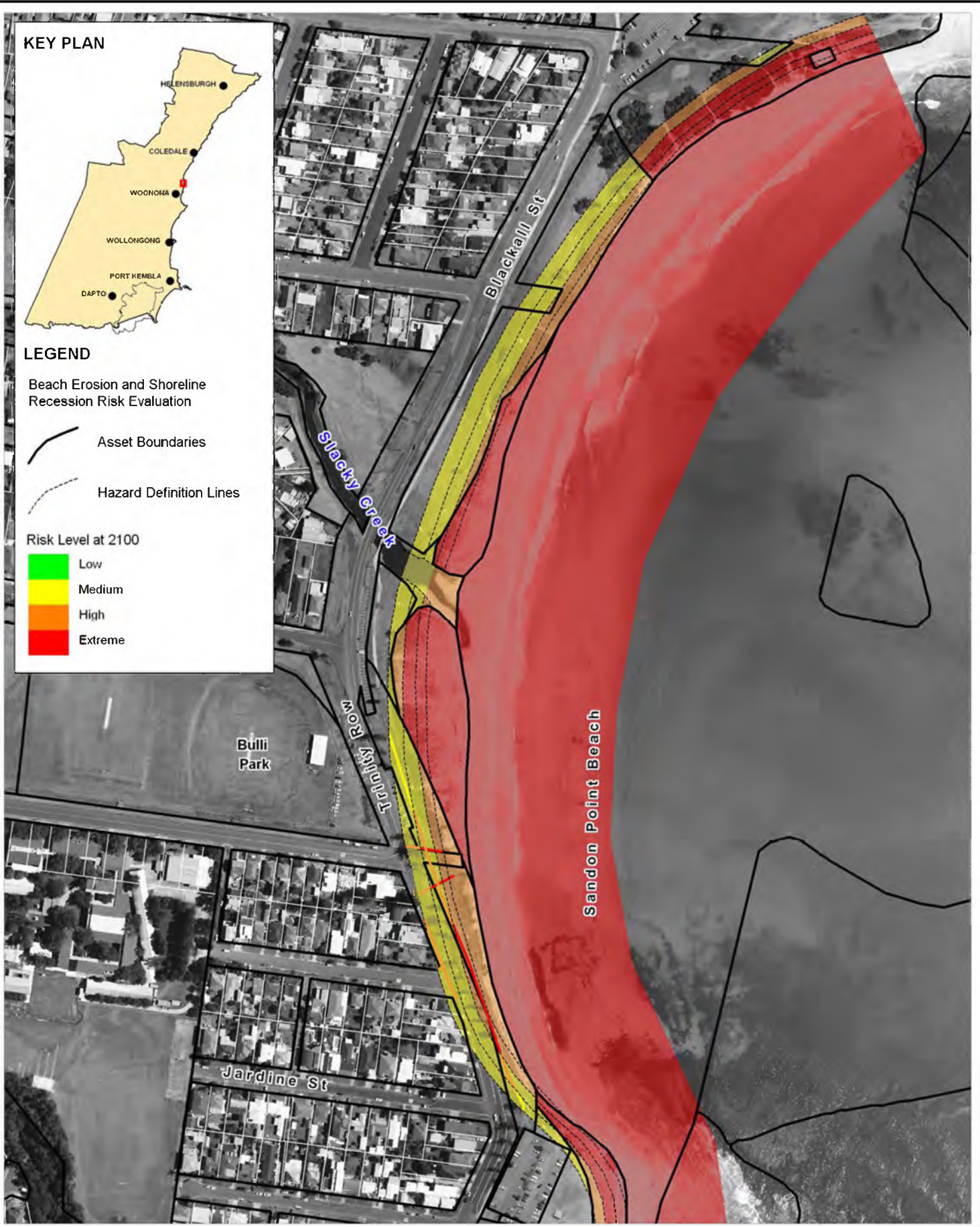
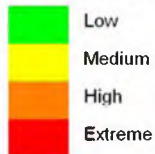


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

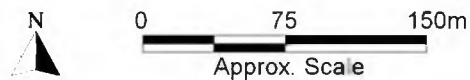
- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100



<p>Title: <b>Erosion and Recession Risk Evaluation 2100 Planning Horizon - Sandon Point Beach</b></p>	<p>Drawing: <b>C-9</b></p>	<p>Rev: <b>A</b></p>
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**KEY PLAN**

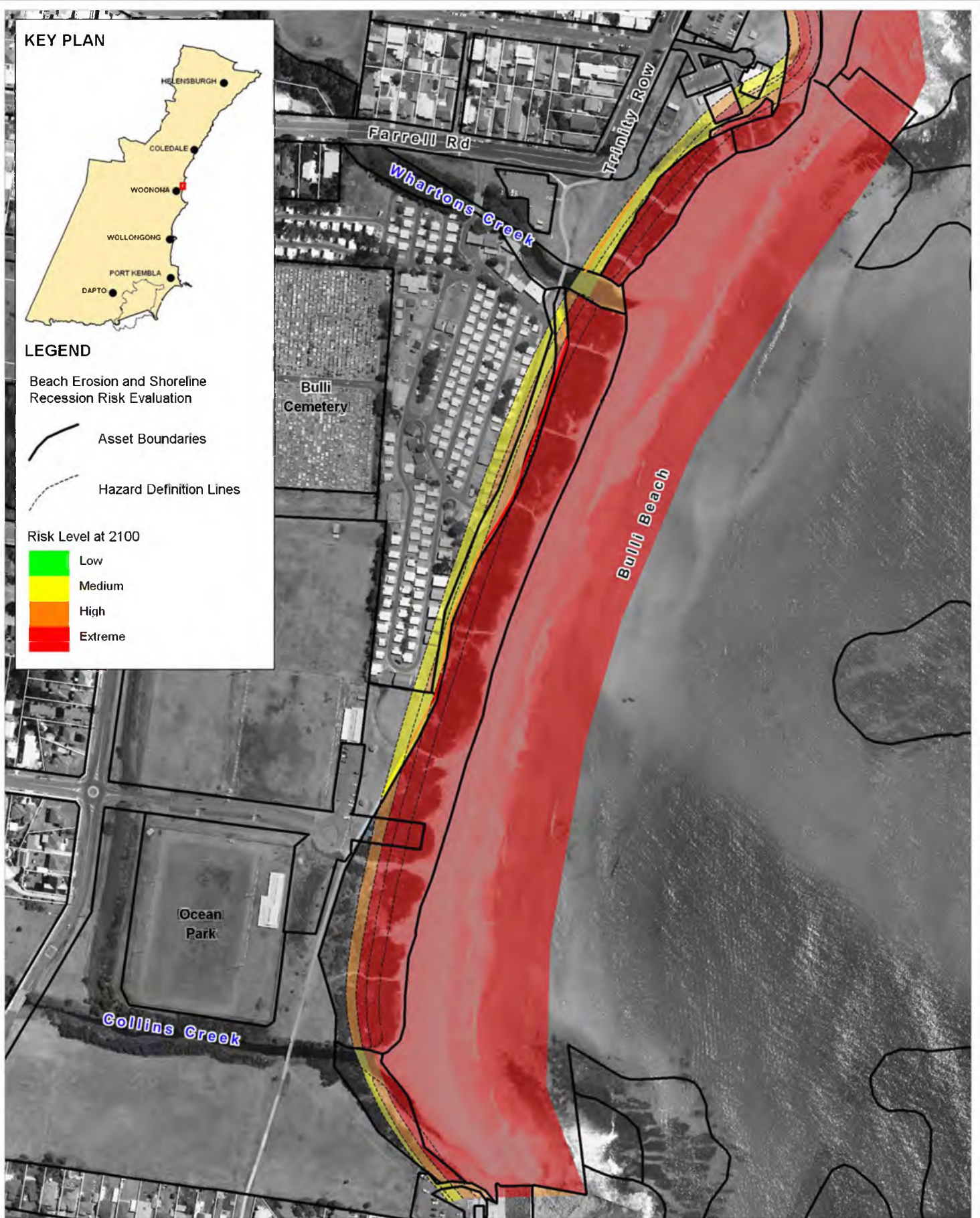


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100



Title:

**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Bulli Beach**

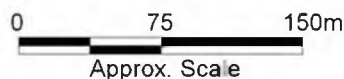
Drawing:

**C-10**

Rev:

**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_170\_110415 Drawing C-10.WOR

**KEY PLAN**



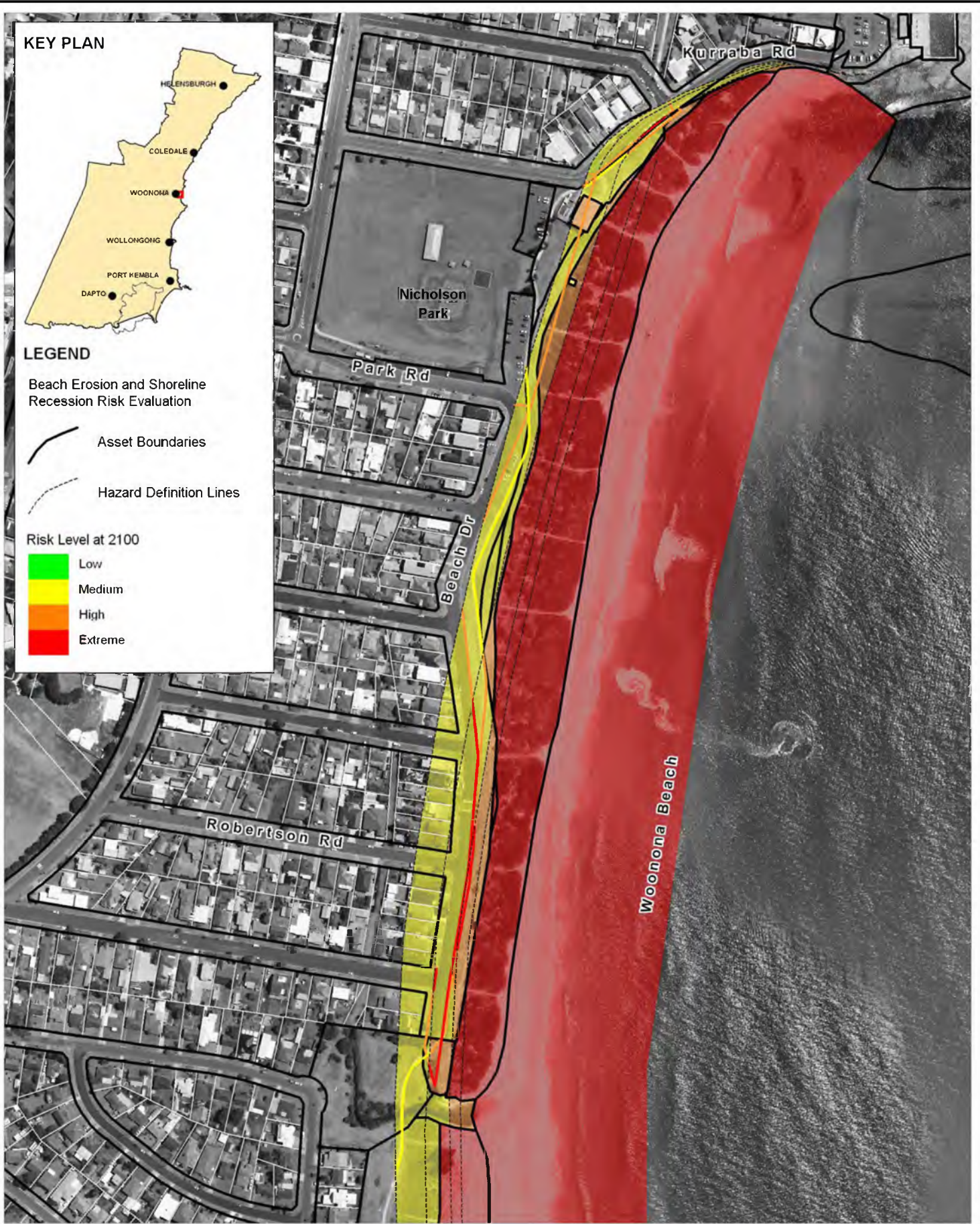
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100

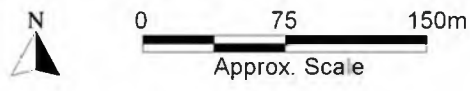
-  Low
-  Medium
-  High
-  Extreme



Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Woonona Beach**

Drawing: <b>C-11</b>	Rev: <b>A</b>
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**KEY PLAN**



**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100

-  Low
-  Medium
-  High
-  Extreme

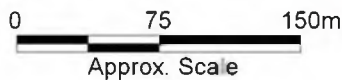


Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Bellambi Beach**

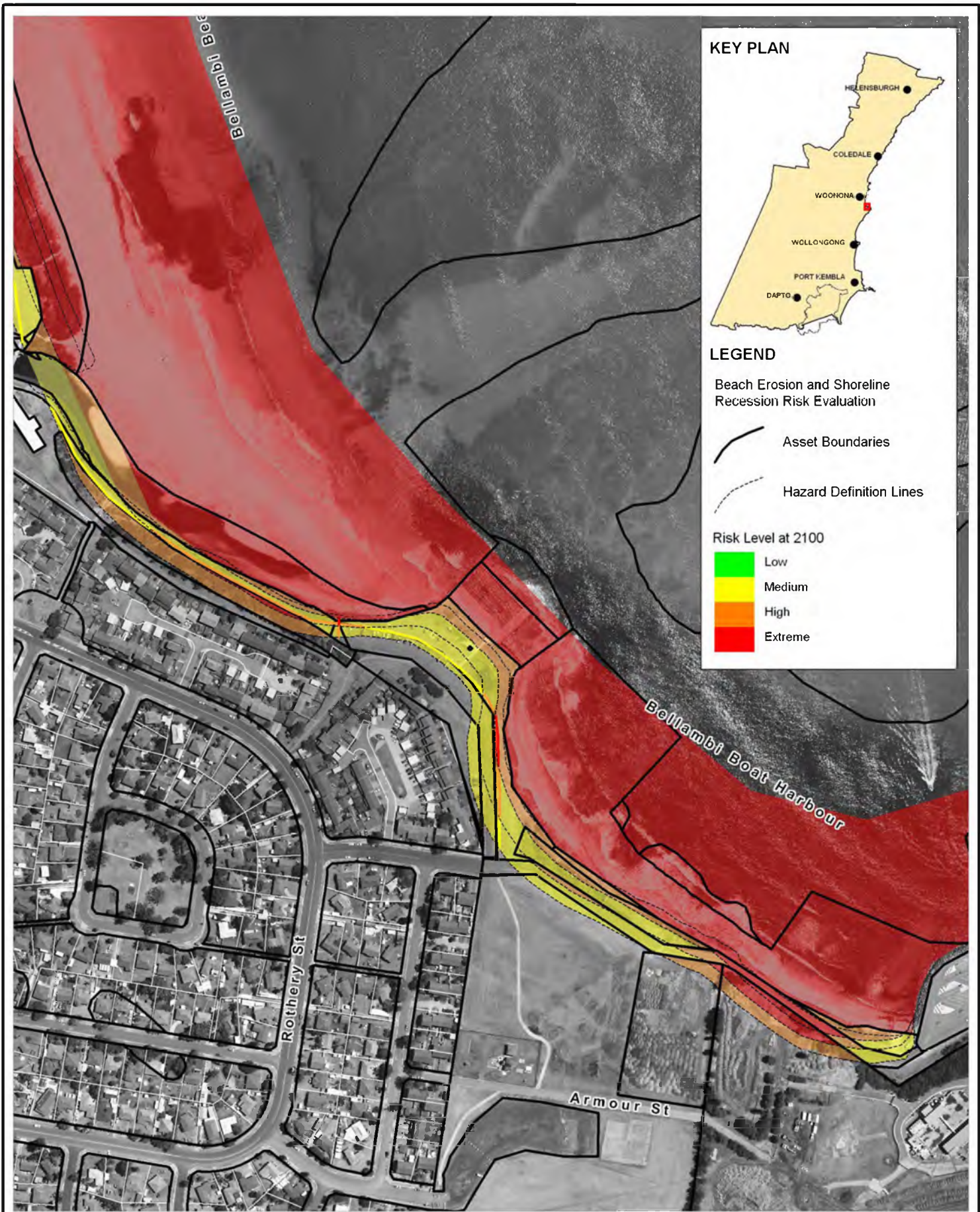
Drawing:  
**C-12**

Rev:  
**A**

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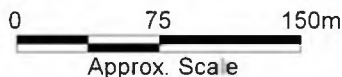


Title:  
**Erosion and Recession Risk Evaluation**  
**2100 Planning Horizon - Bellambi Boat Harbour**

Drawing:  
**C-13**

Rev:  
**A**

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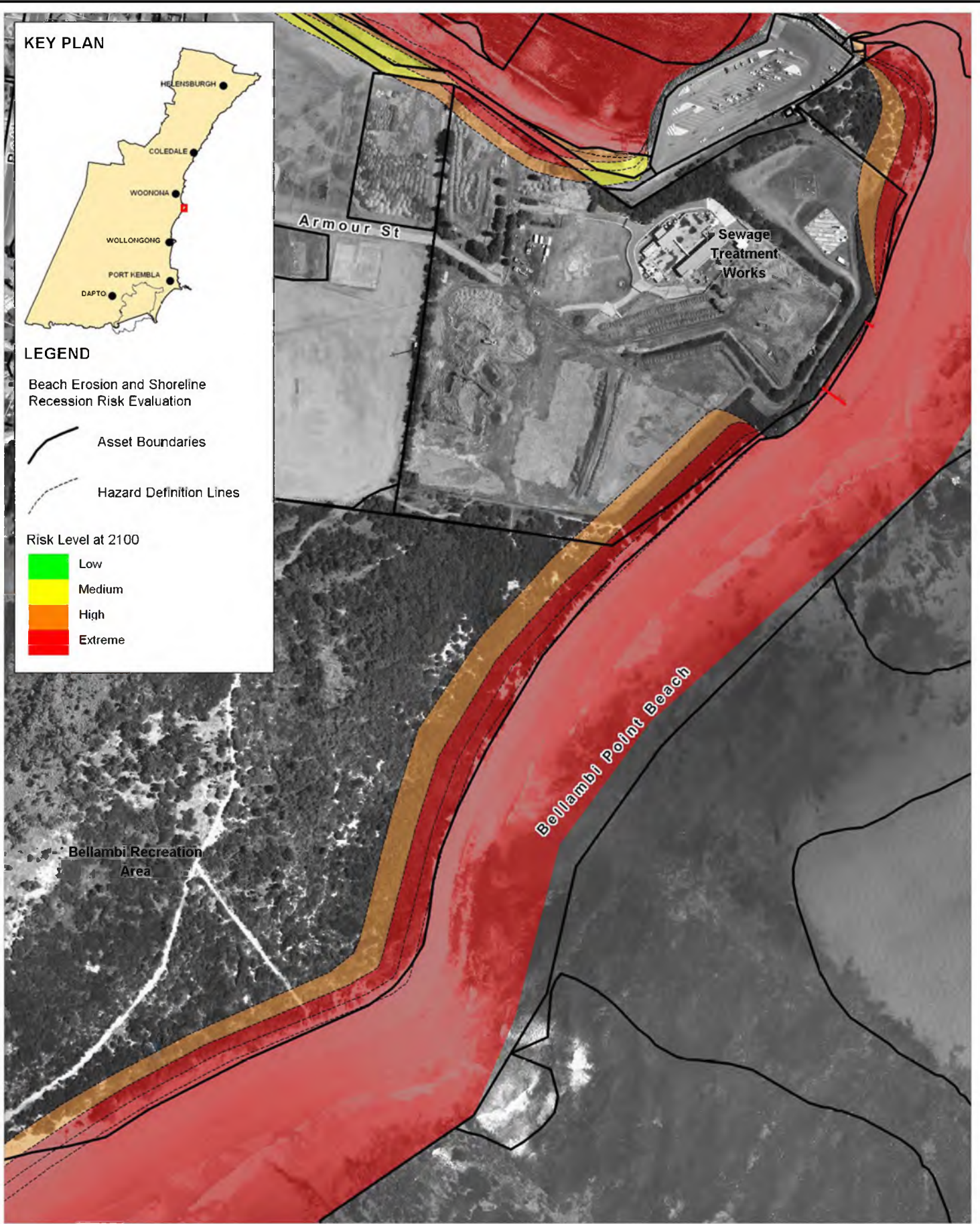
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100

- Low
- Medium
- High
- Extreme

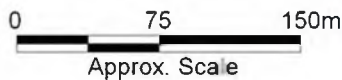


Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Bellambi Point Beach**

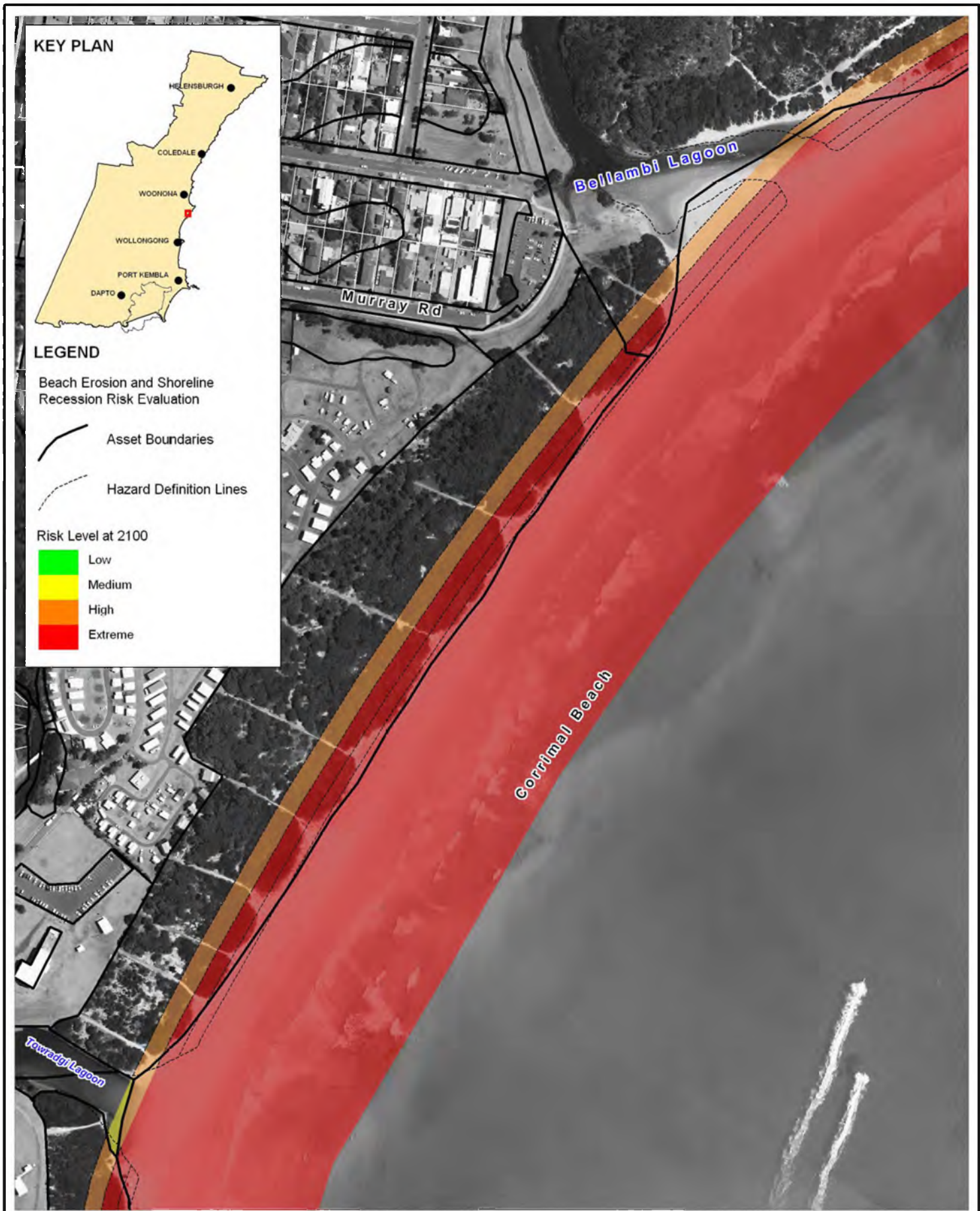
Drawing:  
**C-14**

Rev:  
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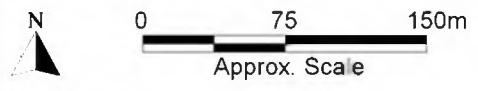
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Title:  
**Erosion and Recession Risk Evaluation  
 2100 Planning Horizon - Corrimal Beach**

Drawing: <b>C-15</b>	Rev: <b>A</b>
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**KEY PLAN**



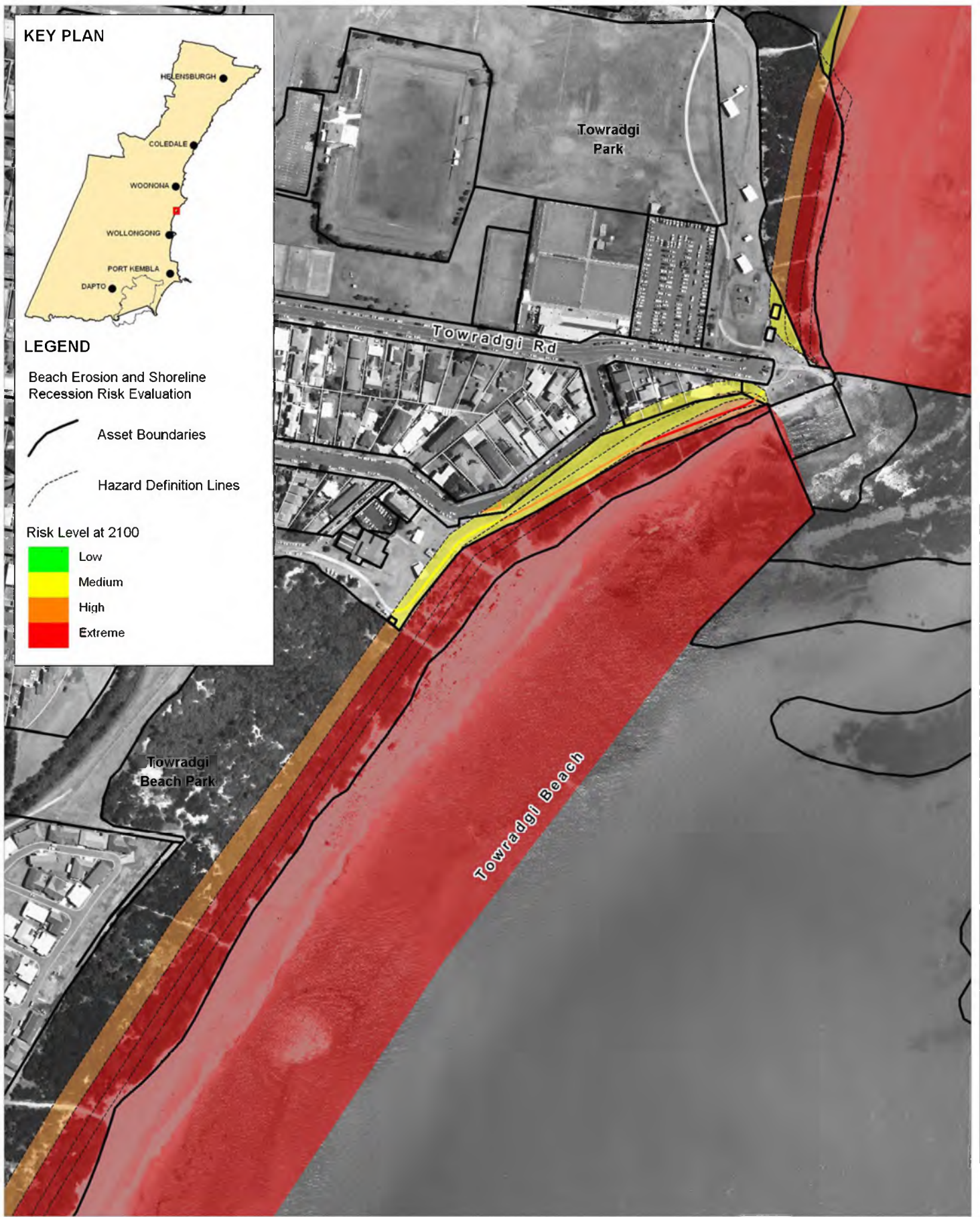
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100

-  Low
-  Medium
-  High
-  Extreme

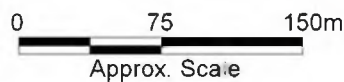


Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Towradgi Beach**

Drawing:  
**C-16**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_176\_110415 Drawing C-16.WOR

**KEY PLAN**



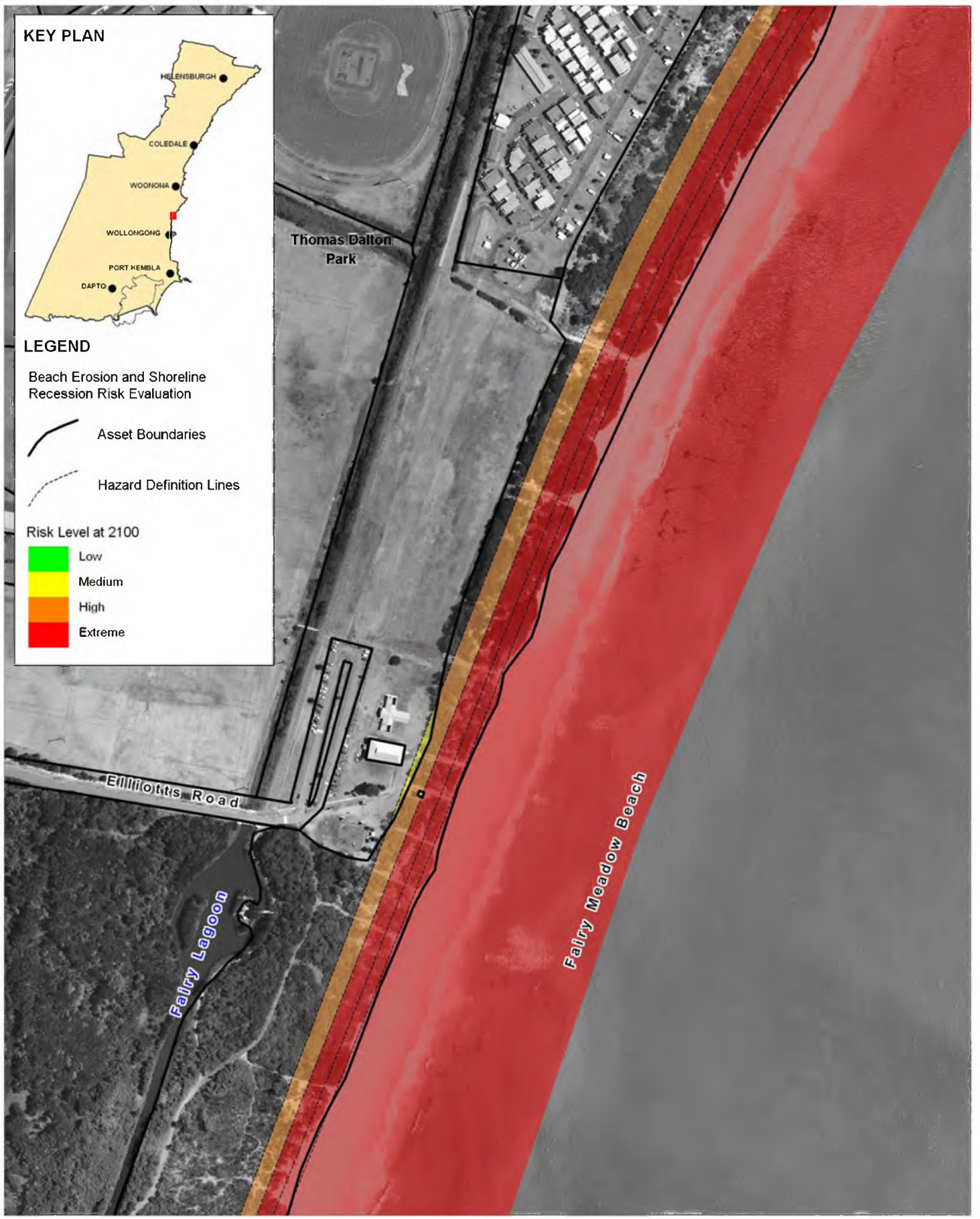
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100

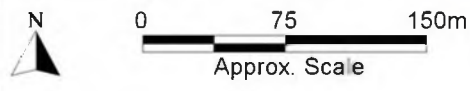
-  Low
-  Medium
-  High
-  Extreme



Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Fairy Meadow Beach (north)**

Drawing: <b>C-17</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_177\_110415 Drawing C-17.WOR

**KEY PLAN**



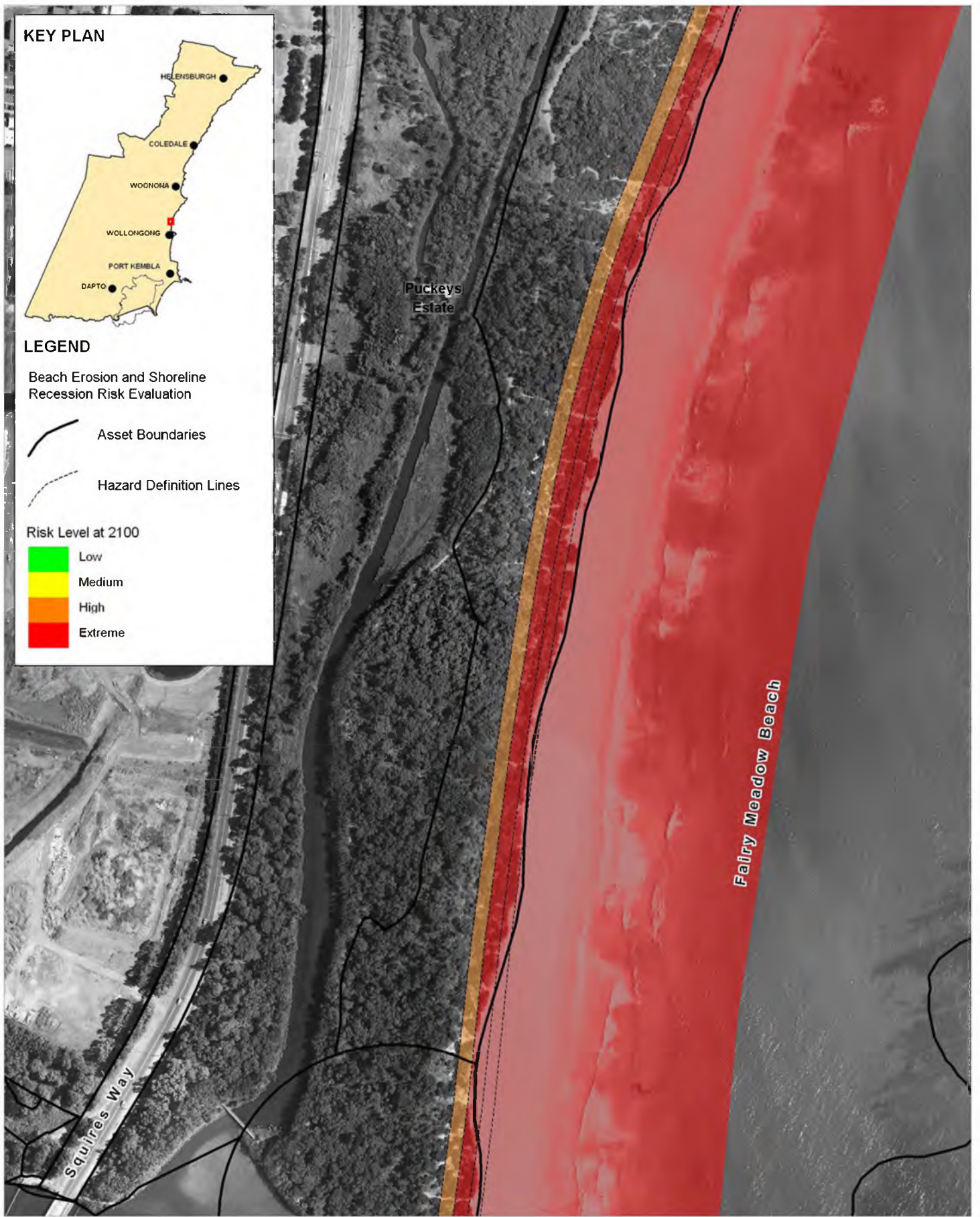
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100

-  Low
-  Medium
-  High
-  Extreme

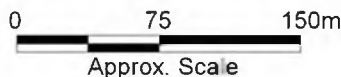


Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Fairy Meadow Beach (south)**

Drawing:  
**C-18**

Rev:  
**A**

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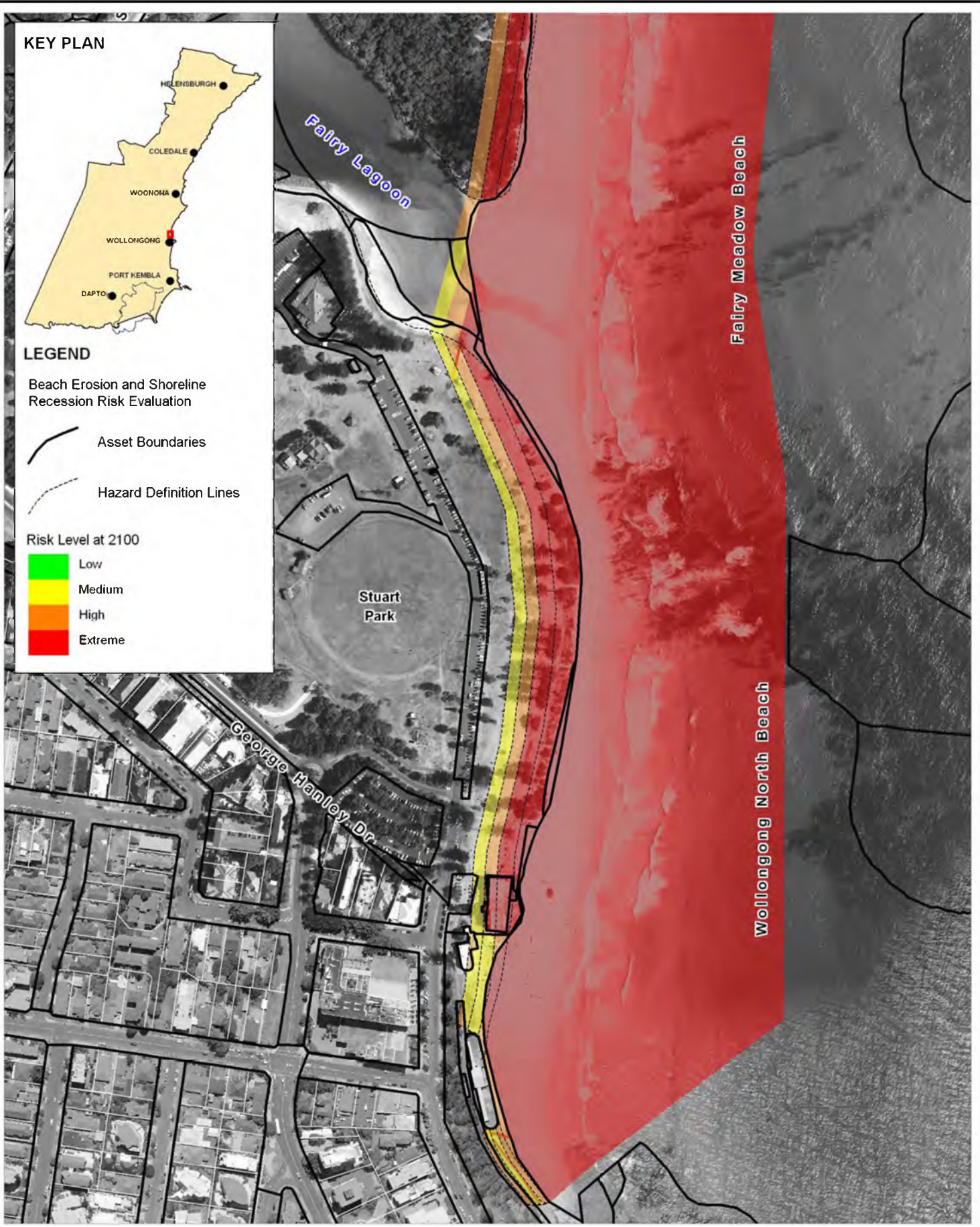


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100



Title:

**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Wollongong North Beach**

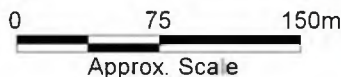
Drawing:

**C-19**

Rev:

**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_179\_110415 Drawing C-19.WOR



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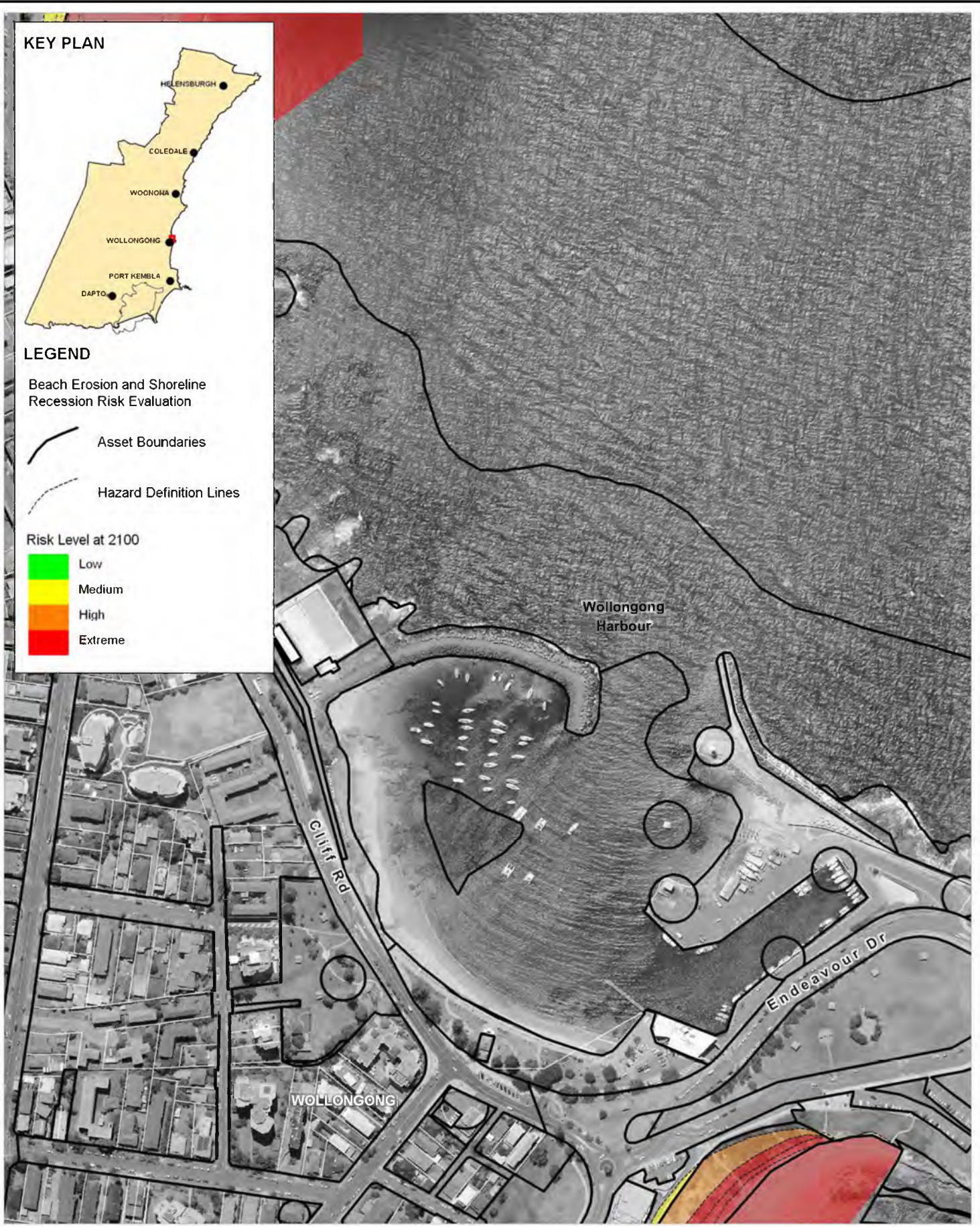


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

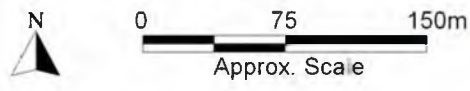
Risk Level at 2100



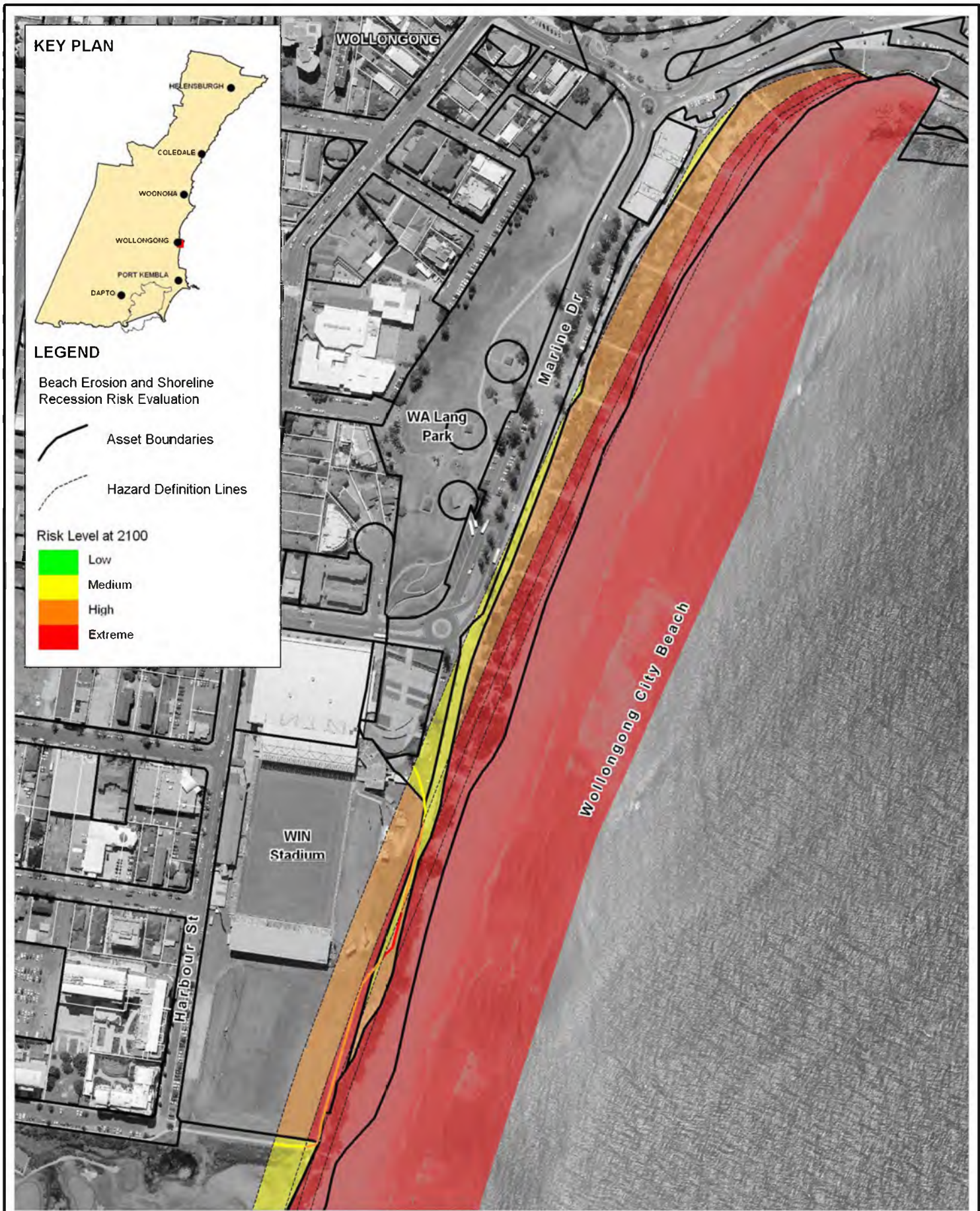
Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Wollongong Harbour**

Drawing: <b>C-20</b>	Rev: <b>A</b>
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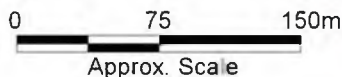


Title:  
**Erosion and Recession Risk Evaluation  
 2100 Planning Horizon - Wollongong City Beach**

Drawing:  
**C-21**

Rev:  
**A**

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**KEY PLAN**

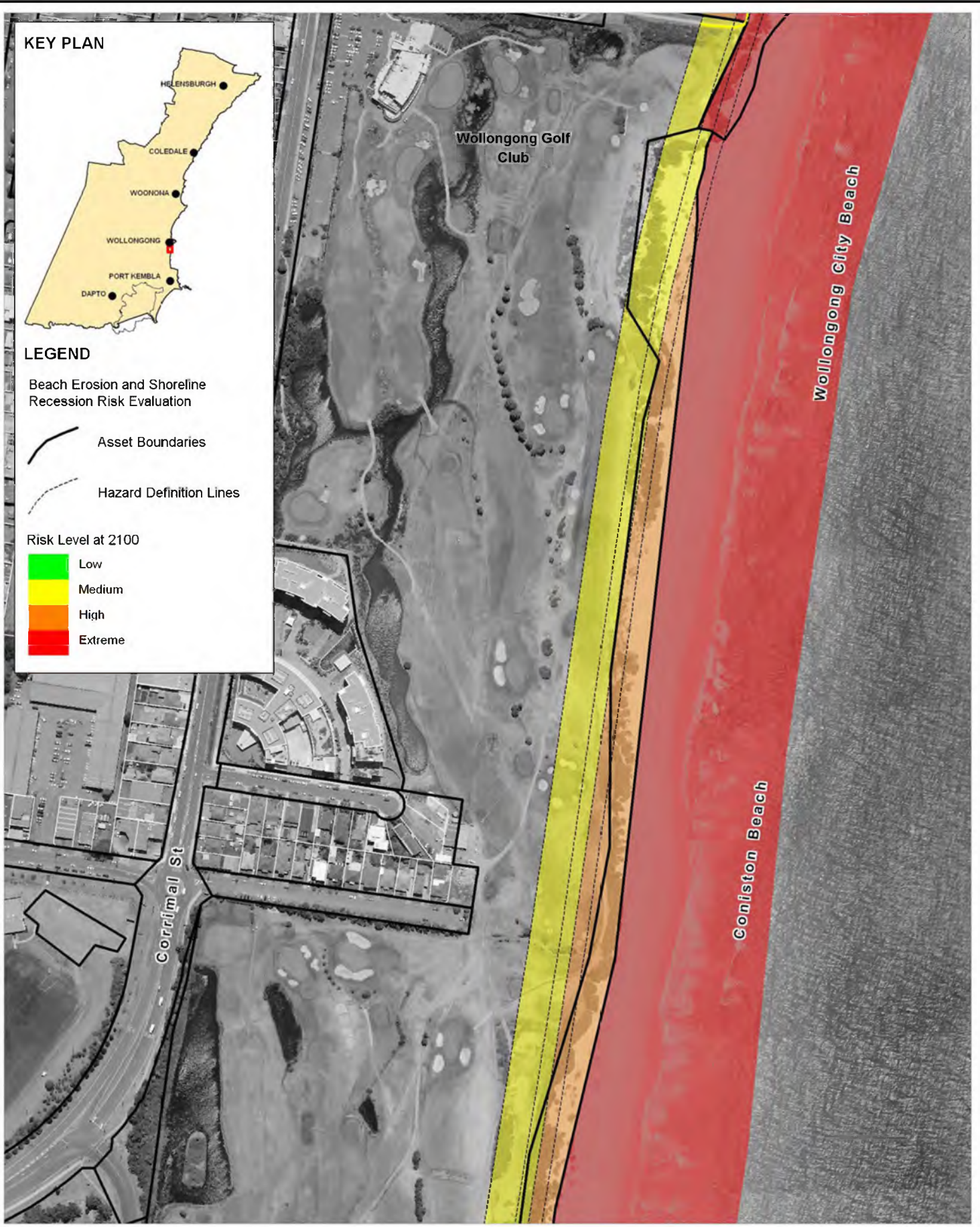


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

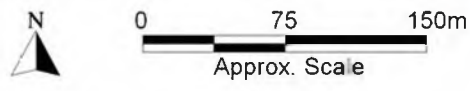
- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100



Title: <b>Erosion and Recession Risk Evaluation 2100 Planning Horizon - Coniston Beach (north)</b>		Drawing: <b>C-22</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_182\_110418 Drawing C-22.WOR

**KEY PLAN**

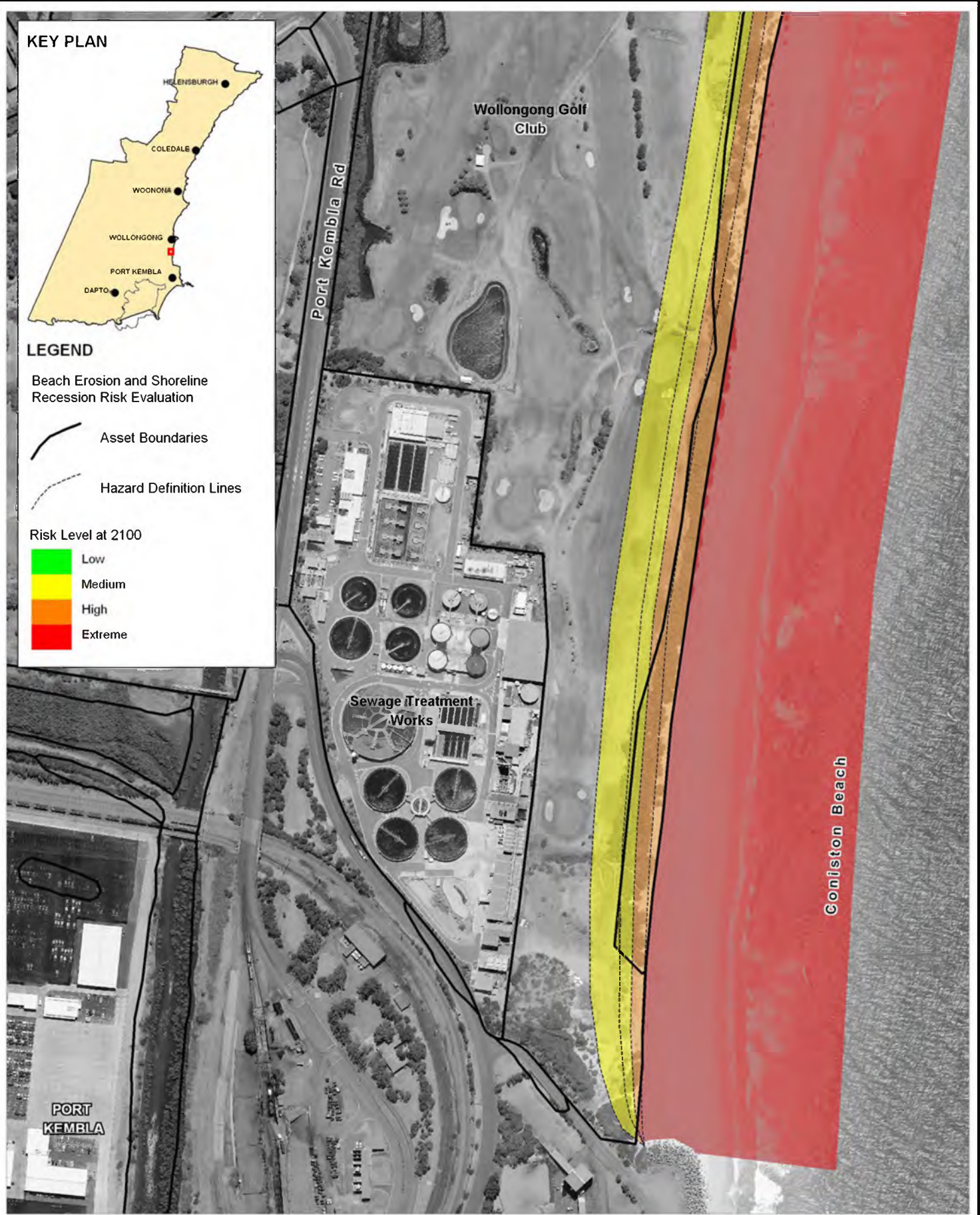


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100



Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Coniston Beach (south)**

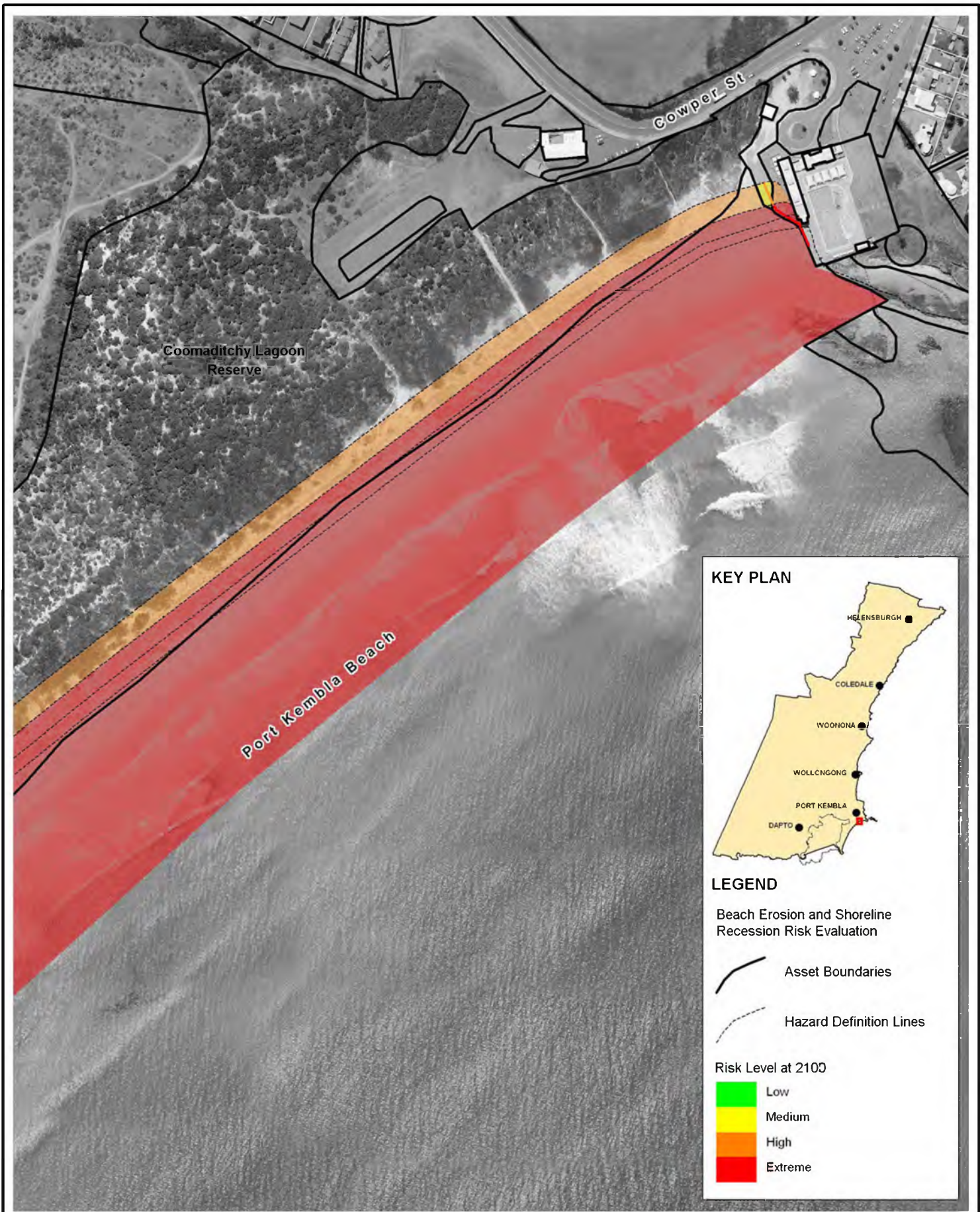
Drawing:  
**C-23**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_183\_110418 Drawing C-23.WOR

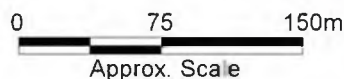


Title:  
**Erosion and Recession Risk Evaluation  
 2100 Planning Horizon - Port Kembla Beach**

Drawing:  
**C-24**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_184\_110418 Drawing C-24.WOR



**KEY PLAN**



Coomaditchy Lagoon Reserve

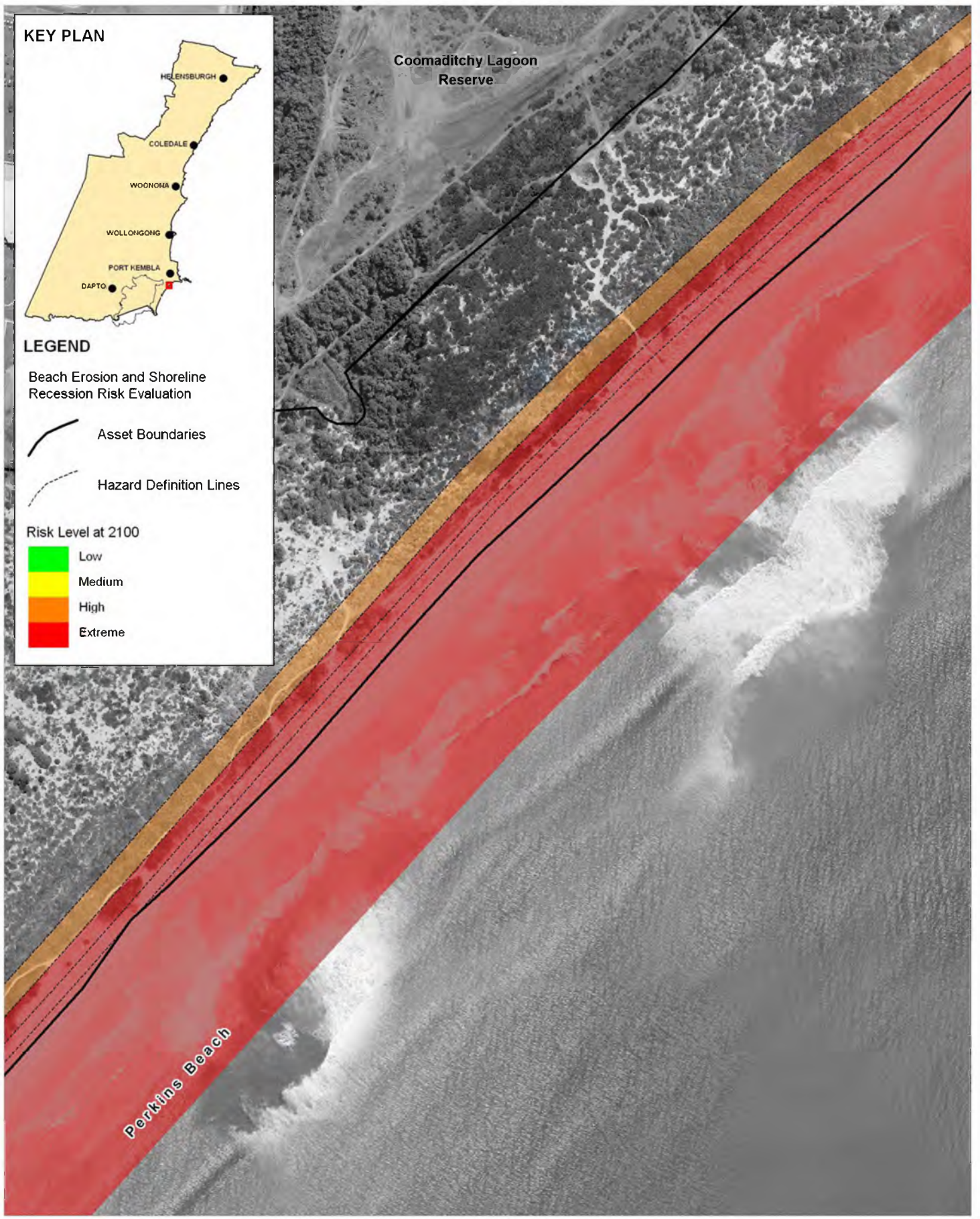
**LEGEND**

Beach Erosion and Shoreline Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100

-  Low
-  Medium
-  High
-  Extreme

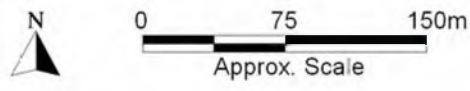


Perkins Beach

Title:  
**Erosion and Recession Risk Evaluation  
 2100 Planning Horizon - Perkins Beach (1)**

Drawing: <b>C-25</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_185\_110418 Drawing C-25.WOR

**KEY PLAN**



**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100

-  Low
-  Medium
-  High
-  Extreme

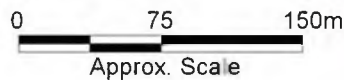
*Perkins Beach*

Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Perkins Beach (2)**

Drawing:  
**C-26**

Rev:  
**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_186\_110418 Drawing C-26.WOR

**KEY PLAN**



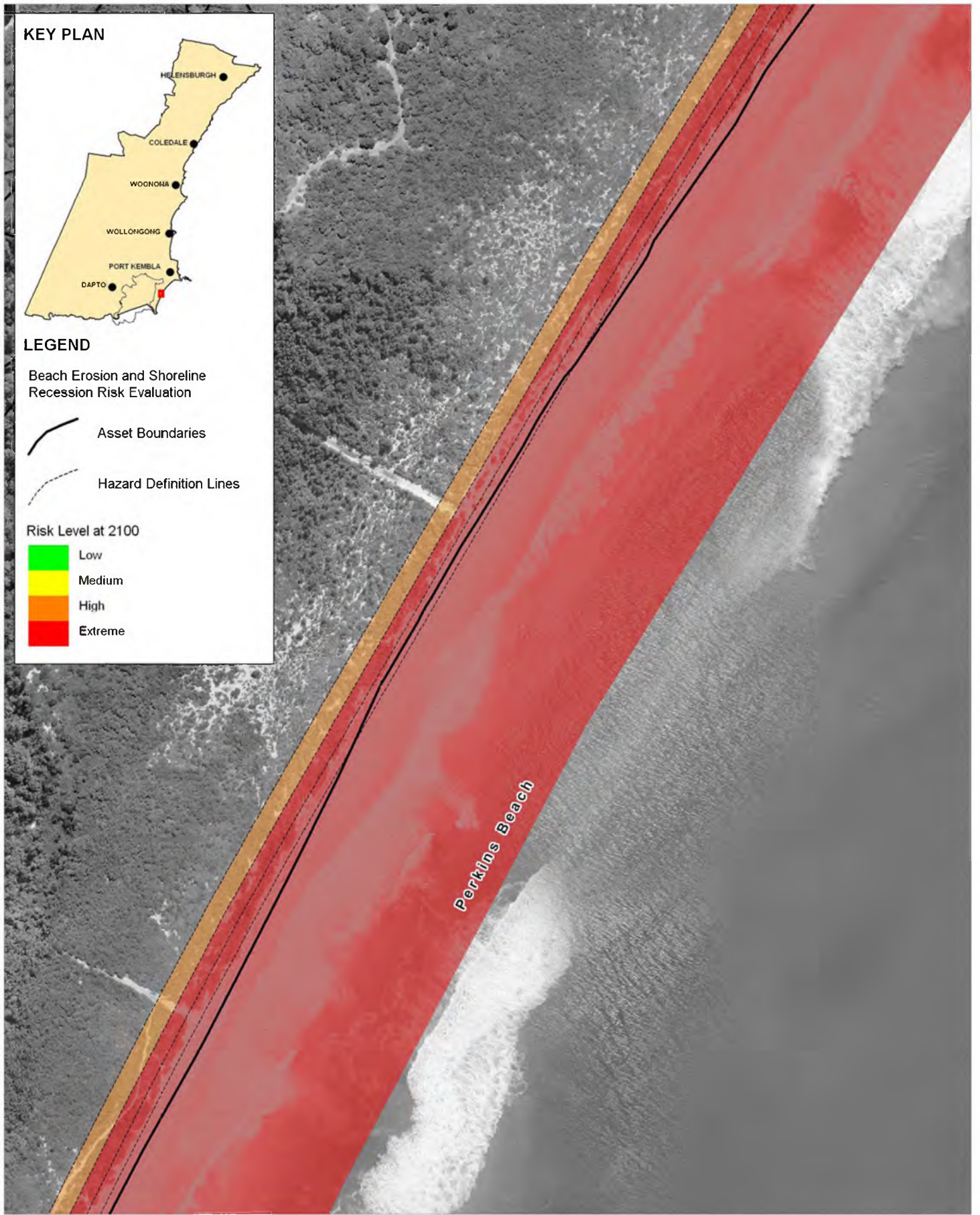
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100

-  Low
-  Medium
-  High
-  Extreme



*Perkins Beach*

Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Perkins Beach (3)**

Drawing: <b>C-27</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_187\_110418 Drawing C-27.WOR





**KEY PLAN**



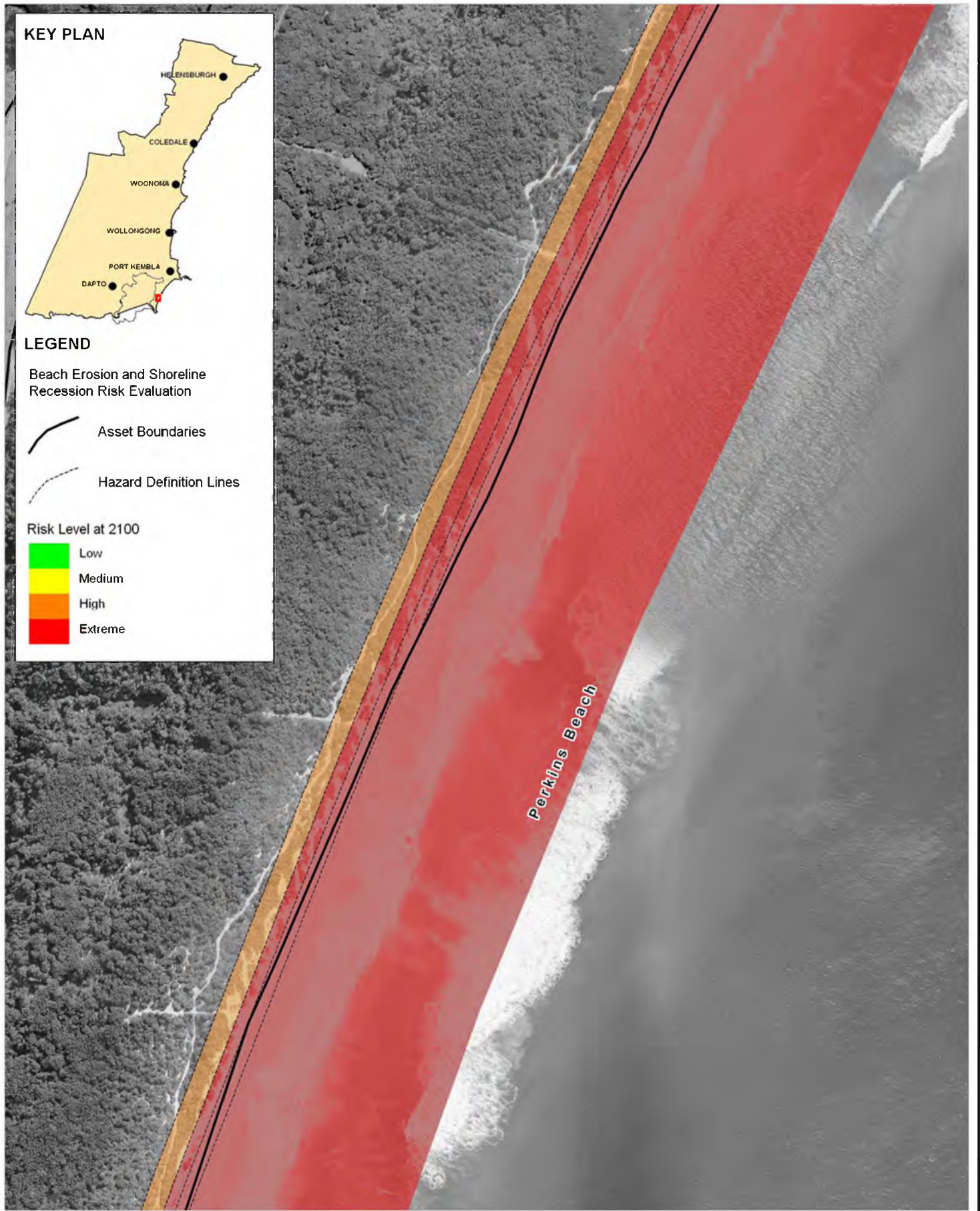
**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100

-  Low
-  Medium
-  High
-  Extreme

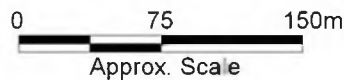


Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Perkins Beach (4)**

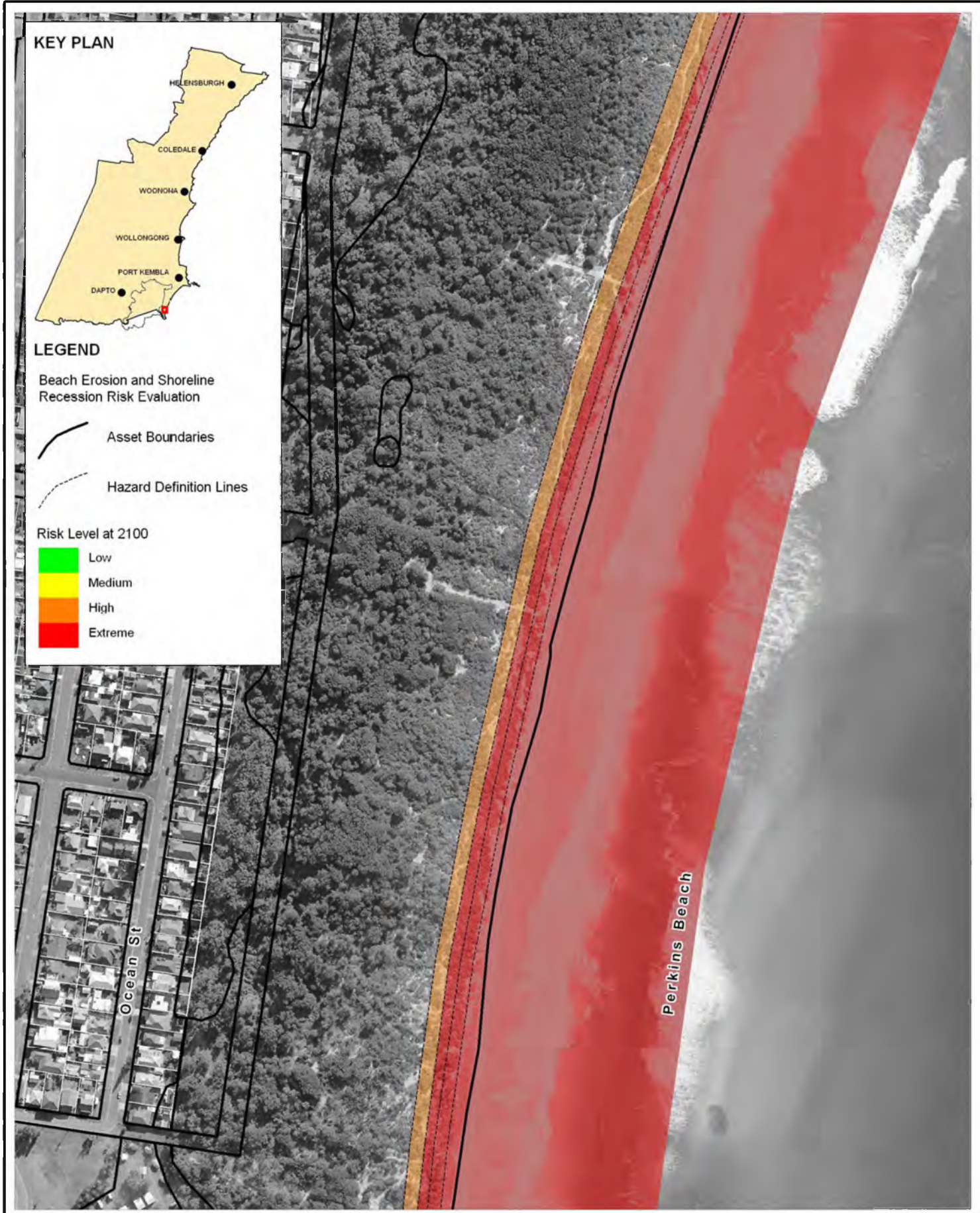
Drawing:  
**C-28**

Rev:  
**A**

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**KEY PLAN**



**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100

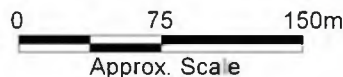
-  Low
-  Medium
-  High
-  Extreme

Title:  
**Erosion and Recession Risk Evaluation  
2100 Planning Horizon - Perkins Beach (5)**

Drawing:  
**C-29**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_189\_110418 Drawing C-29.WOR

**KEY PLAN**

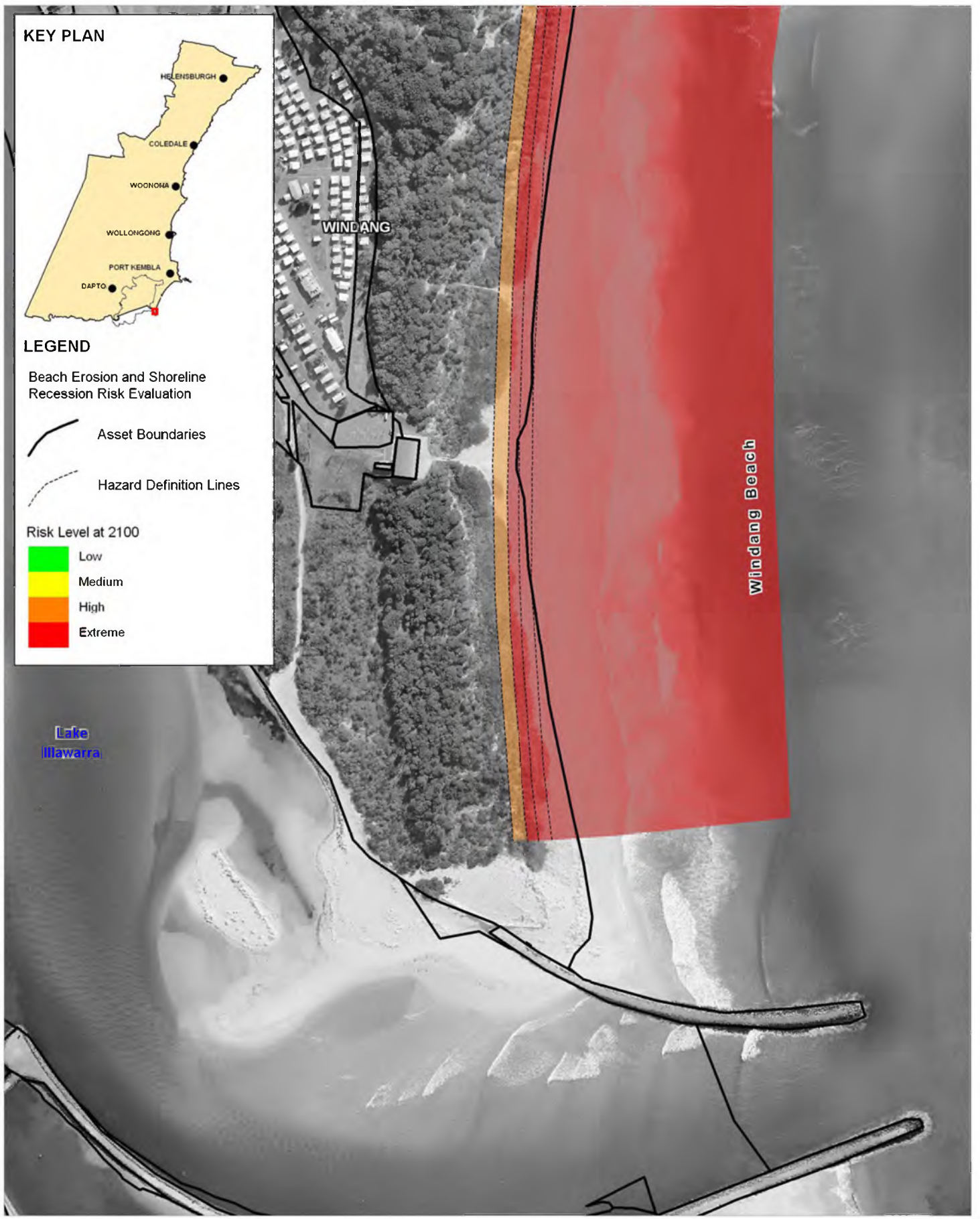


**LEGEND**

Beach Erosion and Shoreline  
Recession Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100



<p>Title: <b>Erosion and Recession Risk Evaluation 2100 Planning Horizon - Windang Beach</b></p>	<p>Drawing: <b>C-30</b></p>	<p>Rev: <b>A</b></p>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_190\_110418 Drawing C-30.WOR

**KEY PLAN**

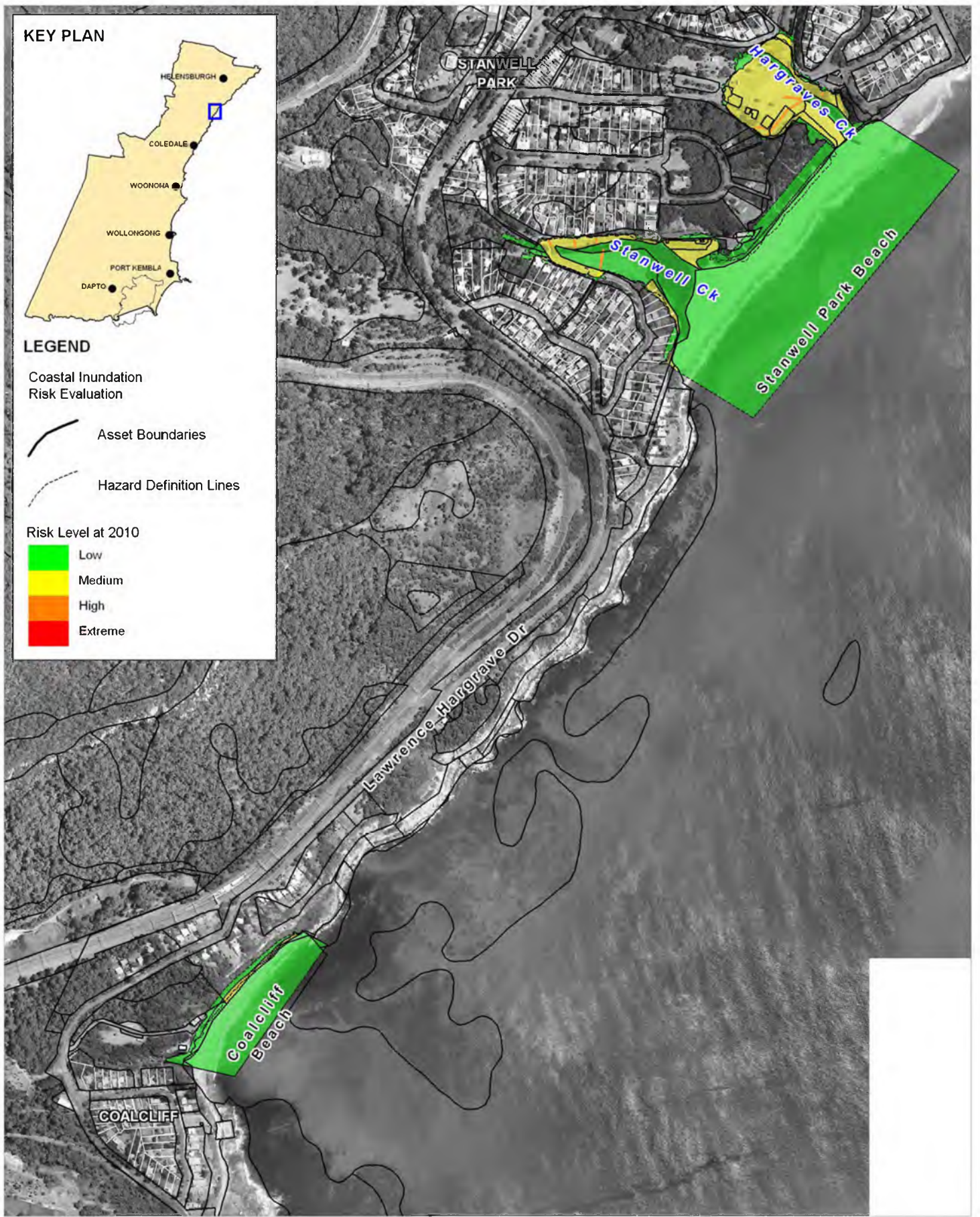


**LEGEND**

Coastal Inundation Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2010



Title:  
**Coastal Inundation Risk Evaluation  
 Immediate Planning Horizon - Stanwell Park / Coalcliff**

Drawing:  
**D-1**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_191\_110419 Drawing D-1.WOR

**KEY PLAN**

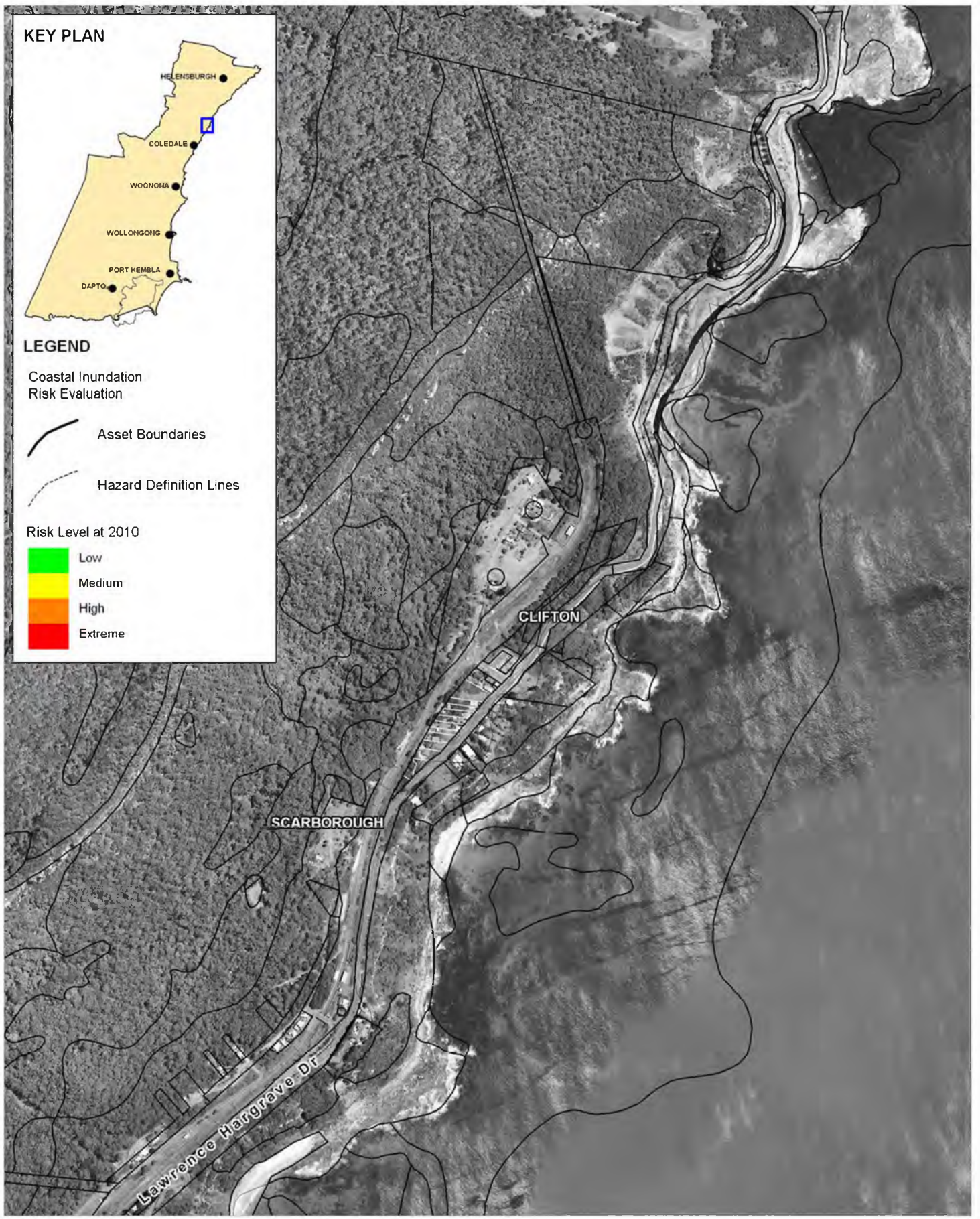


**LEGEND**

Coastal Inundation Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2010



Title:  
**Coastal Inundation Risk Evaluation**  
**Immediate Planning Horizon - Clifton / Scarborough**

Drawing: <b>D-2</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_192\_110419 Drawing D-2.WOR

**KEY PLAN**

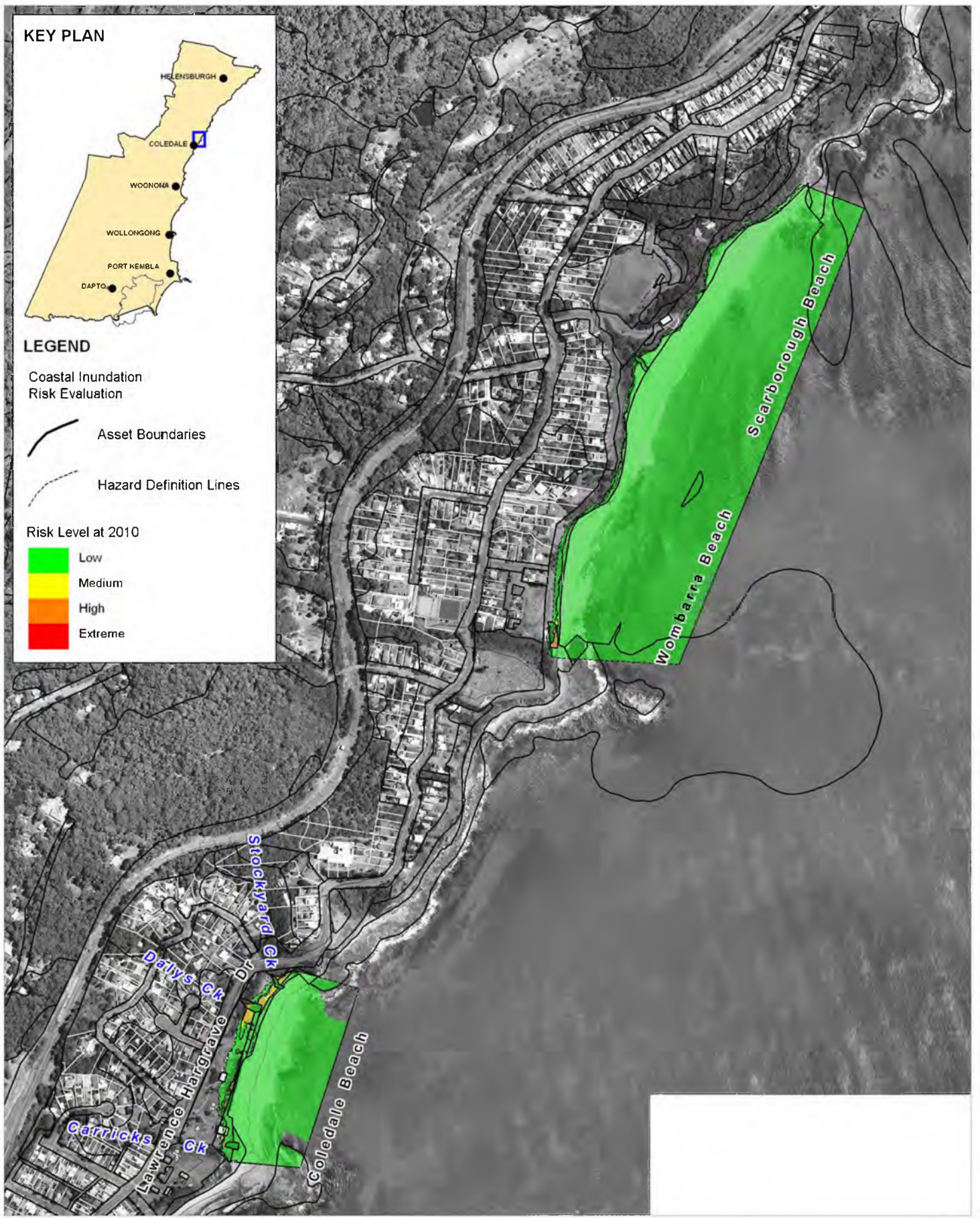


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

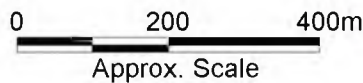


Title:  
**Coastal Inundation Risk Evaluation  
 Immediate Planning Horizon - Scarborough/Coledale**

Drawing:  
**D-3**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_193\_110419 Drawing D-3.WOR

**KEY PLAN**

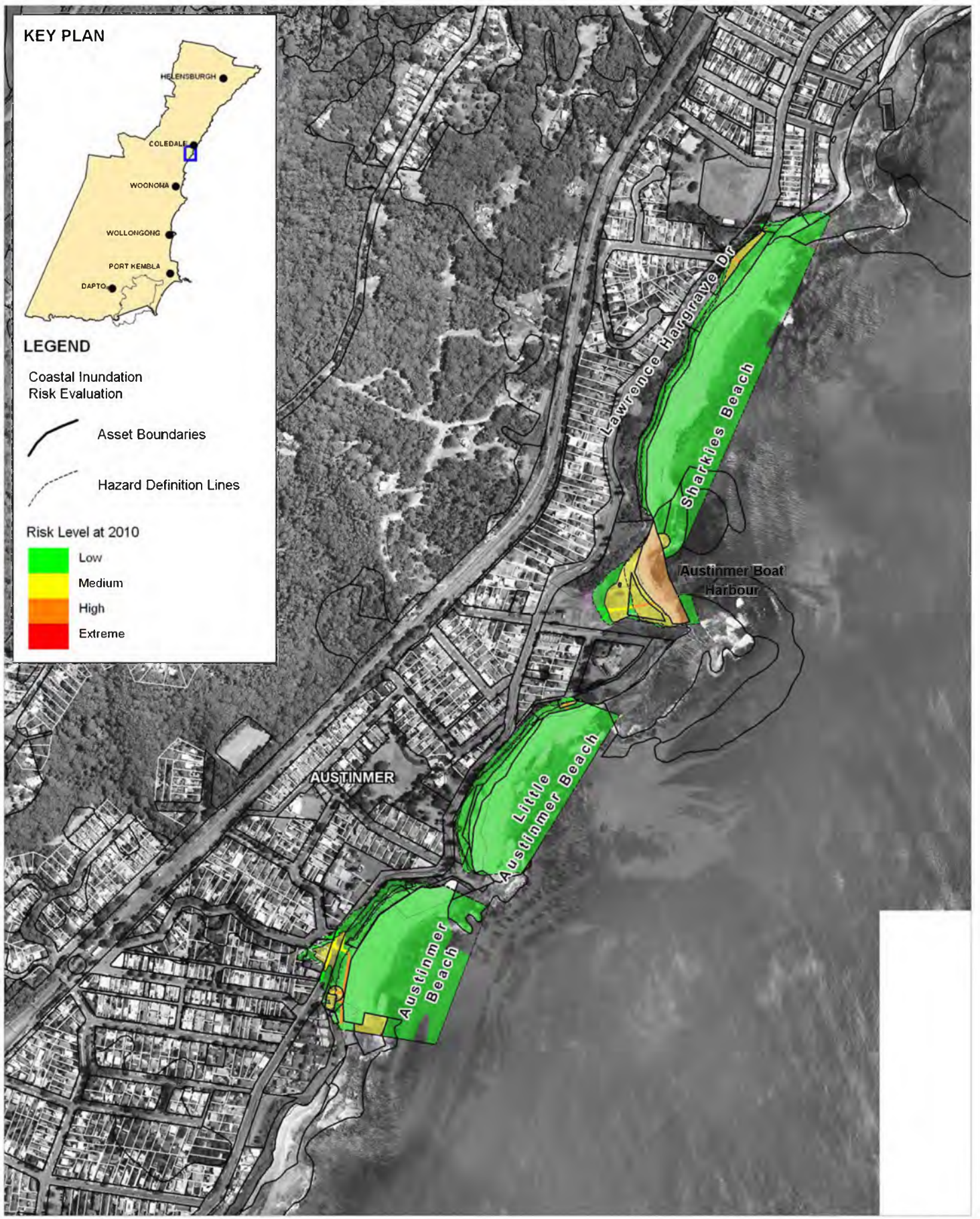


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

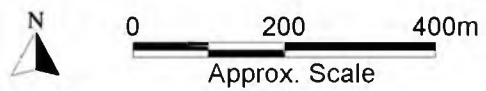
Risk Level at 2010



Title:  
**Coastal Inundation Risk Evaluation  
 Immediate Planning Horizon - Austinmer**

Drawing: <b>D-4</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_194\_110419 Drawing D-4.WOR

**KEY PLAN**

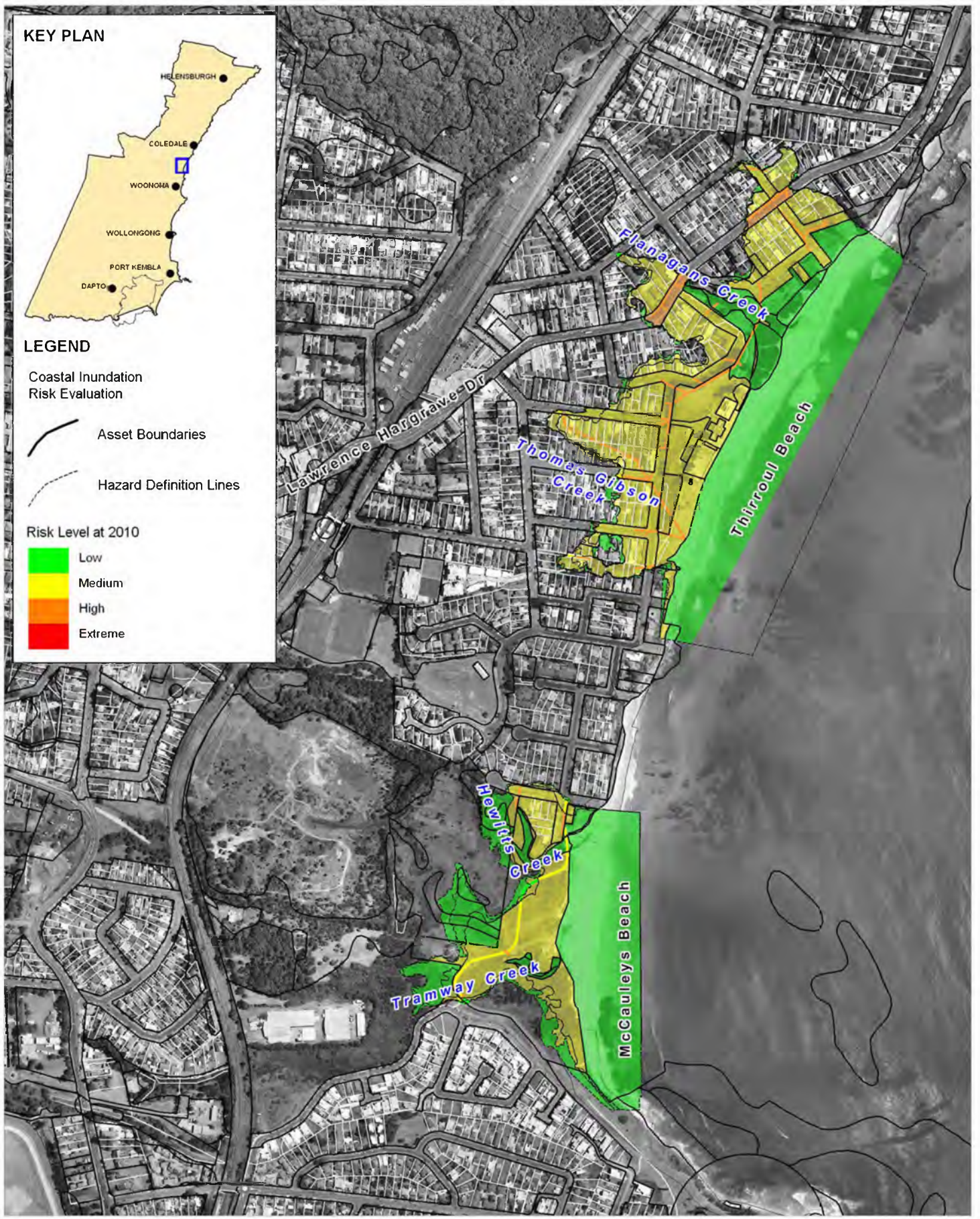


**LEGEND**

Coastal Inundation Risk Evaluation

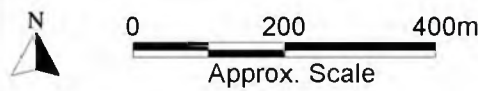
- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



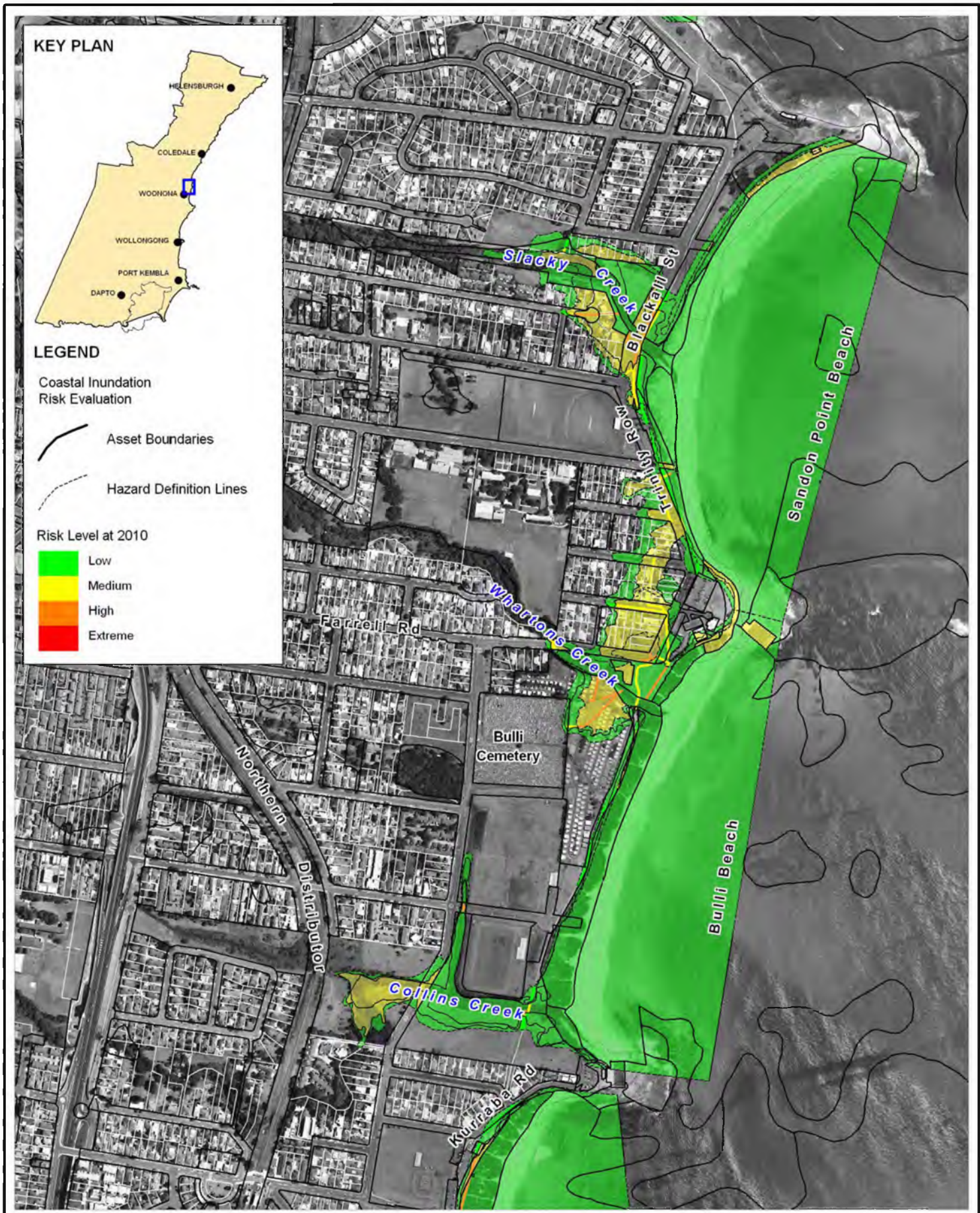
<p>Title: <b>Coastal Inundation Risk Evaluation Immediate Planning Horizon - Thirroul/McCauleys</b></p>	<p>Drawing: <b>D-5</b></p>	<p>Rev: <b>A</b></p>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_195\_110419 Drawing D-5.WOR





**KEY PLAN**



**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

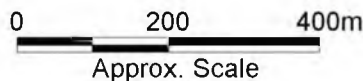


Title:  
**Coastal Inundation Risk Evaluation  
 Immediate Planning Horizon - Sandon/Bulli**

Drawing:  
**D-6**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_196\_110419 Drawing D-6.WOR

**KEY PLAN**

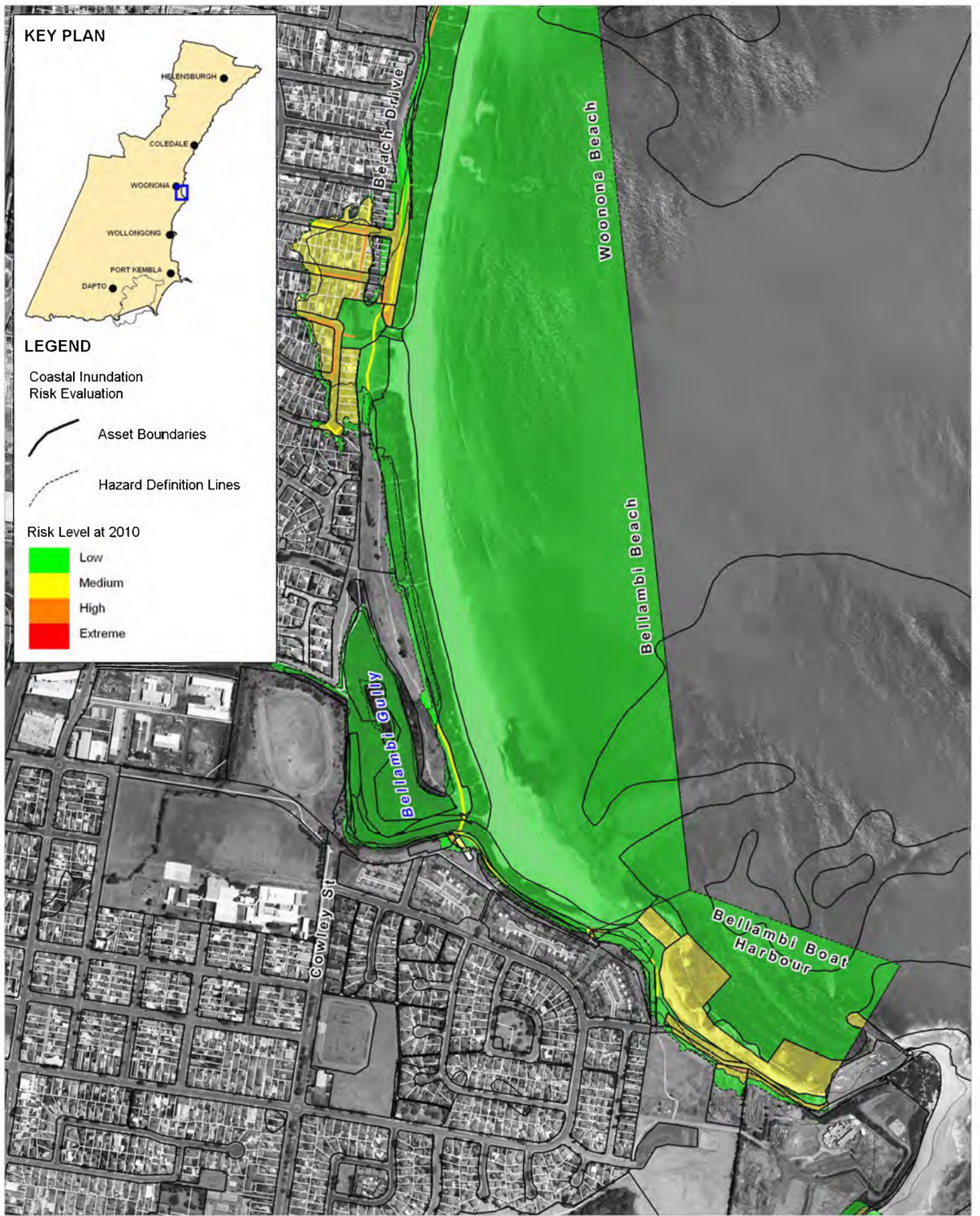


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:  
**Coastal Inundation Risk Evaluation  
 Immediate Planning Horizon - Woonona/Bellambi**

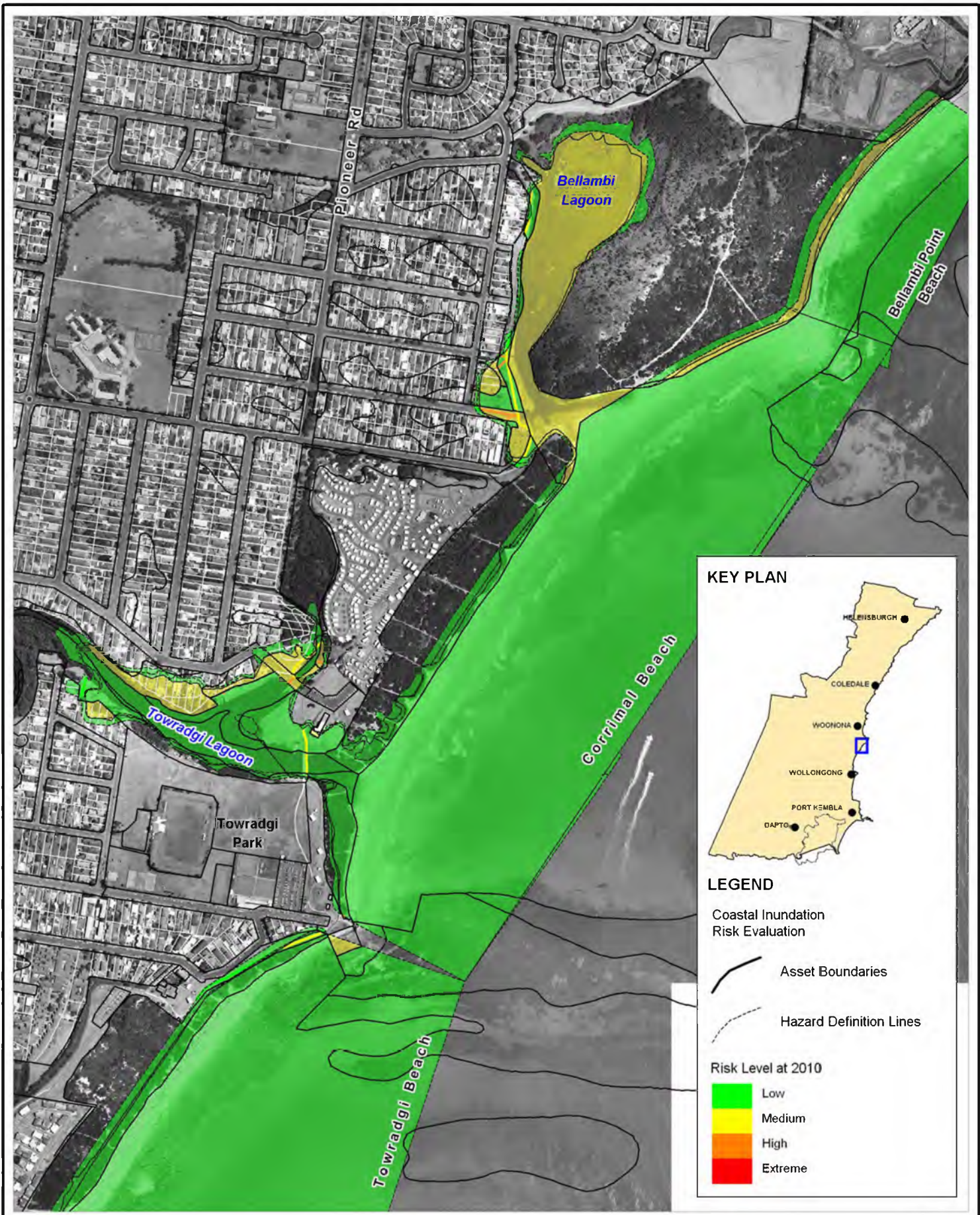
Drawing:  
**D-7**

Rev:  
**A**

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**KEY PLAN**

**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

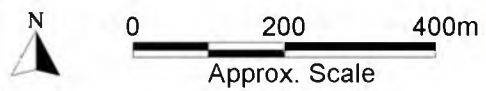
**Risk Level at 2010**

- Low
- Medium
- High
- Extreme

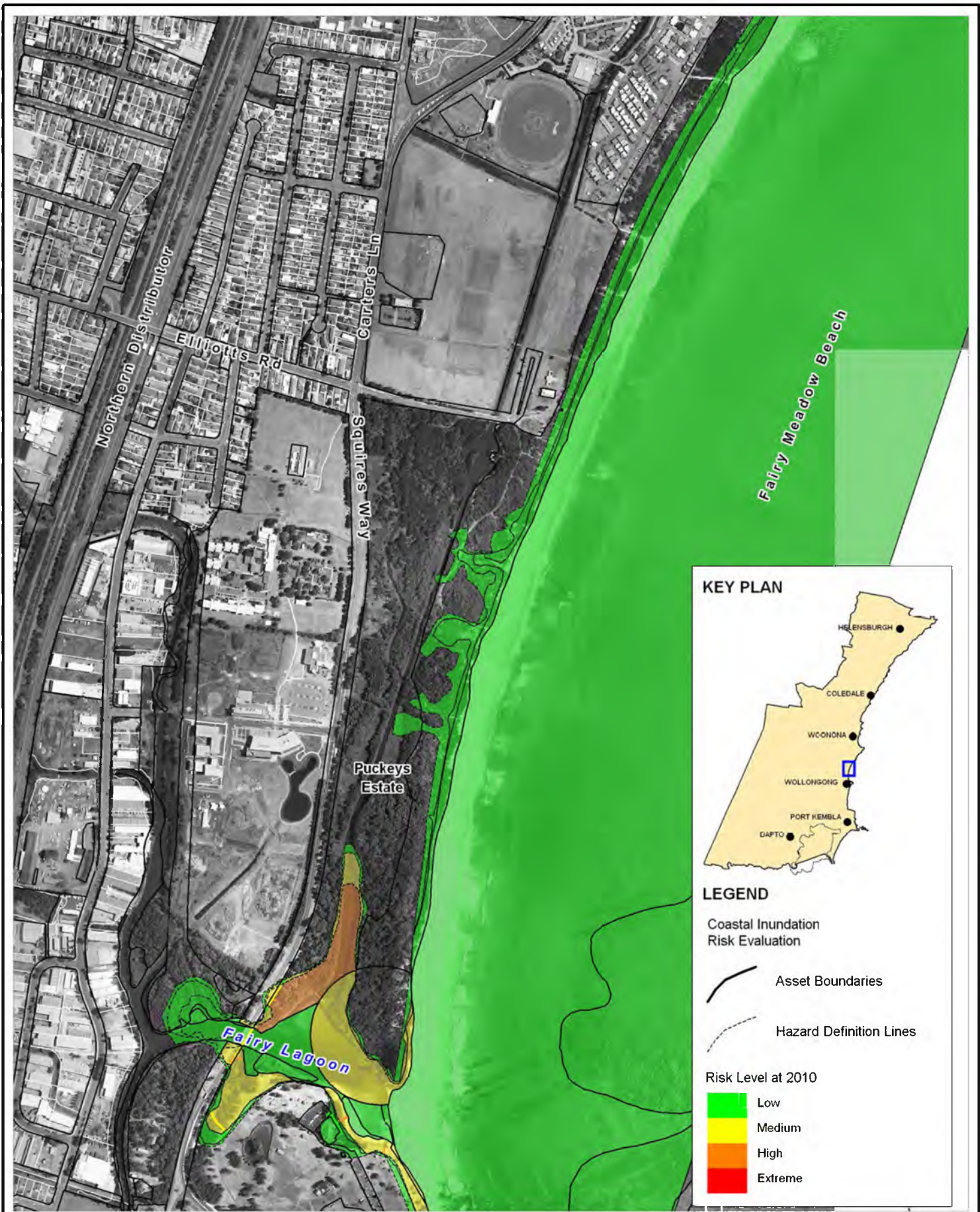
Title:  
**Coastal Inundation Risk Evaluation  
 Immediate Planning Horizon - Corrimal Beach**

Drawing: **D-8**      Rev: **A**

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Title:  
**Coastal Inundation Risk Evaluation  
 2010 Planning Horizon - Fairy Meadow**

Drawing:  
**D-9**

Rev:  
**A**

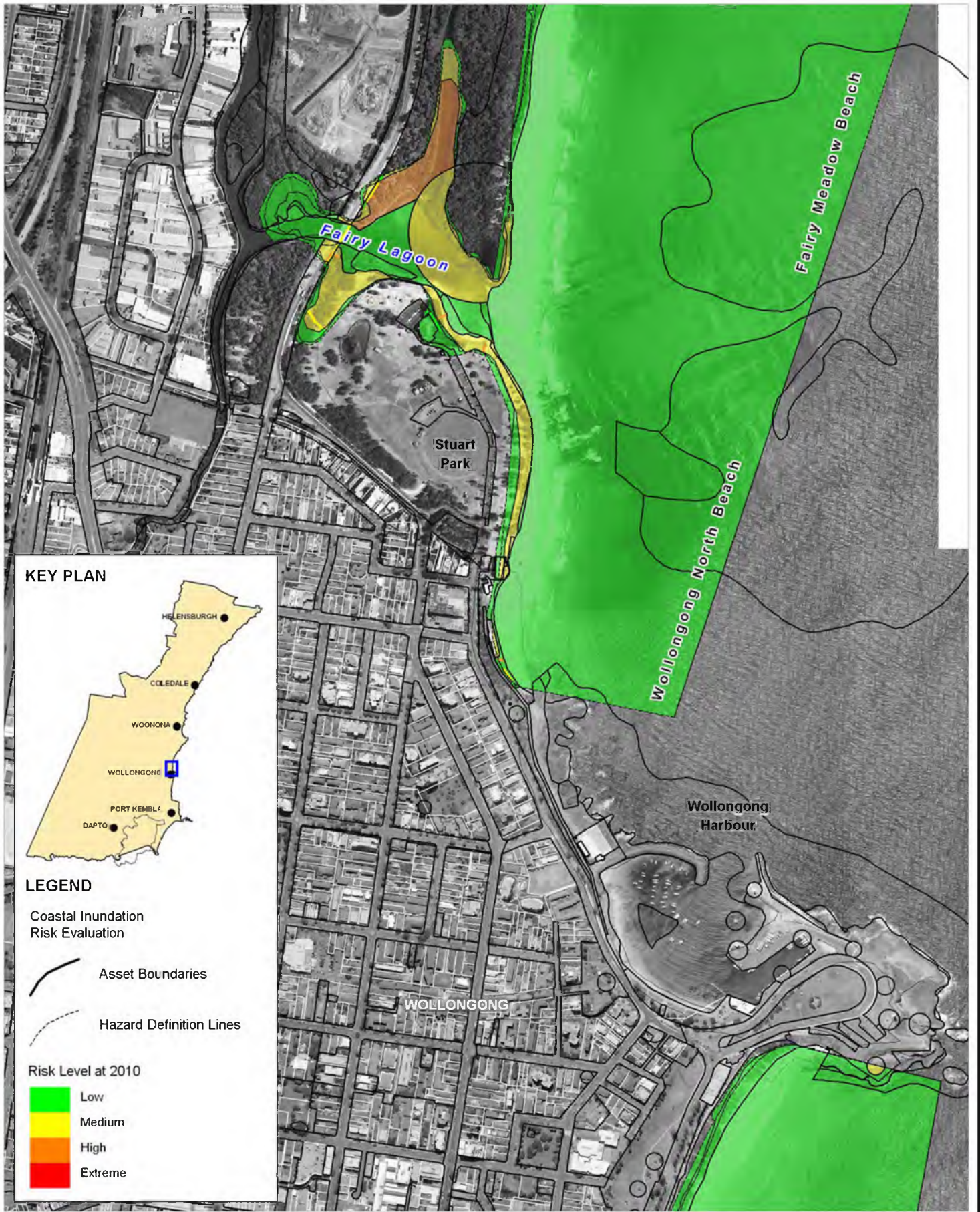
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0      200      400m  
 Approx. Scale



Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_199\_110419 Drawing D-9.WOR

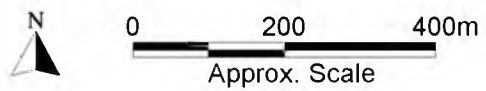


Title:  
**Coastal Inundation Risk Evaluation  
 2010 Planning Horizon - Wollongong**

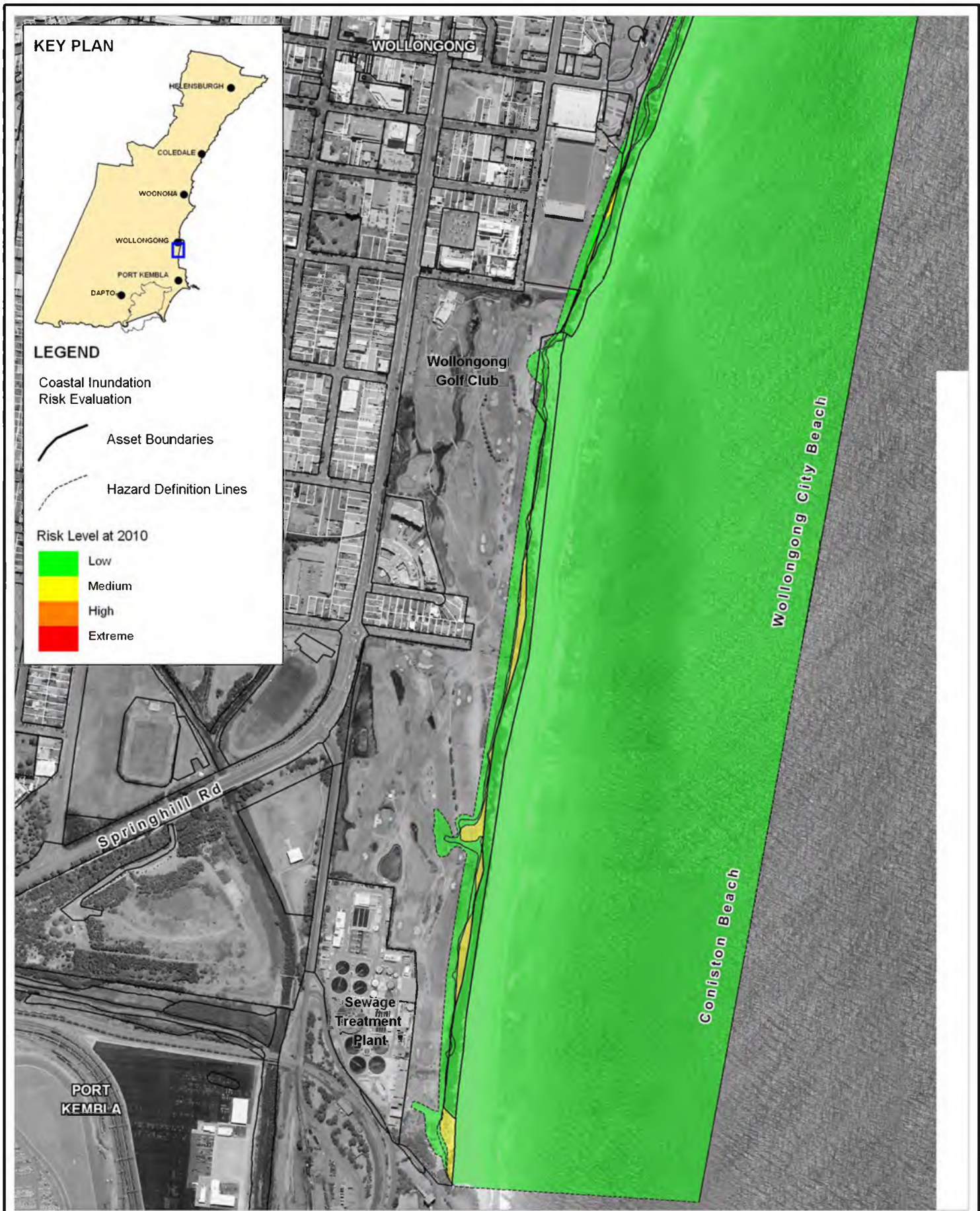
Drawing:  
**D-10**

Rev:  
**A**

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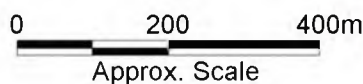


Title:  
**Coastal Inundation Risk Evaluation  
 Immediate Planning Horizon - Wollongong City Beach**

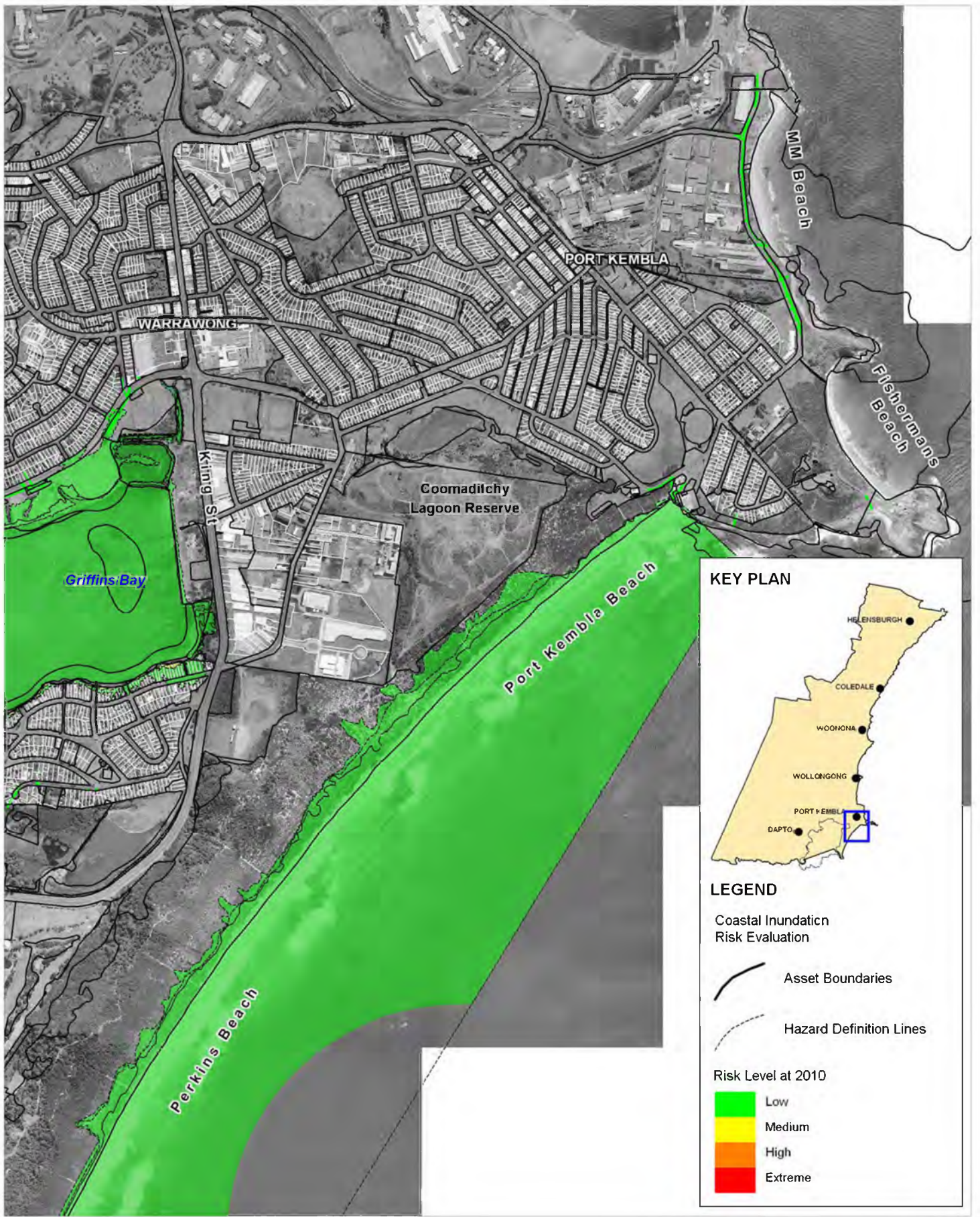
Drawing:  
**D-11**

Rev:  
**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_201\_110419 Drawing D-11.WOR

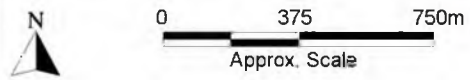


Title:  
**Coastal Inundation Risk Evaluation  
 Immediate Planning Horizon - Port Kembla**

Drawing:  
**D-12**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_202\_110419 Drawing D-12.WOR

**KEY PLAN**

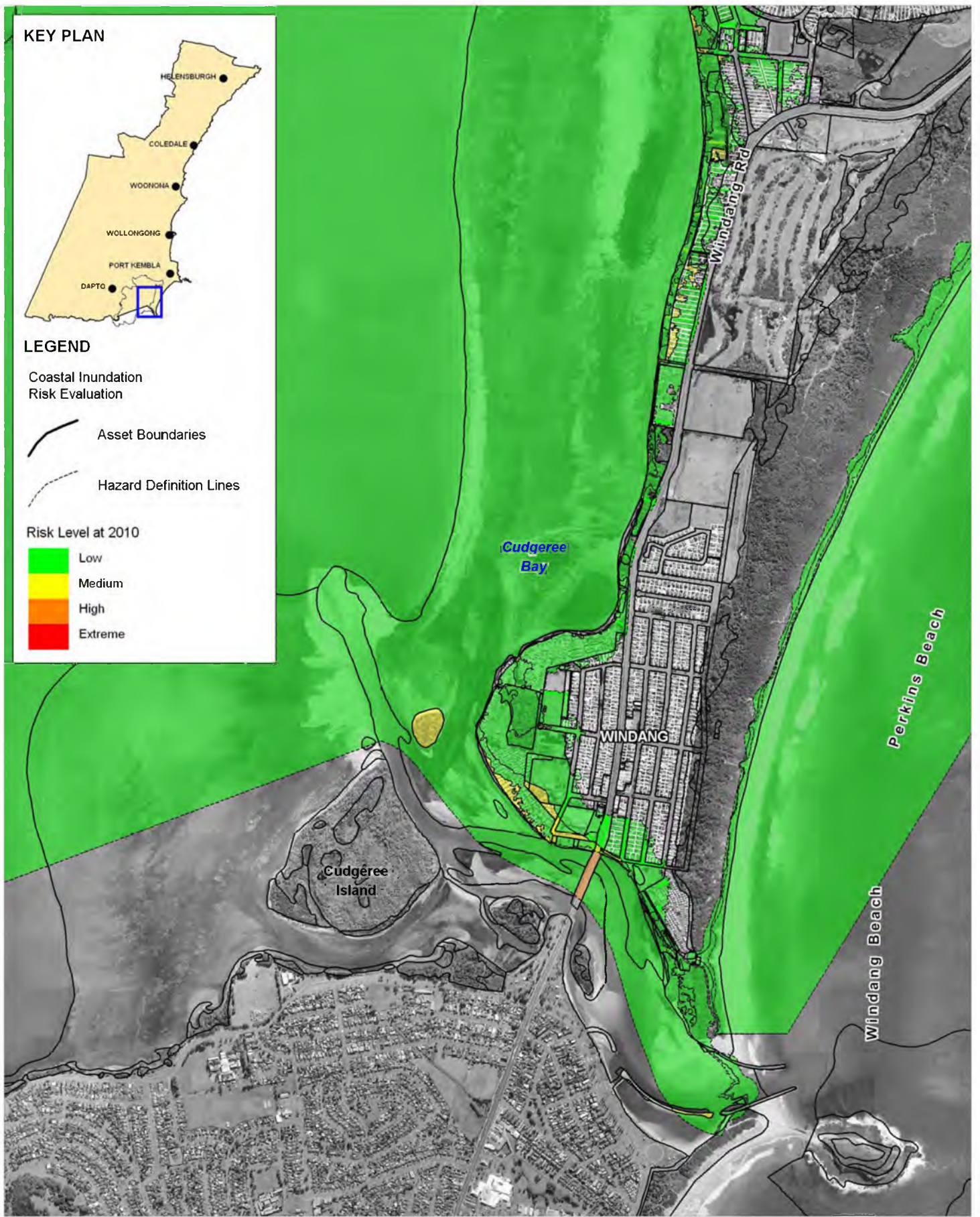


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

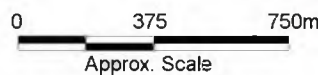


Title:  
**Coastal Inundation Risk Evaluation  
Immediate Planning Horizon - Windang**

Drawing:  
**D-13**

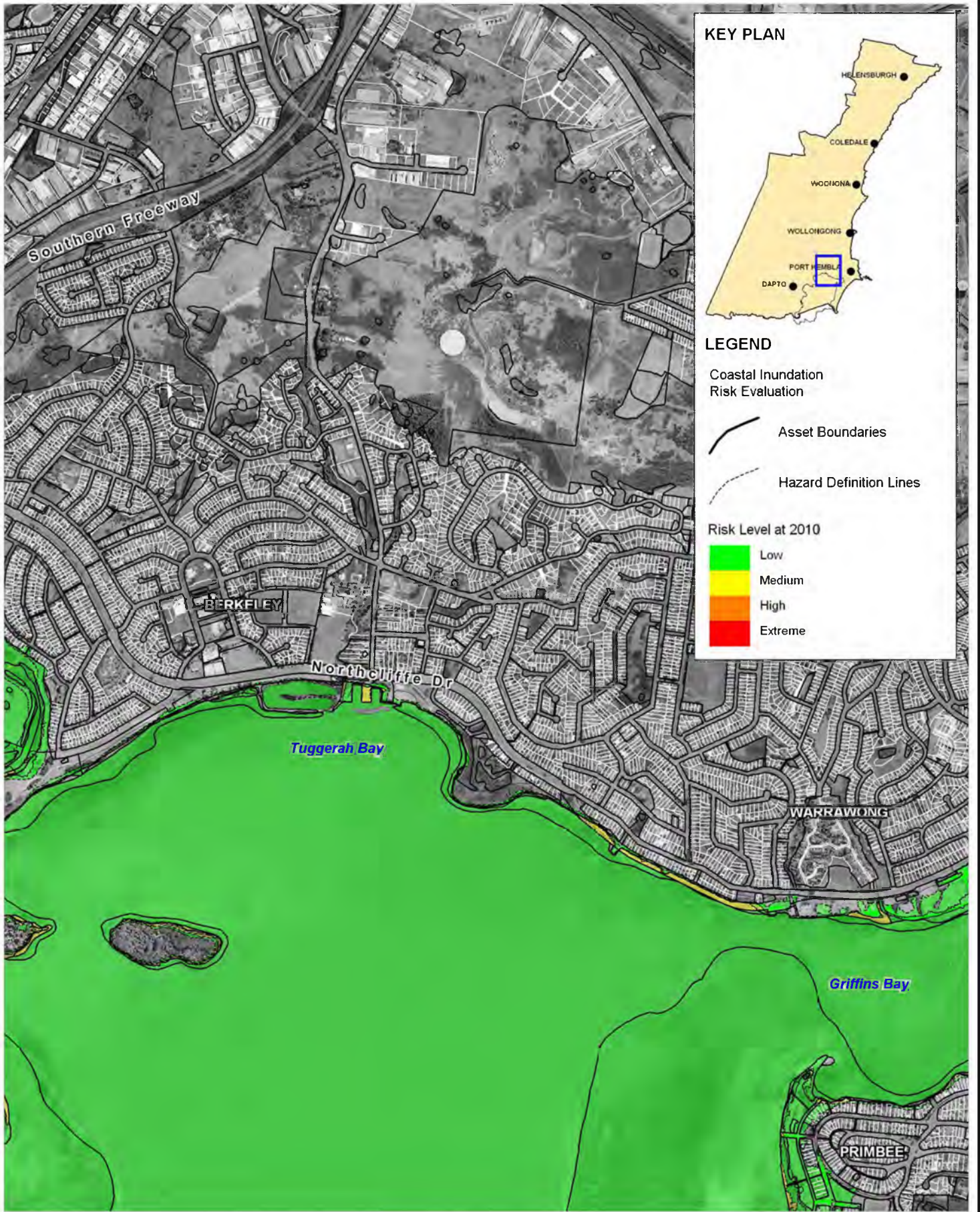
Rev:  
**A**

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**KEY PLAN**



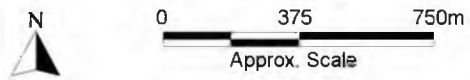
**LEGEND**

- Coastal Inundation Risk Evaluation
- Asset Boundaries
  - Hazard Definition Lines
- Risk Level at 2010
- Low
  - Medium
  - High
  - Extreme

Title:  
**Coastal Inundation Risk Evaluation  
 Immediate Planning Horizon - Berkeley/Warrawong**

Drawing: **D-14**      Rev: **A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_204\_110420 Drawing D-14.WOR

**KEY PLAN**

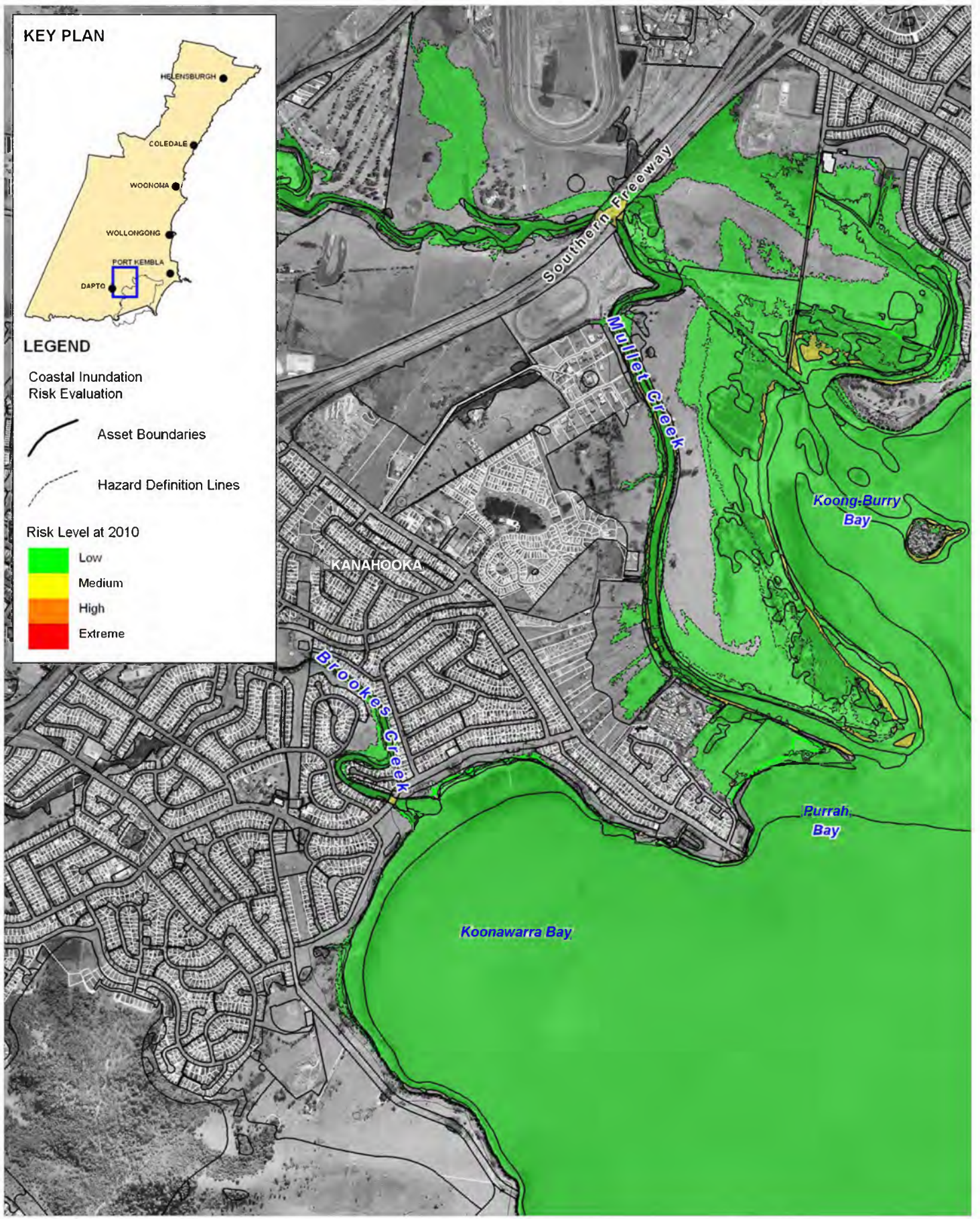


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

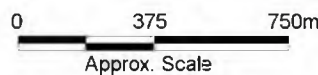


Title:  
**Coastal Inundation Risk Evaluation  
 Immediate Planning Horizon - Kanahooka**

Drawing:  
**D-15**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_205\_110420 Drawing D-15.WOR

**KEY PLAN**

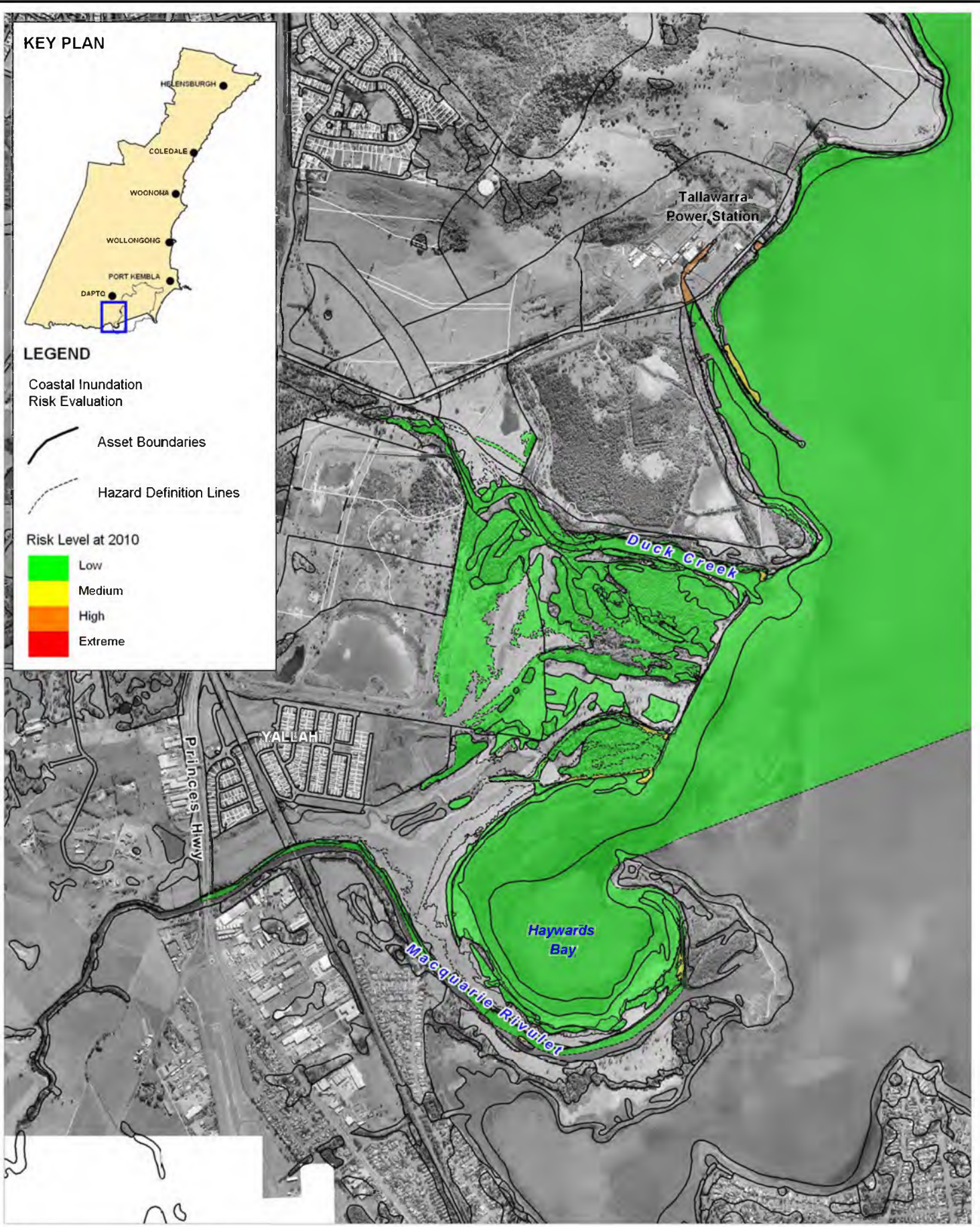


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

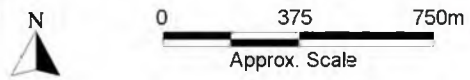
Risk Level at 2010



Title:  
**Coastal Inundation Risk Evaluation  
 immediate Planning Horizon - Tellawarra**

Drawing: <b>D-16</b>	Rev: <b>A</b>
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**KEY PLAN**

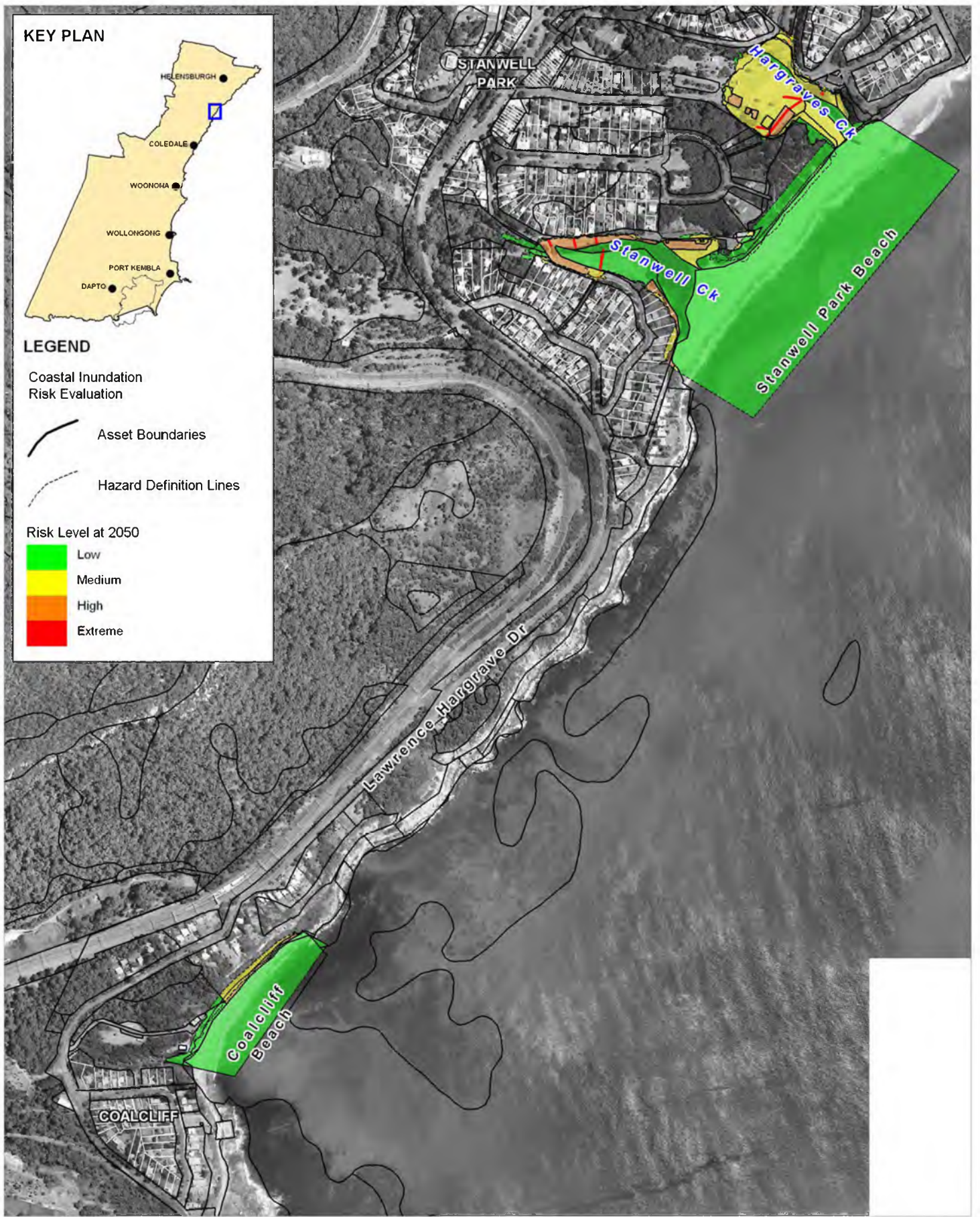


**LEGEND**

Coastal Inundation Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2050

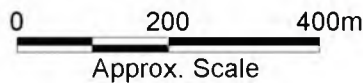


Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Stanwell Park / Coalcliff**

Drawing:  
**E-1**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_207\_110419 Drawing E-1.WOR

**KEY PLAN**

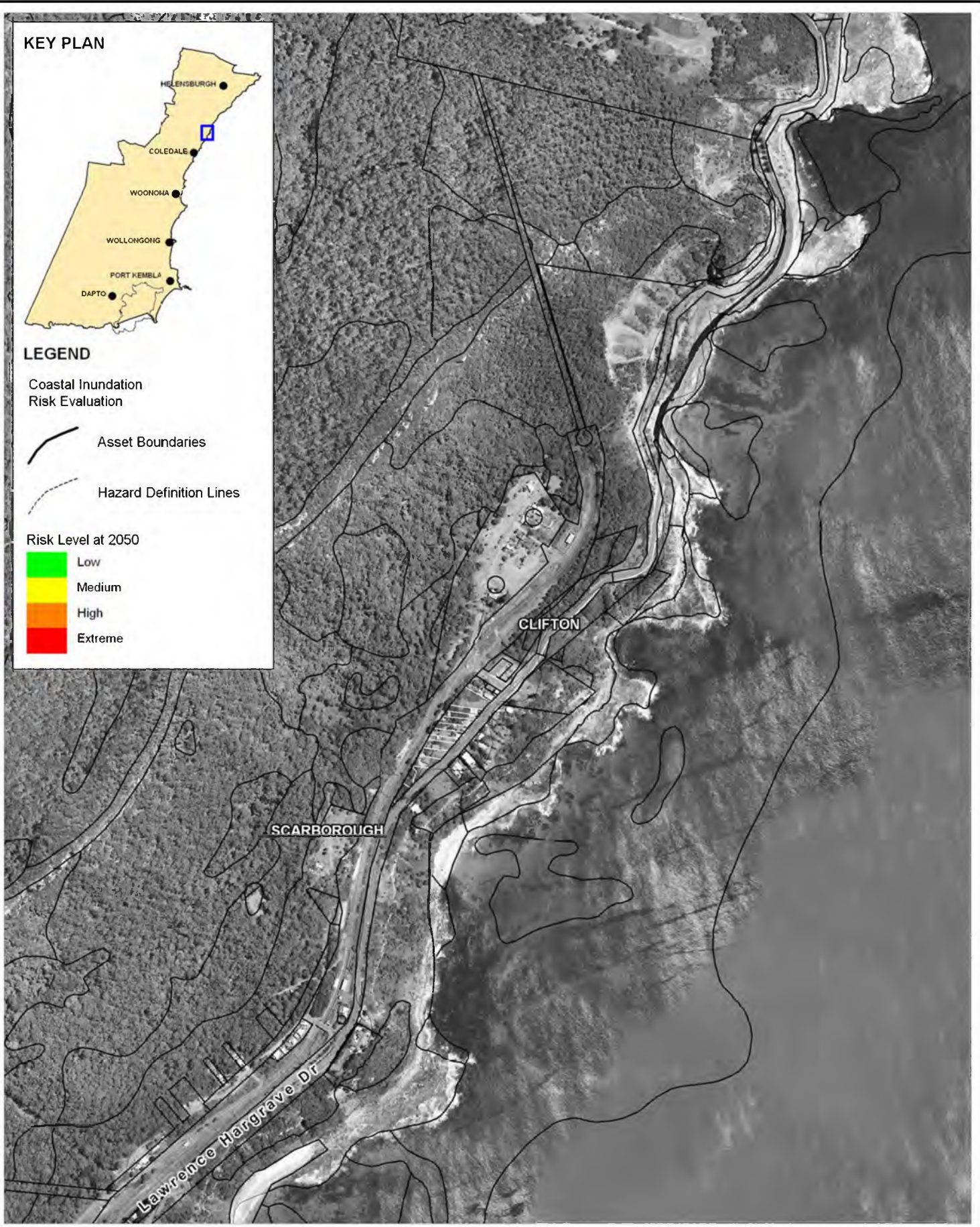


**LEGEND**

Coastal Inundation Risk Evaluation

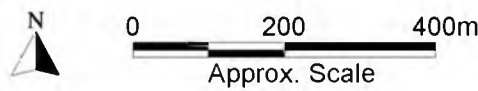
- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050



<p>Title: <b>Coastal Inundation Risk Evaluation 2050 Planning Horizon - Clifton / Scarborough</b></p>	<p>Drawing: <b>E-2</b></p>	<p>Rev: <b>A</b></p>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_208\_110419 Drawing E-2.WOR

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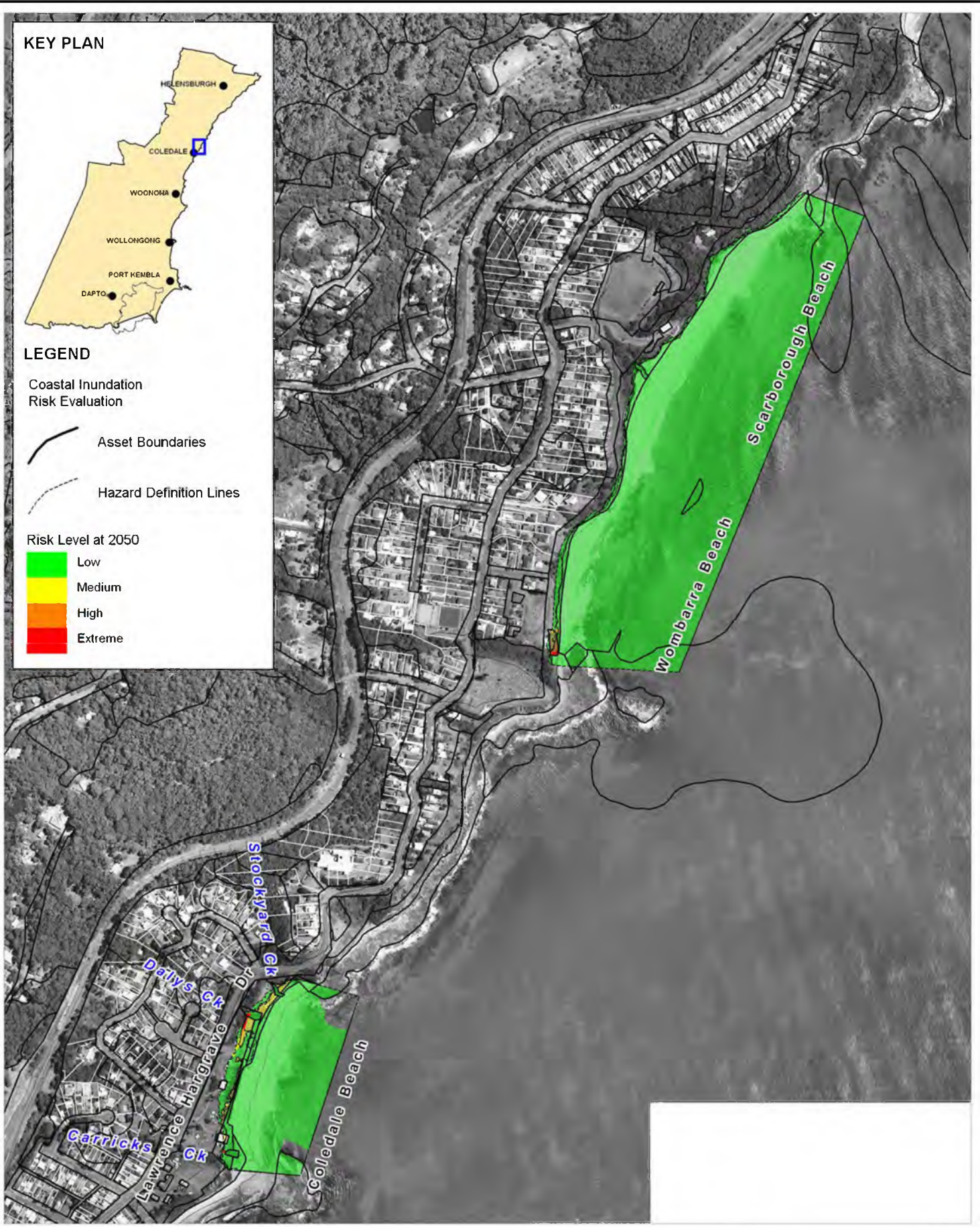


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050



Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Scarborough/Coledale**

Drawing:  
**E-3**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_209\_110419 Drawing E-3.WOR

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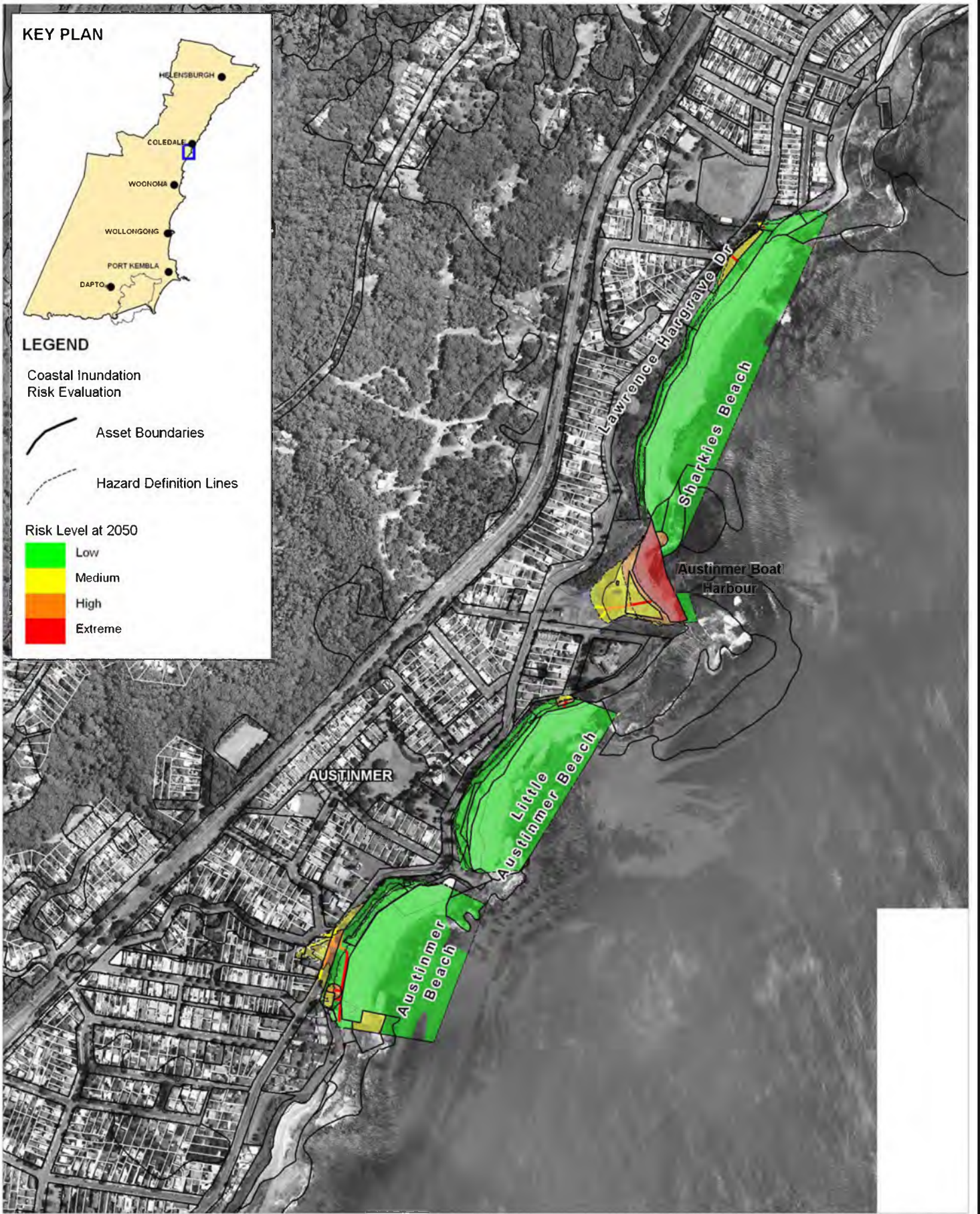


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050

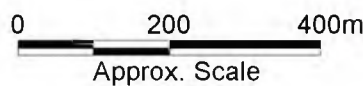


Title:  
**Coastal Inundation Risk Evaluation  
2050 Planning Horizon - Austinmer**

Drawing:  
**E-4**

Rev:  
**A**

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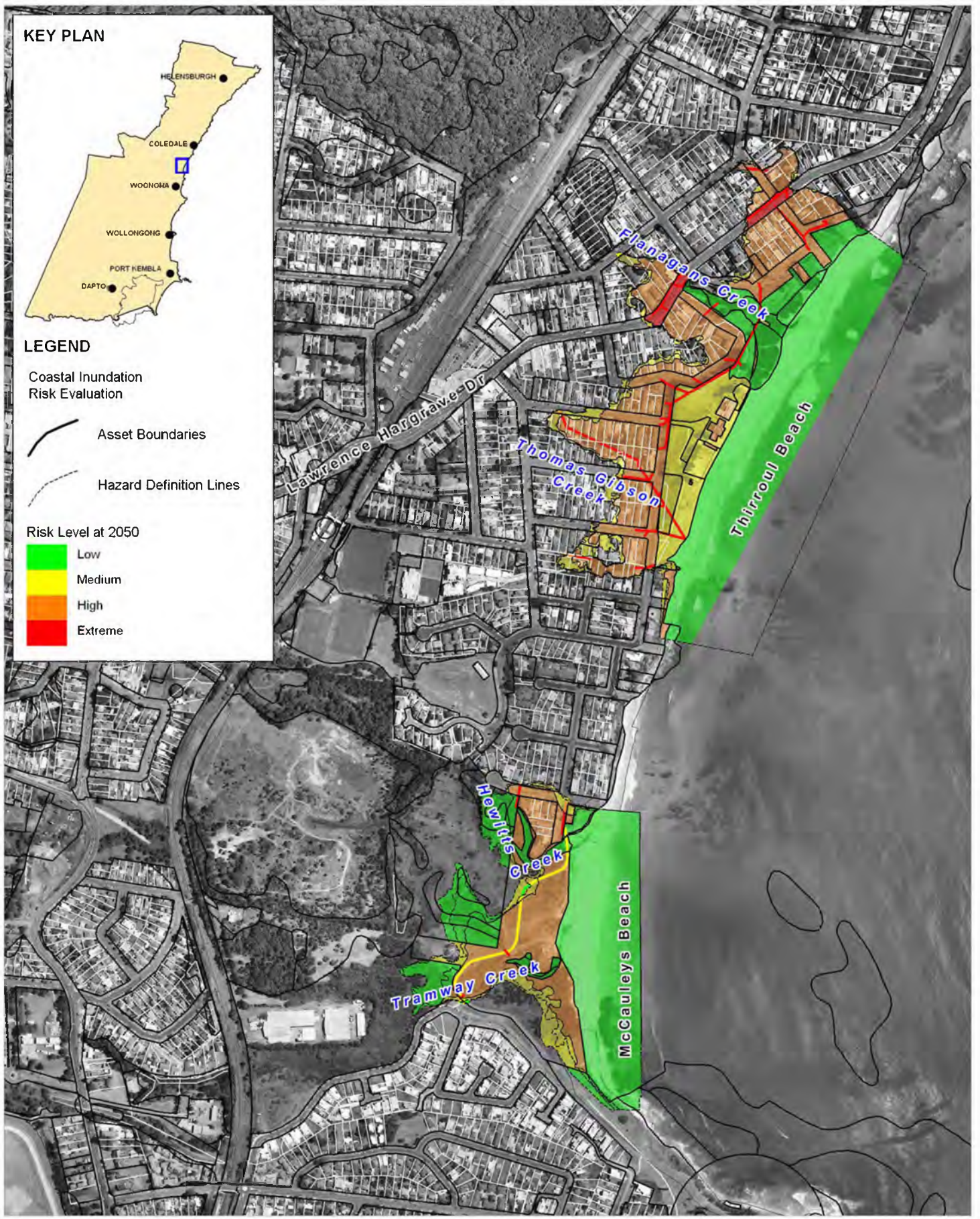


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050

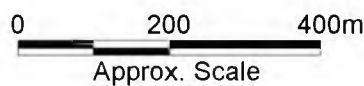


Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Thirroul/McCauleys**

Drawing:  
**E-5**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_211\_110419 Drawing E-5.WOR



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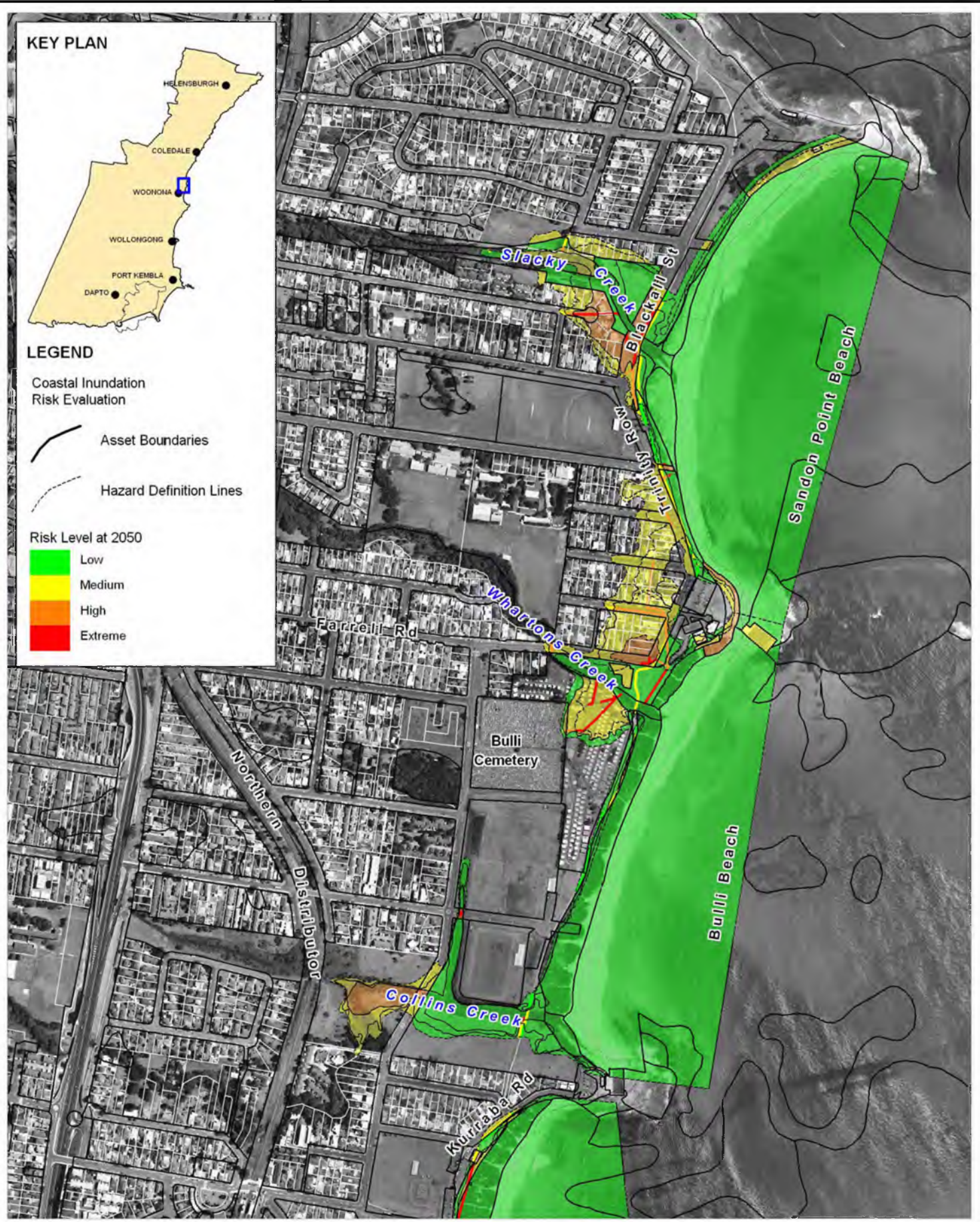


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2050

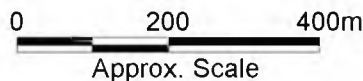


Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Sandon/Bulli**

Drawing:  
**E-6**

Rev:  
**A**

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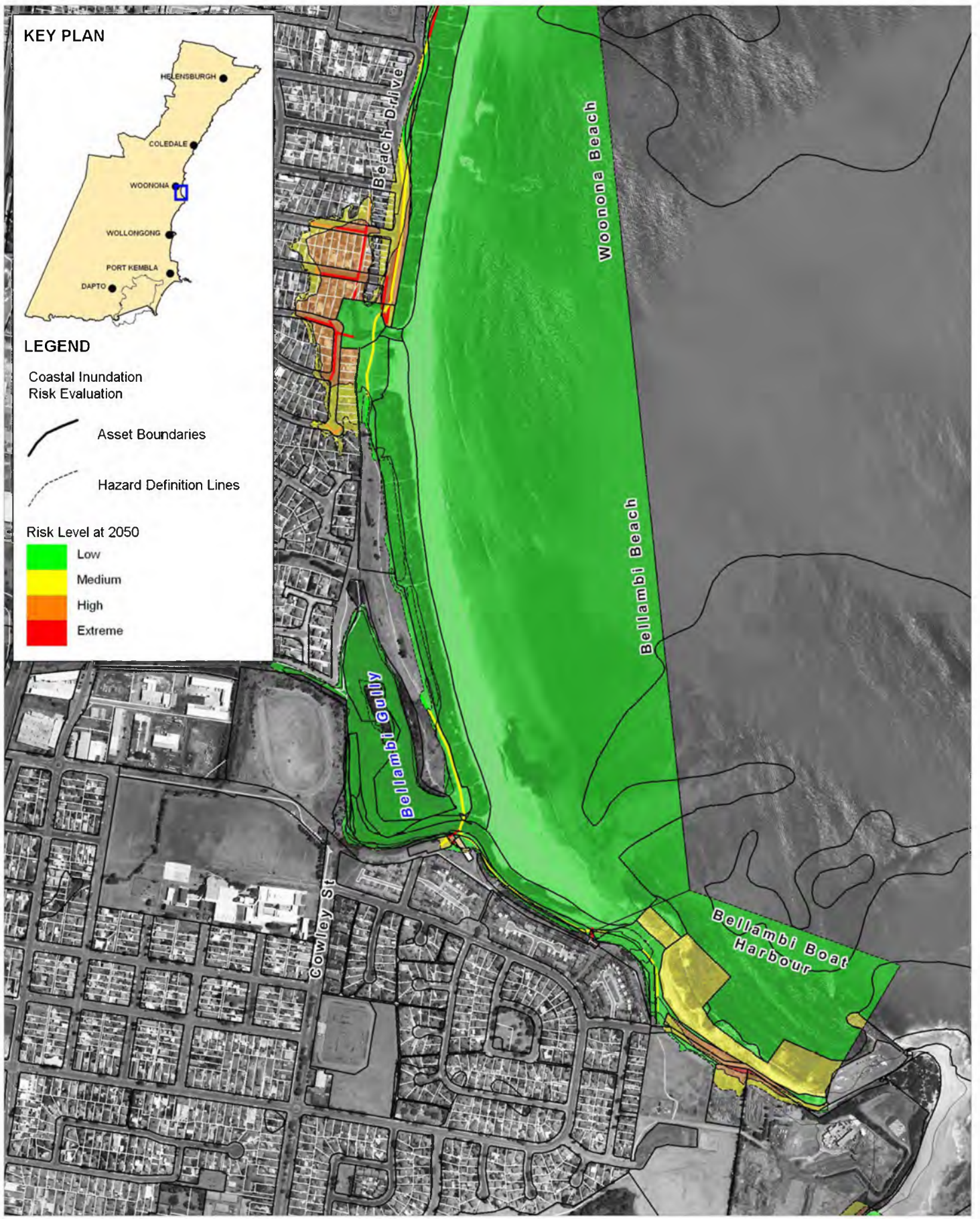


**LEGEND**

Coastal Inundation Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

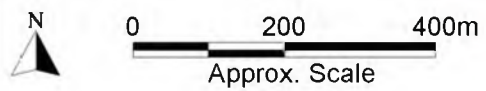
Risk Level at 2050



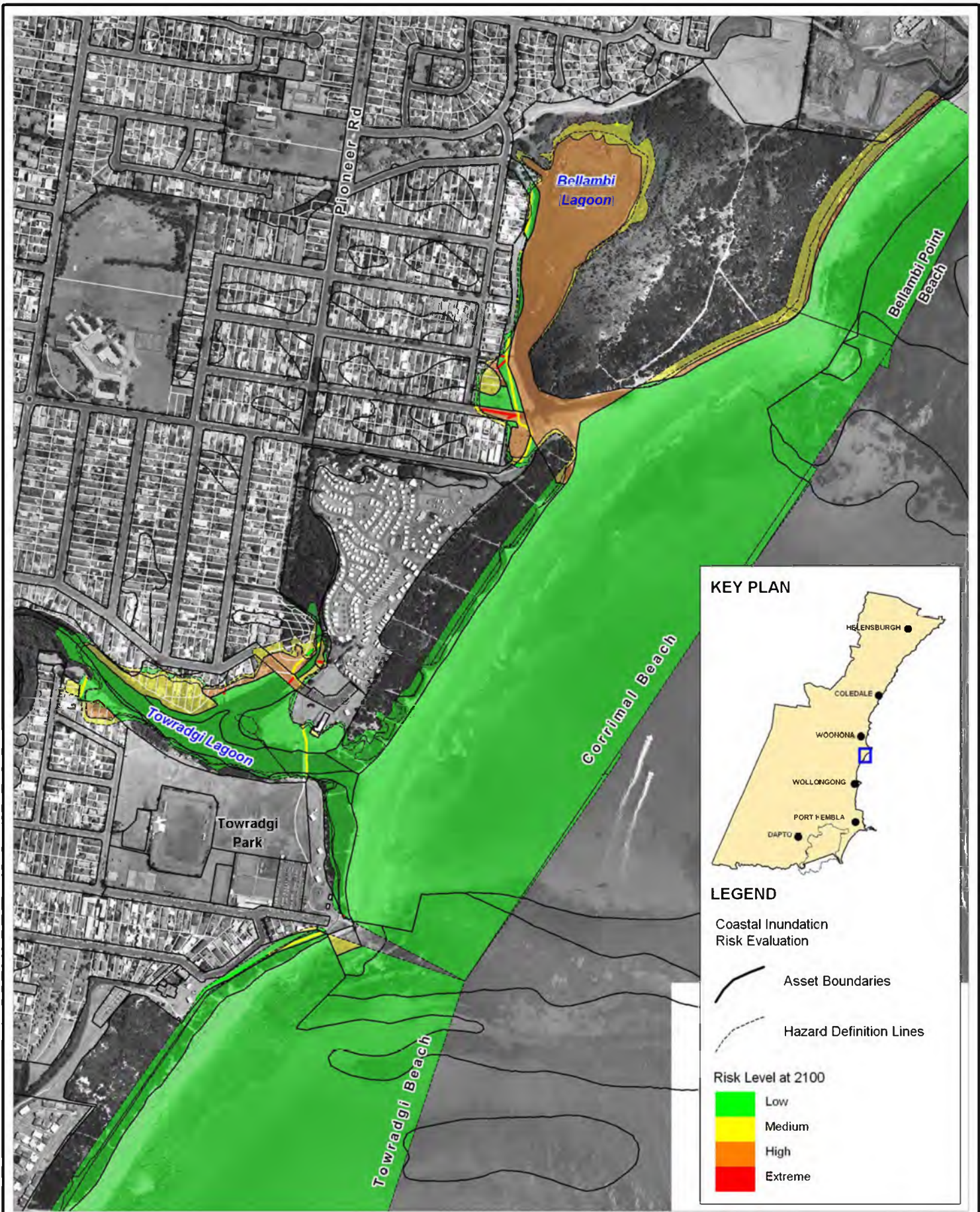
Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Woonona/Bellambi**

Drawing: <b>E-7</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_213\_110419 Drawing E-7.WOR



Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Corrimal Beach**

Drawing:  
**E-8**

Rev:  
**A**

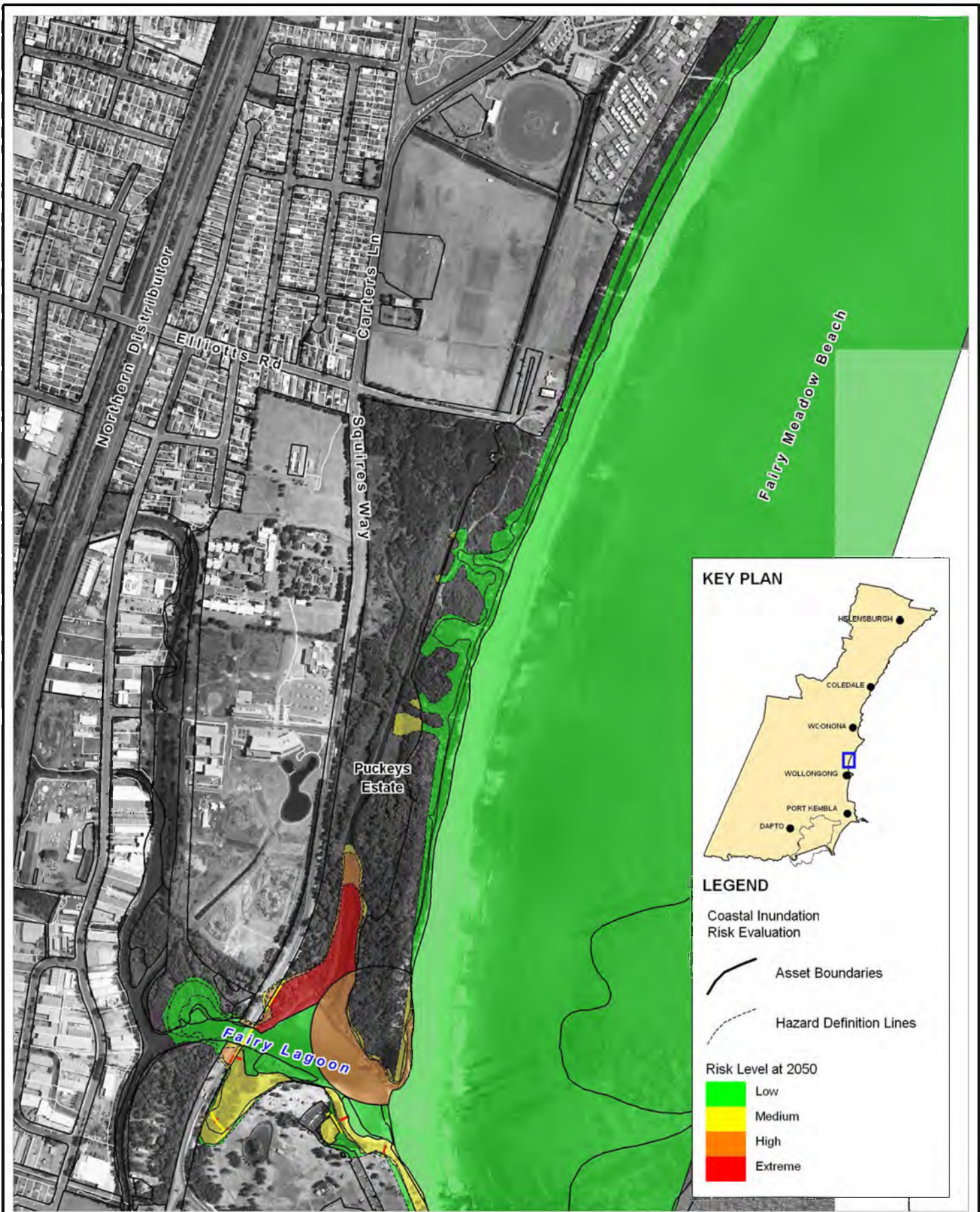
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 Approx. Scale



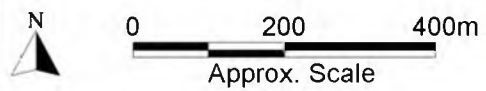
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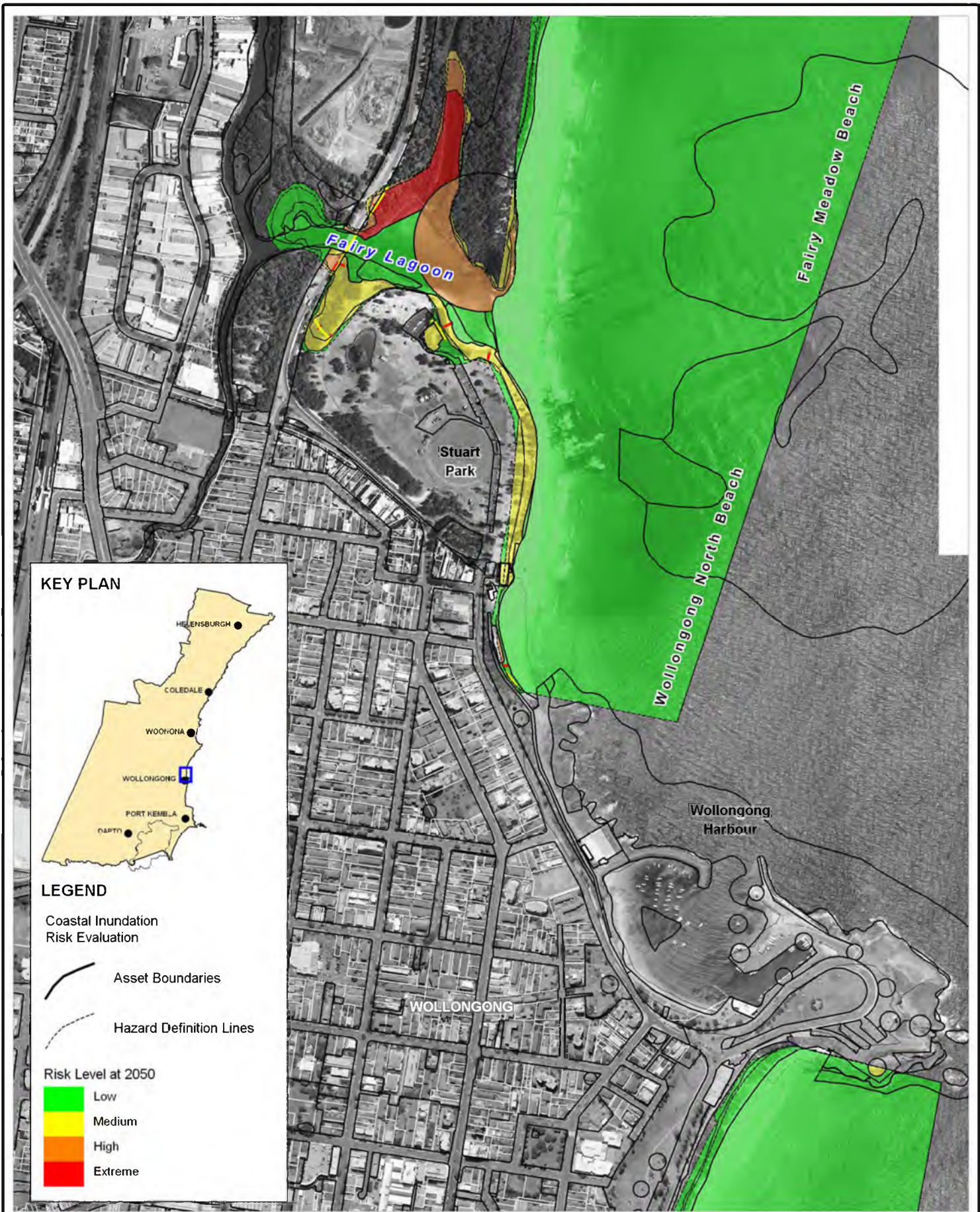
Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Fairy Meadow**

Drawing: **E-9**      Rev: **A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_215\_110419 Drawing E-9.WOR



Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Wollongong**

Drawing:  
**E-10**

Rev:  
**A**

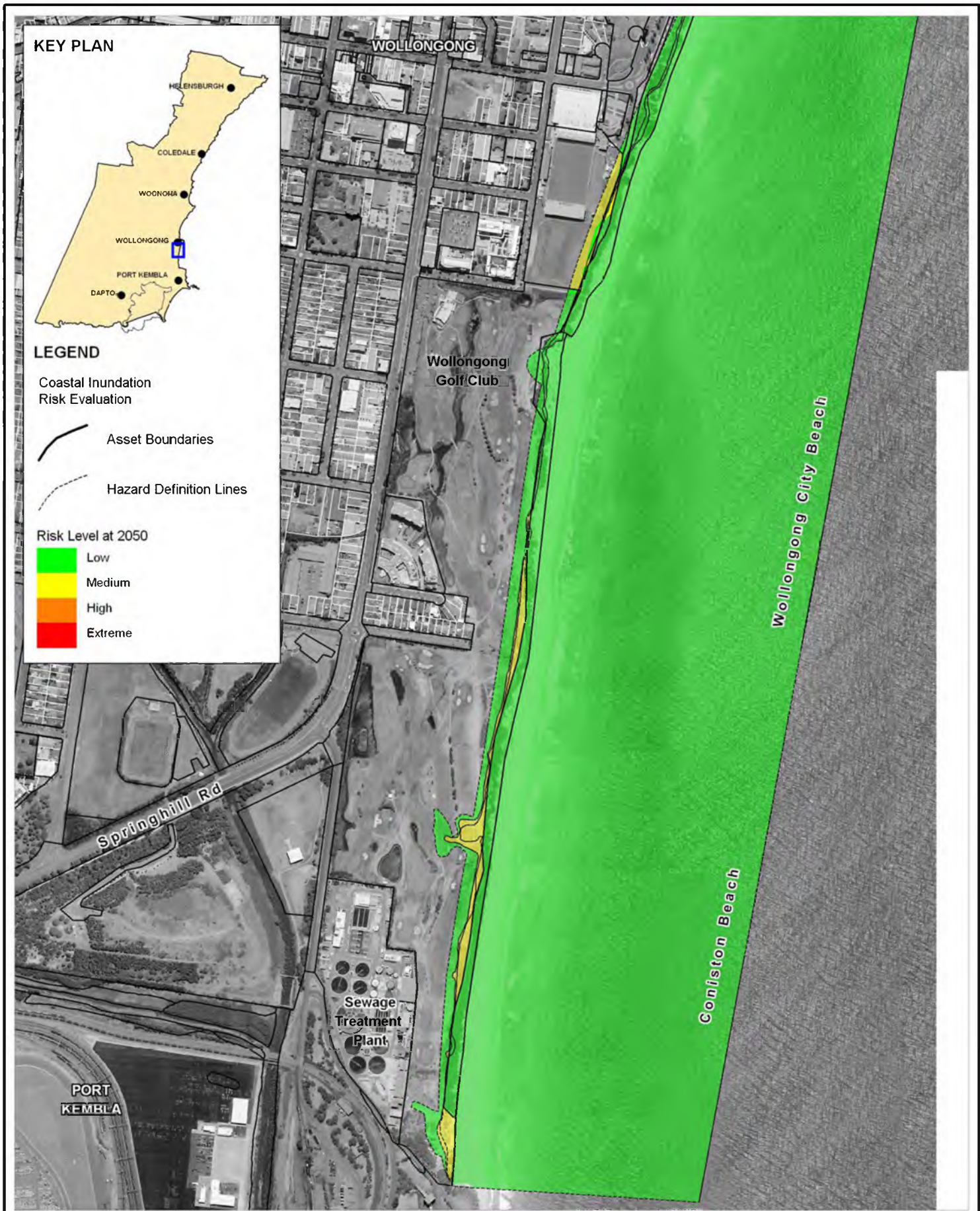
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Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Wollongong City Beach**

Drawing:  
**E-11**

Rev:  
**A**

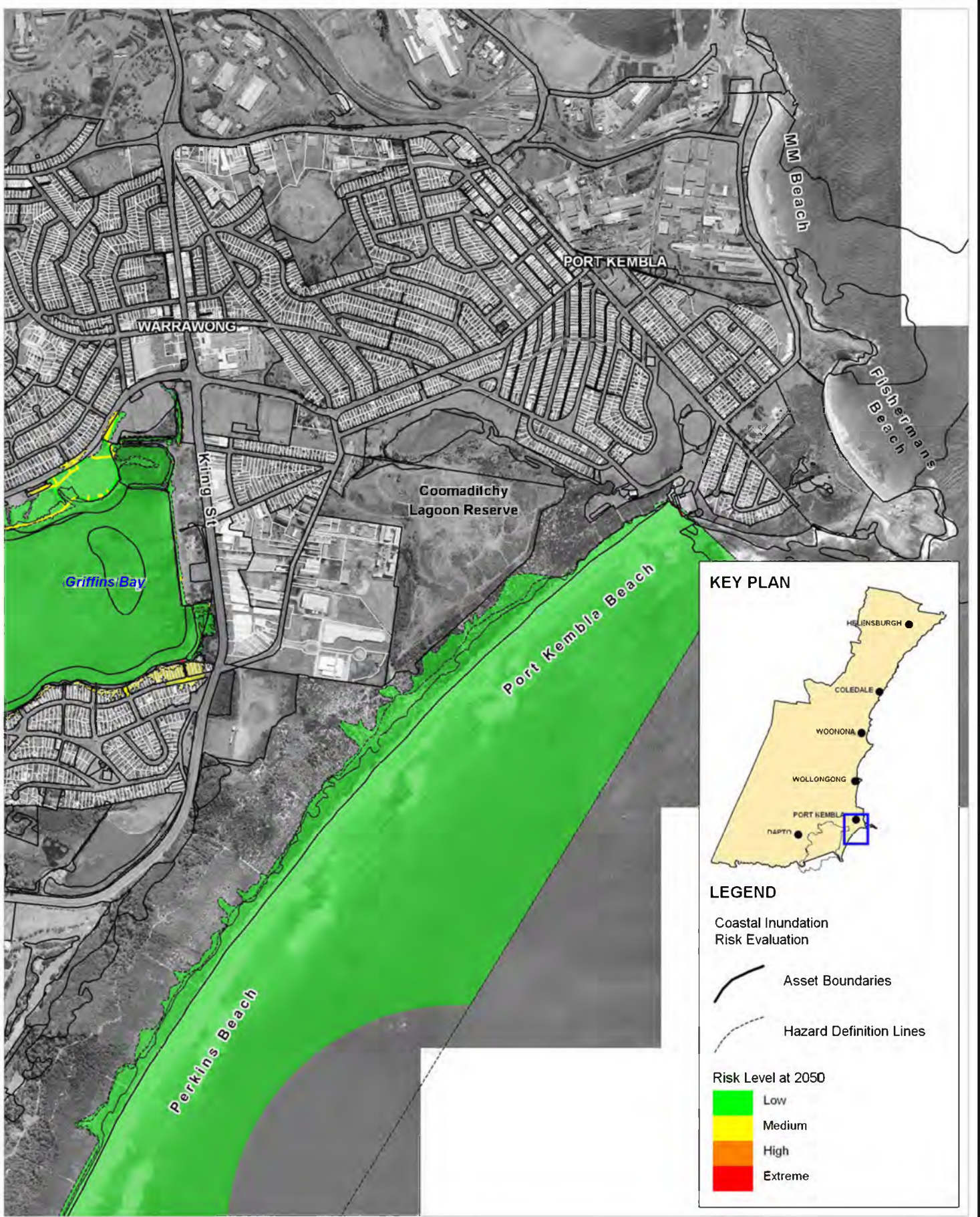
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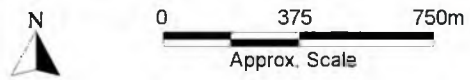


Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Port Kembla**

Drawing:  
**E-12**

Rev:  
**A**

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**KEY PLAN**

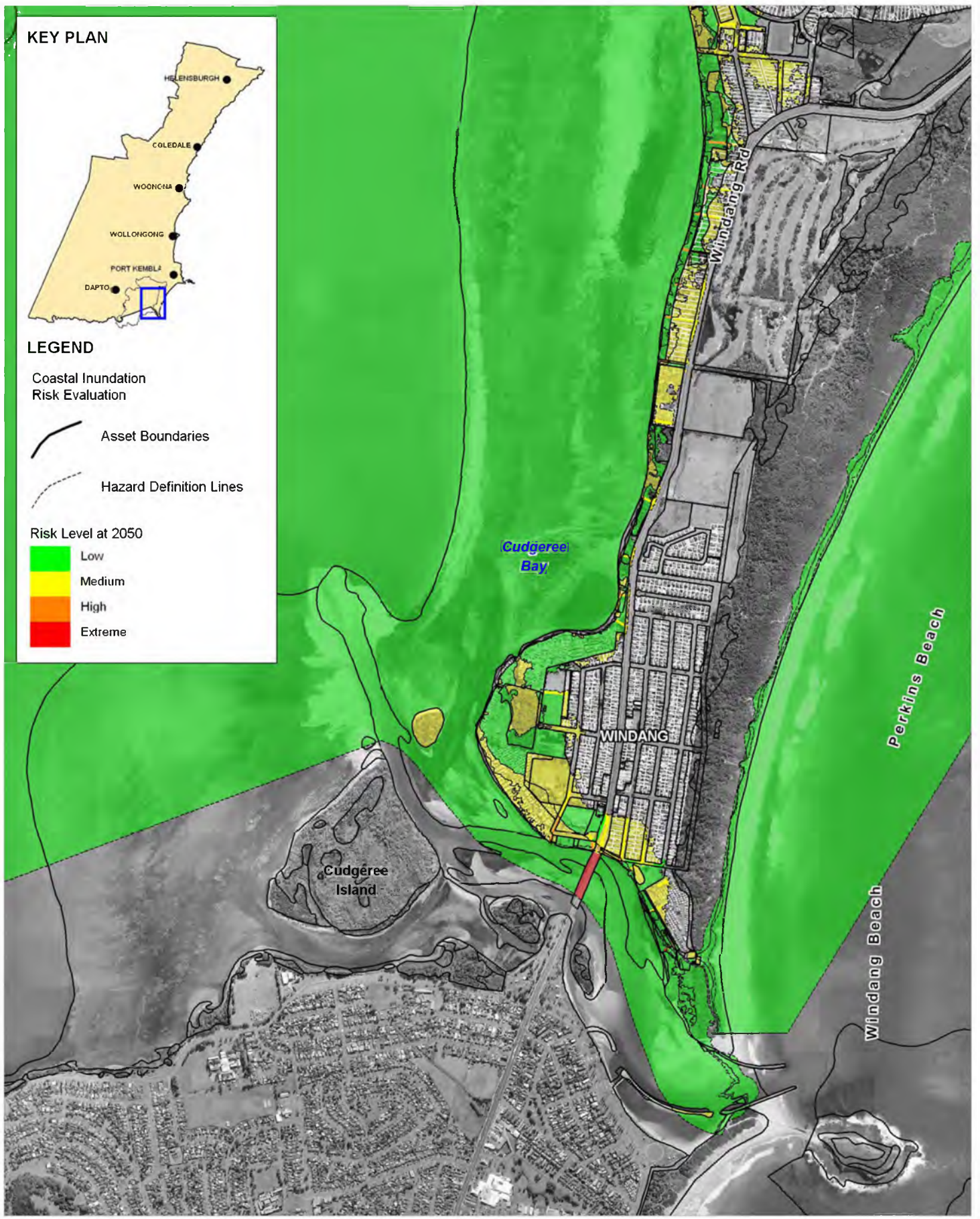


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

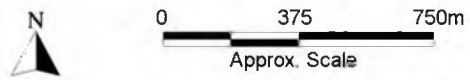
Risk Level at 2050



Title:  
**Coastal Inundation Risk Evaluation  
2050 Planning Horizon - Windang**

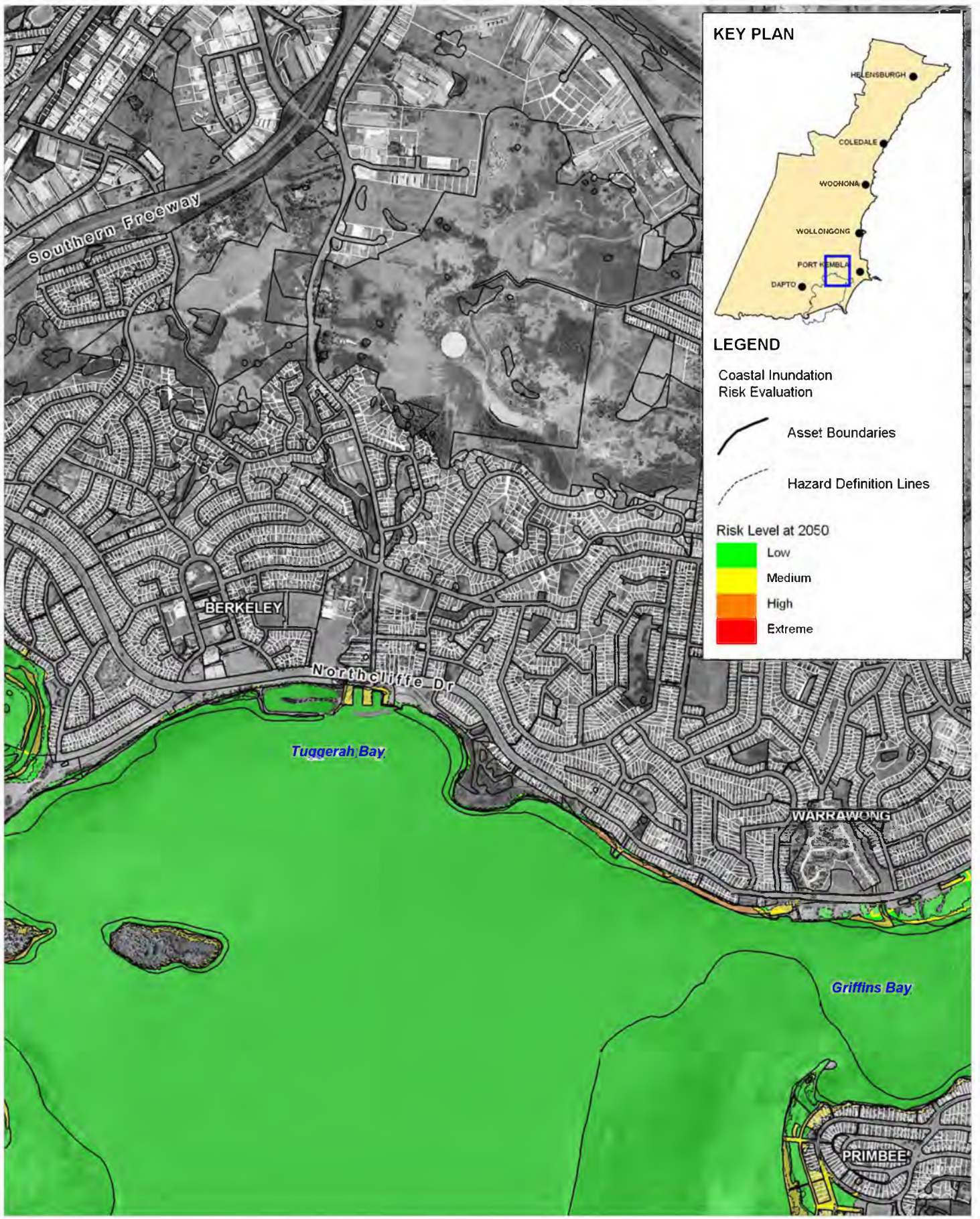
Drawing: <b>E-13</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_219\_110419 Drawing E-13.WOR

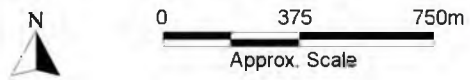




Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Berkeley/Warrawong**

Drawing: <b>E-14</b>	Rev: <b>A</b>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_220\_110419 Drawing E-14.WOR

**KEY PLAN**

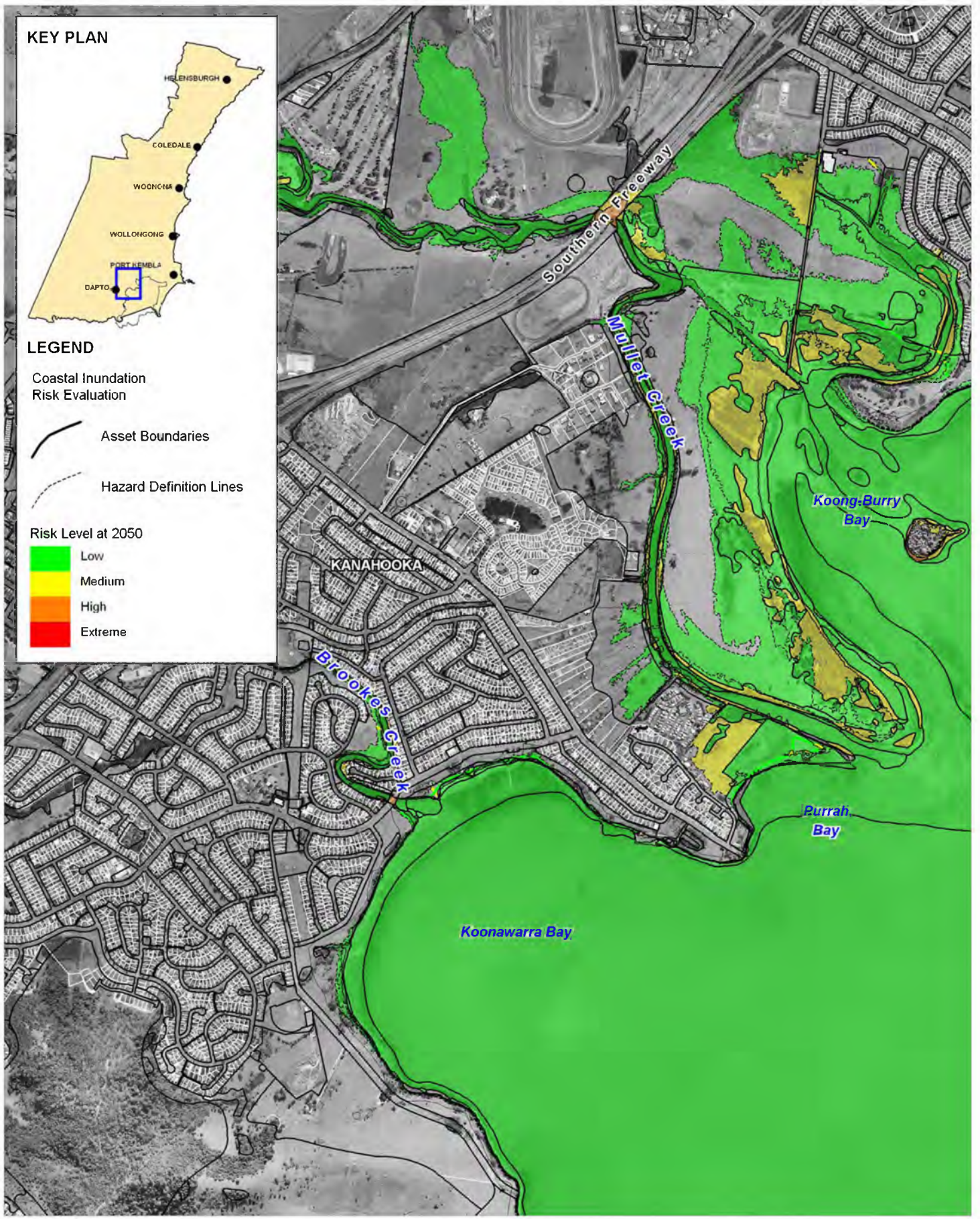


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

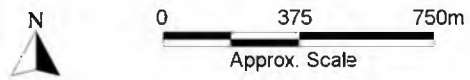
Risk Level at 2050



Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Kanahooka**

Drawing: <b>E-15</b>	Rev: <b>A</b>
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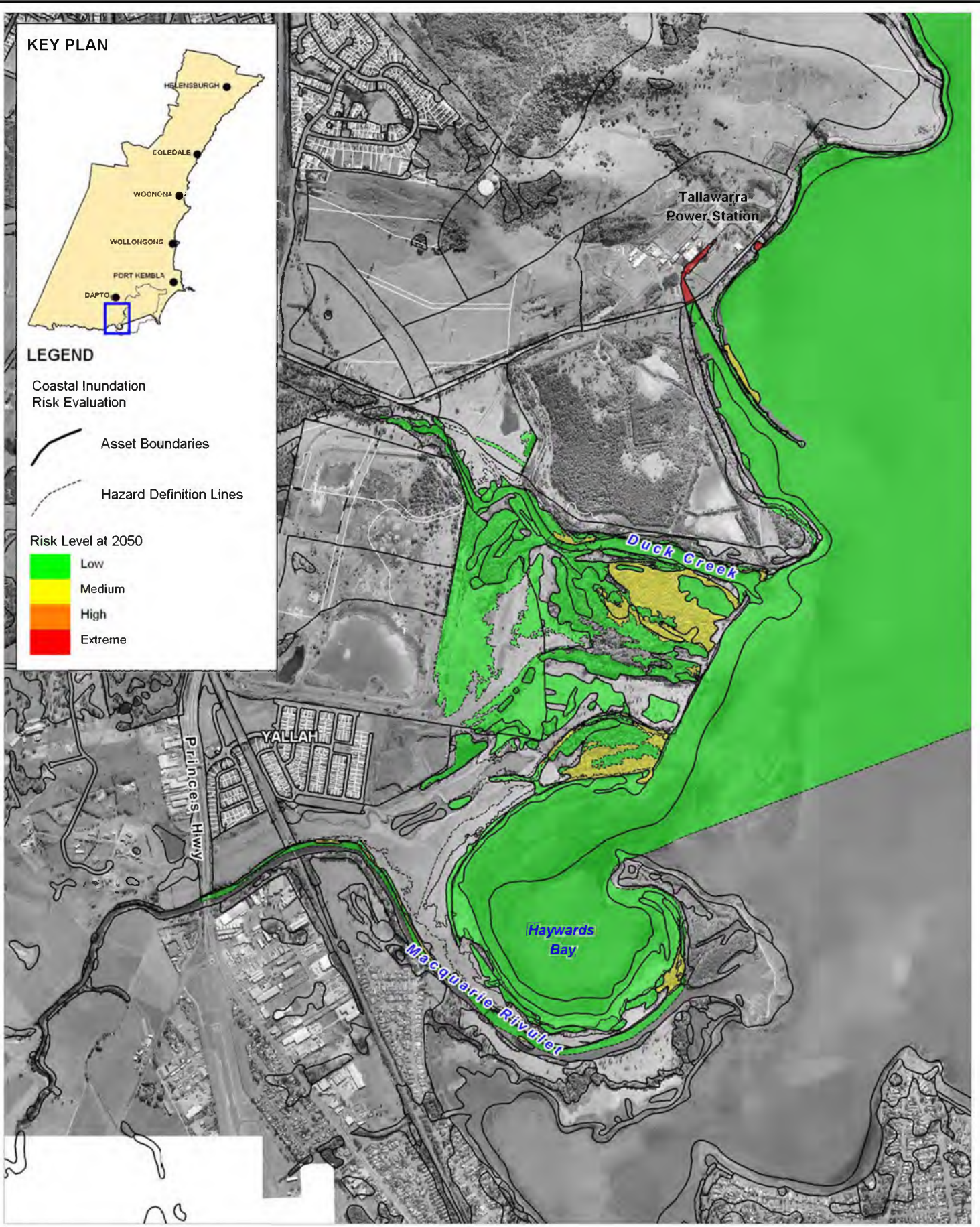


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

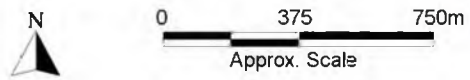
Risk Level at 2050



Title:  
**Coastal Inundation Risk Evaluation  
 2050 Planning Horizon - Tallawarra**

Drawing: <b>E-16</b>	Rev: <b>A</b>
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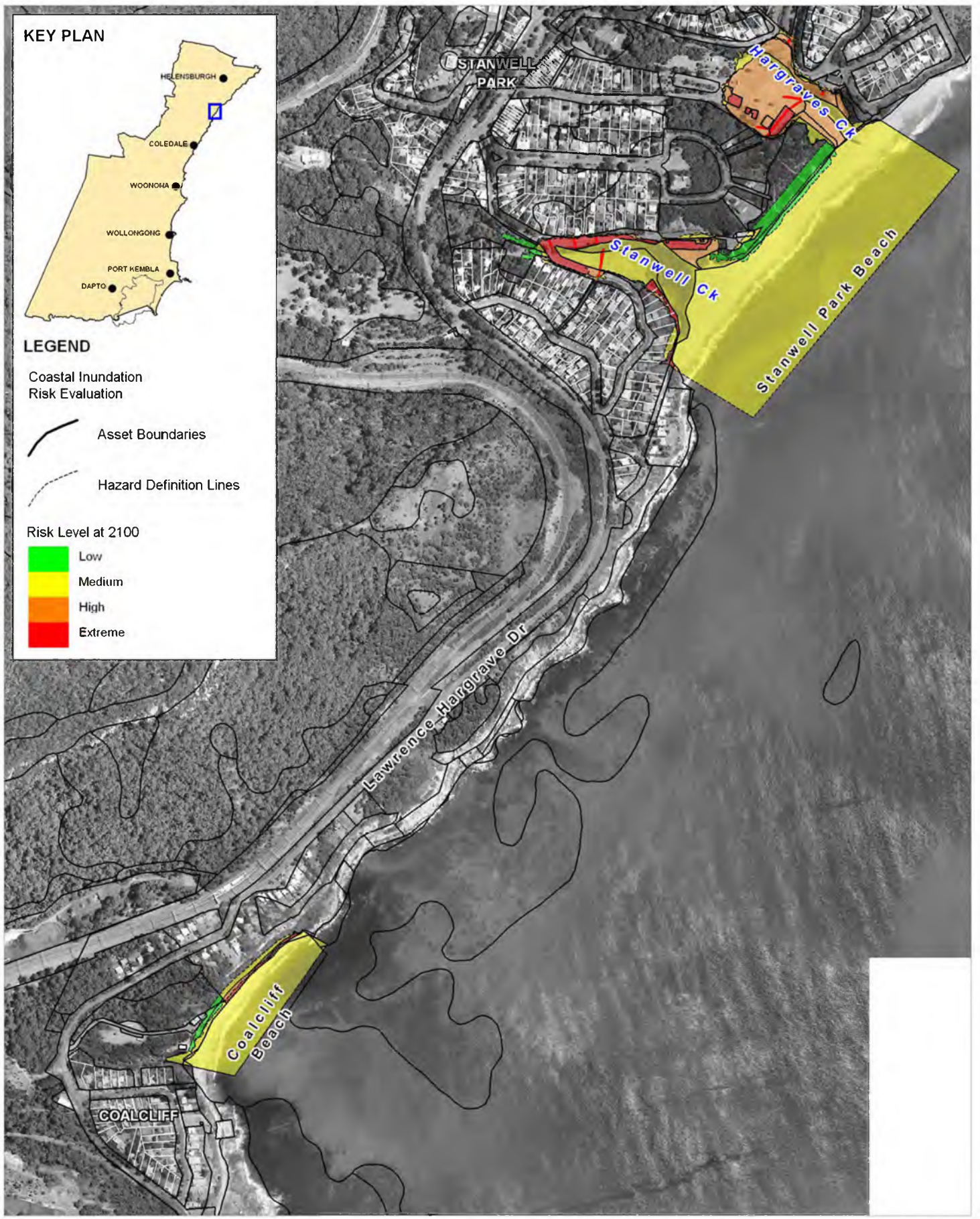


**LEGEND**

Coastal Inundation Risk Evaluation

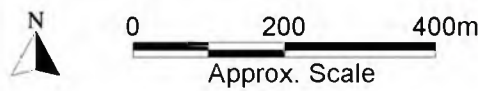
-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100



<p>Title: <b>Coastal Inundation Risk Evaluation 2100 Planning Horizon - Stanwell Park / Coalcliff</b></p>	<p>Drawing: <b>F-1</b></p>	<p>Rev: <b>A</b></p>
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_223\_110419 Drawing F-1.WOR

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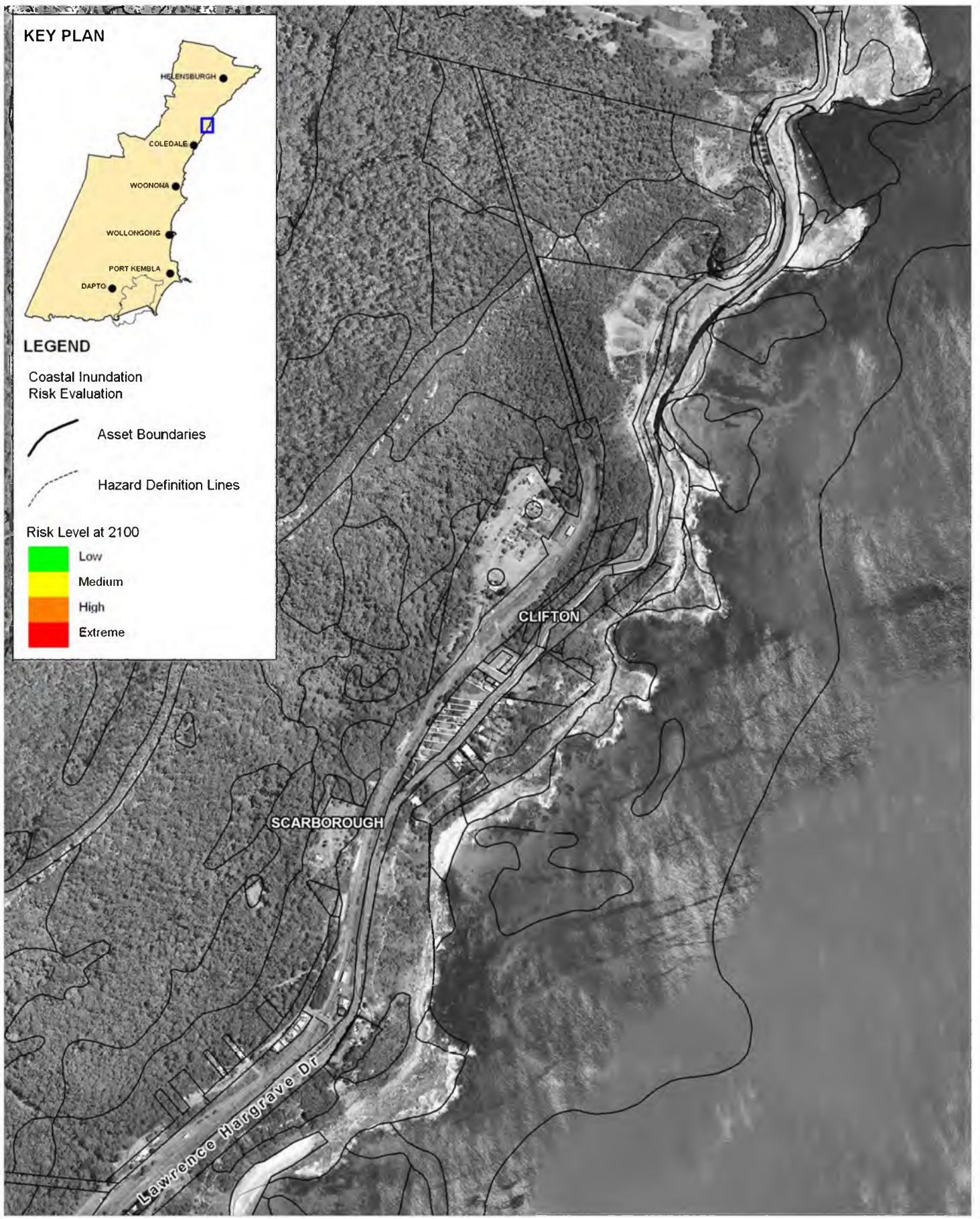


**LEGEND**

Coastal Inundation  
Risk Evaluation

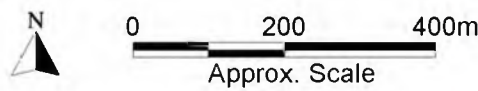
-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2100



<p>Title: <b>Coastal Inundation Risk Evaluation 2100 Planning Horizon - Clifton / Scarborough</b></p>	<p>Drawing: <b>F-2</b></p>	<p>Rev: <b>A</b></p>
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**KEY PLAN**

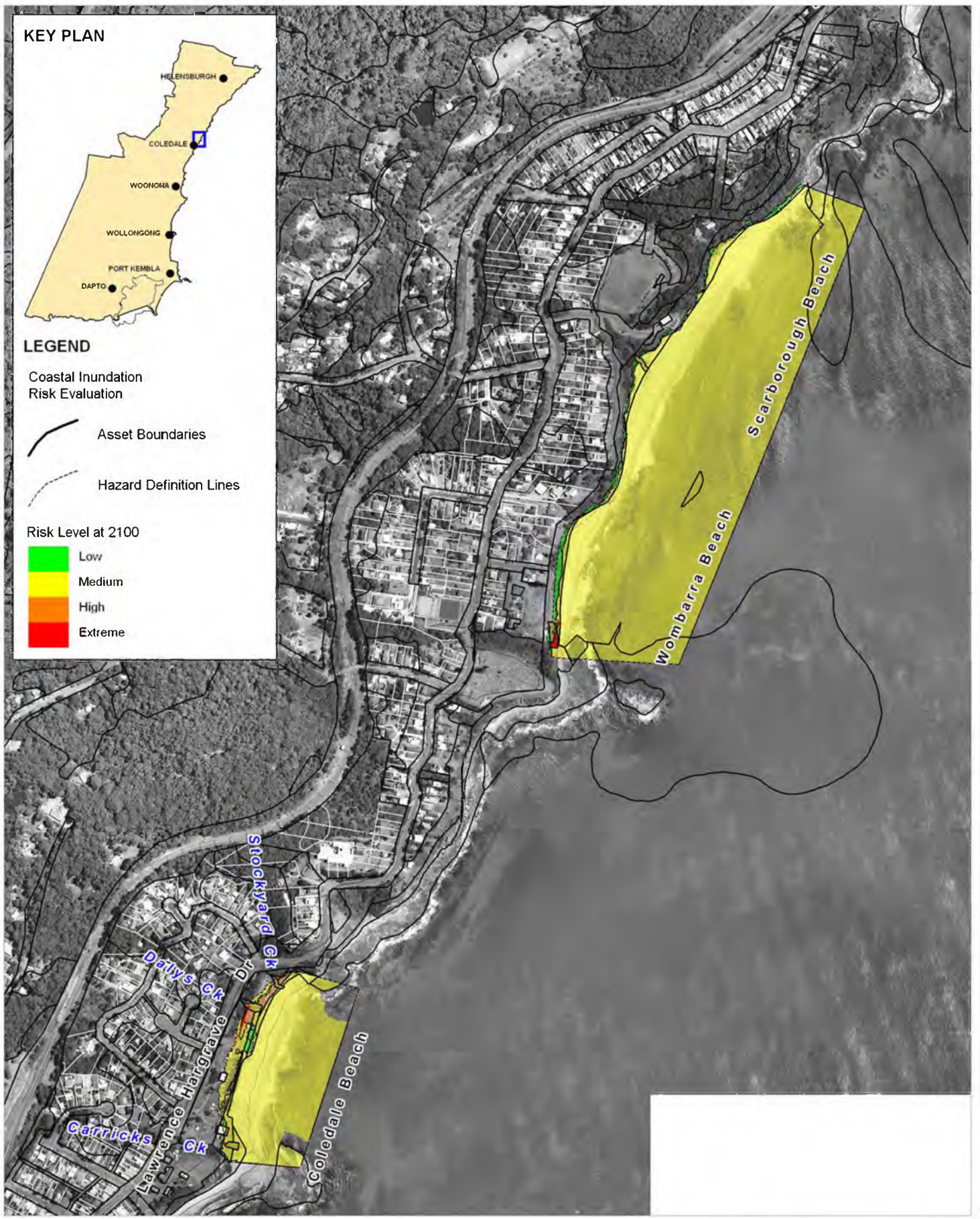


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100

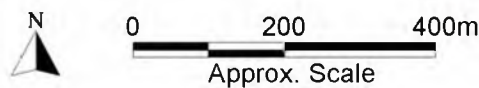


Title:  
**Coastal Inundation Risk Evaluation  
 2100 Planning Horizon - Scarborough/Coledale**

Drawing:  
**F-3**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_225\_110419 Drawing F-3.WOR

**KEY PLAN**

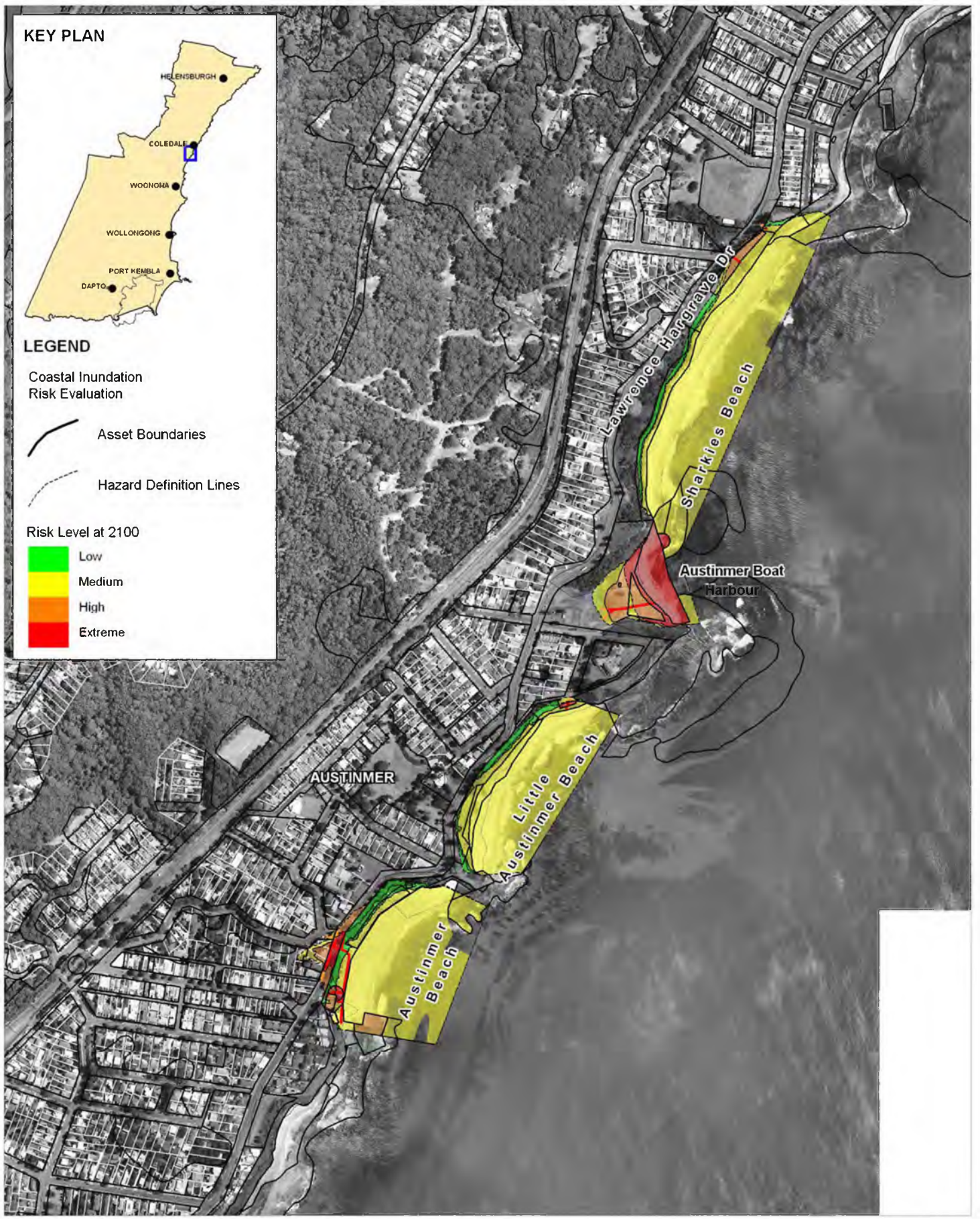


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100

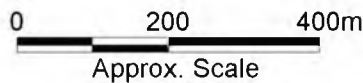


Title:  
**Coastal Inundation Risk Evaluation  
2100 Planning Horizon - Austinmer**

Drawing:  
**F-4**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_226\_110419 Drawing F-4.WOR

**KEY PLAN**

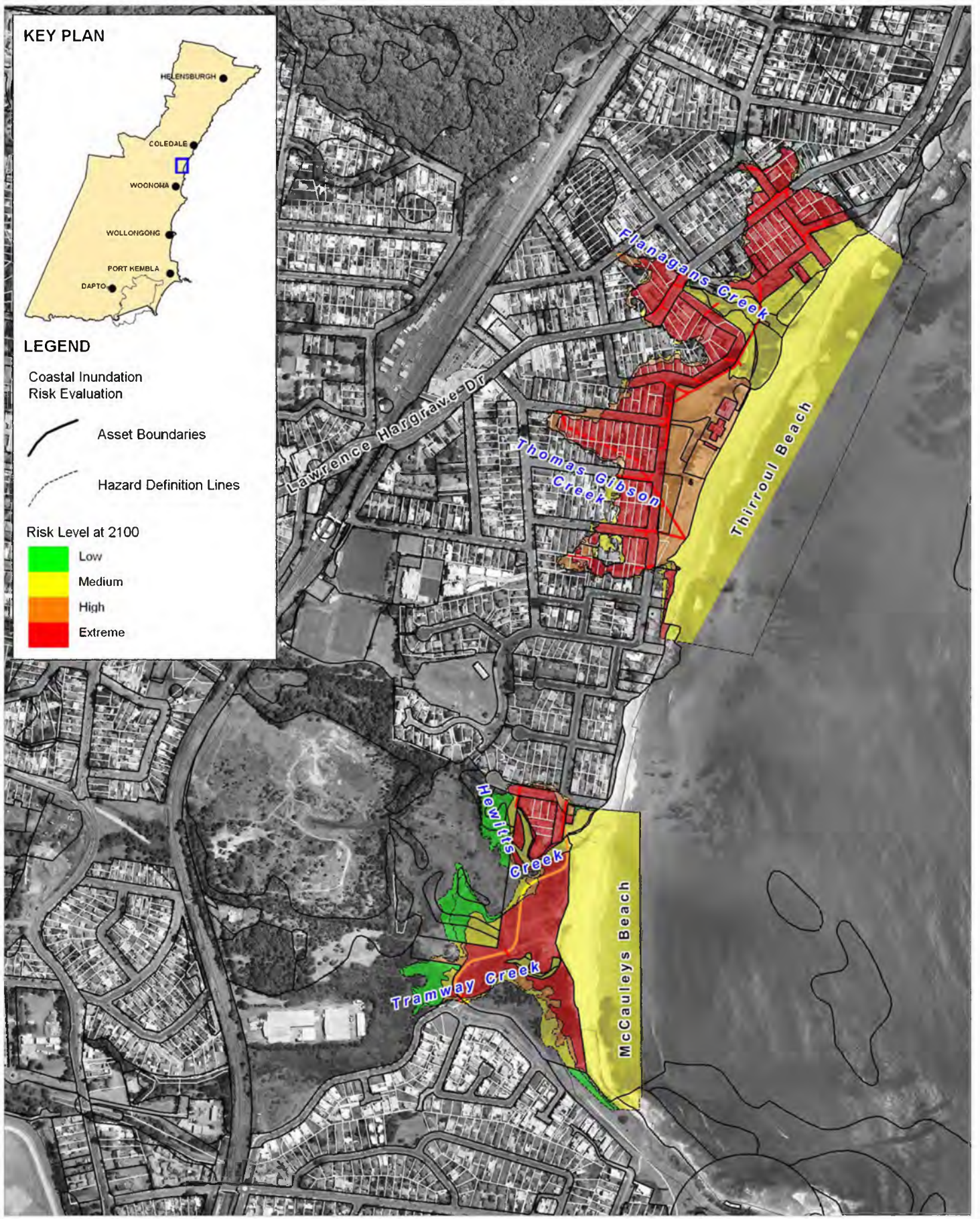


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100

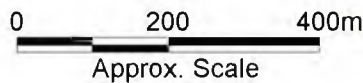


Title:  
**Coastal Inundation Risk Evaluation  
 2100 Planning Horizon - Thirroul/McCauleys**

Drawing:  
**F-5**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_227\_110419 Drawing F-5.WOR



**KEY PLAN**

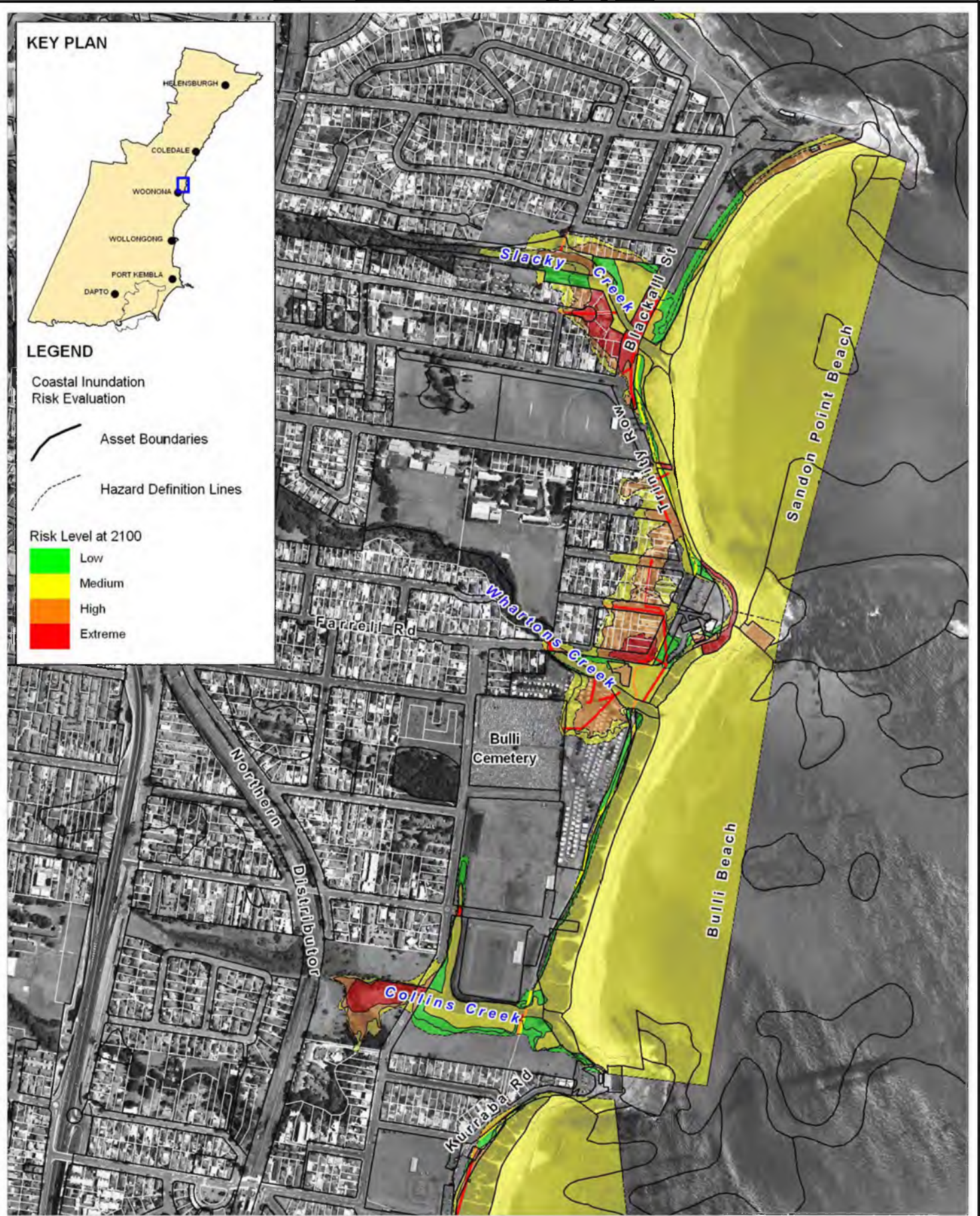


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100

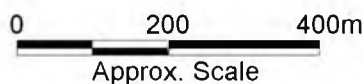


Title:  
**Coastal Inundation Risk Evaluation  
 2100 Planning Horizon - Sandon/Bulli**

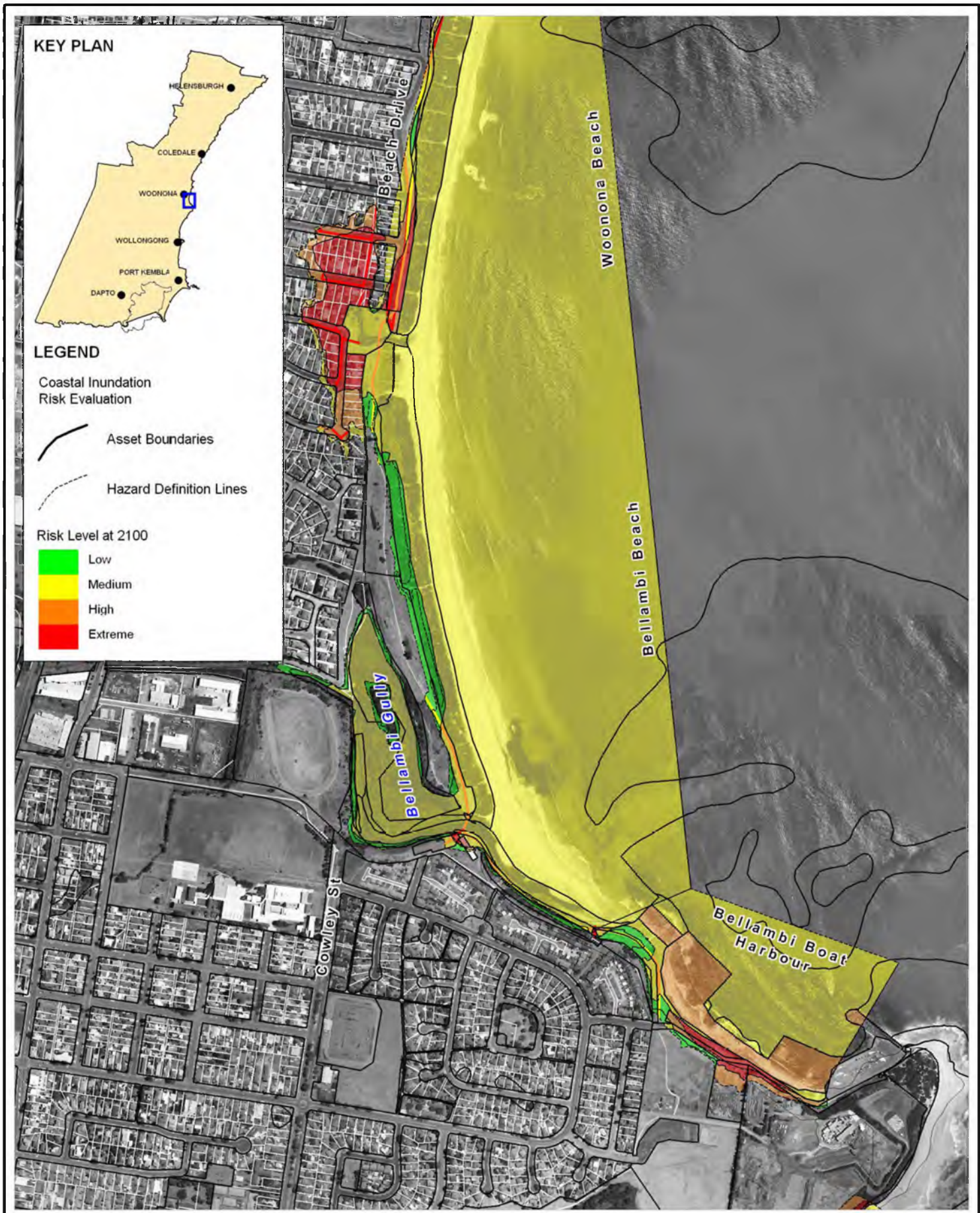
Drawing:  
**F-6**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_238\_110419 Drawing F-6.WOR



Title:  
**Coastal Inundation Risk Evaluation  
 2100 Planning Horizon - Woonona/Bellambi**

Drawing:  
**F-7**

Rev:  
**A**

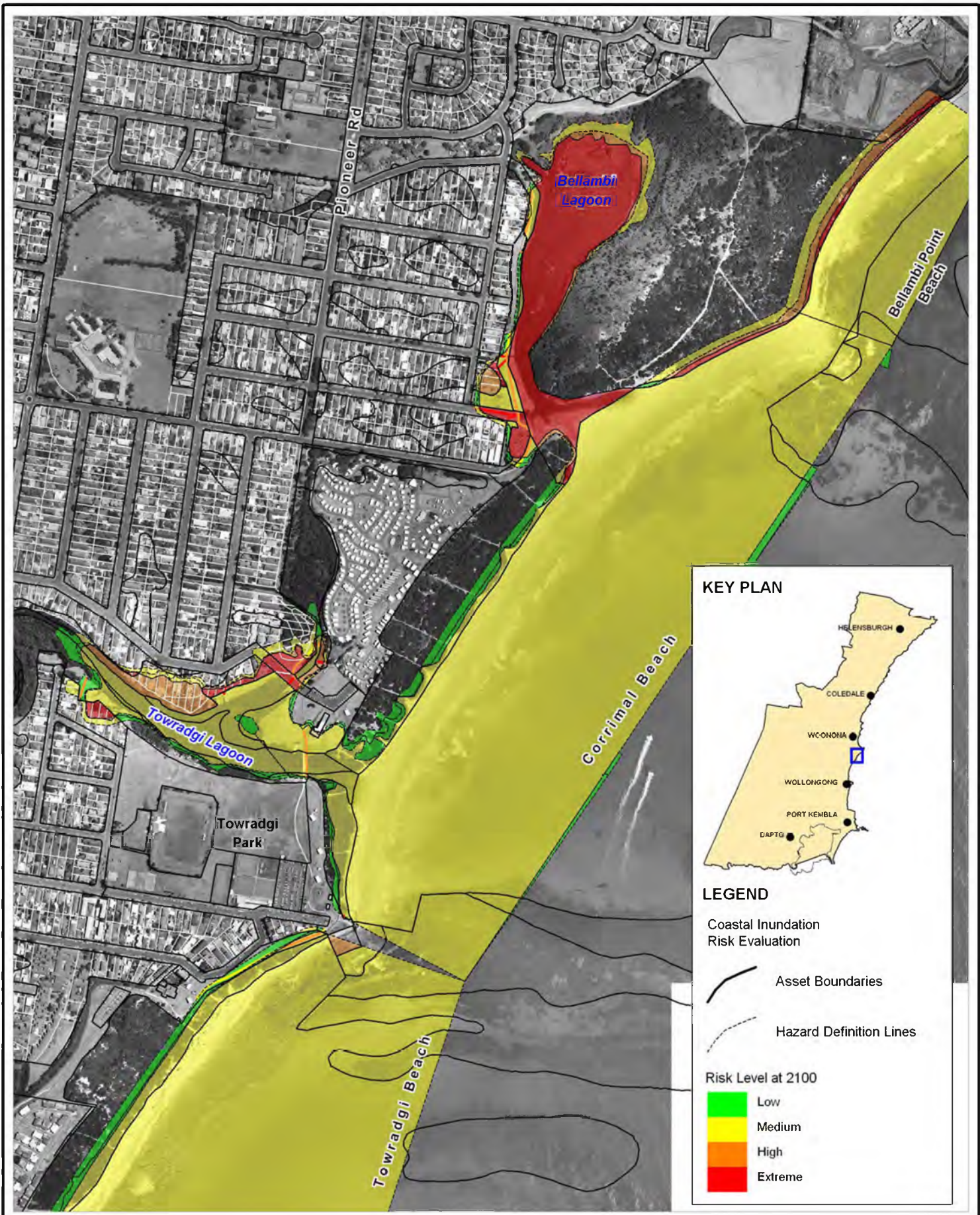
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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_229\_110419 Drawing F-7.WOR

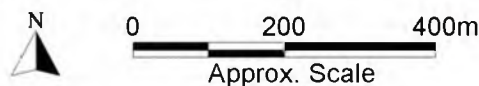


Title:  
**Coastal Inundation Risk Evaluation  
 2100 Planning Horizon - Corrimal Beach**

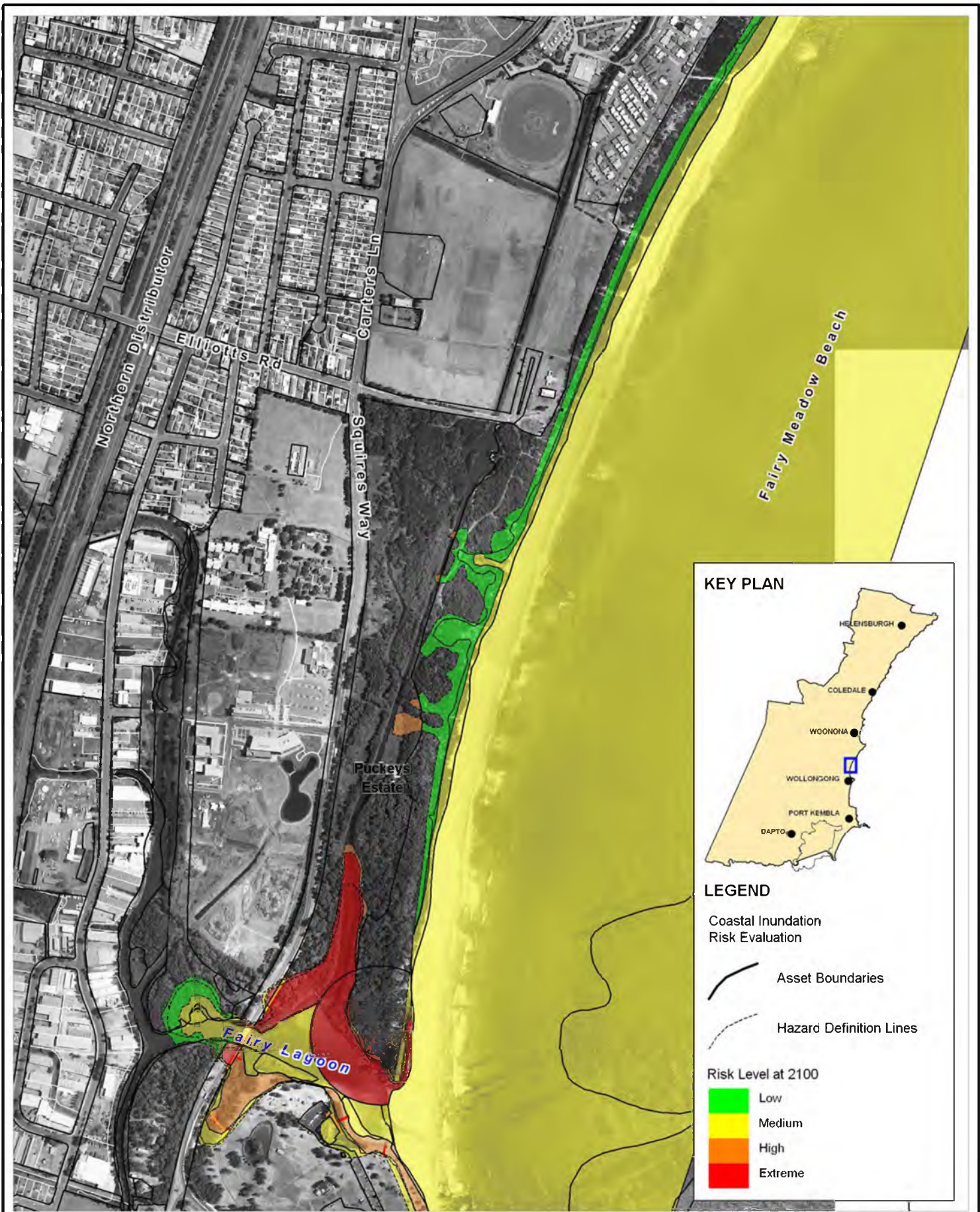
Drawing:  
**F-8**

Rev:  
**A**

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Filepath : K:\N1965\_WollongongCZMP\MapInfo\Workspaces\DRG\_230\_110419 Drawing F-8.WOR



Title:  
**Coastal Inundation Risk Evaluation  
 2100 Planning Horizon - Fairy Meadow**

Drawing:  
**F-9**

Rev:  
**A**

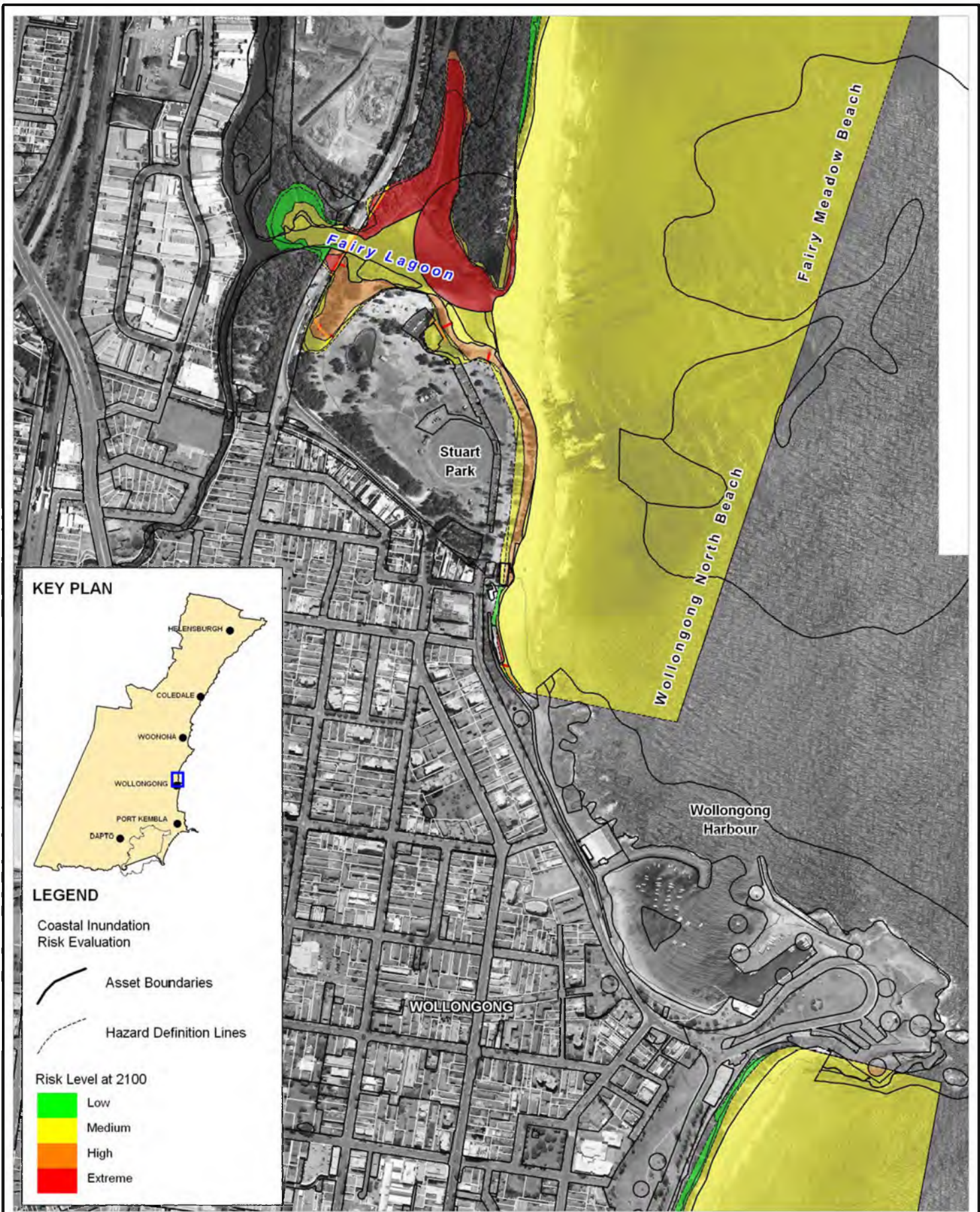
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 Approx. Scale



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Drawing:  
**F-10**

Rev:  
**A**

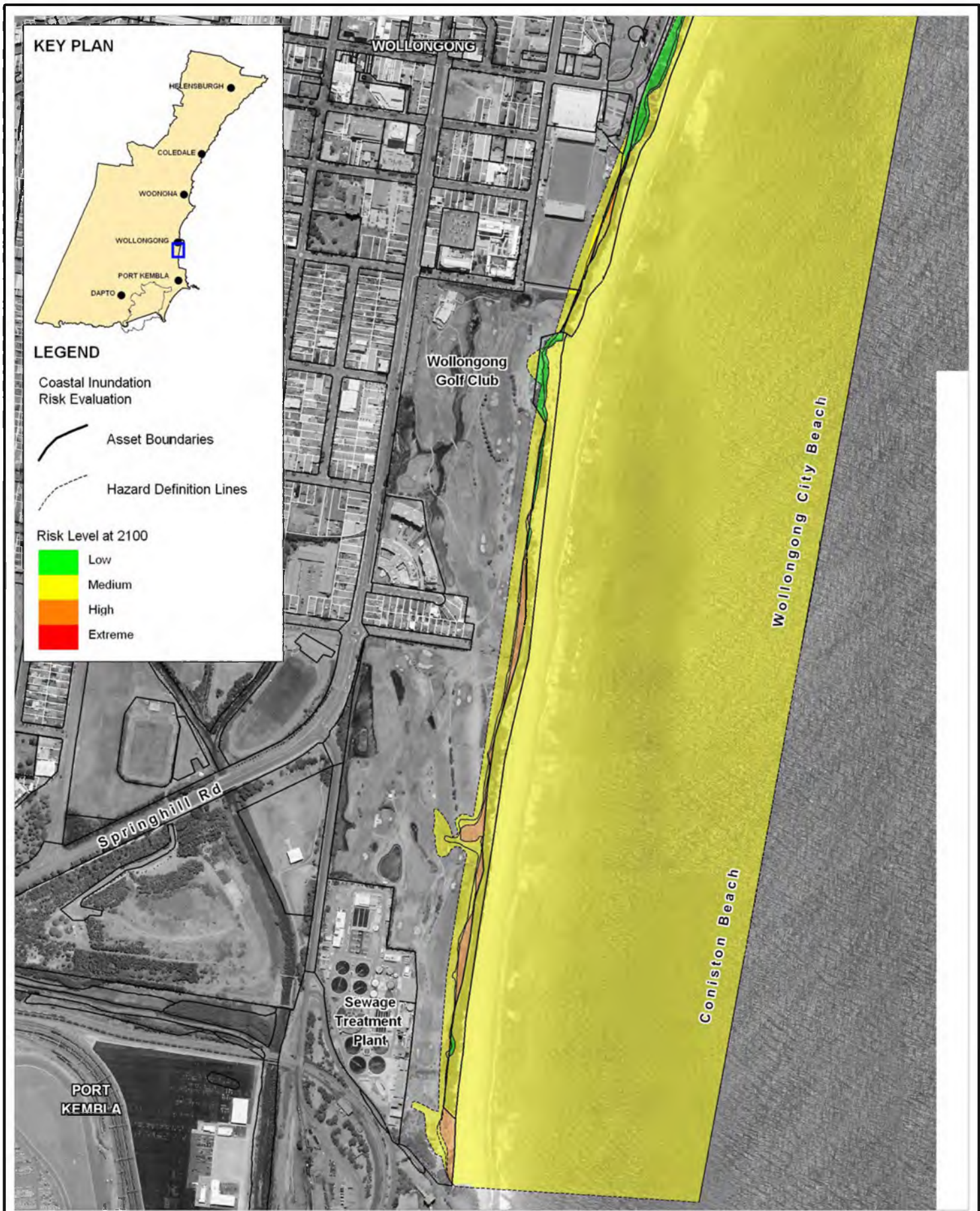
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Drawing:  
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Rev:  
**A**

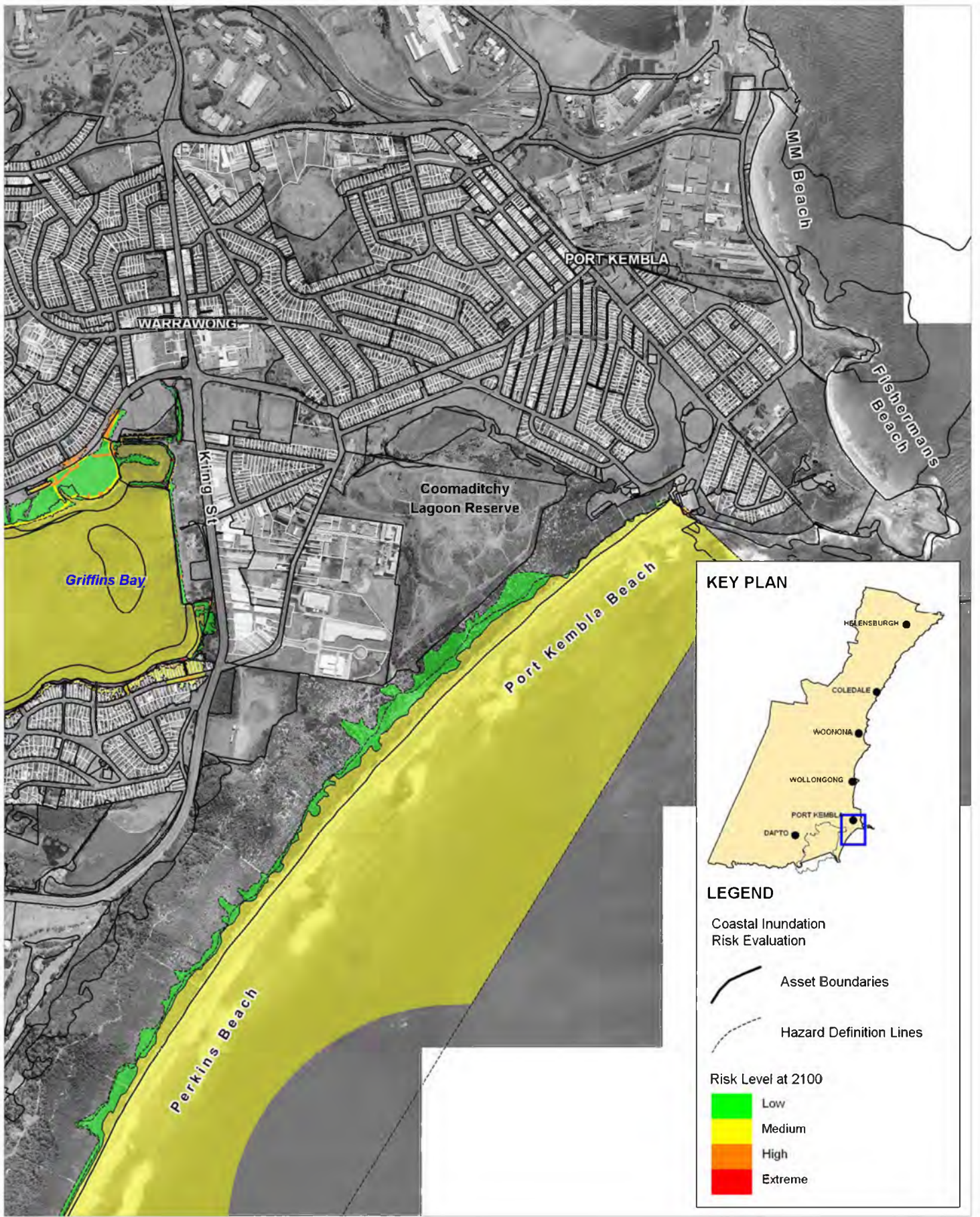
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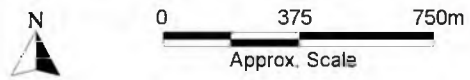


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 2100 Planning Horizon - Port Kembla**

Drawing:  
**F-12**

Rev:  
**A**

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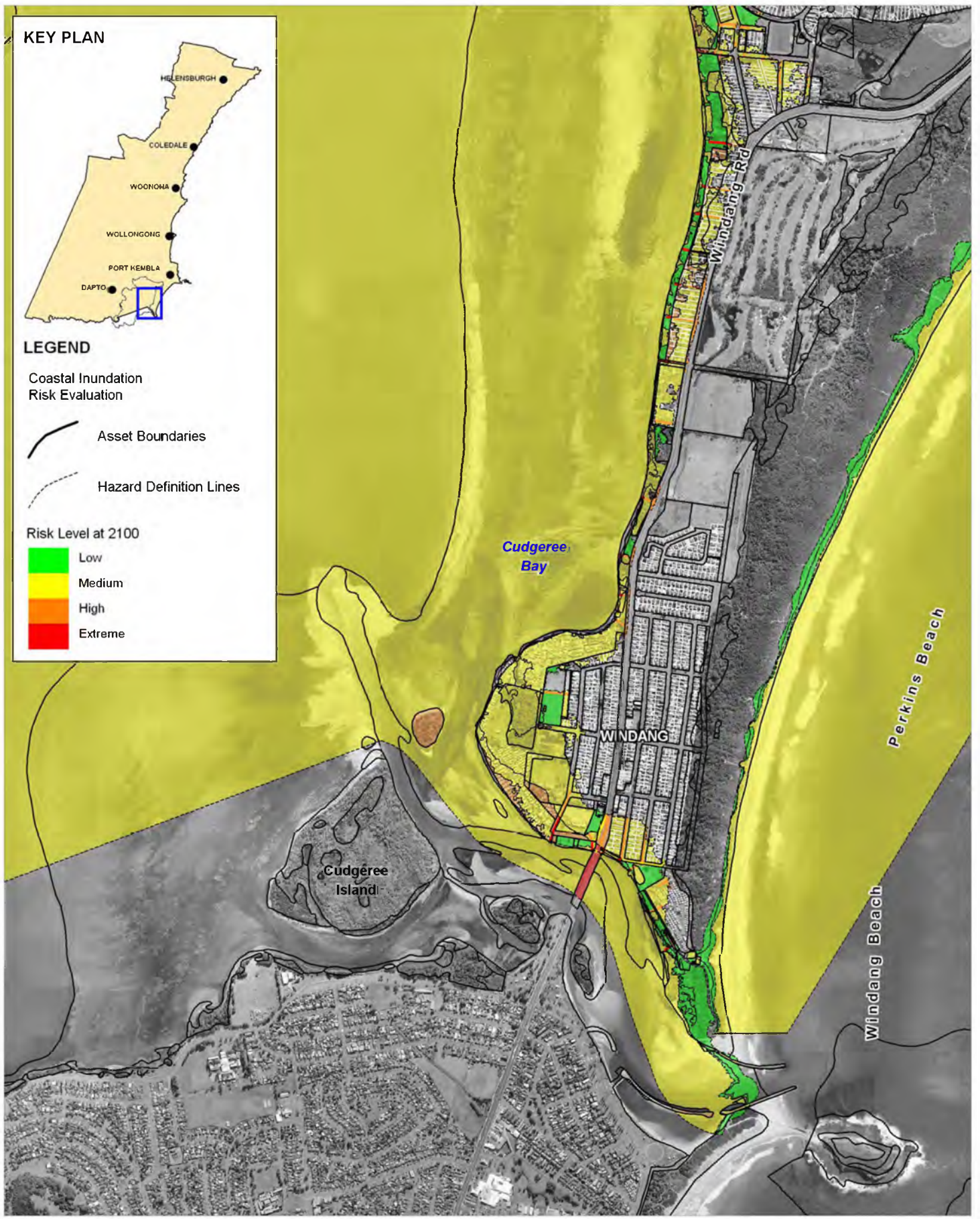


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2100



Title:

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2100 Planning Horizon - Windang**

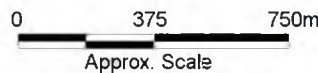
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**F-13**

Rev:

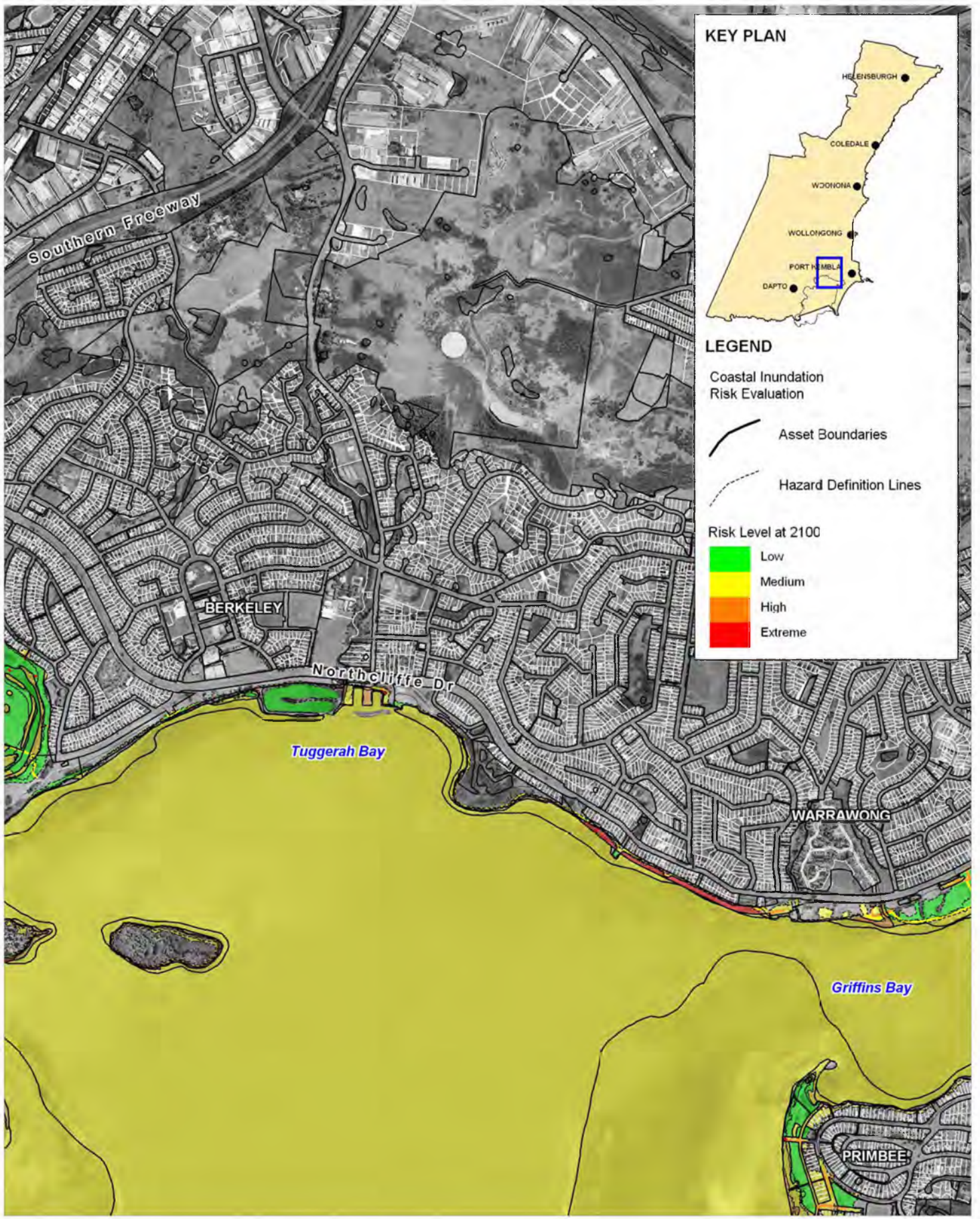
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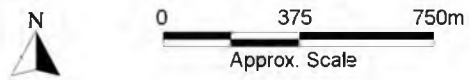
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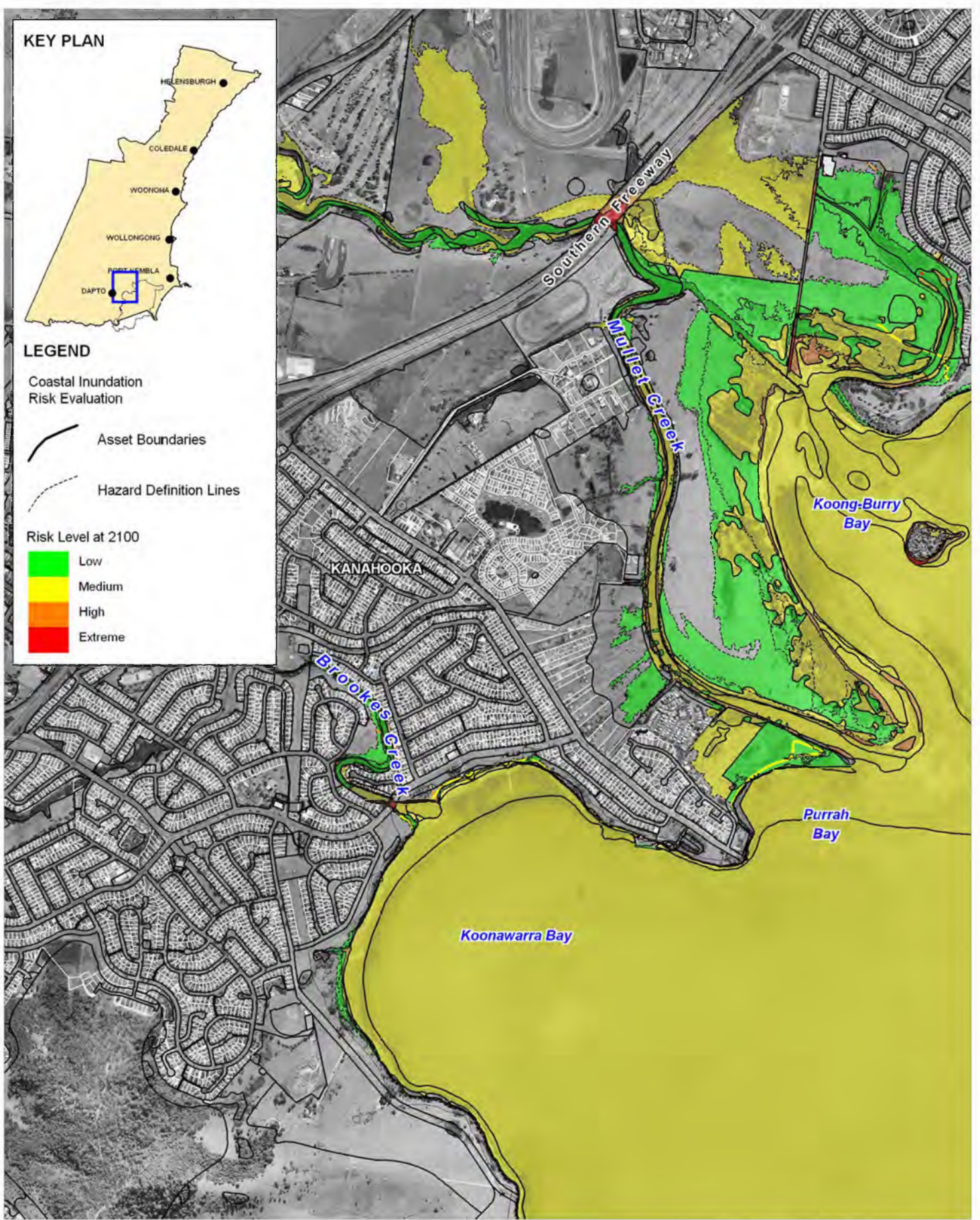


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

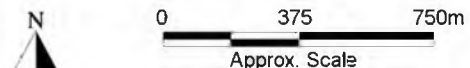
Risk Level at 2100



Title:  
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 2100 Planning Horizon - Kanahooka**

Drawing: <b>F-15</b>	Rev: <b>A</b>
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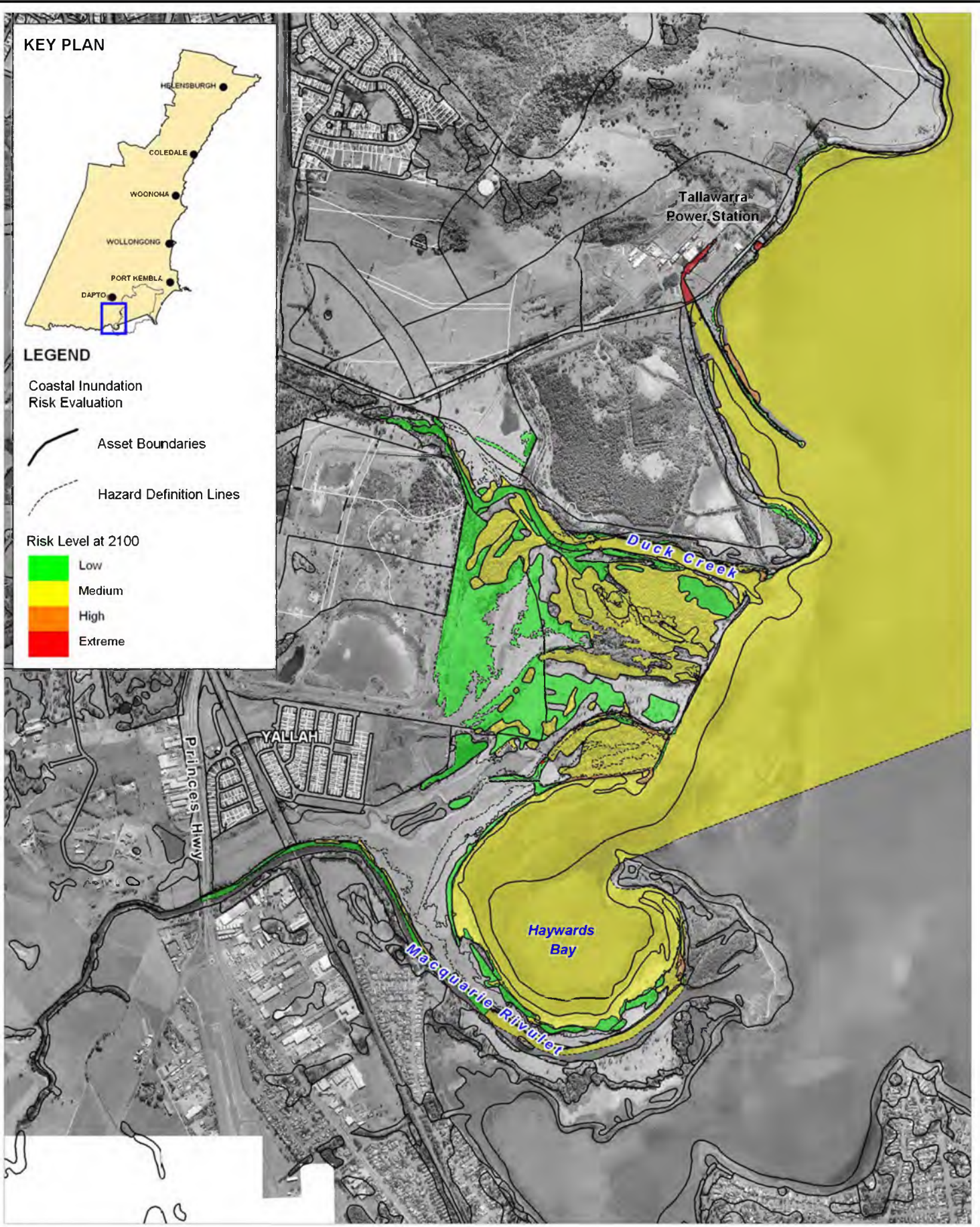


**LEGEND**

Coastal Inundation Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

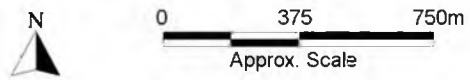
Risk Level at 2100



Title:  
**Coastal Inundtion Risk Evaluation  
2100 Planning Horizon - Tallawarra**

Drawing: <b>F-16</b>	Rev: <b>A</b>
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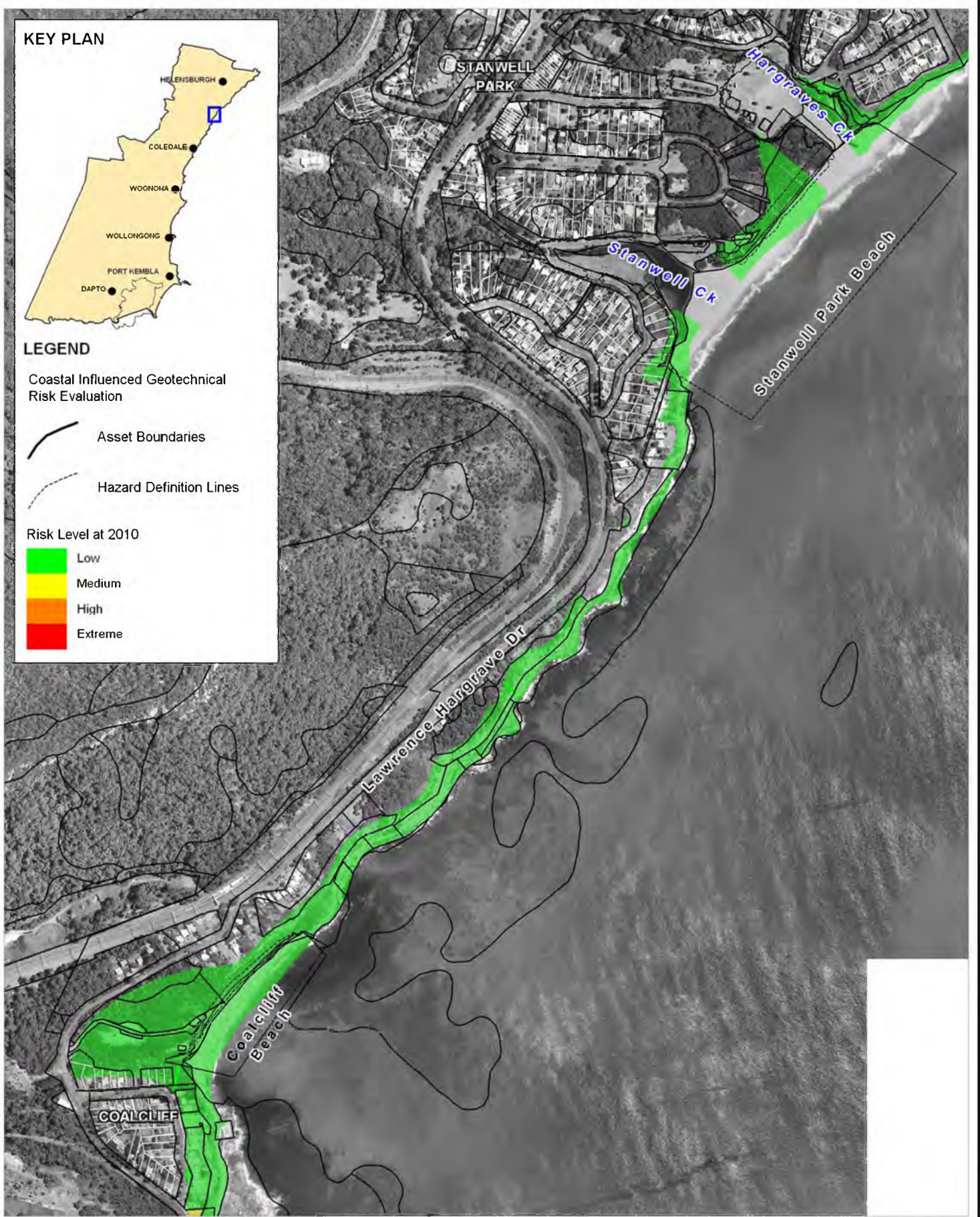


**LEGEND**

Coastal Influenced Geotechnical Risk Evaluation

-  Asset Boundaries
-  Hazard Definition Lines

Risk Level at 2010

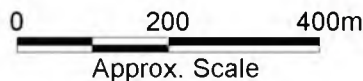


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 Immediate Planning Horizon - Stanwell Park / Coalcliff**

Drawing:  
**G-1**

Rev:  
**A**

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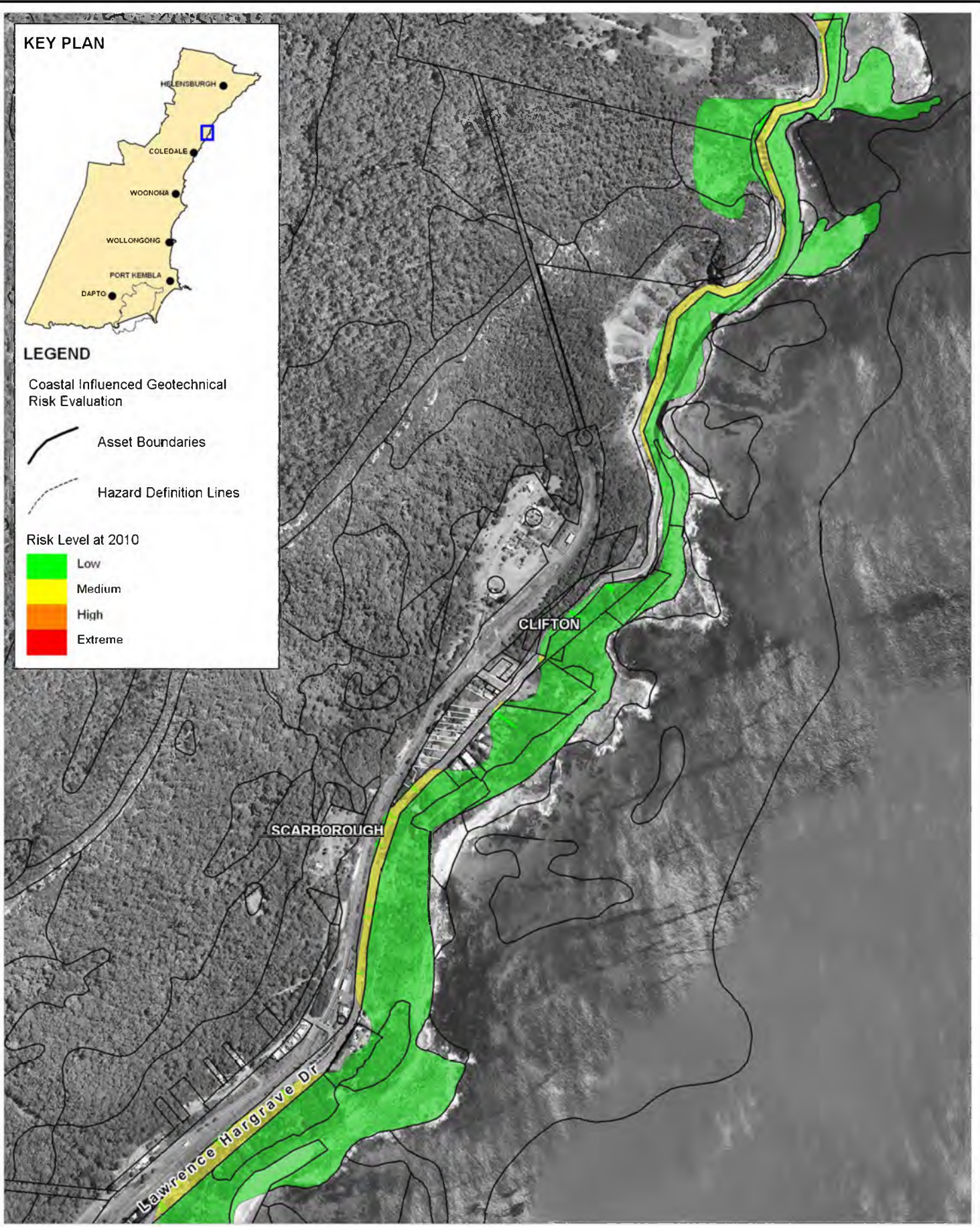


**LEGEND**

Coastal Influenced Geotechnical Risk Evaluation

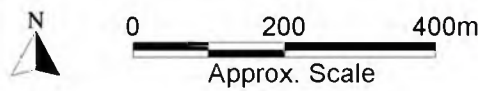
- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title: <b>Coastal Influenced Geotechnical Risk Evaluation Immediate Planning Horizon - Clifton / Scarborough</b>		Drawing: <b>G-2</b>	Rev: <b>A</b>
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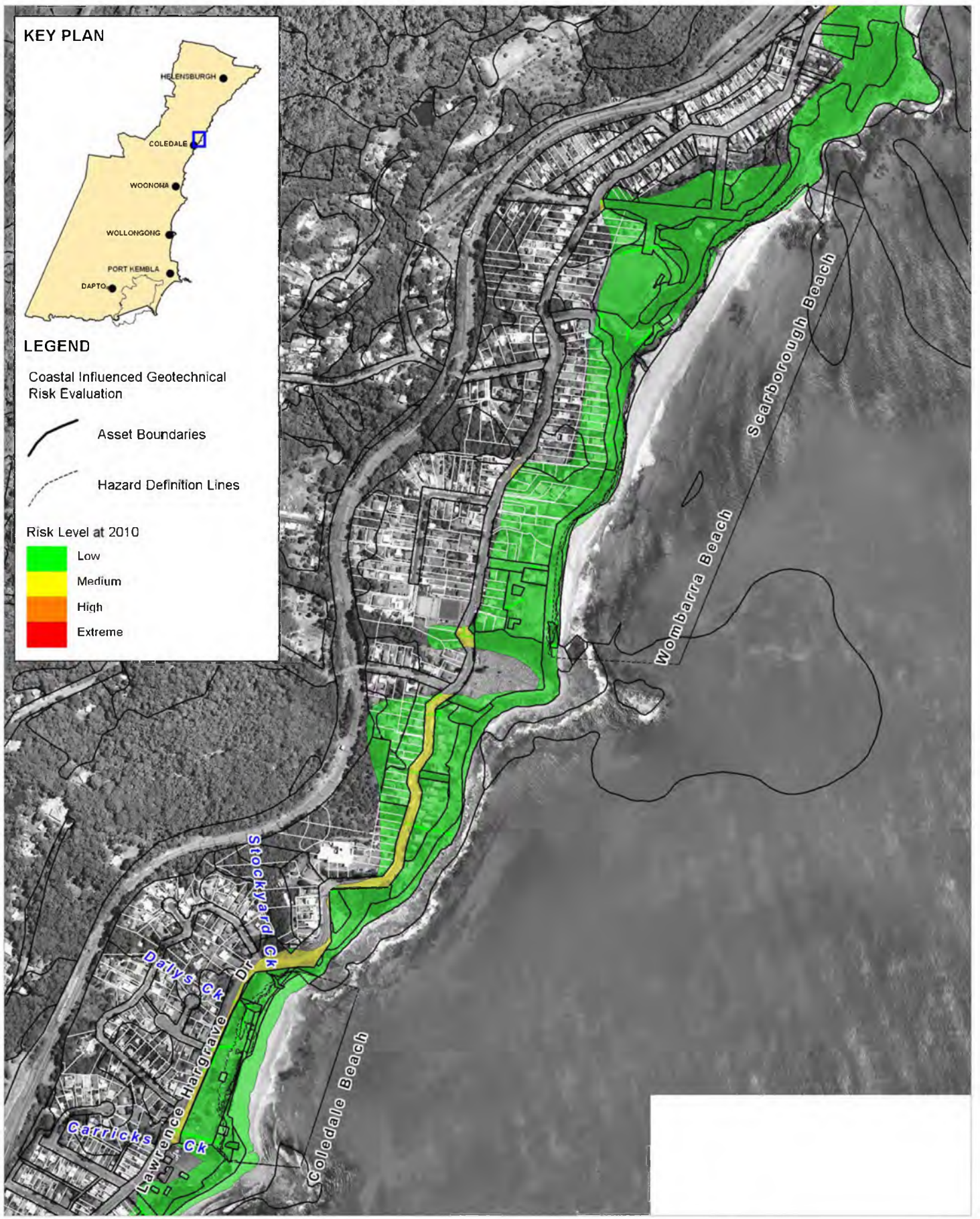


**LEGEND**

Coastal Influenced Geotechnical Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

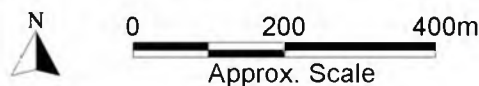


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 Immediate Planning Horizon - Scarborough/Coledale**

Drawing:  
**G-3**

Rev:  
**A**

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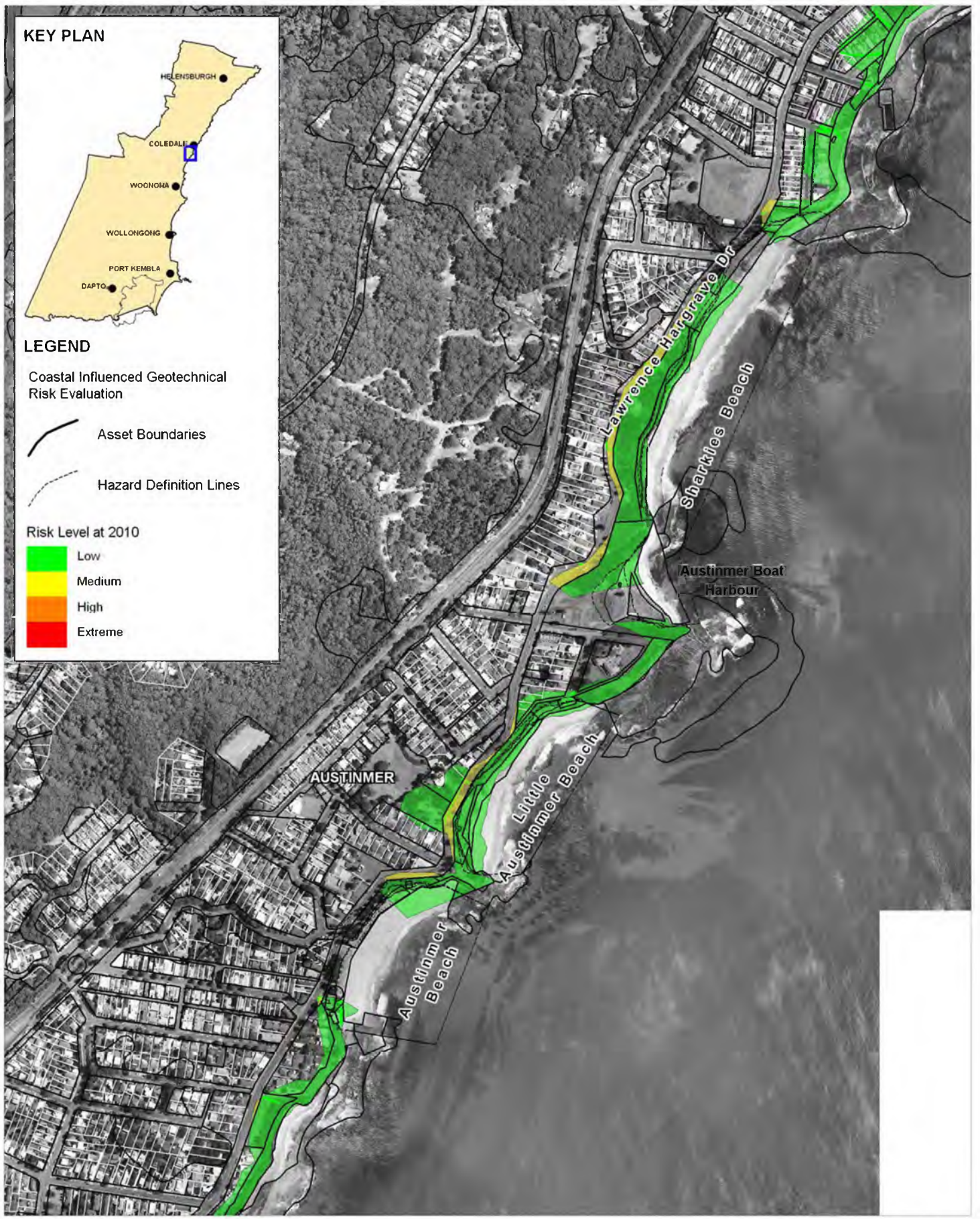


**LEGEND**

Coastal Influenced Geotechnical Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

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Immediate Planning Horizon - Austinmer**

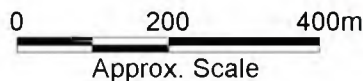
Drawing:

**G-4**

Rev:

**A**

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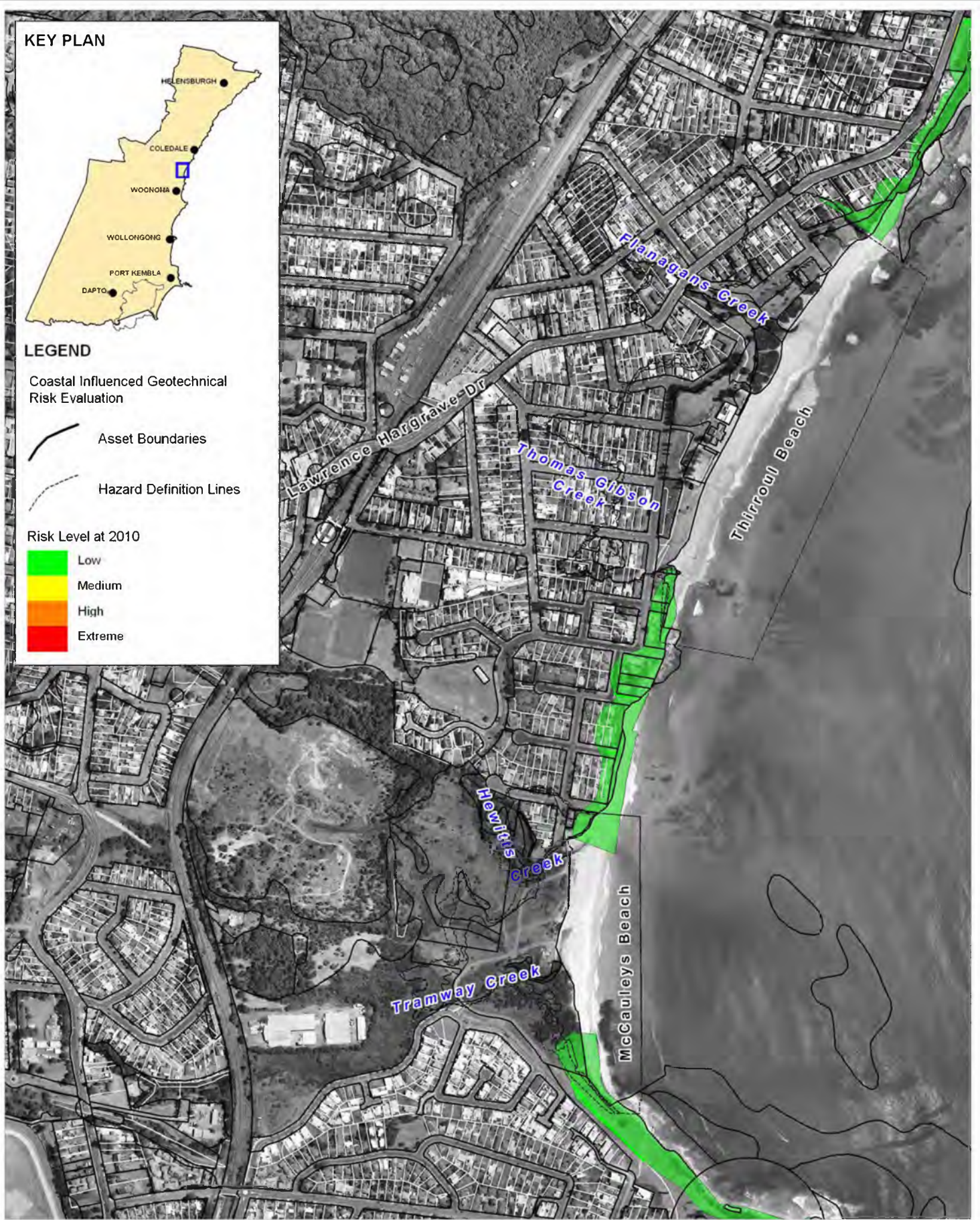


**LEGEND**

Coastal Influenced Geotechnical Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010

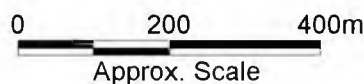


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Drawing:  
**G-5**

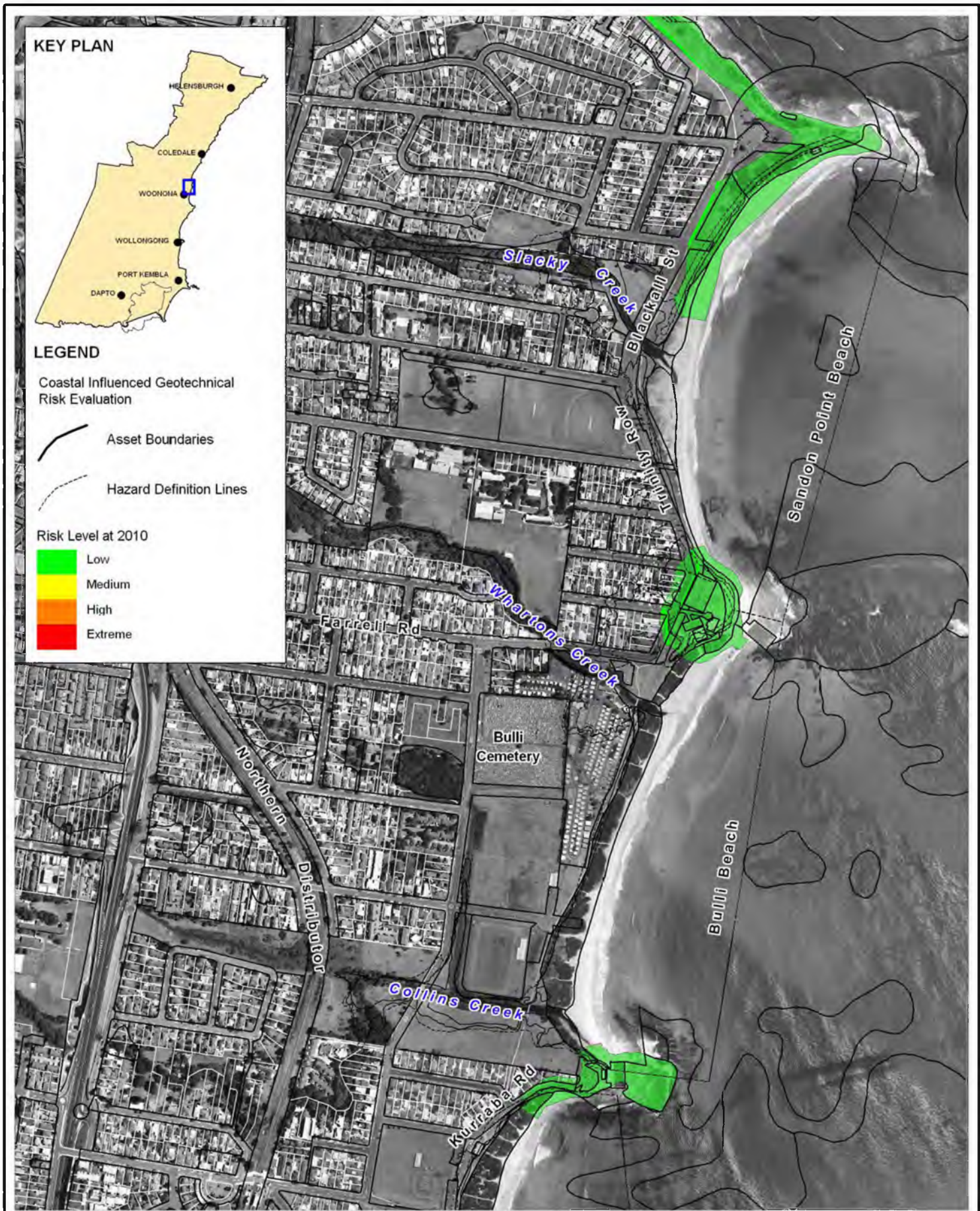
Rev:  
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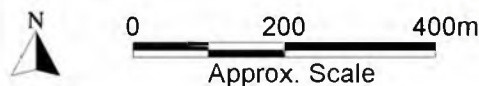


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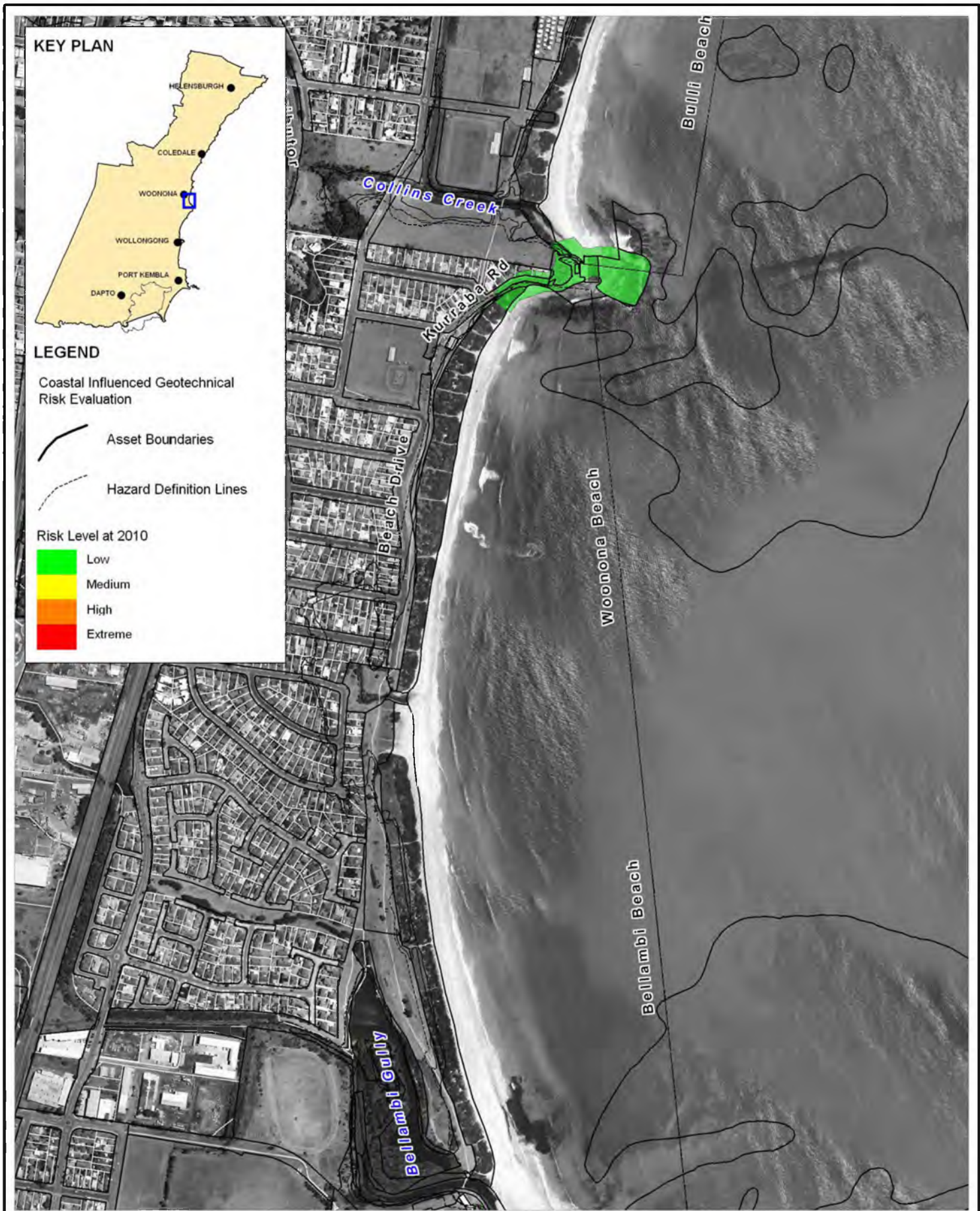
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**G-6**

Rev:  
**A**

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Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_244\_110419 Drawing G-6.WOR



Title:  
**Coastal Influenced Geotechnical Risk Evaluation  
 Immediate Planning Horizon - Woonona/Bellambi**

Drawing:  
**G-7**

Rev:  
**A**

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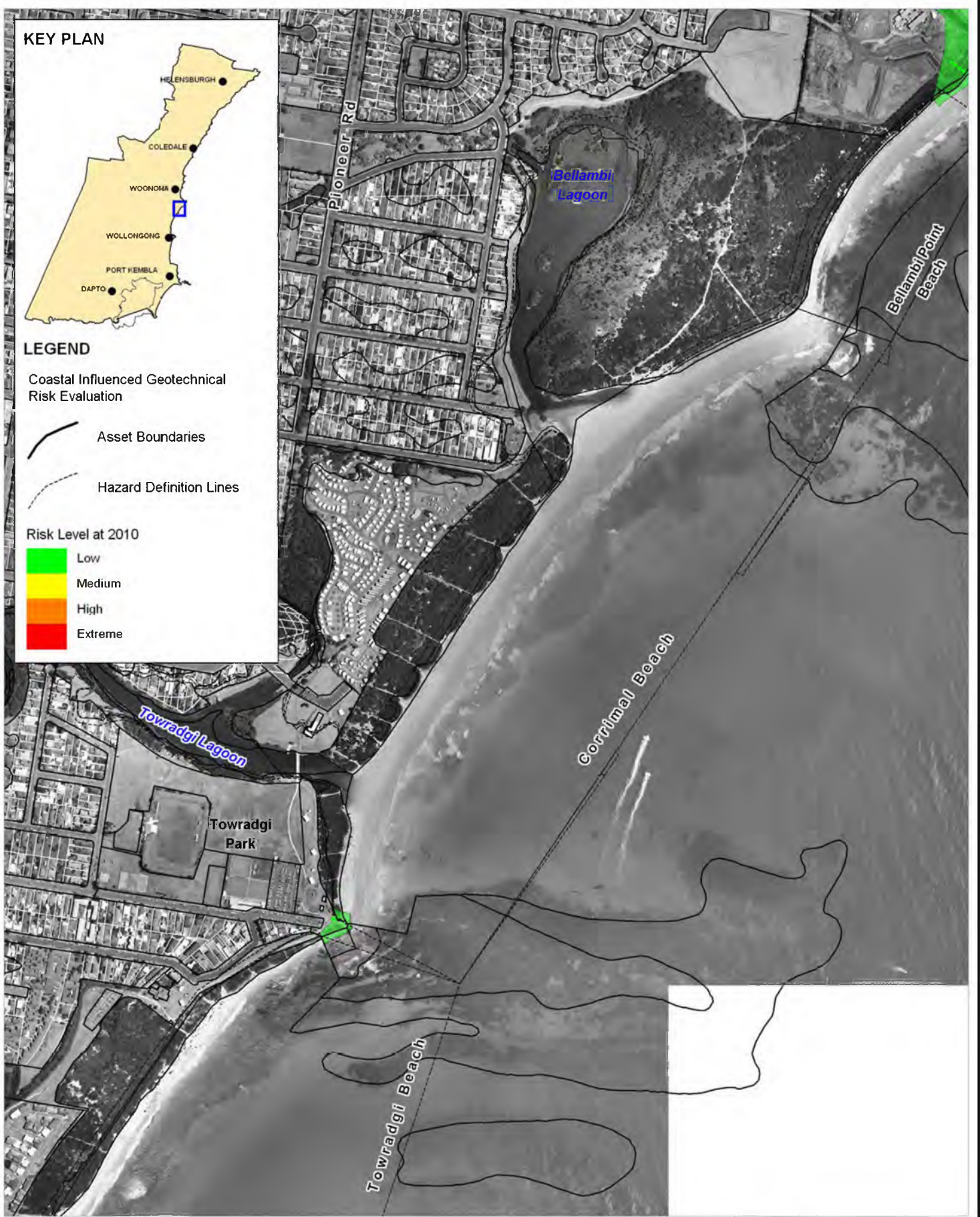


**LEGEND**

Coastal Influenced Geotechnical Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

**Coastal Influenced Geotechnical Risk Evaluation  
Immediate Planning Horizon - Corrimal Beach**

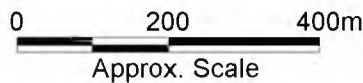
Drawing:

**G-8**

Rev:

**A**

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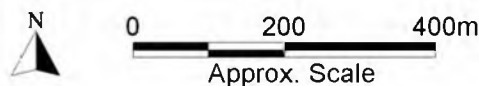


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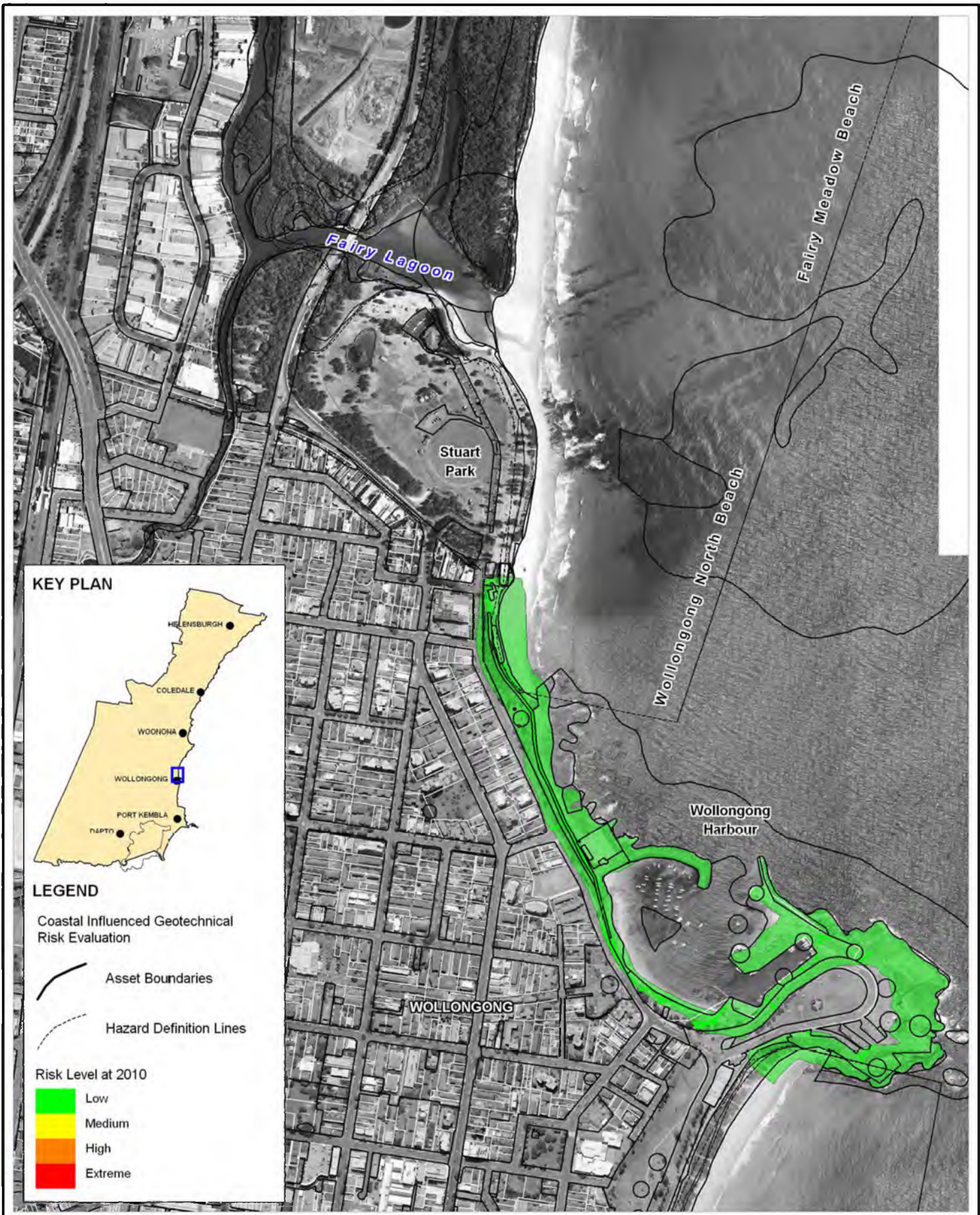
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Rev:  
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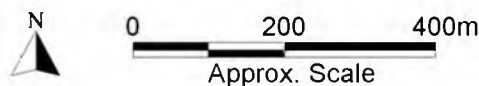


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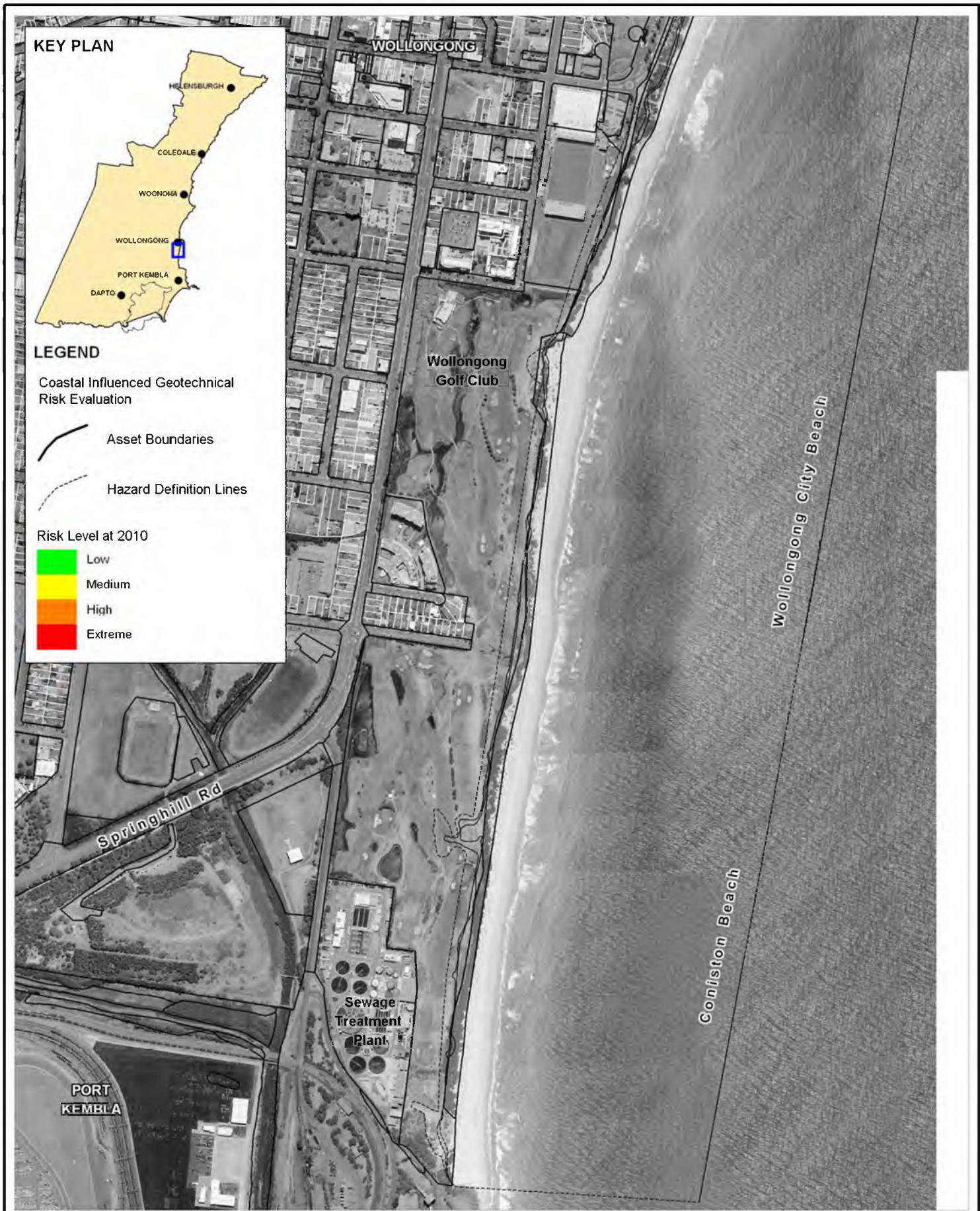
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Rev:  
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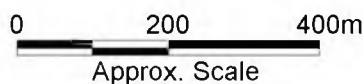


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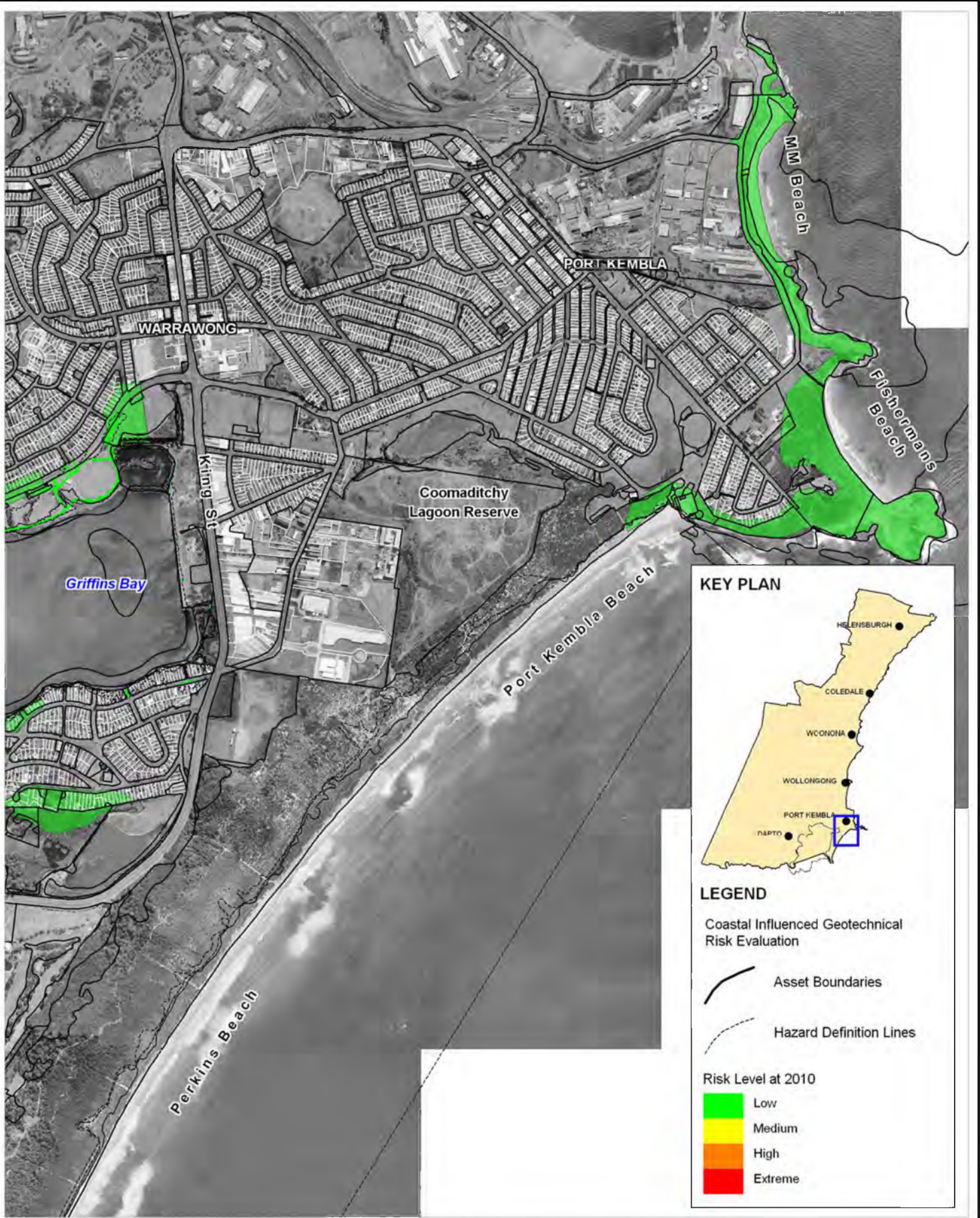
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Rev:  
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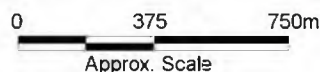


Title:  
**Coastal Influenced Geotechnical Risk Evaluation  
 Immediate Planning Horizon - Port Kembla**

Drawing:  
**G-12**

Rev:  
**A**

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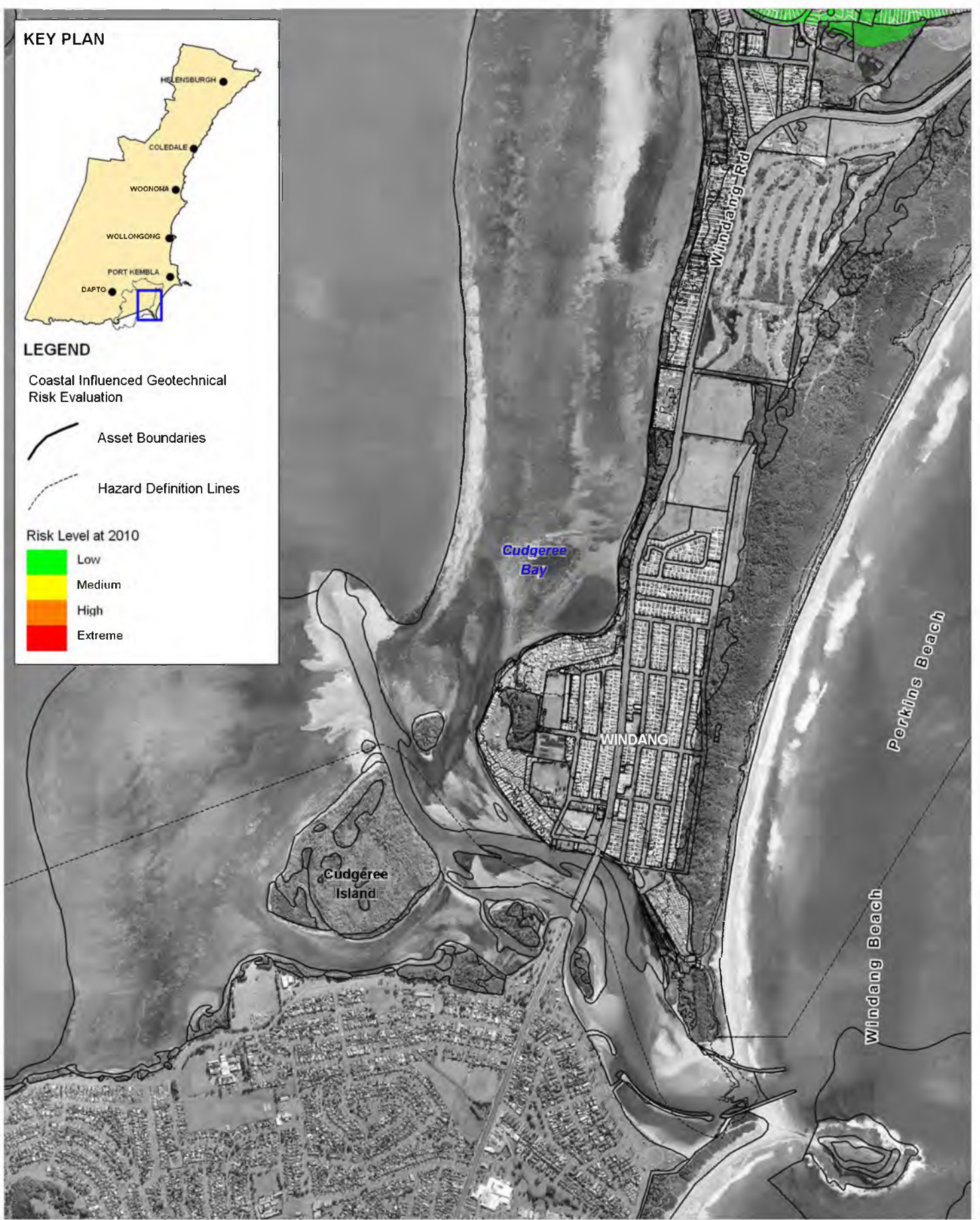


**LEGEND**

Coastal Influenced Geotechnical Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

**Coastal Influenced Geotechnical Risk Evaluation  
Immediate Planning Horizon - Windang**

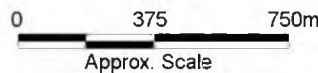
Drawing:

**G-13**

Rev:

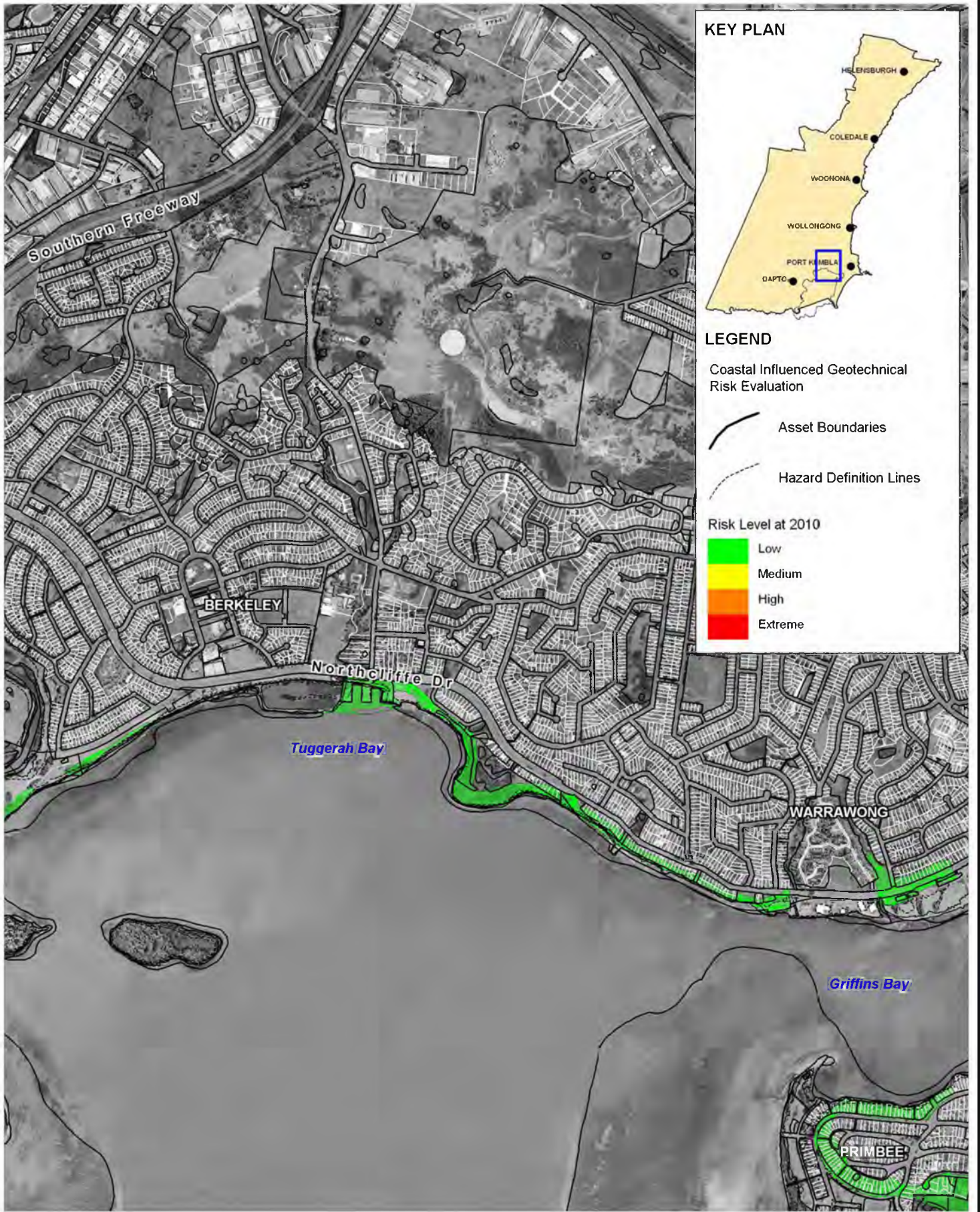
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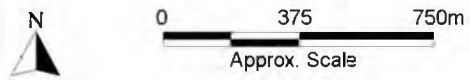




Title:  
**Coastal Influenced Geotechnical Risk Evaluation  
 Immediate Planning Horizon - Berkeley/Warrawong**

Drawing: <b>G-14</b>	Rev: <b>A</b>
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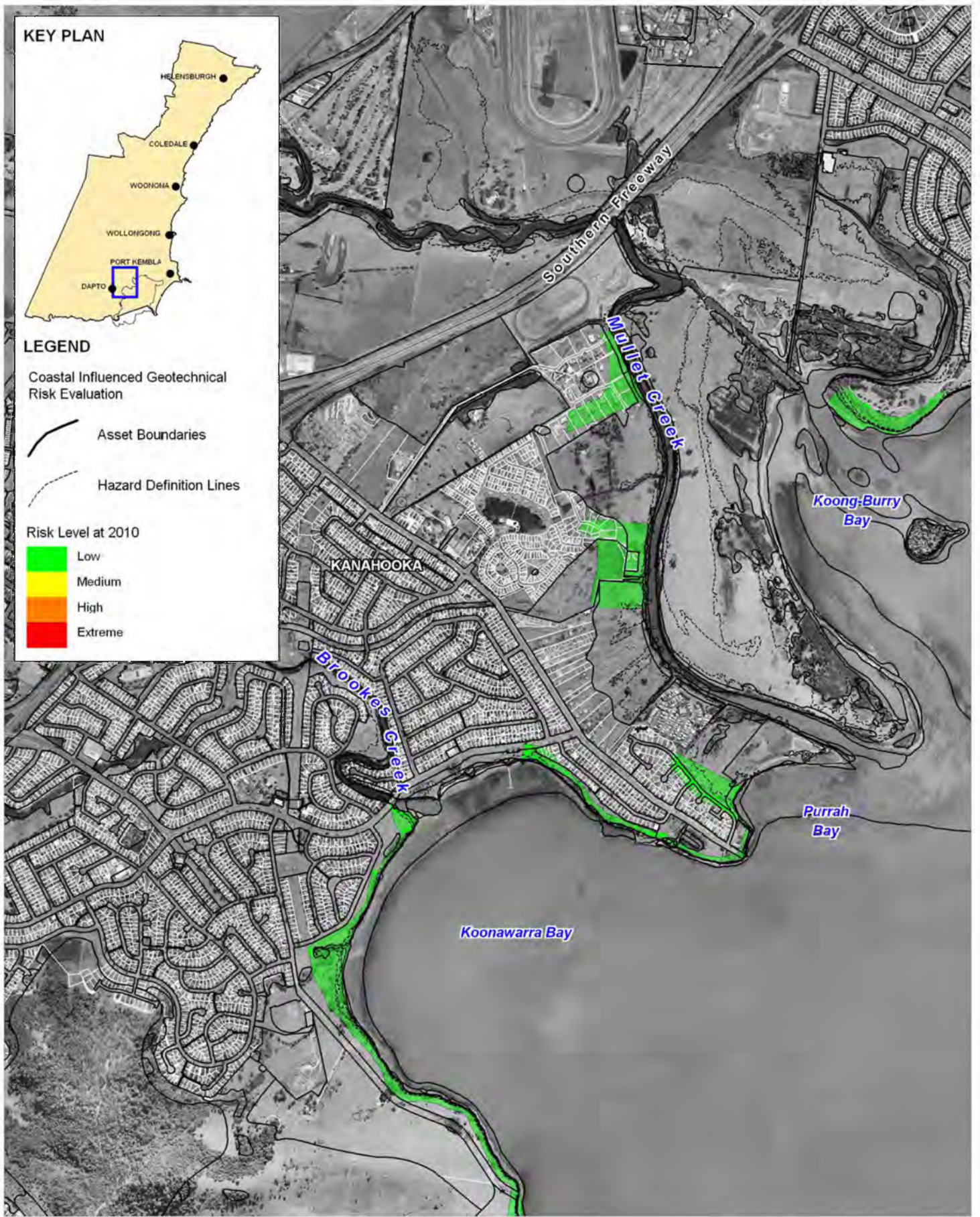


**LEGEND**

Coastal Influenced Geotechnical Risk Evaluation

- Asset Boundaries
- Hazard Definition Lines

Risk Level at 2010



Title:

**Coastal Influenced Geotechnical Risk Evaluation  
Immediate Planning Horizon - Kanahooka**

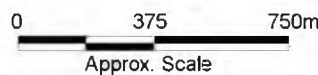
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**G-15**

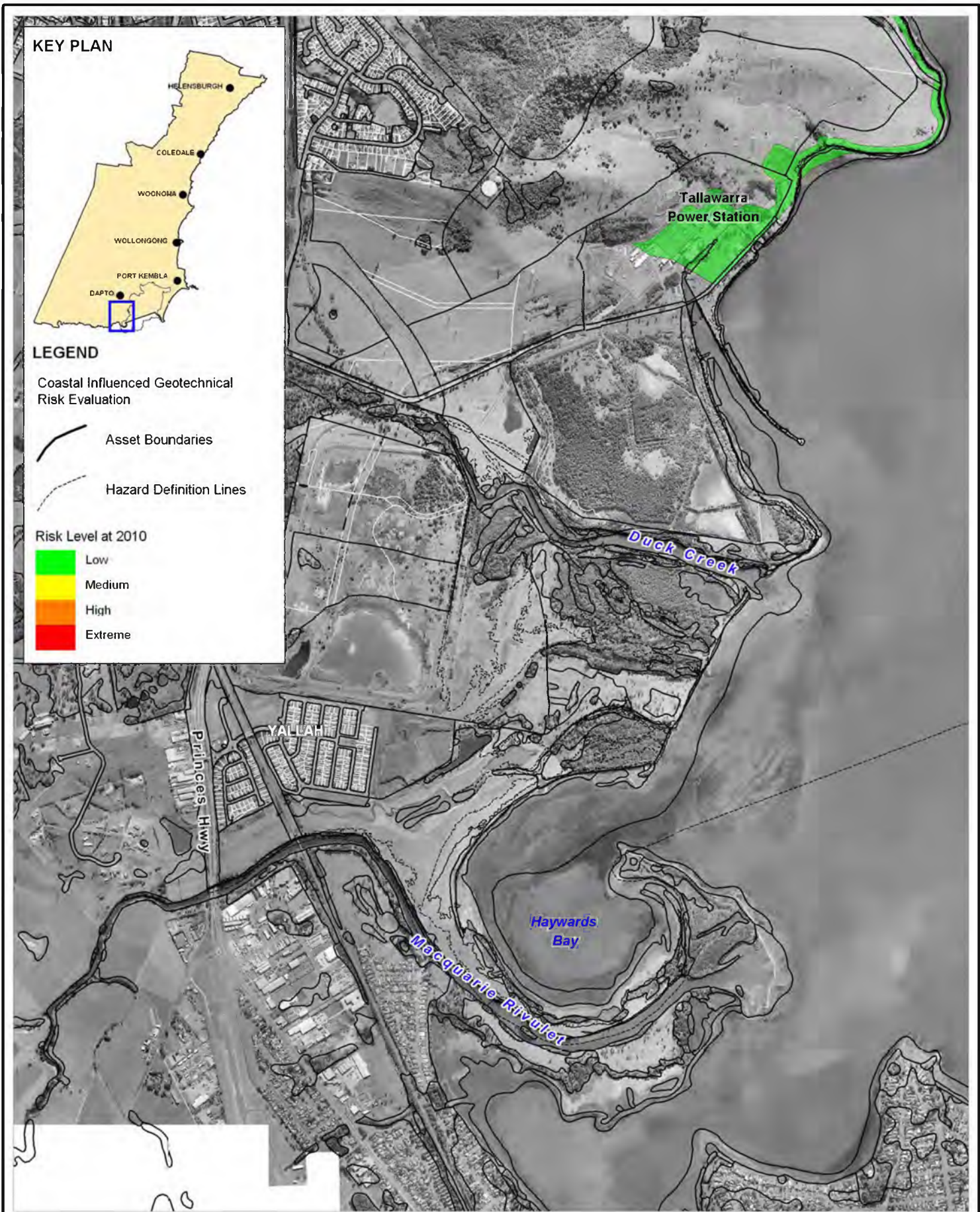
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Title:  
**Coastal Influenced Geotechnical Risk Evaluation  
immediate Planning Horizon - Tallawarra**

Drawing:  
**G-16**

Rev:  
**A**

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0 375 750m  
Approx. Scale



Filepath : K:\N1965\_Wollongong\CZMP\MapInfo\Workspaces\DRG\_254\_110420 Drawing G-16.WOR

## APPENDIX B: ESTUARY PLANS AND BEACH ACCESS ARRANGEMENTS

### Estuary Management

Council has prepared two Estuary Management Plans for the 14 coastal creeks and lagoons for which it has management responsibility. These Plans have been adopted by Council and are now in the implementation stage. They address the estuary health issues. Entrance Management Policies have also been prepared for Fairy and Towradgi lagoons and Council is in the process of preparing one for Bellambi Lagoon. The Estuary Management Plans and Entrance Management Policies are listed below:

- Estuary Management Study and Plan for Fairy, Towradgi, Hewitts/Tramway Creeks;
- Estuary Management Study and Plan for Several Wollongong Creeks and Lagoons;
- Entrance Management Policy for Fairy Lagoon; and
- Entrance Management Policy for Towradgi Lagoon.

### Community Use and Beach Access Arrangements

Several Plans of Management (POMs) have been prepared, which guide the management of certain foreshore areas along the Wollongong coastline. These POMs are listed in Section 2.2.7.1 of the Management Study. In addition, Council has Dune Maintenance Program, through which beach access is maintained. Through a Beach Services Program, beach combing and lifeguard services are provided at several reaches. Beach access and amenity is therefore considered to be satisfactory at all beaches at the present time. The table below provides a summary of the beach access and amenity arrangements.

Beach	Access Road	Car Parking	Beach Access	Beach Patrol	Recycling Bin	Other Facilities
Stanwell Park	Yes	Yes	Dune Walkways	Yes	Yes	Surf Club, Kiosk
Coalcliff	Yes	Yes	Tracks	Yes		Surf Club, Rock Pool
Scarborough/Wombarra	Yes	Yes	Tracks	Yes		Rock Pool
Coledale	Yes	Yes	Tracks	Yes		Surf Club, Rock Pool; Camping Ground
Austinmer	Yes	Yes	Tracks	Yes	Yes	Surf Club, Rock Pool, Seating
Thirroul	Yes	Yes	Tracks	Yes	Yes	Surf Club, Pool, Kiosk, Seating

Beach	Access Road	Car Parking	Beach Access	Beach Patrol	Recycling Bin	Other Facilities
Sandon Point	Yes	Yes	Dune Walkways	Yes		Surf Club
Bulli	Yes	Yes	Dune Walkways	Yes	Yes	Surf Club, Rock Pool, Kiosk, Cycleway, Seating
Woonona	Yes	Yes	Dune Walkways	Yes		Surf Club, Pool, Cycleway
Bellambi	Yes	Yes	Dune Walkways	Yes		Surf Club, Rock Pool, Cycleway
Corrimal	Yes	Yes	Dune Walkways	Yes		Surf Club, Cycleway
Towradgi	Yes	Yes	Dune Walkways	Yes		Surf Club, Rock Pool, Kiosk, Cycleway, Seating
Fairy Meadow	Yes	Yes	Dune Walkways	Yes		Surf Club, Cycleway
North Wollongong	Yes	Yes	Walkways	Yes		Surf Club, Pools, Kiosk, Cycleway, Seating
City	Yes	Yes	Dune Walkways	Yes	Yes	Surf Club, Kiosk, Cycleway, Seating
Port Kembla	Yes	Yes	Paths	Yes	Yes	Surf Club, Pools, Kiosk, Seating
Windang	Yes	Yes	Dune Walkways	Yes		Surf Club

## APPENDIX C: LEGISLATION SUMMARY

### Coastal Protection Act 1979

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

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

- to protect, enhance, maintain and restore the environment of the coastal region, its associated ecosystems, ecological processes and biological diversity, and its water quality;
- to encourage, promote and secure the orderly and balanced utilisation and conservation of the coastal region and its natural and man-made resources, having regard to the principles of ecologically sustainable development;
- to recognise and foster the significant social and economic benefits to the State that result from a sustainable coastal environment, including
  - benefits to the environment, and
  - benefits to urban communities, fisheries, industry and recreation, and
  - benefits to culture and heritage, and
  - benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water;
- to promote public pedestrian access to the coastal region and recognise the public's right to access;
- to provide for the acquisition of land in the coastal region to promote the protection, enhancement, maintenance and restoration of the environment of the coastal region;
- to recognise the role of the community, as a partner with government, in resolving issues relating to the protection of the coastal environment; and
- to ensure co-ordination of the policies and activities of the Government and public authorities relating to the coastal region and to facilitate the proper integration of their management activities.

The Act allows the Minister for the Environment to direct a council with land within the coastal zone to prepare a Coastal Zone Management Plan, and gives directions as to how such Plans shall be prepared, approved, gazetted and amended where necessary. The Act also requires Coastal Zone Management Plans to incorporate provisions for emergency beach erosion management and to provide for the unobstructed access to the coastline (beaches, headlands, waterways) by the public.

Changes to the act as part of the *Coastal Protection and Other Legislation Amendment Act* are outlined below.

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

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

The objectives of the EPA Act are to encourage:

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

Approval processes for "development" and "works" in NSW are provided for in Part 3A, Part 4, Part 5 and Part 5A of the EPA Act. Key provisions are outlined briefly below.

Part 3A – Major Infrastructure and Other Projects (now repealed)

Part 3A came into operation in August 2005 and applies to development that is declared to be a project to which the part applies. A project can be declared by:

- A State Environmental Planning Policy (SEPP), with SEPP No. 71 – Coastal Protection of relevance to the coastal zone, or
- By order of the Minister for Planning published in the Government Gazette.

There are two types of development that may be declared for Part 3A approval (i.e. in addition to those directed to the Minister via a SEPP):

- Major infrastructure or other development that in the opinion of the Minister is of state or regional environmental significance, or
- Old Part 5 activity approvals where the proponent is the determining authority and an EIS would have been required.

Guidelines regarding Part 3A projects have been provided by the Department of Planning.

#### Part 4 – Development Assessment

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

The controls and permissibility for development of particular sites and / or uses are found in the Wollongong Local Environment Plan (LEP) and Wollongong Development Control Plan (DCP) (see Section **Error! Reference source not found.**).

#### Part 5 – Environmental Assessment

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

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

Part 5 obliges the “determining authority” for the proposal to consider the environmental impact of any activity. A determining authority is the public authority which is required to approve an activity, and can also be the public authority proposing to carry out the activity. For example, Council is permitted to undertake certain environmental management activities under SEPP (Infrastructure) 2007 without development consent, however may need to complete an environmental assessment under Part 5 of the EPA Act.

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

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



## **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. The CL Act provides principles for the proper assessment, development, reservation or dedication and conservation of Crown Lands.

Waterbodies such as beaches and foreshores and estuaries / creeks / lagoons to the mean high water mark are designated as Crown Land. The lands below MHW are 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 Wollongong City Council (WCC) 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). These Crown reserves must be managed in accordance with the public purposes of the land and the principles as set out in Section 11 of the *Crown Lands Act 1989*.

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

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

A Plan of Management (POM) should be prepared for Crown land reserves to 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. Division 6 of the Act discusses the preparation and adoption of POMs by the reserve trust and the Minister. Plans of Management relating to Council managed Crown lands in Wollongong are discussed below in relation to the *Local Government Act 1993*.

## **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 are defined in Chapter 6 of the LM Act. The service functions of councils relate to 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). Section 35 of the

act provides that community land only be used in accordance with the plan of management applying to the parcel of community land; any law permitting the use of the land for a specified purpose or otherwise regulating the use of the land; and the provisions of Division 2 Chapter 6 of the Act. Community land can be categorised into a range of categories under Section 36 of the act, and each of these categories have their own core objectives specified under the Act. The categorisation of community lands is important as the Act requires Council to only grant a lease, licence or another estate (other than in respect of public utilities) for a purpose consistent with the core objectives of the category of that community land.

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
- 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

There are also other POMs that relate to Andrew Lysaght Park (December, 2002), City Beach (July, 2001 and December 1995), North Beach and Stuart Park (August, 2000), and these areas are now largely covered within the Wollongong City Foreshore POM. 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.

A review of these POMs indicated that 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 to structural protection was not indicated). In contrast, the other POMs, particularly the Blue Mile Master Plan (supported by the Wollongong City Foreshore POM), provide for a range of improvements to community facilities, but did not specify that planning for coastal erosion or other hazards be incorporated into the improvement works. The proposed improvements included:

- Replacement of the seawall at North Beach, although the length of this wall (or coastal engineering requirements) was not indicated
- The relocation of the North Beach SLSC, although the proposed location also lies within the 2100 year hazard extent, however designing to accommodate recession and inundation was not noted
- The refurbishment of the North Beach pavilion, again without notation for improving resilience to storm waves and water levels
- Improving access to the northern breakwater of the harbour, without notation for incorporating raising of the breakwater as part of access improvements, that would provide for sea level rise,

- Improving and widening the cycleway and shared pathways from North Beach through Brighton Lawn Reserve to City Beach, again without noting the opportunity to improve the path's resilience to coastal erosion.

While the various POMs provide suitable guidance for use and enjoyment of Community Lands, there is little provision for incorporating improvements of these lands with improving the resilience to coastal hazard impacts.

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

The NSW (2009) Sea Level Rise Policy Statement (the Policy Statement) sets the planning standards for projected sea level rise over the next century that are to be adopted in all forms of coastal assessment, from development applications to coastal hazards definitions studies and coastal zone management plans.

The NSW Government has adopted benchmarks of 0.4 m rise in sea level by 2050 and 0.9 m by 2100 as the best national and international projections for the NSW Coast (at the present time). These benchmarks were used to prepare the Wollongong Coastal Zone Study and hazard lines.

The Policy Statement also provides guidance on the risk-based assessment approach recommended by the NSW Government, and the support the state intends to provide to coastal communities to prepare and adapt to the medium to long term social, economic and environmental impacts of sea level rise.

The NSW Government intends to support local councils through funding assistance for voluntarily purchasing of property or for protection works, provided such actions are based upon thorough assessments (such as a CZMP) that outline the magnitude of the hazard risk, cost-effectiveness of the action including maintenance costs, ability to adequately protect from sea level rise, and the genuine hardship of coastal residents and benefiting landholders. The NSW Government has stated a commitment to:

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

The Sea Level Rise Policy Statement (2009) supersedes the 1988 Coastline Hazards Policy with respect to managing sea level rise. The Policy Statement is to be used in conjunction with the existing legislation and policies for coastal management.

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.

## **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. SEPP 71 aims for development in the NSW coastal zone to be appropriate and suitably located, in accordance with the principles of the Ecologically Sustainable Development (ESD). SEPP 71 applies to all lands within the coastal zone of NSW, which is defined on gazetted maps under the SEPP.

The policy provides for: the protection of and improvement to public access compatible with the natural attributes coastal foreshores; and protects and preserves Aboriginal cultural heritage, visual amenities of the coast, the beach environment and amenity, native coastal vegetation, marine environment of New South Wales, and rocky platforms.

SEPP 71 also 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. Development applications received by Council on such lands must be sent to the Director-General of Planning, and Council is required to take the 'matters for consideration' given in Clause 8 of SEPP 71 and any additional matters specified by the Director-General into account when determining the application.

A master plan is required to be submitted and adopted by Minister for Planning (prior to Council granting consent) for subdivision of land within a residential zone or rural residential zone if part or all of the land is in a 'sensitive coastal location'. This would apply to any future subdivision of land in the Study area.

SEPP 71 does not apply to land within the Wollongong city centre.

## **The NSW Coastal Planning Guideline: Adapting to Sea Level Rise**

The NSW Coastal Planning Guideline: Adapting to Sea Level Rise (the Planning Guideline), support the SLR Policy Statement and were finalised by Department of Planning (DP) in August 2010. The Planning Guideline describes how sea level rise should be considered in land use planning and development assessments. The Planning Guideline outlines six coastal planning principles for adapting to climate change, including:

- assessing and evaluating the coastal risks taking into account the sea level rise benchmarks set by the NSW Government (refer the Policy Statement);
- advising the public as to coastal risks to facilitate informed land use planning and development decision making;
- avoiding the intensification of land use in coastal risk areas through appropriate strategic and land use planning;
- considering options to reduce the intensity of land use in coastal risk areas;
- minimising exposure of development to coastal risks; and

- implementing appropriate management responses and adaptation strategies that consider the environmental, social and economic impacts of such responses.

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

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

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

## **Coastal Risk Management Guide – Incorporating sea level rise benchmarks in coastal hazards assessments**

The Coastal Risk Management Guide – Incorporating sea level rise benchmarks in coastal hazards assessments (DECCW, 2010) states that the identified risk area for coastal planning is to include the existing coastal hazards region plus an additional area affected by sea level rise. DECCW (2010) suggests coastal hazards studies should assess a coastal hazard planning line both with and without sea level rise (at benchmark levels set by the Policy Statement).

The guideline also indicates that the defined coastal inundation hazard should include sea level rise to benchmark levels as part of the assessment, and Design Still Water Levels to be used in such assessments are provided. This Guide was used to prepare the beach erosion and recession and coastal inundation hazard extents in the Wollongong Coastal Zone Study (Cardno, 2010).

The CZMP Guidelines will replace this Guide once adopted by the Minister.

## **Coastal Protection and Other Legislation Amendment Act 2010**

NSW Government's reforms to coastal erosion management were facilitated through the Coastal Protection and Other Legislation Amendment Act 2010 resulting in amendments to the *Coastal Protection Act 1979*, the *Local Government Act 1993* and *Environmental Planning and Assessment Act 1979*. The amendments were passed in October 2010, and came into effect in January 2011. Key amendments are as follows.

- The amendments outline emergency coastal protection works that landholders or public authorities (Council) are permitted to carry out under Part 4C of the *Coastal Protection Act*. The emergency coastal protection works must be consistent with a Code of Practice associated with this Part, which includes the authorised locations for these works, the trigger for their implementation, length of time they are permitted, form of the works (i.e. no higher than 1.5 m AHD, using sand and sand bags placed at toe of erosion scarp only, and only using imported

sand), and . There are no authorised locations in the Wollongong LGA. Additional amendments to Part 4C of the *Coastal Protection Act* in 2012 have modified the allowances for such works (now named 'temporary protection works'; see below for details).

- Improved order powers for Council officers to order the removal or fine landholders who have placed inappropriate protection works (temporary or otherwise) on public or private land was outlined, including 'stop work' orders, increased penalties for such illegal actions, and exemptions from liability for Council officers who place the orders (Section 4D of the *Coastal Protection Act 1979*).
- Amendments to enable Council to levy an annual coastal protection service charge to landholders under Section 55B of the *Local Government Act 1993* who have funded or part-funded coastal protection works (such as seawalls), to pay for ongoing maintenance of the works and management of offsite impacts were implemented.
- 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, including ongoing works such as 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 annual coastal protection service charge (as above).
- A joint state-local body called the NSW Coastal Panel was established under Part 2A of the *Coastal Protection Act 1979* to act as a consent authority for proposed long term protection works (e.g. as above) where a council does not have an adopted CZMP and / or requires further technical assistance in assessing such development applications, and to assist the Minister when requested, such as for reviewing CZMPs.

## Coastal Protection Amendment Act 2012

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

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

The fines for inappropriate placement of sand or sandbags (such as associated with the erection of temporary coastal protection works) have been halved, to reflect the lesser nature of such incidences.

The heavy fines for placement of other non-beach materials (e.g. rocks, car bodies, bricks etc.) remain as per the 2010 CP Act amendments.

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

## **Coastal Protection Service Charge Guidelines**

Also in December 2010 the former DECCW published the Coastal Protection Service Charge Guidelines which outlines the Coastal protection Service Charge, described as a service to maintain and repair coastal protection works or to manage the impacts of coastal protection works. The guidelines detail how it can be used to fund the protection of private property by those property owners deemed to benefit from the works and describing how the amount of the rate should be calculated over the design life of the works. The Minister for Climate Change and the Environment published a notice in the Government Gazette on 31 December 2010 that he had issued these guidelines for the purposes of the Local Government Act.

Eligible coastal protection works for the CPSC include:

- works voluntarily constructed by a benefiting landowner (or landowners)
- works constructed jointly by a public authority (e.g. council) with voluntary contributions from benefiting landowners
- works that existed before section 496B of the Local Government Act 1993 commenced, where the landowner or a previous landowner voluntarily agreed to pay the CPSC
- works that existed before section 496B of the Local Government Act 1993 commenced, where the landowner has voluntarily agreed to upgrade the works. A pro-rata CPSC then applies, based on the incremental additional costs of maintaining the works and managing their off-site impacts.

Residents must agree to pay the CPSC 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 CPSC.

## **SEPP (Infrastructure) 2007**

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

The SEPP also relates to 'waterway or foreshore management activities' (Division 25) which are defined as:

- (a) riparian corridor and bank management, including erosion control, bank stabilisation, resnagging, weed management, revegetation and the creation of foreshore access ways, and
- (b) instream management or dredging to rehabilitate aquatic habitat or to maintain or restore environmental flows or tidal flows for ecological purposes, and
- (c) coastal management and beach nourishment, including erosion control, dune or foreshore stabilisation works, headland management, weed management, revegetation activities and foreshore access ways.'

Section 129 of the SEPP states that development for the purposes of waterway or foreshore management activities (such as defined above) may be carried out by or on behalf of a public authority (i.e. Council) without consent on any land. Such activities include:

- construction works;
- routine maintenance works;
- emergency works, including works required as a result of flooding, storms or coastal erosion;
- environmental management works.

Thus in the study area, Council is permitted to undertake foreshore management (such as a revetment walls, beach nourishment environmental rehabilitation etc), provided they undertake a Review of Environmental Factors (REF) (under Part 5 of the EPA Act), and any other relevant approvals required relating to the land (e.g. *Crown Lands Act 1989*, *Fisheries Management Act 1994*, *Water Management Act 2000* etc).

SEPP (Infrastructure) 2007 repealed SEPP 35 Maintenance Dredging of Tidal Waterways. Further, changes to SEPP Infrastructure are proposed to permit landholders to construct seawalls, as outlined in the the *Coastal Protection and Other Legislation Amendment Bill 2010*.

## **Coastline Hazard Policy 1988**

The NSW Government's Coastline Hazard Policy (1988) aims to reduce the impact of coastal hazards upon land owners and occupiers in the coastal zone, and to reduce public and private losses which may result from coastal hazards. With respect to sea level rise, the 2009 NSW Sea Level Rise Policy Statement supersedes this policy. The remaining objectives from that policy are incorporated into the NSW Coastal Policy 1997.

## **Coastline Management Manual (1990)**

The Coastline Management Manual (1990) documented the NSW Government's Coastline Hazard Policy (1988) and provided guidance for undertaking the required Coastal Hazards Definition studies, Coastline Management Studies, and the preparation of Coastline Management Plans. This document was the guideline document for the Wollongong City Council Coastal Zone Study (Cardno, 2010) (Wollongong Coastal Zone Study).

OEH (formerly DECCW) adopted the *Guidelines for Preparing Coastal Zone Management Plans* in December 2010 which replace the Coastline Management Manual (and other documents).



## APPENDIX D: SUMMARY OF APPROACH TO ASSESSING BEACH EROSION

The SBEACH modelling package calculates cross-shore sediment transport under storm waves and water levels to determine erosion from the beach and dunes during a storm event. The model assumes fine to medium grained sands, and rock layers can be specified within the cross-shore profile used in the model. Geotechnical surveys were conducted at most of the study area beaches, to determine the presence or otherwise of rock layers and sediment grain size data, which was incorporated into the SBEACH model for storm demand analyses, to provide better certainty to the model results.

A key limitation of SBEACH is that it does not include longshore sediment transport, and thus cannot account for the movement of sediment along a beach that may enhance or reduce erosion at any one cross shore profile. SBEACH also does not include rip cell circulation and erosion.

In order to investigate beach erosion, a single design storm condition was adopted by Cardno (2010). The 'design' storm event analysed at Wollongong used the peak 100 year ARI offshore wave height (of 10.6 m  $H_s$ ) calculated from wave data from Botany Bay over the 1971 to 1985 period (Cardno, 2010). This period of wave data was analysed because it covers the stormiest wave period on record, therefore providing a conservative the 'design' storm wave height for investigation.

Based upon the directional wave data from Sydney, storm waves are expected to originate from the east-south-east to south sector (Cardno, 2010). The critical offshore wave direction, as determined from the nearshore wave modelling was found to be ESE at Wollongong's beaches (the critical offshore wave direction was defined by Cardno (2010) as the offshore wave direction that leads to the largest nearshore wave height, for a specified offshore wave height).

Based upon the nearshore wave modelling, wave heights at the 6 m contour at each beach profile to be modelled in SBEACH was output for the 100 year ARI wave height (presumably for the critical offshore wave direction of ESE).

However, it should be noted that the greatest extents of beach erosion recorded have been in response to a series of closely spaced storms, rather than a single storm, most notably, the series of storms during 1974, particularly May – June. Care is thus required in interpreting storm demand estimates from a single storm event for planning purposes.

Photogrammetric data provides the only available data on change in beach volumes and width overtime. Aerial photographs are analysed in stereo to calculate ground elevations. The use of historical aerial photographs can therefore provide a snapshot of beach volume at that time. The data can provide insight into the response of the beach to storm events, and potential trends in beach volume change over time, for example, long term recession. However, given the large times (years) between dates compared with the varying timescales of beach systems (hours to thousands of years) care must be taken to interpret the photogrammetric data, particularly to recognise inaccuracies and anomalies from long term trends.

Photogrammetric data was available from ten of Wollongong's beaches, namely Austinmer, Thirroul, Coledale, Sandon Point, Bulli, Woonona, Corrimal, North Wollongong, Coniston and Perkins. The data sets variously captured dates between 1936 and 2007, with between four and twelve dates for each beach. At almost all beaches, the 1974 photogrammetric profiles demonstrated the most eroded beach position. Since this time, the photogrammetric data indicated a steady increase in beach volumes to the latest date in 2007 (Cardno, 2010).

Photogrammetric data was processed to determine the largest volume difference between consecutive photogrammetric dates. This was said to provide an indirect estimate of the erosion due to large storm events. Within individual beaches, volume losses between consecutive dates were averaged across all profiles within that beach, to provide a single average value for that beach. It should be noted that this may significantly underestimate the potential erosion at any one location along a beach. For planning future development, the average beach profile volumetric loss will be less than the potential hazard to back beach development relating to both rip cells and longshore sediment transport within an embayment (often termed beach rotation). The photogrammetric data can capture rip cell erosion, which cannot be modelled and which is typically much greater than the average erosion along a beach.

The SBEACH modelling was completed for 2 – 4 profiles on each beach (depending on the length of the beach). The "average" beach profile (i.e. the average beach position from all dates of photogrammetry) at each beach with photogrammetric data, or the current beach profile from ALS data was used as the starting profile for the SBEACH modelling, and to measure the beach erosion hazard adopted. The 'design' storm were modelled over a 7-days storm event (as described by Carley and Cox, 2003, where the wave height and water level increases to its peak at the middle of the 7 day period, then dissipates).

SBEACH model results at each beach were then scaled up based on the scaling of Bulli Beach to the 'high' storm demand estimate of 250 m<sup>3</sup>/m.

The volumetric losses given in the photogrammetric data for some beaches were greater than both the modelled and scaled storm demand values adopted (e.g. measured 'average' volume loss of 206 m<sup>3</sup>/m compared with an adopted 147 m<sup>3</sup>/m at central Woonona Beach). This is likely because the photogrammetric volumes were calculated from consecutive dates of photogrammetry that were too widely spaced (> 2 years) to be representative of the single 'design' storm. The widely spaced dates of photogrammetry do not represent a 'design' storm, but do indicate the envelope of beach erosion-accretion cycles that may occur. Therefore, it is possible that the storm demand estimates adopted for each beach will be exceeded, particularly in relation to consecutive storms over longer (decadal) periods.

The potential change in storm erosion due to climate change was not explicitly investigated (Cardno, 2010), as the current climate change projections are inconclusive. In the present climate, long period (inter-annual to inter-decadal) oscillations in climate occur, such as the ENSO phenomenon which is documented to modify the frequency of east coast low events. Current evidence suggests east coast lows can occur twice as often during La Nina compared with El Nino climate cycles (Verdon, et al, 2004). These variable climatic processes affect wave conditions such that it can be expected there will be periods of relatively enhanced storminess over years to decades, such as was reported during the 1970s. Cardno (2010) attempted to include the 1970s period of enhanced storminess by adopting the peak offshore wave height of 100 yr ARI from measured wave data over 1971 to 1985. However,

the SBEACH modelling of Cardno (2010) did not account for consecutive storms, which are known to have produced the enhanced erosion measured on NSW beaches during the 1970s. Therefore, it is possible that the SBEACH storm demand values adopted for the beach erosion hazard at Wollongong may be exceeded.

An erosion hazard or recession hazard (due to sea level rise) was not defined for the Lake Illawarra foreshore. This was because the very low wave energy within the lake was thought to result in episodic but small erosion events at the shoreline. While it is expected that the lake foreshores shall also recede in response to a rise in sea level, Cardno (2010) again this was assumed to be small.

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## **APPENDIX E: BEACH ASSET CONSEQUENCE TABLES**

Stanwell Park Beach	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Parks, Beaches and open space</b>							
Stanwell Park Beach	Major	Insignificant		Beach and adjacent parkland is regionally recognised, has iconic status as a day trip destination, with many day visitors from Sydney.			
Stanwell Park Recreation Area Park	Moderate	Minor		Area is used as a hang-gliding landing area and parking and pack up area. Area has been used by the Stanwell Park Hang Gliding & Paragliding Club (SPHGPC) for many years. They lodged DA in 2002 (still in negotiation in 2009) to use the reserve and Bald Hill sites for this purpose. POM states intent to provide a Lease / Licence to the SPHGPC for hang gliding and paragliding activities carried out in accordance with the DA consent up to 10 years. Consequence for this park is major as area used extensively for hangliding, with oldest club. The park land is associated with regional recognition of beach, with regular visitors and users both from the northern LGA and Sydney. It is also the only sandy beach between Coalcliff and the more inaccessible beaches in Royal National Park. Beach and dunal regions are identified as a High Priority site for restoration works.	Stanwell Park / Bald Hill POM	Update POM to enable use of other park sections, as required due to inundation / erosion impacts	
Coastal Dune Systems	Major	Insignificant			Illawarra Biodiversity Strategy 2010 (Draft)*	Dune restoration as consistent with biodiversity strategy	
Hargraves Creek	Moderate	Minor		Creek has good structural complexity in estuarine vegetation communities, and does support some Saltmarsh EEC (GHD, 2007a). Creek is said to provide good potential foraging habitat for amphibians, microchiropteran bats, terrestrial and coastal birds, and birds of prey (GHD, 2007a). Periodic inundation may be beneficial for estuarine habitats and species.	Council staff		
Stanwell Creek	Moderate	Minor		Stanwell Park lagoon area is said to be a significant Aboriginal area. The estuarine reaches of Stanwell Creek provide good potential habitat for amphibians, microchiropteran bats, and birds (GHD, 2007a). Structural complexity is moderate, and a number of estuarine vegetation communities are supported including Saltmarsh EEC and Swamp Oak Forest EEC (GHD, 2007a). Periodic inundation may be beneficial for estuarine habitats/species.	Council staff / LALC		
<b>Community Infrastructure</b>							
Helensburgh / Stanwell Park SLSC	Major	Moderate	Major	Desire to increase footprint of SLSC, no plans to move (see POM notes) Currently operate out of this building (not separate tower) = need to retain line of sight Storage facility was intended / has been built (recommended in POM) POM noted "The surf club building is significantly constrained by bushfire threat, coastal hazards, a protected tree to the west and its proximity to the boundary of the adjoining privately owned property to the east". The POM indicates that the SLSC could be altered or expanded to improve usefulness for SLSC. Future expansion / alteration only possible within these constraints, and as suitable to character of Stanwell Park / Bald Hill	Council staff / Stanwell Park Bald Hill POM	Consider accommodate or relocate options in more detail	B02030

Stanwell Park Beach	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Stanwell Park SLSC Storage Shed			Minor				B03455
Stanwell Park Beach Toilets (South)		Insignificant		Consequence value assumes damage/spills from the sewerage system would not occur during periodic inundation. Unknown if inundation levels may affect sewerage systems in this location			B02006
Kiosk (in Stanwell Park Recreation Area)		Moderate	Moderate	Plans for expansion and refurbishing, possible knockdown and rebuild. Assessing structure at present (to compare with cost of knockdown and rebuild). Structure is currently on ground. Consider possibility of raising structure (if choose not to knockdown and rebuild) The kiosk has a private residence (leased out, typically to manager of kiosk, not a caretaker). No reported inundation at this building in last 40 years Building is in good repair. Asset provides a valuable community resource, particularly for the northern section of the LGA and visitors from Sydney, as it is only sandy beach between Coalcliff and the more inaccessible beaches in Royal National Park. Building is currently rented out as part of Kiosk facility, as noted above.	Council Staff	Ensure re-design of Kiosk accounts for coastal processes and sea level rise (inundation)	B02240
Stanwell Park Reserve Dwelling		Moderate					B02559
Stanwell Park Reserve Toilets		Minor	Minor				B02241
<b>Transport Infrastructure</b>							
Local Roads, (including car parks)	Minor	Moderate	Minor	Main access to beach for cars is unaffected by erosion.			
<b>Water and sewage infrastructure</b>							
Stormwater outlets and pipes		Major	Major	Area is steep sided, requires suitable infrastructure			
<b>Residential Development</b>							
Existing Residences (4 ppty S end, 1 centre of beach)	Moderate						
Vacant Land (Future Development) (1 blocks)	Minor					Setting development controls or preclude future development	
Existing Residences (7 ppty S end, edge of 1 centre of beach, edge of 9 pplies at end of creek)		Moderate		No flood study completed for Hargraves or Stanwell Creeks as yet, therefore the inundation levels are the first pass. Residents etc will not have been subject to flood controls (or Section 149) previously. Guidance and education required.			
Vacant Land (Future Development) (3 blocks)		Insignificant				as above	
Existing Residences (19 ppty S end, 2 centre of beach)			Moderate				
Vacant Land (Future Development) (1 blocks)			Insignificant			as above	

Coastal Asset	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Parks, Beaches and open space</b>							
Coastal Beach	Major	Insignificant	Major				
Coastal Beach Reserve Nature Area, Coastal Beach Reserve	Minor	Insignificant		This area provides a buffer for recession of the beach amenity as there are little to no backing dunes, while still providing habitat value.			
Leeder Park		Minor	Minor	Park contains a childrens playground, likely to be one of few for the area, and access through to Coastal pool.			
Stoney Creek	Minor	Minor		Rocky creek relatively steep before flowing to a limited outlet directly to beach. Only the area of outlet onto beach is likely to be affected, upper reaches of creek likely to be above impacts. Creek has low structural complexity in estuarine vegetation communities, although does support some Saltmarsh EEC (GHD, 2007a). The estuarine reaches provide limited habitat for fauna (GHD, 2007a).			
<b>Community Infrastructure</b>							
Coastal Surf Club	Moderate		Moderate	Surf club is lower priority - this is just a shed (for storage) with a viewing platform (newly constructed storage building)	Council staff		B02031
Coastal SLSC Public Toilets Extension	Minor		Minor	Attached to SW end of SLSC			B03172
Coastal Boatshed	Minor		Minor	Building to south of SLSC			B02908
Leeder Park facility Toilet Block			Minor				B02242
Coastal Tidal Rock Pool (S end)	Major	Minor		Pool considered highly utilised / important to community, should be maintained. Council has indicated an engineering solution may be required.	Council staff		
<b>Transport Infrastructure</b>							
Beach access road and car park	Minor	Insignificant		Access to beach for cars will still be possible even with erosion impacts. Access to beach or properties during periodic inundation is not significantly affected.			
<b>Water and sewage infrastructure</b>							
Stormwater outlets and pipes			Major				
<b>Residential Development</b>							
Existing Residences (11 ppty N end, but edge of ppty below cliff)	Moderate	Moderate		Effect of this on redevelopment potential of properties	Community		
Existing Residences (19 N end but edge of ppty not houses, 26 centre of beach)			Moderate	Area has measured rates of movement (landslip), leading to strong controls on development. Development is allowed, so long is a suitable and correct design (in this area, can be expensive)	Council staff		
Vacant Land (Future Development) (4 N end)			Minor				

Clifton	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Parks, Beaches and open space</b>							
Moranga Park			Minor				
EEC Habitat Moranga Park Cliff Vegetation (local significance to heritage also)			Moderate				
<b>Community infrastructure</b>							
Heritage Site: Coalcliff Colliery mine shaft (state significance)			Major	See comments in Appendix G from Hazards Study	Cardno, 2010		
Heritage Site: Imperial Hotel			Major				
Heritage Site: Stand of Norfolk Island Pines			Minor				
Heritage Site: Scarborough Hotel			Major				
Heritage Site: Police Station			Major				
<b>Transport infrastructure</b>							
Seacliff Bridge and Lawrence Hargrave Drive			Major	Bridge has been built to withstand geotechnical hazards, therefore risk is mitigated. (Likelihood reduced to rare, consequence reduced to moderate (as impacts accounted for in design), risk level reduced to Low)			
<b>Water and sewage infrastructure</b>							
Stormwater outlets and pipes			Major				
<b>Residential Development</b>							
Existing Residences (22)			Moderate				
<b>Institutional infrastructure</b>							
Primary School (heritage listed)			Major				



Scarborough & Wombarra	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Parks, Beaches and open space</b>							
Scarborough Wombarra Beaches	Major	Insignificant					
Scarborough Recreation Reserve, Jim Allen Oval Natural Area	Minor	Insignificant	Minor	Area presents a buffer for recession of the beach amenity, particularly as there are no significant dunes at the beaches (rocky pocket beach type). Park additionally has grounds for use in sports by community. Likely to be more limited facilities in northern end of LGA.			
Jim Allen Oval	Minor	Minor					
Littoral Rainforest (N end of Scarborough Beach)	Moderate	Minor	Moderate				
Small creek / drainage line (S end of Scarborough beach)	Minor	Insignificant		Stormwater outlets feed into this creek (consequence for stormwater reviewed below). Likely to have limited habitat value as highly developed / existing stormwater impacts. Scattered trees interspersed with residential development, likely to have lower habitat value.			
Important Habitat (Scattered Blackbutt Forest EEC)			Moderate				
<b>Community Infrastructure</b>							
Wombarra Rock Pool	Minor	Insignificant		Pool not considered as important to community, currently being managed to fail, is in poor repair and failing, no maintenance. However, pool requires tidal input and so may benefit from SLR	Council staff		B03720
Wombarra Rock Pool Amenities	Minor	Insignificant					
Heritage Site: Scarborough Cemetery			Minor	The heritage asset covers a large area, likely to be able to relocate affected burial sites.			
Seawall?	N/A	N/A	N/A	Apparently there is a failing seawall built in the Depression (1920s) located along Scarborough Beach. Unknown capacity of wall to protect from erosion impacts.	Workshop	Audit condition of existing structure. Refurbish as required.	
Scarborough/Wombarra SLSC			Major				B02032
Jim Allan Oval, Illawarra Park, Changerooms-toilets			Minor				B02243
Jim Allan Oval, Illawarra Park, Kiosk			Minor				B02244
Wombarra Community Hall and Child- Care Preschool			Moderate				B02143
Wombarra Community Hall and Preschool garage			Minor				B03745
<b>Transport Infrastructure</b>							
Lawrence Hargrave Drive			Major	Major Coastal Road linking to Seaciff Bridge			
Haig Street Reserve (Local Road and car park at Scarborough Beach)			Moderate	Boulders have been used to protect road area. Impacts to roadway would limit access to private properties in this location	Council staff		
Local road reserves and local roads			Minor				
Local roads (inc road access within William Sweeney park area at Wombarra)	Minor						
Railway System			Major	STA already undertaking action to reduce risk of landslip (both consequence and likelihood), risk level reduced to Low.			
<b>Water and sewage infrastructure</b>							
Stormwater outlets and pipes	Major	Major	Major				
<b>Residential Development</b> Existing Residences (60)			Moderate				
<b>Institutional Infrastructure</b> Coledale Hospital			Major				

Coledale Beach extending to N edge of sharkys <b>Parks, Beaches and open space</b>	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Coledale Beach	Major	Insignificant	Major	Creek is essentially stormwater outlet located immediately south of SLSC. Likely to have limited habitat value, high disturbance.	Coledale Beach Reserve POM		
Carricks Creek	Minor	Insignificant		Creek is essentially stormwater outlet located at northern end of the beach. EEC adjacent to creek further upstream.	Coledale Beach Reserve POM		
Stockyard Creek	Minor	Insignificant		Creek is essentially stormwater outlet located at centre of the beach. Likely to have limited habitat value, high disturbance.	Coledale Beach Reserve POM		
Dalys Creek	Minor	Insignificant		EEC adjacent to Stockyard Creek.			
EEC - Coastal Headland Banksia Scrub	Moderate	Minor	Moderate				
<b>Community Infrastructure</b>							
Coledale Surf Club	Minor	Moderate	Major	Coledale Beach Reserve POM stated that any new storage shed and / or SLSC needed to be behind the 50 yr line. At time of plan, club was operational and included a caretakers residence, but the facilities were inadequate, need for new storage shed (or new SLSC depending on funds) was flagged. Operate from a portable tower crane removal will cost around \$5000 Concept designs in place for a relocatable structure (~\$20,000-\$30,000) that will have electricity and sewage connections, but can be moved by a crane at notice of a pending storm. With relocatable structure, risk level reduced to Insignificant (as the likelihood reduced to rare, and consequence reduced to minor based on cost of building).	Coledale Beach Reserve POM / Council staff	Relocatable structure design for new SLSC, reducing risk (likelihood) from coastal hazards	B02033
Coledale Beach Camping and Caravan Park	Minor	Minor	Minor	The campground also provides a buffer for recession of the beach.			
Coledale Beach Camping Reserve - Amenities Building	Minor	Minor	Minor	This is an aging asset, and redevelopment will be required in future, relocation or redesign is then possible	Council staff	Redesign / relocation of structure when replaced	B02011
Heritage Site: Norfolk Island Pines	Minor	Insignificant	Minor	See <i>comments for Thirroul</i>	Council staff		
Coledale seawall	N/A	N/A	N/A	There is a seawall located along the southern part of the beach (beginning adjacent but not in front of SLSC), extending ~ 200m. Coledale Beach Reserve POM (2004) stated the wall to be decaying and in need of repair. Unsure of protective ability, the wall may be just to provide beach access. Money has been spent here to retain structure - seen as important to community - also recent cba showed its cheaper to fix than fill / decommission - the way its cut restricts water movement SLR would probably help with this	Coledale Beach Reserve POM	Audit of condition of seawall repair/remove as recommended	
Coledale Rock Pool	Major	Minor	Minor	West of Coledale Rock Pool	Workshop		B02012
Coledale Rock Pool toilets			Minor				
<b>Transport Infrastructure</b> Lawrence Hargrave Drive (Major Coastal Road)			Major				
Local Beach Access Road and car parking	Minor	Insignificant	Minor	Entire stretch of roadway backing the beach will be lost to erosion, however allows for recession of beach. Would require carpark further westward (immediately behind campground) and Lawrence Hargrave Drive to become main beach access route. (NB cadastral boundary for roadway extends beyond actual roadway). Periodic inundation likely to have limited damages or impacts.	Council staff		
<b>Water and sewage infrastructure</b> Stormwater outlets and pipes	Major	Major	Major				
<b>Residential Development</b> Existing Residences (33 at S end of beach)			Moderate	Geotechnical issues unknown of in some of these areas	Community		
<b>Institutional Infrastructure</b> Coledale Public School - Grounds only	Minor		Minor	Erosion hazard only affects school grounds, not main building			
Coledale Public School - Buildings			Moderate				

Sharkys Beach	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Parks, Beaches and open space</b>							
Sharkys Beach	Major	Insignificant	Major				
Public open space	Minor	Insignificant	Minor	This area immediately backing beach provides buffer to enable recession of the beach, particularly as there is little to no backing dunes.			
<b>Community Infrastructure</b>							
Heritage Site: Norfolk Island Pines (backing entire beach)	Minor	Insignificant	Minor	See <i>comments for Thirroul</i>	Council staff		
Shark Beach toilet block (mural painted)			Minor	South end of car park			B02013
Austinmer Boat Harbour toilets			Minor	Western side of car park that is adjacent to the harbour			B02412
<b>Transport Infrastructure</b>							
Lawrence Hargrave Drive (Major Coastal Road)			Major				
Car park (behind Sharkys beach and at boat harbour)	Minor	Minor	Minor	This area provides a buffer for recession of the beach amenity. Would need to be relocated to enable continued provision of parking for community associated with the Harbour.			
Sharkys / Austinmer Boat Harbour (Heritage listed)	Major	Major	Major	Concerns raised over availability of harbours for community use - there are very few harbours available in Wollongong.	Committee		
<b>Water and sewage infrastructure</b>							
Stormwater outlets and pipes	Major	Major	Major				
<b>Residential Development</b>							
Vacant Land (Shark Park)	Minor	Insignificant	Minor	Shark Park - assume this is Council owned land, but is still currently zoned as residential land. (First residential cadastral block at N end of beach). The land could provide a buffer for recession of the beach amenity.		Rezoning to public open space	

Little Austinmer (Austinmer North) Beach	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)	Council asset #
<b>Parks, Beaches and open space</b>								
Little Austinmer Beach	Major	Insignificant	Major					
Public open space	Minor							
Coastal Dune Systems	Major	Insignificant	Major					
<b>Community infrastructure</b>								
Heritage Site: Norfolk Island Pines (backing entire beach)	Minor	Insignificant	Minor	See comments for <i>Thirroul</i>	Council staff			
Heritage Site: Glastonbury Gardens			Moderate	The gardens, as a heritage asset, are more spread out, and therefore, the impacts can be managed across the site without loss of all heritage value.				
Tuckerman Park Toilet/Shed	Minor	Insignificant	Minor					B02249
<b>Transport Infrastructure</b>								
Lawrence Hargrave Drive (Major Coastal Road)	Catastrophic		Catastrophic	Major access route to Northern Wollongong LGA, limited land area for relocation.		Major access route to Northern Wollongong LGA, limited land area for relocation.		
Local roads and car park	Minor		Minor					
<b>Water and sewage infrastructure</b>								
Stormwater outlets and pipes	Major	Major	Major					
<b>Residential Development</b>								
Existing Residences (2)	Moderate			Community needs to have better information about development potential, development controls, and DA assessment requirements for coastal hazards, should they wish to subdivide (or sell)	Community*			
Existing Residences (14)			Moderate					
<b>Commercial and Industrial Development</b>								
Heritage site: Austinmer Headland Hotel			Major	While a private commercial asset, the site is heritage listed.				

Austinmer Beach	Erosion / Recession	Periodic Inundation	Periodic Inundation	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Parks, Beaches and open space</b>							
Austinmer Beach	Major	Insignificant	Major				
Austinmer Beach Reserve and Tuckermans Park	Minor	Minor					
<b>Community Infrastructure</b>							
Austinmer Surf Club	Major	Moderate	Major	Surfclub said to have been relocated in the 1980s.	??		B02034
Heritage Site: Norfolk Island Pines (backing entire beach)	Minor	Insignificant		See comments for Thirroul	Council staff		
Geologic Site: Rock headland / platform		Insignificant	Major	Little detail regarding this site.			
Austinmer Rock Pool	Major	Minor		Council has indicated Austinmer is a priority pool for community, and engineering solution may be required to retain pool. Walk from Thirroul to Austinmer Pool only possible at low tide, this will become impassable with sea level rise. Pool is easily accessible from Austinmer Beach, however.	Community* / Council staff		
Changeroom & toilets	Minor	Insignificant	Minor	Immediately south of SLSC, site is associated with functioning of surf club. Concept plans have been provided for an extension to the boatshed, to provide changerooms, gym, kitchenette and viewing facility. The plans have taken coastal hazards into consideration, therefore lower consequence from coastal erosion impacts is expected. Structure to be built on ground level at 4.8 m RL.			B02014
Austinmer Boatshed	Insignificant	Minor	Insignificant		Council staff		B02015
Austinmer Seawall	N/A	N/A	N/A	There is said to be a substantial wall along this beach. Coastal engineering condition and protection from wall unknown. LPMA (Brian Dooley) has photographs.	LPMA / LIA Authority	Assessment of seawall condition. Repair and update hazard lines or remove as recommended.	
<b>Transport Infrastructure</b>							
Lawrence Hargrave Drive (Major Coastal Road)	Catastrophic	Major		Major access route to Northern Wollongong LGA, limited land area for relocation.			
Lawrence Hargrave Drive (Major Coastal Road) in area between Austinmer & Thirroul Beaches			Catastrophic	Major access route to Northern Wollongong LGA, limited land area for relocation. Given history of geotechnical hazards in this location, risk level reduced to low (likelihood rare, consequence minor as designed to accommodate landslip).			
Beach access and car park	Minor	Insignificant		Periodic inundation would have limited impact to community services and limited damages.			
<b>Water and sewage infrastructure</b>							
Stormwater outlets and pipes	Major	Major					
Stormwater outlets and pipes in area between Austinmer & Thirroul Beaches			Major				
<b>Residential Development</b>							
Existing Residences (~ 30) in area between Austinmer & Thirroul Beaches			Moderate				
<b>Commercial and Industrial Development</b>							
Neighbourhood Business Centre (local shops)		Moderate		Local shops said to have been raised and are on piles (done by developer), to accommodate inundation	Council		

Thirroul Beach	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Parks, Beaches and open space</b>							
Thirroul Beach	Major	Insignificant		Said to be small amount of change in beach position in last 70 years. 1911 photograph of Thirroul Beach taken from southern end provided by local resident shows unvegetated dunes (higher than present), beach is similar position (refer copy of photograph).	Community*	Undertake dune establishment works to protect back beach development (inc residential properties). May include sacrificing some assets to provide area for re-establishment (RA Workshop)	
Tingara Park	Minor	Insignificant		Except for small area (noted below) majority of beach has no coastal dune protection. Unsure of seawall structural condition for providing protection. Park area provides only available land for migration of beach amenity.			
Flanagans Creek	Minor	Insignificant		The creek is quite large, with vegetated foreshores. However the creek provides limited habitat for fauna and no EECs and limited estuarine vegetation types (GHD, 2007a). Therefore, impacts to habitat value from erosion considered minor, and from periodic inundation considered insignificant.	Council Staff		
Coastal Dune System (small area adjacent to creek outlet)	Major	Insignificant		Remainder of beach (ie, in front of seawall) has no dune system	Workshop		
<b>Community Infrastructure</b>							
Thirroul Surf Club	Major	Moderate		10 yr horizon for replacement of building	Council staff	Rebuild on same footprint (e.g. double storey) to accommodate inundation, or relocate landward (RA Workshop)	B02035
Thirroul Pool (also heritage site)	Major	Minor		Pool shell will require replacement in next 5 - 10 yrs. Greater expectation from community for management from heritage perspective. Highly valued community asset.	Council staff	Allow pool to become a tidal pool, rebuild new pool landward (RA Workshop)	
Thirroul Pool office and amenities	Major	Moderate		Assume part of pool asset, therefore of higher consequence.			B02052
Thirroul Pool toilet	Major	Moderate		South end of pool. Assume part of pool asset, therefore of higher consequence.			B02053
Thirroul Pool storage shed (large)	Major	Moderate		South end of pool. Assume part of pool asset, therefore of higher consequence.			B03183
Thirroul Pool intake	Major	Moderate	Major	Blue building and pipes, southern end of beach. Provides for filling of pool, therefore part of pool asset and so higher consequence.			B02066
Heritage site: Thirroul Pavilion (being used as kiosk / restaurant) and residence	Major	Moderate		Council is currently processing a DA for refurbishment of the Pavilion (as both proponent and consent authority). Hazard assessment and design being completed by Cardno for this project. Seawall has possibly been incorporated into hazard assessment. Using State Govt guidelines for hazards consideration, in lieu of Wollongong specific hazard guidelines.	Council staff	Ensure refurbishment adequately considers design elements to accommodate coastal hazards	B02016
Heritage Site: Thirroul Beach Reserve (S of pool)	Moderate	Minor		Public open space that has heritage value, as part of Thirroul Beach precinct.			
Heritage Site: Norfolk Island Pines	Minor	Insignificant		Pines are a marker of the foreshore area. Currently strong restrictions on development near the pines, cannot be removed. Pines will have a limited lifespan and may perish over next 100 years. In future, the Pines are unlikely to be able to be relocated but could be replanted (when undetermined in future). The species is still commonly used in foreshore plantings. Protection may not be a viable option where pine will perish at some point in future.	Council staff		
Thirroul Beach seawall	N/A	N/A	N/A	Unsure of ability of seawall to protect against erosion. Was completely exposed after 1974 storms, apparently has piles to stronger foundation, however stormwater erosion shows base of concrete at 1 -2 m AHD. Wall built in early 1950s (further information may be available from Brian Dooley at LPMA)	Council staff / LPMA	Rebuilding or enhancement along entire beach may be appropriate, as part of a local area planning strategy for Thirroul (RA Workshop)	
Heritage site: DH Lawrence House			Major	At southern "headland", house where DH Lawrence was staying when wrote "Kangaroo".	Council staff		
Heritage site: Former Quest House		Moderate					

Thirroul Beach	Erosion / Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Transport Infrastructure</b>							
Major Roads (Lawrence Hargrave Drive)		Major					
Local Roads (Bath St linking to the Esplanade, Henley St, Road reserve for Harbord & Ocean Sts)	Minor	Moderate					
Beach access and car park (N end of beach)	Minor	Minor					
Beach access and car park (S end of beach)	Minor	Minor					
Local Roads (*at headland south)			Minor				
<b>Water and sewage infrastructure</b>							
Stormwater outlets and pipes	Major	Major		Cause erosion on beach during heavy catchment rainfall events This is the main stormwater line back through houses west of beach, exits to beach at southern end adjacent to pool intake. Flood management plan completed as part of Hewitts Creek FRMP. FRMP suggested opening the creek at 2.8 m RL, but this is essentially a stormwater outlet / drainage line rather than an entrance berm that would significantly impede flood flows?? As above, outlet causes erosion during heavy rainfall events. Residents affected by inundation (below) should already have Section 149 notation of flooding, as this creek (and its floodplain risk areas as per the FRMP) is contained in DCP E13. Creek is essentially a piped stormwater outlet, does not appear to have any associated habitat.	Hewitts Creek FRMP	Scour protection for drainage outlets (RA Workshop)	
Thomas Gibson Creek - Stormwater outlet	Major	Major					
Stormwater outlets and pipes (*at headland south)			Major				
<b>Residential Development</b>							
Existing Residences (10 ppty at S end of beach toward DH Lawrence heritage site: 1 property at centre of beach)	Moderate		Moderate			Set foreshore building line, communicate risk and signal council intent (ie will not protect), develop local adaptation strategy, develop evacuation plan (RA Workshop)	
Existing Residences (extensive, relating to creek and stormwater pipe)		Moderate		Flanagans Creek & Stormwater drainage line - no flood study completed as yet, therefore the inundation levels provide first pass. Residents etc will not have been subject to flood controls (or Section 149) previously. Guidance and education required. Filling of 186 Lawrence Hargrave Drive residential property caused more flooding from upstream to ppty e.g. 182 / 184 L. H Drive. 1998 flood level reached laundry below house. Residents have raised concerns over changes to Section 149 - there needs to be better notation on what the risk actually is (ie, more than just "affected by coastal hazards", but explaining what hazard (e.g. inundation), what impact this may have (e.g. couple hours over high tide) and perhaps likelihood (e.g. possible / likely by 2100), to better convey to owners / potential buyers the risk. Understandably, the residents have raised questions about the science and modelling (e.g. neighbours there for 50 years have never seen inundation), as they are concerned about how the science affects their property value. However, they would be more comfortable to accept the science if better notation was on the Section 149 / available to community and buyers.	Community** / Community** * / Hewitts Creek FRMP	As above. For future development, DCP controls for inundation, potentially downgrade LEP zoning in high coastal inundation hazard zones, develop an evacuation plan (RA Workshop)	
Existing Residences (21 from 157 Lawrence Hargrave Dr on headland north, 11 south to Cnr Craig St)			Moderate	At residence adjacent to pool intake = has a concrete seawall (headland), acting well to protect from cliff erosion There is an informal coal shaft within the two properties to the south of the seawalled ppty. Coal seam at base of cliff - unstable, sprayed concrete to fix*	Council staff / Community*	Set a Foreshore Building Line for geotech hazard (e.g. rock, platform and cliff along 'the Boulevard'), to manage land redevelopment (RA Workshop).	





Sandon Point Beach	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Boundary ends at car park on S							
<b>Parks, Beaches and open space</b>							
Sandon Point Beach	Major	Insignificant					
Sandon Point Beach Reserve (not including Sandon Point Heritage area)	Minor	Insignificant		Reserve provides buffer area for roll back of beach and dunes.			
Slacky Creek	Minor	Minor		Slacky Ck comes under the Hewitts Ck FRMP, which recommends Council open lagoon / clear entrance when berm reaches RL 2.8 m. Needs to confirm with Council if this is done at present?? (also check EMPs). The lower estuarine reaches of Slacky Creek provide limited habitat for fauna, and structural complexity is low at the entrance bar, with only two estuarine vegetation communities and no EECs supported in the creek. (GHD, 2007a). Much further upstream there may be an EEC with good riparian habitat, may be affected by inundation, but not erosion.	Hewitts Ck FRMP		
Coastal Dune Systems (N end of beach)	Major	Insignificant					
<b>Community Infrastructure</b>							
Sandon Point Surf Club	Major	Moderate	Major	Re-development of SLSC in current location is planned. Not possible to relocate structure from current position to outside of hazard zone due to Aboriginal heritage of Sandon Pt. Significant money (\$millions) planned for redevelopment. Site was subject to specific hazard study. Results have not been made available for CZMP (as yet), unknown what design or other provisions have been made to accommodate the immediate beach erosion hazard - it is expected the structure shall have foundation piles to rock and be designed to accommodate erosion, wave forces. Given location of SLSC near to Sandon Pt, likely to find stable rock for foundations, but will need to be built to withstand wave forces, erosion of sand, and occasional inundation in current location.	Council staff	Redevelopment of SLSC is currently underway - ensure redevelopment is built to withstand erosion, inundation hazards and wave impacts.	B02037
Heritage Site: Sandon Point (also under NPW Act)		Minor	Major	Heritage site includes for Aboriginal significance. Have received grant funding to do revegetation of Sandon Point. Nearshore reef is of high value to community (e.g. recognised surfing location, snorkelling, fishing). Weedy Sea Dragon habitat exists off Sandon Point	Council staff / Community / Community**		
Heritage Site: Sandon Point Boat Sheds		Minor	Moderate	Located along northern margin of Sandon Point itself (north around point from SLSC) Unusual lease arrangement (100yr with Lands) but if destroyed, current management approach is that they will not be rebuilt or protected. Currently in a state of disrepair, known to be subject to coastal processes in very vulnerable location. Still used occasionally.	Council staff	Retain current management approach	B03095
Northern Cycleway / Shared Pathway (at S end of beach)	Moderate			Where the cycleway eroded, a stormwater outlet was also replaced. No erosion design code for stormwater at present. Rocks used to prop up cycleway in this location.	Council staff		
Northern Cycleway / Shared Pathway		Minor	Moderate				
Heritage Site: Norfolk Island Pines (S end of beach)	Minor	Insignificant		See comments for Thirroul	Council staff		
<b>Transport Infrastructure</b>							
Local Roads: Blackall St, Ursula St, Alroy St	Minor	Moderate					
Beach car parks (S end of Beach)	Minor	Minor					
<b>Water and sewage infrastructure</b>							
Stormwater outlets and pipes (S end of beach)	Major			Trinity Row inadequate drainage pipes at Ursula road and south between Ursula and Alroy Streets	Community*		
<b>Residential Development</b>							
Existing Residences (8 at S end of beach)	Moderate			Clarity required on effect of hazard on redevelopment potential of land.			
Existing Residences (adjacent to creek)		Moderate		As above, plus most of the affected pities will already have Section 149 notation and be subject to Medium Risk Flood development controls (DCP E13). Only an extra 4 pities affected by inundation compared with flood planning area (which was prob modelled without SLR)	Community / Hewitts Ck FRMP		

Bull Beach (including Waioria Pt headland and Parks, Beaches and open space	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Bull Beach	Major	Insignificant	Major	Note the Bull Area is listed on the Register of the National Estate*			
Bull Beach Reserve	Minor	Insignificant	Minor	Reserve provides a buffer to enable roll back of beach			
Ocean Park	Minor	Insignificant		The area of land affected at Ocean Park is open space grassed area			
Wharfons Creek	Minor	Insignificant		Creek supports only a few estuarine vegetation communities (no FEECs), and structural complexity is low at the entrance bar. The estuarine reaches of Wharfons Creek provide limited habitat for fauna (GHD, 2007a).			
Collins Creek	Moderate	Minor		The estuarine reaches of Collins Creek provide good potential foraging habitat for amphibians, microchiropteran bats, terrestrial and coastal birds, and birds of prey. Structural complexity is quite high at the entrance bar, with a mixed assemblage of saltmarsh species (an EEC), beach grasses and coastal dune vegetation. The coastal dune vegetation has been recently planted (GHD, 2007a)			
Coastal Dune Systems	Major	Insignificant		Dunes have been established at Bull specifically to provide a buffer to erosion	Maintain dunes to provide erosion buffer (RA Workshop)		
Waioria Point (Heritage site)	Major	Moderate	Major	Area has high heritage significance. Grant recently received to protect Aboriginal midden, and rehabilitate from existing erosion impacts. Works will commence after summer, to reduce likelihood of public access / damage to works.	Council staff		
<b>Community Infrastructure</b>							
Bull Surf Club	Major	Moderate	Major	DA on surfclub was refused. Norfolk Pine may limit moving the club; Dune vegetation and line of sight issues at this site - expressed an interest in helping with dune vegetation	Council / Community	Determine suitable relocation site, and relocate structure when trigger is reached (replacement schedule or distance from erosion scarp, whichever occurs first) (RA Workshop)	B02036
Bull Kiosk and residence	Moderate	Moderate	Moderate	Plan to maintain current building (not rebuilt as yet), with ~25 years life remaining on building. Recent maintenance works on building with grant including water tank (\$50 - 100K). Kiosk also has a residence, recently signed 10 yr lease for tenants.	Council staff	Relocate cabins into adjacent park area when trigger is reached (replacement or distance from scarp), to maintain current commercial asset. (RA workshop)	B02017
Bull Tourist Park (caravan park)	Moderate	Minor		Very high commercial value to Council, will be aiming to retain asset into the future. A new kiosk (temporary facility) has recently been built within the tourist park.	Council staff		Various*
Cycleway / Shared Pathway	Moderate	Minor	Moderate	At Waioria point, the cycleway was undermined during storms, prompting Council to rebuild and protect the path using rock to stop further erosion (unknown if was also raised for inundation).			
Bull Pool	Moderate	Minor	Minor	Gets inundated with sand, requiring regular costly cleaning (~ \$6K per clean). Woonona pool is located nearby, however site is said to also have community value.	Council staff	Engineering option to increase height of walls, with trigger of 0.2 m SLR for implementation (RA Workshop)	
Heritage Site: Bull Cemetery		Minor		The heritage asset is covers a large area, likely to be able to relocate affected burial sites.			
<b>Transport Infrastructure</b>							
Car parks (Bull SLSC, Collins Pt reserve)	Minor	Minor					
Local Road (Campbells St, Ocean St road reserve)		Moderate					
<b>Water and sewage infrastructure</b>							
Stormwater outlets and pipes	Major	Major					
<b>Residential Development</b>							
Existing Residences (adjacent to creek)		Moderate		Residents have raised concerns over changes to Section 149 - there needs to be better notation on what the risk actually is (ie, more than just "affected by coastal hazards"; but explaining what hazard (e.g. inundation), what impact this may have (e.g. couple hours over high tide) and perhaps likelihood (e.g. possible / likely by 2100), to better convey to owners / potential buyers the risk. Understandably, the residents have raised questions about the science and modelling (e.g. neighbours there for 50 years have never seen inundation), as they are concerned about how the science affects their property value. However they would be more comfortable to accept the science if better notation was on the Section 149 / available to community and buyers. Also requested ground truthing / spot checks on ground along inundation boundary, to better confirm mapping.	Community**	Section 149 notification, redesign of structures (e.g. raising floor levels) (RA Workshop)	
Existing Residences (8 behind Waioria Pt)			Moderate	as above			
<b>Institutional Infrastructure</b>							
Bull High School		Moderate					

Woonona Beach (extends to creek at centre of beach) <b>Parks, Beaches and Open Space</b>	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Council asset #
Woonona Beach	Major	Insignificant		At high tide, no beach, as dunes and incipient dunes with spinifex and <i>Acacia sophorae</i> in particular have grown and advanced significantly seawards (particularly compared with the wide beach area with no dunes during the 1970s). At high tide, the water extends to incipient dunes, no beach width for sunbathers.	Council Staff, community		
Nicholson Park, Beach reserve	Minor	Insignificant		Provides buffer for recession of beach amenity. Sports grounds on Nicholson Park would not be affected.			
Unnamed Creek and adjacent habitat	Moderate	Minor		Evidence of stormwater outlets flowing into the creek. Appears to be some habitat surrounding creek. Unsure of habitat value.			
Coastal Dune Systems	Major	Insignificant		Request for change in dunal species to allow viewing of the beach, removal of snakes/vermin and weeds. [NB - better education required to explain to community value of coastal dunes for erosion protection and habitat]. Concerns raised over dune species height (and dune height) that is now too high and too wide. One resident stated the dune height has blocked views from SLSC for members, and from roadway for surfers and passers by. This resident has lived in area whole life and remembers the beach in 1960s and 70s as having no dune, walk straight onto a wide low beach. On occasion, sand blown up over the road (either side of and into Nicholson Park). The sand was then mechanically shifted back onto the beach. After storms, the high tide came up to the present surf club. Resident said he preferred beach in those days, because could see water and have a wide beach for sun bathing, SLSC activities. Resident also said the dunes house rats, rabbits and weeds (prickly pear, bitou, asparagus weed), walkways are overgrown. Believes cant see beach from the lifeguard tower. Member from Woonona SLSC also noted the dune species were too high (blocking views at present) and incipient dunes presently too wide to provide much of a beach for sunbathers. Also noted dunes house rats, rabbits and weeds, and walkways are currently overgrown. Requested better species (and cropping of current dune species), but understands why the dunes are needed to protect from erosion. Member not opposed to being involved in volunteer dune care, changing species to lower grasses and shrubs, or use of portable platforms, as needed. But these concerns are also about beach amenity, not just lifeguarding.	Council staff, community (~ 4 different people)		
<b>Community Infrastructure</b>							
Woonona Surf Club	Major	Moderate		Resident noted surf club has piers extending 18 m through the sand down to clay (there is no solid rock), when built.	Community		B02038
Lifeguard Tower	Minor	Insignificant					B03116
Woonona pool	Moderate	Insignificant		Pool may in fact improve with SLR, as currently pool only fills at top of tide, although pump station may be at risk. Pool is located on Collins Point at Northern end of beach. Pool has fairly high community value.		Engineering option to increase height of walls, with trigger of 0.4 m SLR for implementation (RA Workshop)	
Woonona Rock Pool Dressing Shed	Minor	Insignificant		Not actually beneath the erosion or inundation lines, but immediately adjacent to where they end. Possible that will be protected from erosion as founded on rock immediately behind the rock pool.		Relocate cycleway	B02019
Cycleway / Shared Pathway	Minor	Minor					
<b>Transport Infrastructure</b>							
Beach access and car parks	Minor	Minor	Minor				
Local Roads (Kurraba Rd, Park St, Beach Drive, Corinda Rd, Llamina Ave, Robertson Rd, Dorrigo Ave)	Minor	Moderate	Minor	Access to residential property is possible to be retained, even where local roads affected.		Alter traffic routes (inc bus), redesign road network to maintain access to residential properties, then allow road to be eroded (i.e. retreat) (RA Workshop)	
<b>Water and sewage infrastructure</b>							
Stormwater outlets and pipes	Major	Major				Redesign network (over typical replacement schedule) to accommodate / mitigate inundation.	
<b>Residential Development</b>							
Existing Residences (19 at centre of beach)	Moderate	Moderate		Concerned about effect of notation on property value and insurance	Community		
Existing Residences (5 at N end)							
Existing Residences (adjacent to creek)		Moderate	Moderate				

Bellambi Beach (not inc Bellambi Pt)	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Parks, Beaches and open space</b>							
Bellambi Beach	Major	Insignificant					
Beach Drive Park, Bellambi Natural Area, Bellambi Point Reserve, Bellambi Pool Reserve	Minor	Insignificant		Provides buffer for recession of beach amenity.			
Bellambi Gully and adjacent habitat	Moderate	Moderate		Bellambi Gully estuarine condition is classified as extensively modified (Cardno, 2010 CZS). However, the estuarine reaches of Bellambi Gully provide excellent potential foraging habitat for amphibians, microchiropteran bats, terrestrial, estuarine and coastal birds, and birds of prey (GHD, 2007a). Structural complexity is quite high at the entrance bar, with a mixed assemblage of saltmarsh species, beach grasses and coastal dune vegetation (GHD, 2007a), Bellambi Creek and Farrahers Creek run into Gully.			
Coastal Dune Systems	Major	Insignificant					
<b>Community Infrastructure</b>							
Bellambi SLSC		Moderate		Mural painted	Council		B02039
Cycleway / Shared Pathway	Moderate	Minor					
Bellambi Pool	Major	Minor		Pool has been maintained to better withstand wave impacts, \$700000 recently spent on concourse and toddler pool upgrades. Recent works will have increased financial and community value.	Workshop		
Bellambi Pool Toilet Block		Insignificant					B02851
Bellambi Gully training wall	N/A	N/A		Not designed for hazards protection. Will probably need to be maintained to protect property.			
Bellambi boat ramp toilets (Old Coastguard building) - located at southern end of formal carpark area on Bellambi Point)		Insignificant	Minor		Council		B02596
<b>Transport Infrastructure</b>							
Bellambi pool car park	Minor	Insignificant					
Bellambi Boat Harbour	Major	Minor		Concerns raised over community usage of this - there are very few harbours available in Wollongong, functionality of ramp will be an issue	Committee		
Local Access road along coastline	Moderate	Moderate	Moderate	Access is constrained along this shoreline section, therefore local road needs to be retained, which could be done if area of parkland / open space / STP land used for local road.			
<b>Water and sewage infrastructure</b>							
Stormwater outlets and pipes	Major	Major					
Sewage Treatment Plant	Major	Major	Major				
<b>Residential Development</b>							
Existing Residences (~ 20 in 3 developments)			Moderate				

Bellambi Point Beach (to Lagoon entrance) <b>Parks, Beaches and open space</b>	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Bellambi Point Beach	Major	Insignificant		EEC located within residential area, likely to be disturbed.			
EEC area		Minor		Based on aerial photographs (see below) frontal dunes were vegetated very recently. Vegetation mapping describes the dunes as highly disturbed.			
Coastal Dune Systems	Major	Insignificant		Bellambi Lagoon is listed as being of local heritage significance, and also has high habitat value. There has been an ongoing problem relating to the breakout and northwards migration of the entrance channel, which is causing erosion of the northern dunes adjacent to entrance. There have been concerns raised by community over the erosion, which is destabilising attempts to revegetate the northern bank, and concerns the erosion will continue into the area of middens (which are located further back within the dunes beyond the immediate erosion area, but could potentially be impacted). (Discussion of aeriels and DECC analysis of photogrammetry below ***). Solution being trialed is a hybrid approach entailing maintenance of a pilot channel and berm configuration to allow the entrance to breakout in the desired location (further south).	Council staff / workshop / DECC study into erosion / Illawarra Biodiversity Strategy 2010 (Draft)*	DECC study recommended options for management.	
Heritage Site: Bellambi Lagoon (Lake), Sandpit Point and associated habitat	Major	Moderate		Bellambi Lagoon is identified as a Highest priority site for restoration works. Bellambi Lagoon estuarine condition is classified as extensively modified (Cardno, 2010 CZS). However, GHD (2007a) found the estuarine reaches of Bellambi Lagoon provide excellent potential foraging habitat for amphibians, microchiropteran bats, terrestrial,			
<b>Community Infrastructure</b>							
Heritage Sites: Bellambi Point	Major	Moderate	Major	There are likely to be sites of Aboriginal heritage significance in this location. The area is now a nominated Aboriginal Place	Council staff / LALC	Need to develop strategy for managing hazard impacts to different types of heritage sites (e.g middens)	
<b>Water and sewage infrastructure</b>							
Sewage Treatment Plant	Major	Major	Major				

Corrimal Beach (extending from south of Bellambi <b>Parks, Beaches and open space</b>	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Corrimal Beach	Major	Insignificant					
Corrimal Beach Natural Area: Coastal Dune Systems	Major	Insignificant		Has been illegal clearing recorded in the past. Vegetation mapping describes the dunes as highly disturbed with weeds, even though vegetation appears to be well established. One resident has concerns over "the effect of backup flooding due to the backup of water from Towradgi Creek. Have contacted the school re: block of stormwater drain at the rear of 4 Gregory Ave - no response forthcoming". Southern side of lagoon is identified as a High Priority site for restoration works. Trigger Level for opening: 1.6 m (with rain falling or impending), with alert level at 1.4 m (ie, to mobilise equipment for opening). If lagoon doesn't breakout and rainfall not impending, emergency trigger level set at 1.85 m, to alleviate flooding of property and assets beyond this level (e.g at 1.8 m some stormwater assets on Lake Pde and Parker Rd and flooding of ppty (not floors) on Parker Rd Arm, Parker Rd crossing at 1.94 m, overfloor flooding of pptides at 1.97 m). Towradgi Lagoon estuarine condition is classified as extensively modified (Cardno, 2010 CZS)	Council staff  Community* / Illawarra Biodiversity Strategy 2010 (Draft)** / Towradgi Lagoon Entrance Management Policy		
Towradgi Lagoon and adjacent EEC Habitat	Moderate	Moderate					
Towradgi Park: Coastal Dune Systems (and small area of open space)	Minor	Insignificant					
<b>Community Infrastructure</b>							
Corrimal Surf Club		Minor		Has removable structure (sied system , no power or water supply)	Check this info??		B02040
Towradgi Rock Pool amenities mens	Minor	Insignificant		There are two blue roofed buildings at the far southern end of the beach (adjacent to roadway dividing this from Towradgi Beach). The mens amenities is slightly further north and in both hazard zones			B02020
Towradgi Rock Pool amenities womens	Minor			The womens building is slightly further south and not in inundation hazard zone.			B03148
<b>Residential Development</b>							
Existing Residences (adjacent to creek)		Moderate		The inundation extents (at 2100) lie within the existing High or Medium Risk Flood planning area from the Towradgi Creek FRMP. Therefore, development controls and Section 149 notation shall already have been issued to residents. Noted by Committee that voluntary acquisition was offered to flood affected residents.	Towradgi Ck FRMP / Committee		

Towradgi Beach (extending to just north of Fairy Parks, Beaches and open space)	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Towradgi Beach	Major	Insignificant					
Towradgi Beach Park: Coastal Dune Systems	Major	Insignificant		Some areas of good vegetation, some areas of high disturbance (based upon vegetation mapping)			
<b>Community Infrastructure</b> Cycleway / Shared Pathway	Moderate	Minor					
Towradgi Pool	Major	Minor		Tidal, would require an engineering solution, highly utilised by the community (NB amenities buildings for the pool are located north, behind Corrimal Beach - see this beach for hazard details)			
Towradgi Beach Lifeguard Tower	Minor			Near (south east of) Towradgi SLSC.			B02049
Towradgi Protection Structure - Training wall?	N/A	N/A		At north end of Towradgi there is a Gabion mattress with toe 1m x 1m to protect the road and houses	LPMA		
<b>Transport Infrastructure</b> Local Roads: Towradgi Road, Marine Parade (N end of beach)	Moderate	Moderate		There may be difficulties maintaining access to some properties (as well as beach visitors) that will make these local roads more important and complicated to manage.			
<b>Water and sewage infrastructure</b> Stormwater outlet / pipe (N end)	Major						
<b>Residential Development</b> Existing Residences (4 at N end)	Moderate	Moderate		Clarity required on effect of hazard on redevelopment potential of properties	Committee		
Vacant Land - 15 lots N end currently vegetated with coastal dune veg'n (immediately adjacent to 2100 line)	Minor	Insignificant		These properties appear to be part of Towradgi beach Park and Coastal Dune Systems. Should not be zoned residential but maintained as environment protection / public recreation			

Fairy Meadow Beach (extends to immediately north of <b>Parks, Beaches and open space</b> )	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Fairy Meadow Beach	Major	Insignificant		Beach currently in eroded state, narrow beach face covered at high tide	Community		
Fairy Lagoon Habitat (part of Puckeys Estate lands)	Moderate	Moderate		Puckeys Estate (extending from northern edge of Lagoon northwards along Fairy Meadow Beach) is identified as a Highest priority site for restoration works. Puckeys Estate heritage assets included in North Beach assessment.	Illawarra Biodiversity Strategy 2010 (Draft)*		
Towradgi - Fairy Meadow Foreshore: Coastal Dune Systems	Major	Insignificant		Adjacent to Thomas Dalton Park. See above for proposed rehabilitation works.			
<b>Community Infrastructure</b>							
Fairy Meadow SLSC Lifeguard Tower	Minor	Insignificant		Small structure south east of SLSC			B03088



Wollongong North Beach	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Parks, Beaches and open space</b>							
North Beach	Major	Insignificant					
Fairy Lagoon	Moderate	Moderate		Trigger Level for opening: 1.6 m (with rain falling or impending), with alert level at 1.3 m (ie, to mobilise equipment for opening). If lagoon doesn't breakout and rainfall not impending, can be broken out at 1.8 m, to alleviate flooding of Live Steamers Site beyond this level. Fairy Creek/Lagoon estuarine condition is classified as modified (Cardno, 2010 CZS)	Fairy Lagoon Entrance Management Policy	Allow retreat of lagoon (RA Workshop)	
Stuart Park (on heritage list, local significance)	Moderate	Minor		The site is heritage listed but provides open space that beach could recede into. At site of existing carpark - Strategy 6A Multi-deck public carpark with commercial / retail component with northern aspect overlooking Stuart Park	Blue Mile Foreshore Masterplan	Allow erosion/recession (ie retreat) (RA Workshop)	
<b>Community Infrastructure</b>							
Puckeys Estate including Seafield House and gardens ruins	Major	Major		At edge of Fairy Lagoon (NW of entrance), there are workings of a "salt" mine, used by Puckey. Periodic inundation could further degrade the limited house and garden remains	Council staff		
Lagoon Kiosk/Restaurant		Moderate		This is located at the end of the car parking immediately south of the lagoon (in the park).		Over the short term, build a bund to protect from coastal inundation to a certain trigger level. Abandon location after trigger/bund is reached, and relocate behind hazard area. (RA Workshop)	B02607
Stuart Park toilet block		Insignificant		South of Lagoon Kiosk/Restaurant			B02314
North Beach Surf Club	Major	Moderate	Major	Strategy 6B Construction of new SLSC to the north of existing building maintaining full access to beach with commercial component and public toilets, creating grassed terraced plaza with public seating and lighting [on old SLSC site]. Plans to knock down and rebuild this site (with State govt assistance) was flagged in the Wollongong City Foreshore POM. The former site will be grassed for public access and use (Strategy 6F). Designs for rebuilding SLSC have not yet been completed, but are intended to address coastal hazards. Unclear if relocation was considered (as proposed site is within hazard area), or if there were other constraints to relocation. Capability of existing seawall in front of site as protection from beach erosion is unknown, but suggested by Council to be inadequate. Pavillion seawall is intended to extend to [future] surf club in the future.	Blue Mile Foreshore Masterplan / Council staff	Ensure design is adequate to withstand future recession and inundation. Ensure extension of seawall to protect SLSC and adjacent buildings	B02043
Heritage Site: North Beach Kiosk	Major		Major	The structure is located next to the SLSC. The Kiosk structure is heritage listed and Council owned/ managed. It has high community value, as well as commercial value as functioning restaurant / kiosk. The Wollongong City Foreshore POM indicated this structure was renovated prior to operation of restaurant and kiosk	Foreshore POM	Extend new seawall at the Pavillion to protect this site also.	B02025

Wollongong North Beach	Erosion & Recession	Periodic Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Heritage Site: North Beach Pavilion	Major	Moderate	Major	Site is seen as a significant community asset with high heritage value. Community noted the pavilion to be a beautiful building of high value. Replacement of seawall across this property (see below) will protect this asset from coastal hazards, reducing the likelihood and impacts of coastal hazards. Strategy 6H Existing Bathers Pavilion building redeveloped incorporating restaurants, public toilets and improved access in accordance with NSW Heritage Office guidelines and DA approval process.	Council staff / Workshop / Community / Blue Mile Foreshore Masterplan	Seawall constructed to protect asset.	B02024
North Wollongong Beach Toilet Block			Minor	West of Pavilion (ie, immediately behind, likely to be protected by Pavilion wall).			B02023
North Beach Seawall				Seawall is to be replaced (cost ??- \$8 m). Existing crib lock wall is said to be on sand (not suitable toe for long term protection). New seawall will be emplaced in front and further east. As per Blue Mile, is will additionally provide beach access stairs and large seating stairs for public access. At present, the seawall will only protect the Pavilion. It is intended to be extended to the SLSC in the future. Has been designed to address coastal hazard issues (and the hazard lines assume this also, stopping at the wall).	Council staff / Blue Mile Foreshore Masterplan / Wollongong City Foreshore POM	Ensure design is adequate for future sea level rise recession and inundation	
Heritage Site: Norfolk Island Pines	Minor	Insignificant		There are ~ 150 Pines in North Beach to Brighton foreshores. See <i>comments on pines for Thirroul</i>	Council staff		
Cycleway / Shared Pathway	Major	Minor		Path between North Beach and Brighton Beach has heritage value as the former railway tramway, with former cutting remains. Path behind North Beach Pavilion to SLSC and Stuart Park - Strategy 6E Widening of existing shared use path with seating, shade, lighting etc. The improvements are intended to also include improved erosion protection for cycleway.	Council staff / Blue Mile Foreshore Masterplan	Ensure improvements include protection from coastal hazards	
Heritage listed: Battery Park Emplacements			Moderate	The emplacements are the concrete structures within Battery Park, and are heritage listed.			B02352
<b>Water and sewage infrastructure</b>							
Stormwater outlets / pipes (in Stuart Park)	Major	Major					
<b>Transport infrastructure</b>							
Major roads (Pioneer Road)		Major		Some parts of this road are RTA road		Opportunistic raising of road (RA Workshop)	
Local road (beach access into Lagoon restaurant and car park)		Minor					

Brighton Lawn Reserve and Wollongong Harbour	Erosion & Recession	Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Parks, Beaches and open space</b>				Coastal Management Plan for this area has recently been completed; copy provided to consultants.	Council staff		
Brighton Lawn Reserve Beach (Heritage listed)	Major	Insignificant		Wave focussing to S end of beach (through harbour mouth). Reported northerly sand drift, captured inside breakwalls at northern end of beach. Installation of seawall will result in loss of beach with sea level rise and recession, without mitigation.	Council staff		
Brighton Lawn Reserve: (Heritage Listed)	Minor			This land is protected by recently replaced Gabion rock wall (S end of beach) using plastic gabion baskets, to improve protection from erosion, therefore impacts from erosion will be mitigated. Was a former Lands/LPMA proposal for large scale development of the area, not approved.	Council staff		
<b>Community Infrastructure</b>							
Heritage Site: Flagstaff Hill and Lighthouse			Major	Strategy 3C involves construction of a Flagstaff Hill Visitors Centre (with kiosk, public toilets) within the park; and other strategies to improve / install walkways along perimeter for public use and access. The harbour is a very important asset from a heritage, community and economic (tourism, boating) view point. Need to consider how this can be maintained with sea level rise.	Blue Mile Foreshore Masterplan		
Heritage Site (state): Brighton Lawn Reserve / Harbour Precinct, including convict built steps and harbour breakwall	Major	Minor		Issues regarding how to preserve the assets with SLR without reducing their heritage value (e.g. building up the convict built breakwater or relocating it would reduce its value as a heritage item). There are lots of heritage items within the harbour, including convict built harbour breakwall which extends back into the edge of the lawn reserve (where lion statue is), the original convict harbour boat area and boat steps, and other younger features. the northern breakwall is relatively recent (~ 70s ?). The harbour, including heritage assets and working harbour, is seen as a significant community asset	Council staff / workshop		
Cycleway / Shared Pathway			Major	Path has heritage value as the former railway tramway, with former cutting remains between here and North Beach. Major upgrade to cycleway and pedestrian pathways between North and Brighton Beaches as below. The upgrades to cycleway are intended to also improve their protection from erosion. Unsure if SLR considered at this stage in upgrades. Strategy 5B Boardwalk projected over rock platform adjacent to lower tramway cutting (at base of Battery Park, on cliff section into North Beach). Strategy 5D Grade separate cyclists and pedestrians (ie. widen cycle and foot paths); Strategy 5G widen existing lower tramway shared way where appropriate, replace handrail, provide viewing platforms with shade seating and interpretive material.	Blue Mile Foreshore Masterplan		

Brighton Lawn Reserve and Wollongong Harbour	Erosion & Recession	Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
Mens and Childrens Tidal Pools (Heritage listed)	Moderate	Insignificant		These are open ended pools, already being maintained to fail. (gentilemens baths are highly valued). Strategy 5H Maintain access to rock pool (formerly gentilemens baths) and pebbly beach. This suggests that will not be maintained to fail? Contradiction between advise from Council staff and BlueMile plan for pool management?	Council staff / Blue Mile Foreshore Masterplan	Continue current management, ie do nothing allowing pools to fail (RA Workshop)	
Continental Pool	Major	Minor	Major	Greater expectation from community for management from heritage perspective. Seen as a significant community asset. Strategy 5L potential upgrade of Continental Baths and building with potential commercial element. Unsure if this was to incorporate SLR or erosion provision.	Council staff / workshop / Blue Mile Foreshore Masterplan	Protect as a priority (RA Workshop)	
Continental Pool - Office/Amenities/Residence	Major	Moderate	Major				B02057
Continental Pool - Pumphouse/Garage	Major	Moderate	Major	South end of pools			B02067
Continental Pool - Storage Shed (North)	Major	Moderate	Major	North end of pools			B02068
Brighton Lawn Reserve Seawall	N/A	N/A		Strategy 4J - Major upgrade to seawall to additionally include improved beach access pathway network and seating, furniture and lighting for public. Gabion rock wall has been replaced (S end of beach) using plastic gabion baskets, to improve protection from erosion (as per CZMP for this area, see above). Design included access and seating arrangements as per the Blue Mile masterplan (photographs provided by Council)	Blue Mile Foreshore Masterplan		
Brighton Lawn Kiosk (heritage listed)	Major	Moderate	Major	Building in middle of reserve, behind harbour. The Kiosk building is heritage listed, part of the harbour precinct. A contractor operates a restaurant / kiosk from the building (see below)	Council Staff		B02301
<b>Transport Infrastructure</b> Local Roads (Cliff Rd, Endeavour Dr) and car parks			Minor				
Wollongong Harbour (heritage listed, state significant)	Major	Minor	Major	There is already pressure upon the heritage aspects, as the harbour is still commercially used. Strategy 4 A is to improve access to northern breakwater (built in 1970s) for public. Unsure if upgrade includes increasing height for SLR impacts	Council staff / Blue Mile Foreshore Masterplan	Raise harbour walls as necessary. For the inner harbour, do nothing. (RA Workshop)	
<b>Water and sewage infrastructure</b> Stormwater outlets / pipes			Major				
<b>Commercial and Industrial Development</b>							
Harbour Front Café Bar Restaurant		Moderate		This site is relatively recent (~ 10 yrs old). Strategy 4 X is for possible expansion of commercial opportunities to provide more dining, café and other recreation / leisure options.	Council staff		

City Beach (extending to end of showground/N Parks, Beaches and open space	Erosion & Recession	Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
City Beach	Major	Insignificant		Before the dune revegetation works around 20 yrs ago, sand used to get blown across roadway into Brighton Beach, would be up to 3-4 ft deep across roadway, roadway closed until this was removed. [NB - This would have allowed for sandbypassing into harbour and further north - erosion impacts on Brighton Beach will be partly caused by revege works on City Beach that have stopped windblown sand supply]	Community*		
Open space, parks etc	Minor	Insignificant		Concern raised over potential impact to this site: Grounds are likely to have high community significance, beyond their commercial value, representing the region's team.	Workshop		
Football Ground (WIN Stadium) and Showground	Major	Moderate		Extensive revegetation work done after 1970s, has allowed build up of dunes to protect beach. However, now have concerns over aesthetics for SLSC members and users of cycleway because cant see beach over dunes. The Wollongong City Foreshore POM recommended additional view platforms be provided along this stretch, to facilitate better viewing by community (this does not appear to have been done).	Community / Blue Mile Foreshore Masterplan		
Coastal Dune Systems	Major	Insignificant		Dune restoration works are strategies (1F, 2L) in Blue Mile Masterplan (as well as other improvements to park plantings).			
<b>Community Infrastructure</b>							
City Beach Surf Club	Major	Moderate		Only designed for a 50 yr timeframe. Has 14 m deep pier foundations down to rock. Was built in 2004 with a 50 yr lease for developer (2 function centres, bar / restaurant and kiosk), in return for providing bottom level for SLSC use. SLSC doesn't have much view of beach, were apparently supposed to build at same height as the dunes, but have built behind and lower - only views from top levels. There are two lifeguarding towers (at either end of club, one for clubbies (S tower), one for council lifeguards, with suitable storage). The towers provide a good view of entire beach. Some trouble with accessing beach to set up equipment after storms, and for this reason lower dune species have been requested. (SLSC also requested shaving of dune to provide them with views from the club - but there are no issues for lifeguarding from their towers). They don't have any portable towers.	Council staff / Community*	B02907	
Heritage Site: Former RC Cemetary, Graves and Monument	Moderate	Minor		Area has been redesigned to take advantage of historic significance. However, the historic sites are relocatable			
Site of former SLSC (now public viewing platform)	Minor			SLSC member notes erosion after 1964 storms - scarp was only 15 m seaward of the current road, then dropped 5 m to waterline. The scoreboard at the football stadium was washed away. The former SLSC had a pile wall built around it which was then back filled with basalt boulders, for protection. This untenable, and that is why ended up rebuilding. The scarp from the 1964 storm extended close to the current 2100 hazard (ZRFC) line. This demonstrates the value of the dune revegetation works, in now providing a buffer from erosion. Old photos of city beach from 1900 on are available on Councils libraries website. Current public viewing platform is on old SLSC site, is very likely that pile wall and basalt remains below the sand.	Community*		
Cycleway / Shared Pathway	Moderate	Minor					
<b>Transport Infrastructure</b>							
Local Roads (Marine Drive, Endeavour Drive, Quilkey Place) and beach access car parks	Minor	Minor		Access roads are not linked to residential property, thus periodic inundation less consequential			
<b>Commercial and Industrial Development</b>							
WIN Entertainment Centre	Moderate	Moderate		Concern raised over potential impact to this site	Workshop		
NB: Nuns Pools and Ladies Pool at rock platform off Flagstaff Hill		Minor		Nuns pool does not have proper public access and Ladies pool has minor steep access. Neither of the pools are acting as viable pools at present. Heritage assets are already highly degraded, with reduced functionality.	Council staff		

Coniston Beach	Erosion & Recession	Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Parks, Beaches and open space</b>							
Coniston Beach	Major	Insignificant					
Wollongong Golf Course	Minor	Y		Some community unconcerned about impact to golf course	Community		
Coastal Dune Systems	Minor	Insignificant					

Perkins Beach	Erosion & Recession	Inundation	Geotech	Comments / Reason for consequence level	Comments from	Potential Management Options?	Asset # (Council)
<b>Parks, Beaches and open space</b>							
Fishermans Beach (MM Beach?)	Major	Insignificant		There are likely to be midden sites at MM Beach	LALC		
Heritage listed: Hill 60 Nature Reserve	Minor	Minor	Moderate	Hill 60 area is heritage listed, however is mostly public open space.			
Port Kembla - Perkins Beach	Major	Insignificant		There are known to be Aboriginal burial sites at Windang	Council / LALC		
Coastal Dune Systems: Pork Kembla Beach, Perkins Beach Reserve	Major	Insignificant		Entire length of beach and coastal dune system is identified as a Highest priority site for restoration works. 4WD and trail bike access through dunes and along beach is destabilising dunes. Believe Council is not as involved in revegetation, updating dune fencing, weed control on dunes any more. More maintenance required. Many areas classified as high disturbance (based on vegetation mapping).	Illawarra Biodiversity Strategy 2010 (Draft)*		
<b>Community Infrastructure</b>							
Hill 60 Battery viewing platform			Minor				B02407
Hill 60 Lookout/Battery			Minor				B02411
Coastguard Complex Port Kembla			Minor				B03080
Port Kembla Olympic Pool	Major	Minor		More community expectation to maintain this pool (from heritage and community perspective). Pool has been maintained to better withstand wave impacts	Council staff / Workshop		
Port Kembla Pool - Amenities/Kiosk/Lifeguard Tower	Major	Moderate	Major	North-west of pool			B03182
Port Kembla Pool - Pumphouse		Moderate	Major	South end of pool			B02059
Port Kembla Pool - Residence & pool office		Moderate	Major	North end of pool			B02058
Port Kembla SLSC - Lower boat shed			Major	North of pool complex			B02026
Windang Surf Club		Moderate		Concern raised over community impact from damage to this structure	Workshop		B02046
Windang Beach Dressing rooms / toilets		Insignificant		Immediately behind SLSC.			B02027
<b>Transport Infrastructure</b>							
Lake Illawarra Training Walls	Major	Minor		Concern raised over community impact from damage to this structure, expensive structure	Workshop		
<b>Water and sewage infrastructure</b>							
Port Kembla Sewage Treatment Plant			Major				

Lake Illawarra Foreshores	Inundation	Comments / Reason for consequence level (if diff't from main grouping)	Comments from	Potential Management Options?	Council asset #
<b>Parks, Foreshores and open space</b>	<b>Consequence</b>				
Lake Illawarra Foreshore	Minor	Foreshore land is largely open space that could enable recession / inundation			
Windang Foreshore Park	Minor	as above			
Boronia Park / Oval	Minor	as above			
Kully Bay Park	Minor	as above			
Hooka Point Park	Minor	as above			
Fred Finch Park Natural Area	Minor	as above			
Purrah Bay Reserve	Minor	as above			
Koonawarra Bay reserve / park	Minor	as above			
Lakeside Drive Reserve	Minor	as above			
Holbom Park Sailing Club	Minor				
Windang Bowls Club (private recreation)	Minor				
Illawarra Yacht Club (private recreation)	Minor				
EEC Swamp Oak Floodplain Forest	Moderate				
EEC Coastal Swamp Oak Forest	Moderate				
<b>Community Infrastructure</b>					
Windang Tourist Park	Moderate	Concern raised over community impact from inundation of this location. Social equity - caravan park residents and other residents along Windang Peninsula foreshores - cant afford to help themselves. Community concerns indicate such parks in this area are more like residential development.	Workshop / Community		
Other caravan parks	Moderate				
Lake Illawarra Cycleway / Shared Pathway	Minor	Cycleway around foreshore is too low. New cycleways need to take into consideration sea level rise and setbacks	Community		
Windang Memorial Park - Toilets	Minor				B02368
Windang Memorial Park - Tennis Clubhouse (leased)	Minor				B02502
Boronia Park Dressing Sheds / toilets / gardeners	Minor				B02370
Boronia Park Kiosk	Minor				B02371
Boronia Park Pigeon Clubroom	Minor				B02369
Boronia Park Scout Hall	Minor				B02441
Fred Finch Park Baseball Kiosk	Minor				B02376
Fred Finch Park amenities	Minor				B03161
Fred Finch Park Pony Clubhouse	Minor				B02404
Fred Finch Park - Berkeley Basketball Stadium	Moderate				B02831
William Beach Park Exeloo, Brownsville	Minor				B02391
<b>Transport Infrastructure</b>					
Major roads, bridges: Windang Rd and Bridge	Major				
Local Roads, car parks	Minor				
Port Kembla Sailing Club Boat ramp and harbour	Moderate				
<b>Water and sewage infrastructure</b>					
Stormwater outlets / pipes	Major				
<b>Residential Development</b>					
Existing Residences (numerous)	Moderate	Resident concerned about future redevelopment, subdivision, on existing properties along Mullet Ck. His example is the Lakeline retirement village, which was developed by placing fill on the floodplain to raise the height of the development. He does not want this type of development to occur on the other remaining blocks. Believes that the Lakeline village development has increased the flooding problem for his property			
Vacant Land (Future Development: Tourist zone at Kully Bay)	Insignificant				
Vacant Land (3 residential zoned blocks at Purrah Bay) <i>Note: 674 land parcels affected</i>	Insignificant				
<b>Commercial and Industrial Development</b>					
Oasis Resort and Caravan Park	Moderate	See notes on Windang Caravan Park. This site is also a private commercial enterprise.			
Tru Energy Gas Powered Station	Major				
<b>Institutional Infrastructure</b>					
Windang Public School	Moderate				
Primbee Heights		Geotech hazard (Barry, 118 Lakeview Parade Primbee) - resident wants to understand what this means			



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## **APPENDIX F: THIRROUL CASE STUDY ECONOMIC ANALYSIS OF MANAGEMENT OPTIONS: GILLESPIE ECONOMICS**



**Benefit Cost Analysis**  
**of**  
**Sea Level Rise Management Options**  
**Thirroul Beach Case Study**

**Draft Report**

Prepared for

**BMT WBM Pty Ltd**

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**May 2011**

## **1.0 INTRODUCTION**

Predicted sea level rise as a result of climate change can have a number of consequences for the coastal environment, including for infrastructure assets and recreational use. Investments to reduce the impacts of sea level rise also have a range of costs and benefits to the community. Consideration of the magnitude and distribution of these costs and benefits is necessary to ensure that decision-makers are fully informed of the consequences of different policy options.

This report uses a benefit cost analysis (BCA) framework to undertake a case study analysis of different investment options to reduce the impacts of sea level rise on Thirroul beach and its environs. To undertake this quantitative analysis it was necessary to make a range of assumptions around which there is considerable uncertainty. While some sensitivity testing of these assumptions has been undertaken, the analysis can be updated if better information becomes available.

## **2.0 BENEFIT COST ANALYSIS**

### **2.1 Introduction**

BCA involves the following key steps:

- identification of the base case or “without” investment case;
- identification of the “with” investment options;
- identification of the incremental costs and benefits of investment options;
- physical quantification and valuation of the investment options’ incremental benefits and costs;
- consolidation of values using discounting to account for the different timing of costs and benefits;
- application of decision criteria;
- sensitivity testing; and
- consideration of non-quantified benefits and costs, where applicable.

### **2.2 IDENTIFICATION OF THE BASE CASE**

In the absence of any form of investment, sea level rise is predicted to result in both inundation and erosion effects at Thirroul.

An increase in the occurrence of inundation will result in periodic damage to up to 71 properties<sup>1</sup>, with the probability of an occurrence assumed to increase from 1:100 in 2011 to 1:10 in 2050 and 1: 1 in 2100. Damage costs are assumed at \$70,000 per property per incident.

Erosion is assumed to result in the loss of a number of beach side assets in 2011, including Thirroul Surf Club, Thirroul Pool, Thirroul Pavillion and Thirroul beach reserve. These facilities have a range of economic use values. Heritage sites such as the Thirroul Pool, Thirroul Pavillion and Thirroul Beach Reserve also have non-use heritage values. These values will be lost under the base case.

The economic value of nine private residences will be lost in 2050 if no investment occurs to reduce the consequences of sea level rise.

Under the base case, the coastal dune system is assumed to migrate naturally landward and hence there is no loss of use values associated with Thirroul Beach.

This dune migration does however result in some loss of stormwater assets.

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<sup>1</sup> An additional 80 properties would also be subject to periodic damage from an increase in the occurrence of inundation, however, these are already subject to planning controls.

## 2.3 IDENTIFICATION OF INVESTMENT OPTIONS

Three investment options to reduce the impacts of sea level rise are analysed in this BCA:

- Option 1 - sea wall - with beach nourishment;
- Option 2 - sea wall - without beach nourishment;
- Option 3 - planned retreat.

## 2.4 IDENTIFICATION OF THE INCREMENTAL COSTS AND BENEFITS

The categories of costs and benefits of these options relative to the base case are summarised in Table 1.

<b>COST AND BENEFIT CATEGORIES</b>	<b>OPTION 1 - SEA WALL - WITH BEACH NOURISHMENT</b>	<b>OPTION 2 - SEA WALL - NO NOURISHMENT</b>	<b>OPTION 3 - PLANNED RETREAT</b>
<b>Costs</b>			
Cost of relocating Thirroul surf club			*
Cost of relocating Thirroul pool			*
Cost of relocating Thirroul pavillion			*
Cost of planning controls on 9 properties plus 151 properties			*
Capital costs of seawall	*	*	
Maintenance costs of seawall	*	*	
Beach nourishment costs	*		
Costs of maintaining pool, pavillion, surf club plus beach			*
Costs of maintaining pool, pavillion, surf club, reserve plus beach	*		
Costs of maintaining pool, pavillion, surf club and reserve		*	
Loss of beach use values		*	
<b>Benefits</b>			
<b>Avoided Inundation damage</b>			*
<b>Avoided Erosion Damage</b>			
Avoid loss of Thirroul Surf Club	*	*	*
Avoid loss of Thirroul pool - use	*	*	*
Avoid loss of Thirroul pool lost - heritage site	*	*	*
Avoid loss of Thirroul pavillion use values -restaurant and residence	*	*	*
Avoid loss of Thirroul pavillion - heritage site	*	*	*
Avoid loss of Thirroul beach reserve - use	*	*	
Avoid loss of Thirroul Beach reserve - heritage site	*	*	
Avoid stormwater asset lost - end of pipe	*	*	
Avoid/delay loss of private properties (2050)	*	*	*

## 2.5 VALUATION OF COSTS AND BENEFITS

Valuation of costs and benefits required a number of assumptions about the annual use for different coastal assets as well as assumptions about the use and non-use economic values. Assumptions are specified in the attached spreadsheets.

## 2.6 CONSOLIDATION OF VALUE ESTIMATES

The present value of costs and benefits for each option are presented in Table 2.

**Table 2 - Benefit Cost Analysis Results (7% discount rate)**

	OPTION 1 - SEA WALL - WITH BEACH NOURISHMENT	OPTION 2 - SEA WALL - NO NOURISHMENT	OPTION 3 - PLANNED RETREAT
<b>COST</b>			
Cost of relocating Thirroul surf club			\$233,645
Cost of relocating Thirroul pool			\$560,748
Cost of relocating Thirroul pavillion			\$233,645
Cost of planning controls on 9 properties			\$1,104,060
Capital costs of seawall	\$3,831,776	\$3,831,776	
Maintenance costs of seawall	\$2,730,343	\$2,730,343	
Beach nourishment costs	\$12,091,865		
Costs of maintaining pool, pavillion, surf club plus beach			\$1,477,581
Costs of maintaining pool, pavillion, surf club, reserve plus beach	\$1,603,010		
Costs of maintaining pool, pavillion, surf club and reserve		\$1,555,974	
Loss of beach use values		\$142,533,279	
<b>TOTAL COSTS</b>	<b>\$20,256,994</b>	<b>\$150,651,372</b>	<b>\$3,609,678</b>
<b>BENEFITS</b>			
<i>Avoided Inundation damage</i>	\$0	\$0	\$1,612,819
<i>Avoided Erosion Damage</i>			
Avoid loss of Thirroul Surf Club	\$712,666	\$712,666	\$712,666
Avoid loss of Thirroul pool - use	\$71,266,640	\$71,266,640	\$71,266,640
Avoid loss of Thirroul pool lost - heritage site	\$475,523	\$475,523	\$475,523
Avoid loss of Thirroul pavillion use values -restaurant and residence	\$8,979,597	\$8,979,597	\$8,979,597
Avoid loss of Thirroul pavillion - heritage site	\$475,523	\$475,523	\$475,523
Avoid loss of Thirroul beach reserve - use	\$28,506,656	\$28,506,656	
Avoid loss of Thirroul Beach reserve - heritage site	\$475,523	\$475,523	
Stormwater asset lost - end of pipe	\$0	\$0	
Avoid/delay loss of private properties (2050)	\$5,500,001	\$5,500,001	\$5,162,471
<b>TOTAL BENEFITS</b>	<b>\$116,392,128</b>	<b>\$116,392,128</b>	<b>\$88,685,238</b>
<b>NET BENEFITS</b>	<b>\$96,135,134</b>	<b>-\$34,259,244</b>	<b>\$85,075,561</b>
<b>BCR*</b>	<b>6.2</b>	<b>-4.2</b>	<b>83.8</b>
<b>NPV/I**</b>	<b>\$5.2</b>	<b>-\$5.2</b>	<b>\$82.8</b>

\*Cost in BCR is capital and operating cost of the action e.g. seawall capital and operating costs and beach nourishment for option 1.

\*\*I is defined to include capital, maintenance and beach nourishment costs.

There are two main decision criteria for assessing the economic desirability of an investment to society:

- net present value (NPV) which is the present value of benefits less the present value of costs. Under this decision rule, an investment is potentially worthwhile (or viable) if the NPV is greater than zero. Both Option 1 and Option 3 are therefore economically viable.

- benefit cost ratio (BCR) which is the present value of benefits divided by the present value of costs. An investment is potentially worthwhile if the BCR is greater than 1. Under this criterion both Options 1 and Option 3 are economically viable.

Where investments are mutually exclusive and there is no capital constraint, the investment which yields the highest NPV would be chosen as the most economically efficient – Option 1. However, this option also requires considerable capital and ongoing costs – 16 times that of Option 3. Where there are constraints on capital funds the problem facing decision-makers is to rank investments in terms of return to the constrained input. The BCR does this to a certain extent (depending on which costs are included in the denominator) however more explicitly NPV per dollar of total capital invested (NPV/I) can be used to maximise the total NPV obtained from a limited capital works budget. In this case, however, funds for both the capital and direct ongoing costs of options are constrained. NPV per dollar invested (both capital and operating costs) has therefore been estimated. On this basis, Option 3 is the preferred option.

## **2.7 SENSITIVITY ANALYSIS**

This NPVs presented in Table 2.2 are based on a range of assumptions around which there is some level of uncertainty. Uncertainty in a BCA can be dealt with through changing the values of critical variables in the analysis to determine the effect on the NPV or NPV/I. From Table 2 it is evident that the key drivers in the analysis relate to loss of beach use values, avoided loss of Thirroul pool use values and avoided loss of Thirroul beach reserve use.

For Option 2 the main cost that drives the analysis is the loss of beach use values. A 24% reduction in loss of beach use values is required to make Option 2 have a positive NPV and a 84% reduction is required for Option 2 to have a higher NPV than Option 3. However, even if there is no loss in beach use under this Option 2 the NVP/I is less than for Option 3.

Avoided loss of Thirroul pool use values is a major and common benefit to Option 1, 2 and 3. Changes in this assumption therefore do not change the relative ranking of the investment options. Even if these benefits are assumed to be zero both Options 1 and 2 have a positive NPV with Option 3 having the highest NPV/I.

Avoided loss of use values from Thirroul beach reserve is another major benefit of Options 1 and 2. A 520% increase in the avoided loss of use benefits from Thirroul beach reserve would be required for Option 1 to have an NPV/I greater than Option 3.

## **2.8 DISTRIBUTIONAL AND FINANCING CONSIDERATIONS**

The main benefit of the preferred investment, Option 3, accrues to those people who use the Thirroul pool and to a lesser extent the tenants of the Thirroul Pavillion and private property owners. Private property owners bear all the costs (i.e. the cost of planning controls) that result in their individual benefit (delay in property erosion). The remainder of the costs are borne by Council in the first instance. There is therefore some rationale under this option for Council to recoup costs from users of the relocated pool and tenants of the Thirroul Pavillion. Whether this is feasible will depend to some extent on size of the charge and the price elasticity of demand of users. For instance, if recouping the costs results in a larger user fee for the Thirroul pool than other pools in the region and users have elastic demand curves they may simply use other pools in the region rather than paying a higher fee. Since the pool is provided for the use of all households in the region an alternative would be an additional levy on all households.

## **3.0 CONCLUSION**

Option 3 – Planned Retreat would result in the greatest net benefit per dollar (capital and maintenance costs) invested. Given that Thirroul beach is only one of many that may be impacted by

sea level rise, options that provide greater net benefits e.g. Option 1, but come at a greater capital and maintenance cost burden could be considered to be inferior to those providing a greater NPV/I. With a planned retreat option there is some rationale for the recoupment of costs from users of the relocated Thirroul Pool and tenants of Thirroul Pavillion. An alternative would be a levy on all households in the Wollongong LGA.



	4%	7%	10%	1	2	3	4	5	6	7	8	9	10
				2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
<b>BASE CASE</b>													
No loss of beach under base case as natural migration of dune occurs													
<b>Inundation</b>													
Probability				0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03
Houses impacted				71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00
Inundation damage	\$13,623,861	\$3,982,725	\$1,822,269	49,700	61,169	72,638	84,108	95,577	107,046	118,515	129,985	141,454	152,923
<b>Erosion</b>													
Thirroul Surf Club lost	\$1,213,364	\$712,666	\$499,906	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000
Thirroul pool use lost	\$121,336,388	\$71,266,640	\$49,990,589	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000
Thirroul pool lost - heritage site	\$809,610	\$475,523	\$333,560	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul pavillion lost use values -restaurant and residence	\$15,288,385	\$8,979,597	\$6,298,814	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000
Thirroul pavillion lost - heritage site	\$809,610	\$475,523	\$333,560	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul beach reserve - use lost	\$48,534,555	\$28,506,656	\$19,996,236	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000
Thirroul Beach reserve - heritage site	\$809,610	\$475,523	\$333,560	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Stormwater asset lost - end of pipe	\$0	\$0	\$0										
Private properties lost (2050)	\$27,389,785	\$5,500,001	\$1,315,778	0	0	0	0	0	0	0	0	0	0
Total costs	\$229,815,169	\$120,374,853	\$80,924,270	7,829,787	7,841,256	7,852,725	7,864,194	7,875,664	7,887,133	7,898,602	7,910,071	7,921,541	7,933,010
<b>Benefits</b>													
Avoided maintenance costs of pool, pavillions SLSC, OS and Beach	\$2,729,235	\$1,603,010	\$1,124,445	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
<b>OPTION 1 - SEA WALL - WITH BEACH</b>													
<b>NOURISHMENT</b>													
no loss of beach under this option													
<b>Costs</b>													
Capital costs	\$3,942,308	\$3,831,776	\$3,727,273	\$4,100,000									
Maintenance costs	\$4,777,677	\$2,730,343	\$1,863,251	0	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000
Beach nourishment costs	\$19,642,766	\$12,091,865	\$8,862,225	2250000	750000	750000	750000	750000	750000	750000	750000	750000	750000
Costs of maintaining pool pavillion, surf club and beach	\$2,729,235	\$1,603,010	\$1,124,445	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
Total costs	\$31,091,985	\$20,256,994	\$15,577,193	\$6,462,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466
<b>Benefits</b>													
Avoided Inundation damage	\$0	\$0	\$0	-	-	-	-	-	-	-	-	-	-
Avoided Erosion Damage													
Avoid loss of Thirroul Surf Club	\$1,213,364	\$712,666	\$499,906	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	\$121,336,388	\$71,266,640	\$49,990,589	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	\$809,610	\$475,523	\$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values -rest:	\$15,288,385	\$8,979,597	\$6,298,814	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	\$809,610	\$475,523	\$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	\$48,534,555	\$28,506,656	\$19,996,236	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage s	\$809,610	\$475,523	\$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	\$0	\$0	\$0	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	\$27,389,785	\$5,500,001	\$1,315,778	-	-	-	-	-	-	-	-	-	-
Total Benefits	\$216,191,308	\$116,392,128	\$79,102,002	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087
Net Benefits	\$185,099,323	\$96,135,134	\$63,524,809	1,317,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621
BCR		6.2											
NPV/I		25.1											
NPV/I k + op costs		5.2											

	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
BASE CASE																				
Inundation																				
Probability	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.08
Houses impacted	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00
Inundation damage	164,392	175,862	187,331	198,800	210,269	221,738	233,208	244,677	256,146	267,615	279,085	290,554	302,023	313,492	324,962	336,431	347,900	359,369	370,838	382,308
Erosion																				
Thirroul Surf Club lost	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000
Thirroul pool use lost	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000
Thirroul pool lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul pavillion lost use values -restaurant and residence	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000
Thirroul pavillion lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul beach reserve - use lost	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000
Thirroul Beach reserve - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Stormwater asset lost - end of pipe																				
Private properties lost (2050)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total costs	7,944,479	7,955,948	7,967,417	7,978,887	7,990,356	8,001,825	8,013,294	8,024,764	8,036,233	8,047,702	8,059,171	8,070,641	8,082,110	8,093,579	8,105,048	8,116,517	8,127,987	8,139,456	8,150,925	8,162,394
Benefits																				
Avoided maintenance costs of pool, pavillions SLSC, OS and Beach																				
	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
OPTION 1 - SEA WALL - WITH BEACH																				
NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000
Beach nourishment costs	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000
Costs of maintaining pool pavillion, surf club and beach	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
Total costs	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466
Benefits																				
Avoided Inundation damage																				
Avoided Erosion Damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values -rest:	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage s	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe																				
Avoid loss of Private properties (2050)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Benefits	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087
Net Benefits	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621
BCR																				
NPV/I																				
NPV/I k + op costs																				

	31 2041	32 2042	33 2043	34 2044	35 2045	36 2046	37 2047	38 2048	39 2049	40 2050	41 2051	42 2052	43 2053	44 2054	45 2055	46 2056	47 2057	48 2058	49 2059	50 2060
BASE CASE																				
Inundation																				
Probability	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.1	0.12	0.14	0.15	0.17	0.19	0.21	0.23	0.24	0.26	0.28
Houses impacted	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00
Inundation damage	393,777	405,246	416,715	428,185	439,654	451,123	462,592	474,062	485,531	497,000	586,460	675,920	765,380	854,840	944,300	1,033,760	1,123,220	1,212,680	1,302,140	1,391,600
Erosion																				
Thirroul Surf Club lost	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000
Thirroul pool use lost	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000
Thirroul pool lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul pavillion lost use values -restaurant and residence	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000
Thirroul pavillion lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul beach reserve - use lost	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000
Thirroul Beach reserve - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Stormwater asset lost - end of pipe																				
Private properties lost (2050)	0	0	0	0	0	0	0	0	0	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000
Total costs	8,173,864	8,185,333	8,196,802	8,208,271	8,219,741	8,231,210	8,242,679	8,254,148	8,265,617	13,677,087	13,766,547	13,856,007	13,945,467	14,034,927	14,124,387	14,213,847	14,303,307	14,392,767	14,482,227	14,571,687
Benefits																				
Avoided maintenance costs of pool, pavillions SLSC, OS and Beach																				
	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
OPTION 1 - SEA WALL - WITH BEACH																				
NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000
Beach nourishment costs	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000
Costs of maintaining pool pavillion, surf club and beach	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
Total costs	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466
Benefits																				
Avoided Inundation damage																				
Avoided Erosion Damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values -rest:	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage s	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe																				
Avoid loss of Private properties (2050)	-	-	-	-	-	-	-	-	-	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000
Total Benefits	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087
Net Benefits	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	6,712,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621
BCR																				
NPV/I																				
NPV/I k + op costs																				

	51 2061	52 2062	53 2063	54 2064	55 2065	56 2066	57 2067	58 2068	59 2069	60 2070	61 2071	62 2072	63 2073	64 2074	65 2075	66 2076	67 2077	68 2078	69 2079	70 2080
<b>BASE CASE</b>																				
<b>Inundation</b>																				
Probability	0.30	0.32	0.33	0.35	0.37	0.39	0.41	0.42	0.44	0.46	0.48	0.50	0.51	0.53	0.55	0.57	0.59	0.60	0.62	0.64
Houses impacted	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00
Inundation damage	1,481,060	1,570,520	1,659,980	1,749,440	1,838,900	1,928,360	2,017,820	2,107,280	2,196,740	2,286,200	2,375,660	2,465,120	2,554,580	2,644,040	2,733,500	2,822,960	2,912,420	3,001,880	3,091,340	3,180,800
<b>Erosion</b>																				
Thirroul Surf Club lost	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000
Thirroul pool use lost	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000
Thirroul pool lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul pavillion lost use values -restaurant and residence	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000
Thirroul pavillion lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul beach reserve - use lost	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000
Thirroul Beach reserve - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
<b>Stormwater asset lost - end of pipe</b>																				
Private properties lost (2050)	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000
Total costs	14,661,147	14,750,607	14,840,067	14,929,527	15,018,987	15,108,447	15,197,907	15,287,367	15,376,827	15,466,287	15,555,747	15,645,207	15,734,667	15,824,127	15,913,587	16,003,047	16,092,507	16,181,967	16,271,427	16,360,887
<b>Benefits</b>																				
<b>Avoided maintenance costs of pool, pavillions SLSC, OS and Beach</b>																				
	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
<b>OPTION 1 - SEA WALL - WITH BEACH</b>																				
<b>NOURISHMENT</b>																				
<b>Costs</b>																				
<b>Capital costs</b>																				
Maintenance costs	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000
Beach nourishment costs	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000
Costs of maintaining pool pavillion, surf club and beach	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
Total costs	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466
<b>Benefits</b>																				
<b>Avoided Inundation damage</b>																				
Avoided Erosion Damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values -rest:	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage s	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000
Total Benefits	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087
Net Benefits	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621
<b>BCR</b>																				
<b>NPV/I</b>																				
<b>NPV/I k + op costs</b>																				

	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
BASE CASE																				
Inundation																				
Probability	0.66	0.68	0.69	0.71	0.73	0.75	0.77	0.78	0.80	0.82	0.84	0.86	0.87	0.89	0.91	0.93	0.95	0.96	0.98	1.00
Houses impacted	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00	71.00
Inundation damage	3,270,260	3,359,720	3,449,180	3,538,640	3,628,100	3,717,560	3,807,020	3,896,480	3,985,940	4,075,400	4,164,860	4,254,320	4,343,780	4,433,240	4,522,700	4,612,160	4,701,620	4,791,080	4,880,540	4,970,000
Erosion																				
Thirroul Surf Club lost	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000	50000
Thirroul pool use lost	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000
Thirroul pool lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul pavillion lost use values -restaurant and residence	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000	630000
Thirroul pavillion lost - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Thirroul beach reserve - use lost	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000
Thirroul Beach reserve - heritage site	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949	33362.22949
Stormwater asset lost - end of pipe																				
Private properties lost (2050)	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$5,400,000	\$77,142,857
Total costs	16,450,347	16,539,807	16,629,267	16,718,727	16,808,187	16,897,647	16,987,107	17,076,567	17,166,027	17,255,487	17,344,947	17,434,407	17,523,867	17,613,327	17,702,787	17,792,247	17,881,707	17,971,167	18,060,627	89,892,944
Benefits																				
Avoided maintenance costs of pool, pavillions SLSC, OS and Beach																				
	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
OPTION 1 - SEA WALL - WITH BEACH																				
NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000
Beach nourishment costs	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000	750000
Costs of maintaining pool pavillion, surf club and beach	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466	112,466
Total costs	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466	\$1,067,466
Benefits																				
Avoided Inundation damage																				
Avoided Erosion Damage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values -rest:	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage s	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	77,142,857
Total Benefits	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	84,922,944
Net Benefits	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	12,112,621	83,855,478
BCR																				
NPV/I																				
NPV/I k + op costs																				

	4%	7%	10%	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
OPTION 2 - SEA WALL - NO NOURISHMENT													
Loss of beach under this option													
Costs													
Capital costs	\$3,942,308	\$3,831,776	\$3,727,273	\$4,100,000									
Maintenance costs	\$4,777,677	\$2,730,343	\$1,863,251	0	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000
Costs of maintaining pool pavillion, surf club and reserve	\$2,649,153	\$1,555,974	\$1,091,451	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166
Lose beach	\$242,672,776	\$142,533,279	\$99,981,178	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
Total costs	\$254,041,913	\$150,651,372	\$106,663,153	\$14,209,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166
Benefits													
Avoided Inundation damage	\$0	\$0	\$0	-	-	-	-	-	-	-	-	-	-
Avoided Erosion Damage	\$0	\$0	\$0	-	-	-	-	-	-	-	-	-	-
Avoid loss of Thirroul Surf Club	\$1,213,364	\$712,666	\$499,906	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	\$121,336,388	\$71,266,640	\$49,990,589	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	\$809,610	\$475,523	\$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	\$15,288,385	\$8,979,597	\$6,298,814	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	\$809,610	\$475,523	\$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	\$48,534,555	\$28,506,656	\$19,996,236	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage site	\$809,610	\$475,523	\$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	\$0	\$0	\$0	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	\$27,389,785	\$5,500,001	\$1,315,778	-	-	-	-	-	-	-	-	-	-
Total Benefits	\$216,191,308	\$116,392,128	\$79,102,002	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087
Net Benefits	<b>-\$37,850,605</b>	<b>-\$34,259,244</b>	<b>-\$27,561,151</b>	6,429,079	2,534,079	2,534,079	2,534,079	2,534,079	2,534,079	2,534,079	2,534,079	2,534,079	2,534,079
BCR		-4.2											
NPV/I		-8.9											
NPV/I k + op costs		-5.2			50								

	No loss of beach under this options				No opportunity cost of land used for relocation as spare open space								
OPTION 3 - PLANNED RETREAT													
Cost of relocating Thirroul surf club	\$240,385	\$233,645	\$227,273	250,000									
Cost of relocating thirroul pool	\$576,923	\$560,748	\$545,455	600,000									
Cost of relocating Thirroul pavillion	\$240,385	\$233,645	\$227,273	250,000									
Cost of planning controls on 9 properties plus 71 properties	\$1,718,575	\$1,104,060	\$793,185	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000
Costs of maintaining pool pavillion, surf club and beach	\$2,515,683	\$1,477,581	\$1,036,461	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666
Total Cost	\$5,291,950	\$3,609,678	\$2,829,647	1,283,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666
				71	70	68	67	65	64	62	61	60	58
Benefits													
Avoided Inundation damage	\$2,660,675	\$1,612,819	\$1,082,145	49,700	59,946	69,733	79,061	87,931	96,342	104,294	111,787	118,821	125,397
Avoid loss of Thirroul Surf Club	\$1,213,364	\$712,666	\$499,906	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	\$121,336,388	\$71,266,640	\$49,990,589	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	\$809,610	\$475,523	\$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	\$15,288,385	\$8,979,597	\$6,298,814	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	\$809,610	\$475,523	\$333,560	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoided loss of private property	\$23,026,109	\$5,162,471	\$1,287,755	0	0	0	0	0	0	0	0	0	0
Total Benefits	\$165,144,141	\$88,685,238	\$59,826,329	5,796,424	5,806,670	5,816,457	5,825,786	5,834,655	5,843,066	5,851,018	5,858,511	5,865,546	5,872,121
Net Benefits	\$159,852,191	\$85,075,561	\$56,996,682	4,512,759	5,623,005	5,632,792	5,642,120	5,650,990	5,659,400	5,667,352	5,674,846	5,681,880	5,688,456
BCR		83.8											
NPV/I		\$82.8											
NPV/I k + op costs		\$82.8											

Results - Option 1 or 3 both good but Option 1 very expensive - under a budget constraint BCR best and where lots of other beaches - planned retreat preferred.

\$6

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
<b>OPTION 2 - SEA WALL - NO NOURISHMENT</b>																				
Costs																				
Capital costs																				
Maintenance costs	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000
Costs of maintaining pool pavillion, surf club and reserve	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166
Lose beach	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
<b>Total costs</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>	<b>\$10,314,166</b>
Benefits																				
Avoided Inundation damage																				
Avoided Erosion Damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Total Benefits</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>	<b>7,780,087</b>
<b>Net Benefits</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>	<b>2,534,079</b>
BCR																				
NPV/I																				
NPV/I k + op costs																				
<b>OPTION 3 - PLANNED RETREAT</b>																				
Cost of relocating Thirroul surf club																				
Cost of relocating thirroul pool																				
Cost of relocating Thirroul pavillion																				
Cost of planning controls on 9 properties plus 71 properties																				
	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000
Costs of maintaining pool pavillion, surf club and beach	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666
<b>Total Cost</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>	<b>183,666</b>
	57	55	54	53	51	50	48	47	45	44	43	41	40	38	37	36	34	33	31	30
Benefits																				
Avoided Inundation damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoided loss of private property	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Total Benefits</b>	<b>5,878,238</b>	<b>5,883,896</b>	<b>5,889,096</b>	<b>5,893,836</b>	<b>5,898,118</b>	<b>5,901,941</b>	<b>5,905,306</b>	<b>5,908,211</b>	<b>5,910,658</b>	<b>5,912,646</b>	<b>5,914,175</b>	<b>5,915,246</b>	<b>5,915,857</b>	<b>5,916,010</b>	<b>5,915,704</b>	<b>5,914,940</b>	<b>5,913,716</b>	<b>5,912,034</b>	<b>5,909,893</b>	<b>5,907,294</b>
<b>Net Benefits</b>	<b>5,694,573</b>	<b>5,700,231</b>	<b>5,705,430</b>	<b>5,710,171</b>	<b>5,714,453</b>	<b>5,718,276</b>	<b>5,721,640</b>	<b>5,724,546</b>	<b>5,726,992</b>	<b>5,728,980</b>	<b>5,730,510</b>	<b>5,731,580</b>	<b>5,732,192</b>	<b>5,732,345</b>	<b>5,732,039</b>	<b>5,731,274</b>	<b>5,730,051</b>	<b>5,728,369</b>	<b>5,726,228</b>	<b>5,723,628</b>
BCR																				
NPV/I																				
NPV/I k + op costs																				
<b>Results - Option 1 or 3 both good but Option 1 very expensive - under a budget constraint BCR best and where lots of other beaches - planned retreat preferred.</b>																				

	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060
OPTION 2 - SEA WALL - NO NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000
Costs of maintaining pool pavillion, surf club and reserve	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166
Lose beach	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
Total costs	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166
Benefits																				
Avoided Inundation damage																				
Avoided Erosion Damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	-	-	-	-	-	-	-	-	-	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000
Total Benefits	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	7,780,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087
Net Benefits	2,534,079	2,534,079	2,534,079	2,534,079	2,534,079	2,534,079	2,534,079	2,534,079	2,534,079	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921
BCR																				
NPV/I																				
NPV/I k + op costs																				
OPTION 3 - PLANNED RETREAT																				
Cost of relocating Thirroul surf club																				
Cost of relocating thirroul pool																				
Cost of relocating Thirroul pavillion																				
Cost of planning controls on 9 properties plus 71 properties																				
	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000	80000
Costs of maintaining pool pavillion, surf club and beach	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666
Total Cost	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666	183,666
	28	27	26	24	23	21	20	18	17	16	14	13	11	10	9	7	6	4	3	1
Benefits																				
Avoided Inundation damage	157,511	153,994	150,018	145,583	140,689	135,337	129,526	123,256	116,527	109,340	117,292	121,666	122,461	119,678	113,316	103,376	89,858	72,761	52,086	27,832
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoided loss of private property	0	0	0	0	0	0	0	0	0	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000
Total Benefits	5,904,235	5,900,718	5,896,742	5,892,307	5,887,414	5,882,061	5,876,250	5,869,980	5,863,252	11,256,064	11,264,016	11,268,390	11,269,185	11,266,402	11,260,040	11,250,100	11,236,582	11,219,485	11,198,810	11,174,556
Net Benefits	5,720,570	5,717,052	5,713,076	5,708,642	5,703,748	5,698,396	5,692,585	5,686,315	5,679,586	11,072,399	11,080,351	11,084,724	11,085,520	11,082,736	11,076,375	11,066,435	11,052,916	11,035,820	11,015,144	10,990,891
BCR																				
NPV/I																				
NPV/I k + op costs																				
Results - Option 1 or 3 both good but Option 1 very expensive - under a budget constraint BCR best and where lots of other beaches - planned retreat preferred.																				



	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080
<b>OPTION 2 - SEA WALL - NO NOURISHMENT</b>																				
Costs																				
Capital costs																				
Maintenance costs	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000
Costs of maintaining pool pavillion, surf club and reserve	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166
Lose beach	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
Total costs	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166
Benefits																				
Avoided Inundation damage																				
Avoided Erosion Damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000
Total Benefits	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087
Net Benefits	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921
BCR																				
NPV/I																				
NPV/I k + op costs																				
<b>OPTION 3 - PLANNED RETREAT</b>																				
Cost of relocating Thirroul surf club																				
Cost of relocating thirroul pool																				
Cost of relocating Thirroul pavillion																				
Cost of planning controls on 9 properties plus 71 properties																				
Costs of maintaining pool pavillion, surf club and beach	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666
Total Cost	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666
Benefits																				
Avoided Inundation damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoided loss of private property	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000
Total Benefits	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724
Net Benefits	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059
BCR																				
NPV/I																				
NPV/I k + op costs																				
Results - Option 1 or 3 both good but Option 1 very expensive - under a budget constraint BCR best and where lots of other beaches - planned retreat preferred.																				

	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
OPTION 2 - SEA WALL - NO NOURISHMENT																				
Costs																				
Capital costs																				
Maintenance costs	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000	\$205,000
Costs of maintaining pool pavillion, surf club and reserve	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166	109,166
Lose beach	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000	10,000,000
Total costs	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166	\$10,314,166
Benefits																				
Avoided Inundation damage																				
Avoided Erosion Damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul beach reserve - use	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000
Avoid loss of Thirroul Beach reserve - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Stormwater asset lost - end of pipe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Avoid loss of Private properties (2050)	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	77,142,857
Total Benefits	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	13,180,087	84,922,944
Net Benefits	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	2,865,921	74,608,778
BCR																				
NPV/I																				
NPV/I k + op costs																				
OPTION 3 - PLANNED RETREAT																				
Cost of relocating Thirroul surf club																				
Cost of relocating thirroul pool																				
Cost of relocating Thirroul pavillion																				
Cost of planning controls on 9 properties plus 71 properties																				
Costs of maintaining pool pavillion, surf club and beach	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666
Total Cost	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666	103,666
Benefits																				
Avoided Inundation damage																				
Avoid loss of Thirroul Surf Club	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Avoid loss of Thirroul pool - use	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Avoid loss of Thirroul pool lost - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoid loss of Thirroul pavillion use values - restaurant and residence	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000	630,000
Avoid loss of Thirroul pavillion - heritage site	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Avoided loss of private property	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000	5400000
Total Benefits	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	11,146,724	65,996,133
Net Benefits	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	11,043,059	66,099,798
BCR																				
NPV/I																				
NPV/I k + op costs																				
Results - Option 1 or 3 both good but Option 1 very expensive - under a budget constraint BCR best and where lots of other beaches - planned retreat preferred.																				

	4%	7%	10%	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
				Wollongong populat		184,213							
				HH		2.5							
						73685.2							
Assumptions													
Inundation													
Probability of event in 2011	0.01												
Probability of event in 2050	0.1												
Probability of event in 2100	1												
Consequence of event per property	70000												
Number of properties	71												
Growth rate of development to avoid flood dar	0%												
Erosion													

Thirroul surf club visitors pa	5000	1	
consumer surplus for surf club use	10	1	
Thirroul pool visitors pa	500,000	1	Implicitly assume revenue covers operating costs so no loss of PS or cost saving - but probably a cost saving if it disappears.
cs for pool visitors	10	1	
Heritage site value per person per annum	0.01	1	
Aggregation to 79% of Aust hh	6,032,953	1	
open space around pool visitors pa	200000	1	Assumed net of maintenance costs
cs for use of open space	\$10	1	
pavillion - restaurant producer surplus	600000	1	Assumed net of maintenance costs
pavillion - value as a residence - rent pa	30000	1	
Private properties no.	9	1	
Private property values	\$2,000,000	1	
private discoun rates	30%	1	

Maintenance costs	Asset value	Maintenance
Pool	1300000	\$20,450
Other pool buildings	641532	\$10,092
Pavillion	2745498	\$43,189
SLSC	1693183	\$26,635
Reserve	112875	\$8,800
Beach		\$3,300
Total		\$112,466

1

OPTION 1 - SEAL WALL - WITH NOURISHMENT

Initial beach nourishment (m3)	90000	1
Ongoing beach nourishment (m3)	30000	1
Cost per m3 of beach nourishment	25	1
Avoid Thirroul beach use lost	500000	1
Consumer surplus for beach use	20	1

OPTION 2 - SEAL WALL - NO NOURISHMENT

Capital costs / metre	\$10,000	1
Metres	410	1
Mainenance costs pa	5%	1
Lost beach		
Annual visit days	500,000	1.00
\$/visit day	20	1
SLSC asset value		
Maintenance costs		
Pavillion asset value		
Maintenance costs		
Pool asset value		
Operating costs including maintenance		
Thirroul Reserve area		
Maintenance costs		

OPTION 3 - PLANNED RETREAT

Relocation costs per tonne	1000	1
Pavillion tonnes	250	1
Pool tonnes	600	1
SLSC	250	1
Rate at which redevelopment happens	2%	1
Number of properties	9	1
No of inundation properties	71	1
Value of properties	2000000	1
private discoun rates	30%	1
Cost of DCP works per property	50000	1

160000

Assumptions  
 Inundation  
 Probability of event in 2011  
 Probability of event in 2050  
 Probability of event in 2100  
 Consequence of event per property  
 Number of properties  
 Growth rate of development to avoid flood dar  
 Erosion

Thirroul surf club visitors pa  
 consumer surplus for surf club use  
 Thirroul pool visitors pa  
 cs for pool visitors  
 Heritage site value per person per annum  
 Aggregation to 79% of Aust hh  
 open space around pool visitors pa  
 cs for use of open space  
 pavillion - restaurant producer surplus  
 pavillion - value as a residence - rent pa  
 Private properties no.  
 Private property values  
 private discoun rates

Maintenance costs  
 Pool  
 Other pool buildings  
 Pavillion  
 SLSC  
 Reserve  
 Beach  
 Total

OPTION 1 - SEAL WALL - WITH NOURISHMENT  
 Initial beach nourishment (m3)  
 Ongoing beach nourishment (m3)  
 Cost per m3 of beach nourishment  
 Avoid Thirroul beach use lost  
 Consumer surplus for beach use

OPTION 2 - SEAL WALL - NO NOURISHMENT  
 Capital costs / metre  
 Metres  
 Mainenance costs pa  
 Lost beach  
 Annual visit days  
 \$/visit day  
 SLSC asset value  
 Maintenance costs  
 Pavillion asset value  
 Maintenance costs  
 Pool asset value  
 Operating costs including maintenance  
 Thirroul Reserve area  
 Maintenance costs

OPTION 3 - PLANNED RETREAT  
 Relocation costs per tonne  
 Pavillion tonnes  
 Pool tonnes  
 SLSC  
 Rate at which redevelopment happens  
 Number of properties  
 No of inundation properties  
 Value of properties  
 private discoun rates  
 Cost of DCP works per property

Assumptions  
 Inundation  
 Probability of event in 2011  
 Probability of event in 2050  
 Probability of event in 2100  
 Consequence of event per property  
 Number of properties  
 Growth rate of development to avoid flood damage  
 Erosion

Thirroul surf club visitors per annum  
 consumer surplus for surf club use  
 Thirroul pool visitors per annum  
 consumer surplus for pool visitors  
 Heritage site value per person per annum  
 Aggregation to 79% of Australian household  
 open space around pool visitors per annum  
 consumer surplus for use of open space  
 pavillion - restaurant producer surplus  
 pavillion - value as a residence - rent per annum  
 Private properties number  
 Private property values  
 private discount rates

Maintenance costs  
 Pool  
 Other pool buildings  
 Pavillion  
 SLSC  
 Reserve  
 Beach  
 Total

OPTION 1 - SEAL WALL - WITH NOURISHMENT  
 Initial beach nourishment (m3)  
 Ongoing beach nourishment (m3)  
 Cost per m3 of beach nourishment  
 Avoid Thirroul beach use lost  
 Consumer surplus for beach use

OPTION 2 - SEAL WALL - NO NOURISHMENT  
 Capital costs / metre  
 Metres  
 Maintenance costs per annum  
 Lost beach  
 Annual visit days  
 \$/visit day  
 SLSC asset value  
 Maintenance costs  
 Pavillion asset value  
 Maintenance costs  
 Pool asset value  
 Operating costs including maintenance  
 Thirroul Reserve area  
 Maintenance costs

OPTION 3 - PLANNED RETREAT  
 Relocation costs per tonne  
 Pavillion tonnes  
 Pool tonnes  
 SLSC  
 Rate at which redevelopment happens  
 Number of properties  
 No of inundation properties  
 Value of properties  
 private discount rates  
 Cost of DCP works per property

Assumptions  
 Inundation  
 Probability of event in 2011  
 Probability of event in 2050  
 Probability of event in 2100  
 Consequence of event per property  
 Number of properties  
 Growth rate of development to avoid flood damage  
 Erosion

Thirroul surf club visitors per annum  
 consumer surplus for surf club use  
 Thirroul pool visitors per annum  
 consumer surplus for pool visitors  
 Heritage site value per person per annum  
 Aggregation to 79% of Australian household  
 open space around pool visitors per annum  
 consumer surplus for use of open space  
 pavillion - restaurant producer surplus  
 pavillion - value as a residence - rent per annum  
 Private properties no.  
 Private property values  
 private discount rates

Maintenance costs  
 Pool  
 Other pool buildings  
 Pavillion  
 SLSC  
 Reserve  
 Beach  
 Total

OPTION 1 - SEAL WALL - WITH NOURISHMENT  
 Initial beach nourishment (m3)  
 Ongoing beach nourishment (m3)  
 Cost per m3 of beach nourishment  
 Avoid Thirroul beach use lost  
 Consumer surplus for beach use

OPTION 2 - SEAL WALL - NO NOURISHMENT  
 Capital costs / metre  
 Metres  
 Maintenance costs per annum  
 Lost beach  
 Annual visit days  
 \$/visit day  
 SLSC asset value  
 Maintenance costs  
 Pavillion asset value  
 Maintenance costs  
 Pool asset value  
 Operating costs including maintenance  
 Thirroul Reserve area  
 Maintenance costs

OPTION 3 - PLANNED RETREAT  
 Relocation costs per tonne  
 Pavillion tonnes  
 Pool tonnes  
 SLSC  
 Rate at which redevelopment happens  
 Number of properties  
 No of inundation properties  
 Value of properties  
 private discount rates  
 Cost of DCP works per property

Assumptions  
 Inundation  
 Probability of event in 2011  
 Probability of event in 2050  
 Probability of event in 2100  
 Consequence of event per property  
 Number of properties  
 Growth rate of development to avoid flood damage  
 Erosion

Thirroul surf club visitors per annum  
 consumer surplus for surf club use  
 Thirroul pool visitors per annum  
 consumer surplus for pool visitors  
 Heritage site value per person per annum  
 Aggregation to 79% of Australian household  
 open space around pool visitors per annum  
 consumer surplus for use of open space  
 pavillion - restaurant producer surplus  
 pavillion - value as a residence - rent per annum  
 Private properties no.  
 Private property values  
 private discount rates

Maintenance costs  
 Pool  
 Other pool buildings  
 Pavillion  
 SLSC  
 Reserve  
 Beach  
 Total

OPTION 1 - SEAL WALL - WITH NOURISHMENT  
 Initial beach nourishment (m3)  
 Ongoing beach nourishment (m3)  
 Cost per m3 of beach nourishment  
 Avoid Thirroul beach use lost  
 Consumer surplus for beach use

OPTION 2 - SEAL WALL - NO NOURISHMENT  
 Capital costs / metre  
 Metres  
 Maintenance costs per annum  
 Lost beach  
 Annual visit days  
 \$/visit day  
 SLSC asset value  
 Maintenance costs  
 Pavillion asset value  
 Maintenance costs  
 Pool asset value  
 Operating costs including maintenance  
 Thirroul Reserve area  
 Maintenance costs

OPTION 3 - PLANNED RETREAT  
 Relocation costs per tonne  
 Pavillion tonnes  
 Pool tonnes  
 SLSC  
 Rate at which redevelopment happens  
 Number of properties  
 No of inundation properties  
 Value of properties  
 private discount rates  
 Cost of DCP works per property

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**APPENDIX G: WOLLONGONG COASTAL EROSION EMERGENCY  
ACTION SUB PLAN**



# Wollongong Coastal Erosion Emergency Action Sub Plan

January 2012

Prepared For: Wollongong City Council

Prepared By: BMT WBM Pty Ltd (Member of the BMT group of companies)

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<b>Title:</b>	Wollongong Coastal Erosion Emergency Action Sub Plan
<b>Author :</b>	Doug Lord (Coastal Environment Pty Ltd)
<b>Synopsis :</b>	This Wollongong Coastal Erosion Emergency Action Sub Plan forms an Appendix to the Wollongong Coastal Zone Management Study and Plan. This sub-plan outlines actions to be performed before, during and after an erosion emergency and the roles and responsibilities for coastal erosion emergencies.

### REVISION/CHECKING HISTORY

REVISION NUMBER	DATE OF ISSUE	CHECKED BY	ISSUED BY
Appendix to Rev 3	02/12/11	VPR	VPR
Appendix to Rev 4	Jan 2012	PEH	VPR

### DISTRIBUTION

DESTINATION	REVISION			
	0	1	2	3
WCC	1			
BMT WBM File	1			
BMT WBM Library	1			

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## ACRONYMS

<b>CEEAS</b>	Coastal Erosion Emergency Action Sub-plan
<b>CPA</b>	Coastal Protection Act (1979)
<b>DECCW</b>	Department of Environment Climate Change and Water (former department, now OEH)
<b>LEMC</b>	Local Emergency Management Committee
<b>LEOCON</b>	Local Emergency Operations Controller
<b>OEH</b>	Office of Environment and Heritage
<b>SERM</b>	State Emergency and Rescue Management
<b>SERMA</b>	State Emergency and Rescue Management Act
<b>WCC</b>	Wollongong City Council

# 1 INTRODUCTION

## 1.1 Coastal Zone Management Planning

The process for managing coastal hazards and coastal risks along the New South Wales coast is through the preparation of Coastal Zone Management Plans. Through the development and subsequent implementation of these plans, the coastal hazards are identified and, as appropriate, the risks are addressed through a range of planning and protection measures. In this way the likelihood of emergencies resulting from erosion during storm events is minimised. The need for unplanned protection is reduced and the risk to life and property managed. The residual risk to properties, assets and life until such time as the key elements of the plan have been adopted or as a result of potential unforeseen outcomes or storm severity are covered by this Coastal Erosion Emergency Action Subplan (CEEAS).

The CEEAS is a required component of the preparation of a Coastal Zone Management Plan (CZMP) as set out in the NSW *Coastal Protection Act 1979* (the CPA). Section 55C(1)(b) of the CPA states a CZMP must provide for *'emergency actions carried out during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event'*. Section 4 of the CPA states that the part of a CZMP that deals with the matters specified in Section 55C(1)(b) is an emergency action sub plan (OEH 2011, page 1).

## 1.2 The Role of the Coastal Erosion Emergency Action Sub-plan

*"The emergency action sub-plan forms an integral component of a CZMP. It outlines a council's intended response to a coastal erosion emergency and explains ways in which and where beachfront property owners can place emergency coastal protection works according to the Coastal Protection Act 1979 (CPA)"* (OEH 2011, page 1).

*"Section 55C(2)(a) of the CPA requires that CZMPs **must not** include matters dealt with in any plan made under the State Emergency and Rescue Management Act 1989 (SERMA) in relation to emergency responses.*

*The roles and responsibilities of government agencies, councils and other relevant organisations during severe storm events (including events that cause erosion) are detailed in the NSW State Storm Plan (SES 2007)"* (OEH 2011, page 1).

## 1.3 Extent of the Coastal Erosion Emergency Action Sub-plan

The OEH Guide (2011) advises that *"The minimum area to be covered by an emergency action sub-plan would be either:*

- *any area defined by a direction from the Minister according to Section 55B of the CPA; or*
- *all beachfront margins where erosion is likely to threaten public and private infrastructure or assets.*

*The sub-plan may also cover areas of the coastline accessed or utilised by the general public where there is an identified threat posed by erosion, e.g. walking tracks through coastal parkland.”*

No direction has been issued under Section 55B for the Wollongong Local Government Area (LGA) coastal zone. The extent of this CEEAS is, therefore defined as the coastal margins of the ocean beaches and headlands within the city boundaries, extending from the Royal National Park at Stanwell Park in the North to the Lake Illawarra entrance in the south (excluding the Port Kembla Harbour foreshores).

## 1.4 Minimum Requirements for Emergency Action Sub-plans

The CEEAS must be consistent with and not duplicate or contradict any plans prepared under the *State Emergency and Rescue Management Act 1989* (SERM Act). The relationship between these two planning frameworks is indicated in Table 1 which has been adapted from OEH, 2011 (page 14).

**Table 1 Contents of CEEAS and SERM Act plans (adapted from OEH, 2011)**

<b>Emergency Action Sub Plans</b>	<b>SERM Act Plans</b>
Any coastal protection works or other actions to be carried out by council when coastal erosion is imminent or occurring, or in recovering from coastal erosion.	Actions in relation to the prevention of, preparation for, response to and recovery from emergencies, excluding permanent or temporary coastal protection works.
Any additional requirements for landowner placement of emergency coastal protection works beyond those in the <i>Coastal Protection Act 1979</i> (e.g. constraints on access and the location of works) *	Actions are consistent with the NSW State Disaster Plan and the State Storm Sub Plan.

\* No locations for emergency coastal protection works in accordance with the CPA 1979 have been identified in the Wollongong LGA coastal zone.

Where landowners are eligible to place emergency coastal protection works, the CEEAS is to be prepared with direct consultation with landowners affected by the subplan. In the Wollongong LGA coastal zone at present there are no private properties identified as eligible to place emergency coastal protection works in accordance with the CPA 1979 (Part 4C). Therefore, this requirement is not currently applicable.

The minimum requirements for a Coastal Erosion Emergency Action Subplan are set out in the NSW Government Guideline (OEH, 2011) which reflects the requirements expressed in the CPA 1979. These are:

- describing intended emergency actions to be carried out during periods of beach erosion, such as coastal protection works for property or asset protection, other than matters dealt with in any plan made under the *State Emergency and Rescue Management Act 1989* relating to emergency response (sections 55C(1)(b) and (g) of the CPA 1979)
- describing any site-specific requirements for landowner emergency coastal protection works
- describing the consultation carried out with the owners of land affected by a subplan.

## 2 EMERGENCY PLANNING HIERARCHY

### 2.1 Declared Storm Emergency

There is a clear hierarchy in planning and responsibility that applies to emergency management in NSW, including those emergencies resulting from a defined storm or disaster. In these events, the NSW State Emergency Services are designated as the lead combat agency and are in charge of the emergency response. The various roles and responsibilities are defined in the NSW Storm Plan and within the City of Wollongong Local Disaster Plan (DISPLAN). The DISPLAN states at paragraphs 114 and 115 that:

*"114 Subject to the requirements and provisions of the SERM Act, and under the provisions of the SES Act, for the emergencies of flood and damage control for storms, including the coordination of evacuation and welfare of affected communities, the overall control of operations in response to these emergencies is vested in the Director General of the State Emergency Service.*

*115 In both flood or storm emergencies, the DISPLAN for the District and/or any Local Area to which the emergency applies is automatically active and Police, the other Emergency Services and Functional Areas are to provide support as required by the Combat Agency Controller. The Local or District Emergency Operations Controller is then to be prepared to coordinate support if requested by the appointed Local/Division State Emergency Service Controller."*

Therefore, the Wollongong DISPLAN informs this Coastal Erosion Emergency Action Sub-plan.

The role of Council in a storm emergency is limited to those activities that may be requested by the SES to assist with the emergency relief or to activities (including protection works) undertaken by the Council to protect assets under Council control. Where any proposed protection works require development approval, Council must only undertake such works during an emergency where the consent has been obtained in advance. Where the works are exempt (such as minor works or emergency works to protect a road or stormwater system under SEPP (Infrastructure) 2007) Council must first undertake an assessment to determine that the works will not result in a significant adverse environmental impact. Before undertaking any works, Council must also confirm that the works proposed are in accordance with the currently gazetted (or adopted) Coastal Zone Management Plan.

There are no protection works proposed for emergency management purposes under this CEEAS that require development consent.

Following the emergency, Council is involved in the remediation of damage or hazards and the reinstatement of the dunes, beaches and accessways in an appropriate and safe manner. This will include works of varying priorities and timeframes in accordance with usual Council maintenance procedures.

## 2.2 Coastal Erosion Emergency (not triggered by a storm)

Where the erosion emergency arises from events other than a declared storm event, then the requirement of the State Storm Plan and Wollongong DISPLAN are not activated. Such an event could arise for example from a period of high tides and large swell, resulting in substantial erosion to the back of the beach. For these conditions it is likely that the erosion resulting would be substantially less than that which would result from the design storm event (unless such an event was to occur immediately following a severe storm event).

It is not possible to determine a trigger event for such an occurrence. Therefore, the determination to invoke the this emergency sub-plan (in this case by Council) would need to be based on monitoring of the beach state. In such a case, the CEEAS would be implemented following a request from the designated Council Officer.

## 2.3 Assets and Development at Threat

The extent of coastal hazards within the Wollongong LGA coastal zone is defined in the Wollongong City Council Coastal Zone Study (Cardno, 2010). This study maps the landward extent of erosion hazards that may be anticipated for various planning timeframes. Specifically, the landward extent of erosion hazards at present are defined in Maps included in the Wollongong Coastal Zone Study (Cardno, 2010) at Figures 8.5 to 8.13 and form the basis for defining the extent of the erosion hazard at present.

Within the Wollongong LGA coastal zone the extent of storm erosion resulting from a severe design storm event at present is mainly restricted to the sandy beach area with little public infrastructure or private property likely to be affected. Significant encroachments of the storm erosion extent threatening existing development are limited to the following locations:

- the parking area and ramp at Austinmer Boat Harbour (Cardno, 2010 Fig 8.5);
- the seaward portion of the Tuckerman Park carpark at Austinmer North (Cardno, 2010 Fig 8.6);  
and
- Thirroul Beach carpark and promenade (Cardno, 2010 Fig 8.7).

At each of these locations the development likely to be impacted is protected by a seawall of unknown design. The potential encroachment of the erosion into these paved areas was calculated on the basis that the seawall at present offered no protection to beach erosion.

In addition to these specific developments there are different types of activities, development and areas that may be impacted during an erosion emergency. These include:

- stormwater and drainage outlet structures located on beaches;
- ocean baths and rock pools;
- defined beach and dune access tracks under care and control of Council; and
- the beaches and dunes.



These exist within an area of known high hazard and are either designed to accommodate the erosion events (such as the stormwater outlets and pools), or are temporarily affected by erosion, limiting their use by the community (such as beaches and accessways). In each case the opportunity to protect the asset prior to an erosion event is low and the risk to life during an event is low. Similarly, the opportunity to undertake emergency works during an event is low and the preferred approach is to identify impacts, assess and repair the asset following the event. In most instances this becomes a routine maintenance role.

The landward extent of the erosion hazard as considered in this CEEAS may increase into the future as sea level rises. The impacts on the future revisions of the CEEAS should take this into account at each plan review.

## 3 EMERGENCY RESPONSES

### 3.1 Communication

#### 3.1.1 Storm Emergency

Where coastal erosion is anticipated as a result of a declared storm emergency, the responsibility for communicating the potential hazards defaults to the SES and the Local Emergency Operations Controller (LEOCON). Activation of the Wollongong DISPLAN would trigger this CEEAS. Council would assist in the provision of information on the current state of beaches and ocean pools as well as potential for impacts on beach access. Internally, Council staff with relevant responsibilities should be placed on standby and commence monitoring the impacts. Council employed Lifeguards and local Surf Life Saving Clubs should be contacted with a view to closure of beaches and ocean pools.

As the emergency progresses Council is required to continue monitoring these areas and updating information through the LEOCON as appropriate. Where specific hazards are resulting in damage, Council will provide this information to the LEOCON and for distribution through the media or directly to community as appropriate.

Following the emergency, Council is responsible for advising the current state of beaches and pools in the Council area (when/if they are re-opened for the public). Where residual hazards remain to be addressed, Council should take appropriate action to convey this to local communities including the use of signage and the release of media bulletins.

#### 3.1.2 Non Storm Erosion Emergency

Where the emergency does not trigger the State Storm Plan or Wollongong DISPLAN, Council is responsible for initially monitoring the potential progress of erosion and subsequently implementing this CEEAS. The roles and responsibilities of Council in communicating the emergency to the community remain the same except that information needs to be provided by Council directly through the media rather than through the LEOCON as outlined in Section 3.1.1 above.

### 3.2 Landowner Initiated Actions

There are no locations in the Wollongong LGA coastal zone at which temporary emergency coastal protection works (CPA 1979, Part 4c Sand/Sandbags ECPW) are permitted. This includes properties within the immediate erosion hazard line in the LGA, such as at Thirroul Beach. Temporary emergency coastal protection works are only permitted under the CPA 1979 at locations listed in Schedule 1 of that act, none of which exist in Wollongong LGA.

Property owners, such as those at locations within the immediate erosion hazard line, are permitted to submit development applications to install permanent protection works, provided such works are consistent with the Wollongong CZMP once it is certified.

Where property owners wish to install permanent protection works (either prior to or during a coastal erosion emergency):

- they must submit a development application for the works,

- they must have a valid approval, and
- they must comply with all conditions of consent applying to that approval, before proceeding with the works.

Any illegal works placed by a property owner may result in prosecution of the person and removal of the works.

A property owner may be able to undertake minor works to minimise damage to their property and/or dwelling where such works do not require development approval and do not result in adverse impacts. The types of things permitted without consent are unlikely to provide significant protection from any coastal erosion that is occurring but may limit consequent damage, for example: Sealing of the space at the bottom of a doorway to limit water entry, repair/replacement of damaged windows, cladding or roofing, clearing of drains, pumping of ponded water, removal of objects from proximity to an escarpment (such as fences, sheds, furniture), etc.

The owner of a property has the right to undertake a wide variety of activities/maintenance in relation to their property which may or may not result from damage during a storm event and which, generally are of a minor nature. As with all activities there is a common law obligation not to cause a nuisance to neighbours or damage to adjacent properties. Generally those works resulting in structural alterations to a building (de including demolition or removal), or significant construction (such as a retaining wall or underpinning a structure) or significant earthworks (excavation or placement of fill) would require prior development/building approval.

### 3.3 Council Actions Prior to a Coastal Erosion Emergency

- Where the likelihood of an emergency event is identified (e.g. Storm warnings or damaging wave warnings from the SES/BOM), the local Lifeguards (employed by Council) will inform the local Surf Life Saving Clubs. The Council Lifeguards and / or the local SLSCs will then take the appropriate action in terms of closing the beaches and/or ocean pools.
- Where difficulties/damage are known to exist on beach accessways and these are likely to be exacerbated by storm erosion, then Council at their discretion may close those walkways and place appropriate signage.
- Council will commence monitoring the effects of the erosion on assets and development potentially at threat (section 5).
- As appropriate, the Council CEEAS controller will initiate the CEEAS.

### 3.4 Council Actions During a Coastal Erosion Emergency

The following activities would be undertaken by Council during the emergency:

- Council activities during a coastal erosion emergency will be guided by issues relating to the safety of Council staff.

- Where damage to walkways is identified and/or reported to Council, as practical Council will take appropriate action to close off the accessways and/or advise the local community of the hazards at the first opportunity.
- Where damage to assets is identified through monitoring (Section 5), Council will assess the damage and any opportunities for limiting further damage that may be appropriate during the event.
- Where repairs are permissible (as outlined in Section 2.1) and may be readily and safely undertaken, this will be done at the first opportunity.
- At the appropriate time the CEEAS controller will determine that the emergency has passed and that the remediation stages of the plan are to commence.

### 3.5 Council Actions Following the Cessation of a Coastal Erosion Emergency

The following activities would be undertaken by Council following the emergency, within their usual maintenance programs.

- Following the erosion emergency, Council will undertake an inspection of all beach accessways to establish any damage to the access or dangers to the public in using the access to the beach.
- Where an accessway is considered unsafe, action will be taken to close the access (top and/or bottom) and to place appropriate signage warning the access is unsafe for use.
- Council will prioritise the work required to repair and reopen any damaged or unsafe accessways in accordance with the Council maintenance works schedule.
- Where an erosion escarpment has been created at the back of the beach (height greater than 1.5m), Council will document the extent of the escarpment and at the earliest opportunity undertake a risk assessment of the likely hazard to beach users (both to persons on the beach and to persons on the dune above the scarp) from collapse of the erosion scarp.
- Where the risk is deemed unacceptable, Council will at the earliest opportunity undertake appropriate mitigation works which may include:
  - regrading the escarpment to a stable slope (following approval from Council's environment division);
  - fencing and signposting escarpments, to discourage public access (top and/or bottom) until such time as the beach recovers naturally; and
  - keeping the beach closed until such time as the risk has reduced to an acceptable level.
- At the appropriate time the Council CEEAS controller will declare the emergency has finished and the CEEAS is no longer operative.

## 4 RESPONSIBILITIES

Specific responsibilities under the CEEAS are tabulated in Table 2.

Council through the nominated CEEAS controller must tabulate relevant Council positions and responsibilities for implementation and execution of the CEEAS. This will require an up to date list (names and contact numbers) for relevant contacts to be maintained by Council and updated as positions or responsibilities change. This list is to be readily available within Council and communicated to each of the nominated contact persons following any update.

**Table 2 Specific Responsibilities in implementation of the CEEAS**

<b>Position</b>	<b>Responsibilities</b>
Local Emergency Operations Controller (LEOCON)	Execution of the Local DISPLAN, including aspects relating to coastal erosion
Council CEEAS controller	Liaison with LEOCON during storm emergency. Implementation of the CEEAS during non-storm erosion emergency
Council Recreation Services Manager	Monitoring repair of beaches and dunes. Closure of Beaches and ocean pools as appropriate. Post storm remediation.
Council Media Liaison Officer	Distribution of warnings and closures via the media.

## 5 PLAN REVIEW

This coastal erosion emergency management plan should be maintained as required and reviewed at intervals not exceeding 5 years from its initial adoption. Earlier review may be triggered by:

- occurrence of a coastal erosion emergency that exceeds the defined hazard extent as outlined in the Wollongong City Council Coastal Zone Study (Cardno, 2010) to redefine the extent of the area covered by the Plan;
- revision of the NSW State Storm Plan, the Local DISPLAN (revised each five years) or the Coastal Protection Legislation and associated guides, to ensure the plan remains consistent with their objectives;
- unsatisfactory outcomes or concerns following a coastal erosion emergency; or
- proposed changes to the gazetted Coastal Zone Management Plan.

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[n2018-759]