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Lake Macquarie Coastal Zone Management Plan Part C for Swansea Channel

Final

October 2015

Lake Macquarie Coastal Zone Management Plan – Part C for Swansea Channel

Prepared for: Lake Macquarie City Council

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<p>Synopsis: This report provides a management action plan for addressing risk associated with coastal hazards within Swansea Channel. Hazards relate to extreme storm inundation, tidal inundation, wave-driven recession and channel evolution. Consideration is given to existing and future hazards, taking into account future sea level rise. A series of options are presented with recommendations for which options are best for different areas within the Study Area. Recommended management options are presented in a Management Action Plan to address risks including actions, timing, responsibility and indicative cost.</p> <p>The Lake Macquarie City Council has prepared this document with financial assistance from the NSW Government through its Estuary Management Program. This document does not necessarily represent the opinions of the NSW Government or the Office of Environment and Heritage.</p>		

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Introduction

1 Introduction

1.1 Background

Lake Macquarie is located on the mid-north coast of New South Wales, approximately 120km north of Sydney. Swansea Channel connects the main body of Lake Macquarie to the ocean. The channel is located entirely within the Lake Macquarie local government area (LGA). Swansea Channel and its locality are shown on Figure 1-1.

The construction of entrance breakwaters, the Swansea Bridge, and revetments has modified processes in the channel. Very broadly, the channel can be divided in two at Swansea Bridge, which carries the Pacific Highway across the channel and connects the suburbs of Blacksmiths to the north, and Swansea to the south. The channel downstream of Swansea Bridge is affected significantly by oceanic swell waves that penetrate the widely spaced breakwaters at the entrance. Upstream, the dominant coastal processes relate to tidal currents and the transport of sediment. The combination of waves downstream of the bridge and tidal currents throughout the channel has caused significant erosion (particularly in Salts Bay and between Mats Point and the entrance to Black Neds Bay) and the upstream transport of sand, with ultimate deposition on the “dropover” at the lake end of the channel.

Management of the channel over the past decade has involved repeated dredging campaigns and various works, such as partial closure of the southern entrance to Swan Bay, commonly to address issues with navigation and foreshore erosion. The channel has a persistent, dynamic nature which creates challenges for those tasked with its integrated management, particularly considering the competing needs of various stakeholders and finite funding. The combined impact of tides and waves with future sea level rise will further complicate those challenges.

The Lake Macquarie Estuary Management Plan (WBM Oceanics Australia, 1997b) and Volume 1 of the underpinning Estuary Management Study (WBM Oceanics Australia, 1997c), which deal with Swansea Channel in particular, were completed under previous guidelines in the Estuary Management Manual (NSW Government, 1992). Those studies identified that around \$40 million dollars were required to begin addressing problems in the lake, including Swansea Channel. In 1998, a Premiers task force was established to develop a priority action plan. The task force produced an “Integrated Estuary and Catchment Management Framework” in 1999, and developed an initial 3 year action plan, to be funded by Lake Macquarie City Council (Council), Wyong Shire Council and the State Government. The Office of the Lake Macquarie and Catchment Coordinator (OLMCC) was established to execute that action plan. Funding for OLMCC was extended to complete the action plan, with its operations winding up in 2009. Council is now primarily responsible for the management of Lake Macquarie.

Recently, changes have been made to the *Coastal Protection Act 1979* and new *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013) were released. More data are available, more studies have been completed and there have been improvements to the analytical techniques available to define coastal hazards and estuarine processes.

Council has resolved to prepare an integrated Coastal Zone Management Plan (CZMP) for (a) the entire open coast of the LGA, (b) the main body of Lake Macquarie, and (c) Swansea Channel, as well as a separate summary of the first four years of actions. The first three documents comprise Parts A, B, and C of the overall CZMP, respectively.



Title:
Swansea Channel: Locality Plan

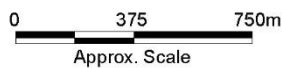
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BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.



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Introduction

The study area begins at the entrance breakwaters and ends at the lake end of the dropover. The study therefore incorporates those components of the system which contribute to the attenuation of tides between the Ocean and Lake Macquarie. The study area extends beyond those areas prone to inundation both now and by 2100.

The Swansea Channel part of the CZMP (i.e. Part C, this study) includes areas that are significantly affected by oceanic swell waves (e.g. Entrance, Salts Bay), and areas of estuarine wetland (e.g. Black Neds Bay, Pelican Inlet). Accordingly, it needs to consider both coastal risk management (Chapter 3 of OEH 2013), and estuarine ecosystem health (Chapter 4 of OEH 2013).

1.2 Context and Objectives of this Report

The *Lake Macquarie Coastal Zone Management Plan – Part C for Swansea Channel* provides a framework for managing the risks arising from coastal and estuarine hazards and impacting on existing and future development, ecological and community assets in and around Swansea Channel.

The Channel part of the CZMP assesses the management options to address those risks including actions, priorities, timing, responsibility and indicative cost. It is supported by the *Swansea Channel Hazard Study and Risk Assessment*, which identifies the likely extent of the hazards and their consequence along Swansea Channel's foreshores from present to 2100 (including sea level rise). The Swansea Channel part of the CZMP should be read in conjunction with the *Swansea Channel Hazard Study and Risk Assessment*.

The Lake Macquarie Coastal Zone Management Plan – Part C for Swansea Channel documents have been prepared to meet the requirements of the *Coastal Protection Act, 1979* and associated *Guidelines for Preparing Coastal Zone Management Plans* (OEH 2013). Further details of the legislative requirements associated with the development of the Plan are presented in Appendix A. The Swansea Channel Risk Management Plan will be adopted by Council and certified by the Minister for Environment under the *Coastal Protection Act 1979*.

Community access and recreation are important considerations in the coastal zone and are required to be considered in CZMPs, in accordance with the *Guidelines for Preparing Coastal Zone Management Plans* (CZMP guidelines) (OEH 2013). This study assesses strategies for managing recreational and community access where these aspects are affected by, or have an effect on, the extent of hazards. Similarly, management strategies are considered which address the interaction of hazards and key ecological assets, both now and for projected future scenarios.

1.2.1 Objectives of the Swansea Channel part of the CZMP

Building on the information provided in the supporting document (Swansea Channel Hazard Study and Risk Assessment), the objectives for this Swansea Channel part of the CZMP are to:

- Identify and assess management options for addressing highest priority risks; and
- Provide an implementation action for Council and other authorities to undertake works and other actions to mitigate existing and future coastal risks.

1.3 Study Area

The study area is outlined on Figure 1-1. The study area covers:

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- Waterway and wetland areas comprising Swansea Channel, Black Neds Bay, Pelican Inlet and Swan Bay.
- Fringing settlements and localities including Swansea Heads, Caves Beach, Swansea, Blacksmiths, Little Pelican, Pelican and Marks Point.
- The dropover region, including the “Sand Islands” of Spoil Island, Elizabeth Island, Spectacle Island and other, unnamed islands within this area.

For this study, the waterway is assumed to start at the entrance breakwaters and end at the lake end of the dropover. The study therefore incorporates those components of the system which contribute to the attenuation of tides between the ocean and Lake Macquarie and hence a transition between open ocean and lake.

Under legislation, the coastal zone extends landwards for one kilometre from the foreshore around estuaries. This report deals primarily with those areas affected by the extent of coastal hazards adjacent to Swansea Channel and their management.

1.3.1 Awabakal Country

Swansea Channel, the open coast and the lake have significant and continuing cultural meaning and value for the Awabakal people. The coastline bears abundant evidence of the traditional economic and cultural value of coastal resources to Awabakal people. Large midden sites of lake and rock platform species occur near Swansea Channel, and on dunes and headlands along the whole coast. Several burials have been discovered, including those now ceremonially reburied in the Swansea Heads reserve. The early European observations of Awabakal people in the lake and along the coast indicate active and prosperous group of several hundred people, with considerable skill in fishing and shell fishing, including with hook and line from canoes, and by diving or with long spears from the shore and rock platforms.

1.4 Report Outline

This report is a continuation of the companion volume (Hazard Study and Risk Assessment report).

Chapter 2 provides an assessment of different strategies and options to treat the coastal risks identified in the Hazard Study and Risk Assessment report.

Chapter 3 provides an Action Plan for implementing the most appropriate strategies and risk management options, including details of costs, responsibilities and suggested timing.

Appendix A includes details of the legislative requirements of the Coastal Zone Management Plan to facilitate approval by the Minister and subsequent gazettal in accordance with the provision and requirements of the *Coastal Protection Act 1979*.

Relevant maps associated with the Action Plan are included in Appendix B.

1.5 Consultation

Major community consultation around the hazards and management options from flooding, storm surge inundation, and rising sea levels along Swansea Channel were conducted during the preparation of the Lake Macquarie Waterway Flood Study and Risk Management Plan in 2011/12. About 7000 local residents were contacted directly, and more than 150 participated in local workshops at Belmont and Swansea.

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The Draft Lake Macquarie Coastal Zone Management Plan (CZMP) was placed on public exhibition from 28 October 2014 through to 31 January 2015. The objective of the public exhibition period was to give all Lake Macquarie City residents a chance to understand and provide feedback on the actions proposed in the draft CZMP or to suggest new actions.

Community workshops, online engagement and ‘pop-up’ information booths were used to give the public information about the contents of the draft CZMP and to get community input to the proposed actions and ensure that the challenges and opportunities from the perspective of the community were identified.

A specific workshop for **Part C – The Channel** was held at Swansea Centre, Swansea on 17 November - 5.30 – 8.30 pm. Input was received from the 12 participants attending this session.

Council’s Have Your Say website also hosted a project page www.haveyoursaylakemac.com.au/coastal-zone-management-plan where participants could rank the actions for the area of the Channel. A total of 20 responses were submitted on the actions for the Channel.

1.5.1 Overview

Of the 20 responses that were related to the Swansea Channel, 9 responses were submitted directly through the website and 11 responses were submitted via the information pop-up booths. The themes of most interest to respondents (highlighted blue in Table 1-1) were:

1. Theme 3 – Actions for sustainable community access, use and value (9 responses);
2. Theme 2 – Actions for a healthy coastal zone, protecting the natural environment (including biodiversity and ecological resilience) (5 responses); and
3. Theme 1 – Actions to manage coastal process hazards and risk (such as erosion and inundation) (3 responses).

Table 1-1 Online Consultation for Part C Swansea Channel

Theme	Online Consultation		
	Website	Pop-up	Total
1. Actions to manage coastal process hazards and risks (such as erosion and inundation)	1	2	3
2. Actions for a healthy coastal zone, protecting the natural environment (including biodiversity and ecological resilience)	1	4	5
3. Actions for sustainable community access, use and value	6	3	9
4. Improve Council’s focus and capacity to manage coastal values	0	1	1
5. Strong governance and supportive partnerships	0	1	1
6. Actions for communication and collaboration	0	0	0
7. Knowledge and adaptation, managing uncertainty	1	0	1
TOTAL RESPONSES	9	11	20

Table 1-2 shows what online participants considered to be the top 6 management actions for the Coastline.

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Table 1-2 Ranked Management Options from Online Consultation

Ranked Management Actions	Theme
1. Work with local communities to develop Local Adaptation Plan to identify strategies for adaptation to changing levels of hazard and risk as a result of rising sea levels	2
2. Restore the recreational amenity of Granny's Pool and improve access and public facilities in the adjacent reserve	2
3. Investigate options for maintaining or relocating tidal wetlands as sea levels rise	2
4. Investigate new protective works such as revetments or groynes to manage eroding foreshores	1
5. Beach shaping, and dune revegetation to increase sand volumes and height of frontal dunes	2
6. Support Dunecare program to rehabilitate and care for dunes	2
7. Assess the condition of the entrance breakwaters and undertake maintenance works to maintain safety and access	1
8. Assess the condition of channel revetments (rock walls) and prepare a program to maintain or replace to prevent failures	1
9. Set design standards for revetments, breakwaters and other foreshore protections to take into account existing hazards and future changes in hazards	1
10. Investigate beach nourishment to manage eroding foreshores	1
11. Progress with existing asset management planning and include revised design standards for new works	1
12. Investigate and prepare new design criteria to account for changing channel conditions (e.g. depths for revetments)	1
13. Monitor changes to tidal wetlands and wetland health	2

Note: The last 7 management actions in grey shared priority.

1.5.2 Conclusion

Online and workshop consultation undertaken for Part C – The Channel has assisted to prioritise the themes and management actions from the draft CZMP. The table below shows combined results of the top ranked theme and management actions for the Channel.

1. Theme 3 - Actions for sustainable community access, use and value
Work with communities to develop Local Adaptation Plans to identify strategies for adaptation to changing levels of hazard and risk as a result of rising sea levels.
2. Theme 2 - Actions for a healthy coastal zone, protecting the natural environment (including biodiversity and ecological resilience)
Investigate options for maintaining or relocating tidal wetlands as sea levels rise.
Beach shaping, and dune revegetation to increase sand volumes and height of frontal dunes.
Support Dune care program to rehabilitate and care for dunes.
Use planning controls and design guidelines to minimise use of foreshore structures that impede ecological transition.
Monitor changes to tidal wetlands and wetland health.

Introduction**3. Theme 1 - Actions to manage coastal process hazards and risk (such as erosion and inundation)**

Investigate new protective works such as revetments or groynes to manage eroding foreshores.

Assess the condition of the entrance breakwaters and undertake maintenance works to maintain safety and access.

Assess the condition of channel revetments (rock walls) and prepare a program to maintain or replace to prevent failures.

Set design standards for revetments, breakwaters and other foreshore protections to take into account existing hazards and future changes in hazards.

Investigate beach nourishment to manage eroding foreshores.

Review development controls to address extreme storm flooding and increased tide levels.

Progress with existing asset management planning and include revised design standards for new works.

Investigate and prepare new design criteria to account for changing channel conditions (e.g. depths for revetments).

2 Risk Management Options

2.1 Summary of High Priority Risks and Objective for Management

Coastal risks applicable to Swansea Channel have been determined through consideration of the extents of impact of coastal hazards, and the potential consequences to assets located within the hazard impact area. Assets cover a broad range of environmental, social and economic values, including private and public lands and infrastructure (e.g. roads, services, facilities).

The objective for risk management is to “reduce risks derived from coastal-related hazards through reducing exposure to such hazards and/or increasing resilience of assets to hazard impacts”.

High priority risks were determined through the risk assessment process, as documented in the companion volume (Swansea Channel Hazard Study and Risk Assessment report). High priority risks are those risks associated with assets that are exposed to frequent hazard impacts and/or assets that have significant consequences if their environmental, social or economic value is substantially compromised.

The assets at highest risk are summarised in Table 2-1.

Table 2-1 Highest Priority Assets at Risk

Asset Category	Highest Priority Asset at Risk	Asset Owner
Foreshore Structures	Blacksmiths breakwater and northern training wall	Crown Lands
	Eastern and middle groynes in Salts Bay	LMCC/Crown Lands (tbc).
	Black Neds Bay entrance training wall	LMCC/Crown Lands (tbc).
	Swansea RSL jetty and wharf	LMCC
	Swansea Bridge and approaches	Roads and Maritime Services
	Swansea boat ramp, wharf and jetty (west of the bridge)	LMCC
	Boat ramps and facilities at Thomas Humphries reserve	LMCC
	Groyne field at Pelican	LMCC/Crown Lands (tbc).
	Pelican boat ramp, jetty and facilities	LMCC & Crown Lands
	Foreshore infrastructure including boardwalk, revetment and walkways at Pelican	LMCC
	Groyne field and beach at Naru Point and Swan Bay southern entrance	LMCC/Crown Lands (tbc).
Land development and community assets	Naru Point boat ramp	LMCC
	Residential lots in Caves Beach / Swansea Heads, Blacksmiths, Marks Point, Swansea, Pelican and Little Pelican	Private
	Kindiamanna Reserve athletics field	LMCC
	Belmont airport site	Private

Risk Management Options

Asset Category	Highest Priority Asset at Risk	Asset Owner
	Pelican marina and adjacent public park	Private, Crown Lands, LMCC
	Aitchison Reserve, Pelican	LMCC
	New Orana Hotel	Private
	Blacksmiths commercial area	Private
	Blue Pacific Motel	Private
	Blacksmiths foreshore park and boat ramp	LMCC
	Blacksmiths Beachside Holiday Park and soccer field	Private, Crown Lands, LMCC
	Swansea peninsula foreshore reserve	Crown Lands, LMCC
	Swansea Gardens Lakeside Holiday Park, Swansea	LMCC
	Buggagallana Reserve / Chapman Oval, Swansea	LMCC
	Quinn Park and Swansea Swimming Centre	LMCC
	Parbury Park, Swansea	LMCC
	Swansea RSL and Swansea Commercial centre	Private
	Swansea industrial zone	Private
Environmental Asset	Habitats and ecosystem communities (including mangroves, saltmarsh, swamp oaks and swamp mahogany complexes) located within Black Neds Bay, Pelican Inlet, Boatrowers Reserve, Coon Island, Pelican / Marks Point and the Sand Islands.	LMCC, Crown Lands
	Salts Bay beach and Mats Point to Black Neds Bay beach	LMCC, Crown Lands
	Spoil Island	Crown Lands
Services	Residential gas, power, and telecommunications transmission	Jemena, Ausgrid, Telstra
Roads and Transport Assets	Pacific Highway	Roads and Maritime Services
	Local roads within Pelican and Swansea	LMCC
Stormwater, Water Supply and Sewerage Assets	Stormwater system within Marks Point, Blacksmiths, Pelican, Swansea and Caves Beach / Swansea Heads	LMCC
	Water supply system within Marks Point, Blacksmiths, Pelican, Swansea and Caves Beach / Swansea Heads	Hunter Water Corporation
	Sewerage system within Marks Point, Blacksmiths, Pelican, , Swansea and Caves Beach / Swansea Heads	Hunter Water Corporation

Risk Management Options

2.2 Options Framework

The risks considered in this study are created by different mechanisms and have different consequences and likelihoods of occurrence.

Storm inundation flooding is a rare event whereby lands will be inundated for a relatively short period of time. Once the inundation subsides, the land will return to its pre-flood conditions. While there is a risk that infrastructure and assets located on the land will be damaged, the infrequent nature of the event means that the development can continue, with the risk managed by appropriate development and planning conditions, and by market signals such as insurance costs.

Tidal inundation flooding is a more frequent event, although it affects a significantly smaller land extent. Within affected areas, the periodic inundation by saline waters would have a permanent impact on the usability of the land, and thus future land improvements may be influenced by the future land suitability. As there is uncertainty around the rate of sea level rise, a likelihood scale has been adopted within the risk framework.

The wave-driven erosion impacts in Swansea Channel will be focused on the Salts Bay foreshore, as this is the main area of exposure for ocean swell waves. The interaction between ocean waves and sea level rise inundation makes it difficult to predict future impacts of wave-driven erosion. Areas at risk contain very little infrastructure, apart from coastal structures that have been constructed for the purposes of minimising shoreline erosion and recession.

Channel evolution is a chronic risk rather than a risk that relates to a discrete event. Drivers for channel evolution can change with time, and it is unclear how future sea level rise will affect channel evolution trends. Historical channel migration patterns have led to the construction of revetments along several sections of the channel foreshores. Future risks are largely associated with failure of these revetments and adjustment of the channel after failure. As channel evolution occurs progressively rather than as a single event, risk management is well-suited to trigger-based approaches.

2.3 Overview of Options

This chapter investigates potential options for managing risks associated with extreme storm flooding, tidal inundation, wave-driven erosion and channel evolution along Swansea Channel. There are a number of potential management options to consider, with relevance depending on whether infrastructure is already in place, or planned for the future.

For **Future Development**, the management approaches are generally as follows:

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

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

Risk Management Options

A Accept the risk where it does not pose unacceptable consequences over the design life of the development.

Existing development is typically much harder to manage as works and infrastructure are already in place that limits the opportunity for both ‘avoiding’ and ‘accommodating’ the risk. Thus, risk management options become either ‘protecting/defending’ the land or asset, or ‘accepting’ the potential for damage or loss given the expected timeframe and likelihood of impact. When existing structures and infrastructure reach the end of their functional design life, they should be relocated away from high-risk areas, or redesigned to accommodate the risk, where appropriate. ‘Like for like’ replacement of infrastructure should only be considered in areas unaffected by existing and potential future hazards. Options for managing existing development include:

P rotect existing development (private or public) from erosion and/or flooding/inundation. Protection may be in the form of hard defence structures (e.g. revetments) or soft-engineering measures (e.g. foreshore sand nourishment, vegetation). 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;

A ccommodate the risk, which aims 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) through careful re-design; and

P lan to R etreat from the risk, which aims to allow natural processes to occur largely uninhibited by infrastructure or development, where alternative options are neither feasible nor affordable.

N o Regrets and Preliminary Actions have been devised to support the implementation of other management options. Such options offer a range of assessments and works to provide further information (including approvals) required prior to implementing larger scale options for specific assets, particularly where a more costly or difficult option may be needed. The ‘no regrets’ options also include activities that will improve resilience and preparedness for future impact, without limiting the ability to change a management approach if future impacts do not emerge as expected.

For existing development, it may be useful to identify ‘trigger points’ for future action rather than undertaking potentially costly actions immediately. This approach effectively defers action until an identified point or event in the future (such as a distance from an erosion escarpment, a frequency of inundation or water level etc) whereby the appropriate action (protection, accommodation, or retreat) should then be implemented.

It must be noted that setting a trigger point is not an excuse to “do nothing”, i.e. undertake no management action at the present time. Planning controls, “no regrets” actions and preliminary investigations must still be undertaken to effectively reduce the scale and cost of risk treatment required in the future. That is, setting triggers without taking action in the present timeframe to reduce the intensity of assets and values within known risk areas only increases the difficult and costly actions required from future generations. Setting triggers must be accompanied by actions

Risk Management Options

now to prepare the funding and resources required and to reduce the scale or costs of impacts in the future.

2.4 Existing Floodplain Risk and Tidal Inundation Management

Risks associated with storm inundation flooding and tidal inundation hazards may be most conveniently managed through Council’s existing floodplain risk and tidal inundation management mechanisms. Council has been pro-active with regards to floodplain management, with a flood policy in place for more than 30 years. This policy was updated in 2008 and 2012 to reflect predicted effects of climate change and sea level rise impacts (to 2100).

Council’s Lake Macquarie Waterway Floodplain Risk Management Study and Plan (WMA Water, 2012) has set a new flood planning area around Lake Macquarie, with Section 149 notations on lots below 3 m AHD. Additionally, any new release areas and major new subdivisions need to be outside the 3m AHD flood planning area, which incorporates provisions for future sea level rise (to 2100) and freeboard allowance.

The existing Council Flood and Tidal Inundation Policy provides the following guidelines:

“1. Council has to consider the effect of climate change when determining development applications.

2. Required floor levels for buildings will be considered in accordance with the following principles:

(a) Each DA is to be considered on a case-by-case basis (as is required by law).

(b) Flood planning levels are based on the findings of the Lake Macquarie Waterway Flood Study (2012), incorporating the NSW Sea Level Rise Policy Statement benchmarks [now repealed, but preserved in Council planning instruments], and adding 0.5 metres freeboard as recommended in the Flood Risk Management Guide: Incorporating sea level rise benchmarks in flood assessment.

For habitable dwellings the flood planning levels are:

Risk Measure	Planning Level for Asset Life to 2050	Planning Level for Asset Life to 2100
<i>1:100 year lake flood (including sea level rise of 0.4 m by 2050) 1.86 m AHD</i>	<i>1.86 m AHD + 0.5 m freeboard = 2.36 m AHD</i>	<i>n/a</i>
<i>1:100 year lake flood (including sea level rise of 0.9 m by 2100) 2.32 m AHD</i>	<i>n/a</i>	<i>2.32 m AHD + 0.5 m freeboard = 2.82 m AHD</i>

For ease of calculation, it is assumed that sea levels and lake flood levels will increase linearly between these benchmarks.

(c) Planning and development assessment guidelines will include criteria for the three risk areas identified in the Lake Macquarie Waterway Flood Risk Management Study and Plan (2012):

“high lake hazard” area below 1.0 metre AHD

“high flood hazard” area below 1.5 metres AHD

“low flood hazard” area for flood-affected properties above 1.5 metres AHD and below 3.0 metres AHD.

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(d) If the developer seeks to fix a lower level for their proposal, or propose alternative methods to deal with the flood and inundation risk, they will submit a site-specific flood study, which enables Council to evaluate the proposal on its merits. However, Council reserves the right to submit the study to peer review or evaluation by an independent expert.”

2.5 Potential Management Options

Presented below are a range of management options that may be applicable to managing the hazards in Swansea Channel. The management options outlined below have been compiled 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* (2010) and other coastal management plans and studies.

2.5.1 Development Controls

Development controls apply conditions appropriate to the type of development and likely hazard over the expected life of the development. Development controls can apply to infill, greenfield and re-developments.

Existing development controls for floodplain management would largely address risks associated with storm inundation. Additional or amended controls may be required to address risks from tidal inundation, wave-driven erosion and channel evolution hazards.

The recommended approach is to utilise the hazard zones provided in this study in combination with the type of the development and its expected lifespan, to determine the appropriate control for hazards.

Development controls should apply to:

- Complete redevelopment of an existing structure or site, including in-fill subdivision;
- Major alterations or refurbishments to existing structures; or
- Subdivision and/or new developments on previously undeveloped land.

Examples for land use categories and the different timeframes and hazard zones applied is given below:

- A residential or commercial development may be expected to have an asset life of 50 to 100 years before it is substantially upgraded or redeveloped. Therefore, the hazard extents that match the asset life, up to 2100 would apply. In determining controls, the ‘possible’ line at 2100 defines the area in which special development controls may be applied.
- Essential facilities and infrastructure may also be expected to be on a site for 100+ years and by its very nature needs to be conservatively sited for coastal risks. Again, the hazard extents by 2100 should apply. In determining controls, the ‘rare’ line at 2100 is the defining line for development. The ‘rare’ line is similar to the PMF used in flooding, and is thus an appropriate hazard boundary for ensuring essential services are located beyond potential impact area. The only exception to this may be stormwater outlets, which by their very nature are located on the shoreline. Consideration for impacts can be included in the structure design.

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Development controls should specify assessment or performance criteria for the Land Use / Development Type that need to be satisfied. Applicable development controls to achieve these criteria may include:

- Setbacks for development landward of the channel (e.g. a Foreshore Building Line);
- Use of temporary or re-locatable structures in high hazard areas;
- Minimum floor levels;
- Special allowance for filling;
- Alternative/additional criteria that may be applied includes:
 - **Adaptable building design**, for structures to be temporary, sacrificial or relocatable, as considered suitable for the type of development;
 - **Alternative locations** for the structure (particularly for public assets, or for private assets within property boundaries); and
 - **Trigger-Based Development Approvals**, which provide new developments/redevelopments with consent until the eroding shoreline (or wave overtopping height / frequency) reaches a certain distance to the property, at which point the development must be removed (to allow retreat), for example. This may apply where the risk over the expected life is high, but development could be accommodated until that trigger occurs. This would be ideal for channel evolution risk, where the timeframe for impact is unknown. The NSW Department of Planning & Infrastructure has indicated that this type of development approval is acceptable. The responsibility for monitoring could be tied to the landholder as part of the development consent, or otherwise undertaken by Council (depending upon existing monitoring programs), as deemed appropriate by Council. This is a relatively new approach to development control, and issues of administration costs, compliance burden, and appropriate legal guarantees will need to be resolved.

Development controls may also control existing development, by controlling the expansion of (or even reducing) development footprints for existing sites applying for re-development in high hazard areas. Development controls do not prohibit existing landholders from remaining on their land until such time as an unavoidable impact occurs. However, the development controls may specify that further expansion of the development footprint (e.g. extensions or renovations, subdivision, change of use) is not permitted, thereby avoiding an increased concentration of assets and therefore risk in high hazard areas over time.

Planning controls and design guidelines may be used to minimise the use of foreshore structures that restrict ecological transition by removing existing barriers to wetland migration wherever possible. Potential application of such development controls, to the extent possible with existing development, include residential development fringing Black Neds Bay wetland and Pelican wetland.

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2.5.2 Beach Management

This option involves managing beach sands through re-contouring and physical transportation from one beach section to another. The objective is to redistribute sand from areas of accretion to depleted areas or areas at risk. Re-contouring of dunes should be undertaken to a level that also reduces wave overtopping, where possible. For example, low areas along a dune barrier could be re-contoured to increase the height, providing a consistent shoreline barrier.

Beach management should ideally be undertaken in combination with dune rehabilitation (see option below) to minimise wind-blown sand losses and is considered as an alternative to beach nourishment providing that there are local areas of sand accretion.

Within Swansea Channel, beach management could be considered for the Salts Bay foreshore and for the foreshore between Mats Point and Black Neds Bay.

2.5.3 Dune Protection and Wetland Rehabilitation

Dune revegetation programs can be implemented in locations where vegetation is currently degraded, limited or overcome by weeds. Again this would primarily target the Salts Bay / Black Neds Bay area.

Dune revegetation allow for ongoing retention of sand by the sand being ‘captured’ by the vegetation, which would otherwise simply blow over the dunes. With time, dunes can increase in height as vegetation adapts to the dune profile. Dune vegetation also provides ecological benefits that promote a functioning beach ecosystem.

This option would therefore also involve “protection” of native coastal vegetation by way of controlling access to dunes for walkers and four-wheeled drives, for example, using fencing, formalising and controlling pathways, signage, etc. Projects to encourage re-establishing estuarine wetland communities, such as saltmarsh and seagrass, which will be affected by higher lake levels should continue and be extended.

2.5.4 Beach Nourishment

Beach nourishment involves the placement of sand onto the beach profile to re-establish and/or build up the sand reserves held on the beach. It is noted that “beach nourishment” differs from “beach management”, because it involves adding sand to the beach system rather than just re-working the existing sand volume.

Within Swansea Channel, beach nourishment would be applicable to the Salts Bay foreshore. At present, the shoreline of Salts Bay is relatively stable, however, it is subject to episodic events that can deplete the beach of sand. As sea level rises and the shoreline attempts to retreat, beach nourishment would be required to maintain the current form and alignment of Salts Bay, and to continue providing protection to the wetland habitats located behind the beach barrier.

A local source of sand would be required to make the option cost-effective. Salts Bay foreshore was originally nourished, at the time of the groyne construction, using sand extracted from the adjacent deeper channel sections (in the vicinity of the former “splodge”). To assist with this management option, establishment of a protocol with Trade and Investment – Crown Lands is

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considered worthwhile regarding how sand dredged from Swansea Channel to maintain the navigation channel could be placed for beach protection works.

2.5.5 Revetments and Seawalls

This option involves the construction of a revetment or seawall along the channel foreshore to hold the shoreline in its current position. A revetment can be built along an entire foreshore, or a section of the shoreline to protect a specific asset. If built for just a section, the revetment must be designed to minimise erosion at the end(s) of the structure and elsewhere along the channel.

Revetments can be constructed from a variety of materials, particularly rock, concrete armour units or sand filled geotextile bags. The most effective designs are sloped with a rough surface, which minimises wave run up and overtopping. The design can incorporate other elements such as walkways / cycleways, steps and seating, and parapets. Revetments can also include wave deflector capping, non-return stormwater outlets and other mechanisms to help increase resilience to sea level rise and adapt to climate change to some degree.

A large proportion of the Swansea Channel already contains revetments. The engineering standard of these structures is unknown. It is reasonable to assume that replacement or significant repair/maintenance of existing revetments in Swansea Channel would be required within the next 20 years or so in order to maintain design functionality into the longer term.

Any new revetment structures within the channel would need to accommodate future sea level rise and associated expected adjustments to channel morphology (e.g. channel deepening). As part of the design and construction of any new revetments and seawall, consideration should be given to establishing well designed and maintained coastal access paths along Blacksmiths Beach, along Swansea Channel and across dunes onto the beach, to manage access risks and enhance amenity. This would be combined with more formal parking arrangements at selected locations.

2.5.6 Groynes

Within a channel context, groynes are shore-normal structures that aim to keep the channel thalweg as far away from the foreshore edge as possible, and to capture any residual longshore sediment transport. A series of groynes have been constructed in Swansea Channel along the Pelican foreshore. As the groynes aim to control channel hydrodynamics, these structure should extend to the expected maximum channel depth, thus making them large structures, if designed correctly.

Groynes would be considered an alternative to a continuous revetment. Although the level of certainty of shoreline protection would be less for a groyne compared to a solid revetment, the use of groynes allows for natural shorelines in between structures, which maintains a degree of recreational and visual amenity, as is the case at Pelican.

Groynes have also been used to control wave swell erosion on the Salts Bay beach where, combined with beach nourishment, they have successfully slowed beach recession. Groynes have also been considered to control beach erosion between Mats Point and the entrance to Black Neds Bay. In place of a groyne field, a tombolo (constructed sandspit tied to a rock end wall) has been proposed for this area

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2.5.7 Asset Management Planning

A detailed audit of assets located within potential hazard areas should be carried out. In general, assets should be considered in terms of the remaining functional life. The remaining life of the assets should then be managed in accordance with an asset plan that gives consideration to the most appropriate long term alternative to the asset. These alternatives may include:

- “manage to fail”, where the remaining life of the asset is approximately equivalent to the timeframe before emerging hazards will have an effect on the essential function of the asset. After this time the asset will need to be replaced and/or relocated to manage the risks associated with the hazards.
- “life extension”, where retrofitting and on-going maintenance can extend the life of the asset to a timeframe equivalent to when the hazards will start to impact on asset function. Life extension can also consider protection works to delay the timeframe for impact of assets by future hazards.
- “replacement”, where the impacts of hazards will not occur for some time, enabling replacement of existing assets with new alternative assets in the same, or similar, locations with only minor changes in design criteria. This would be suitable for assets that have a relatively short functional life and are located in areas that are not subject to immediate hazards.

In the long term, most assets located within hazards areas will require relocation, modification, or significant redesign to accommodate the risks associated with the hazards. Thus, asset planning essentially involves managing the existing asset portfolio until such time that the assets are eventually redesigned or relocated away from the hazards.

Within Council's, Hunter Water's, and other asset owners' asset management plans, all relevant assets should be notated with information regarding hazards. This would include details of the overall risk (low to high), type of hazard (inundation, channel evolution etc) and timeframes for impact (immediate, 2050, 2100). For assets that are critical for community function (e.g. stormwater, sewer, water, telecommunications, gas, public buildings and amenities), effective asset management and planning will be essential for ensuring adequate services are maintained in the future as elements of the relevant systems are progressively replaced and updated. This will require sufficient prior planning and funding preparation.

2.5.8 Asset Re-Design and Retrofit

Re-design and retrofit may be required to extend the life of an asset by making it more resilient to the impacts associated with the hazards. This may involve modifications to an existing structure, or re-building sections of the structure to new design criteria.

Combined with this may be modifications to the use of an asset (e.g. lower levels of dwellings may become inappropriate for habitable uses and are modified for storage, commercial etc).

2.5.9 New Infrastructure Design

This option aims to support the replacement of infrastructure with structural elements that are better able to withstand the effects of future hazards. Within the hazard areas identified in this

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study it is not enough to simply continue like-for-like replacement of infrastructure, as future conditions are likely to be different from existing, and this may have an effect on the infrastructure performance and function.

The low-lying nature of the lands surrounding Swansea Channel present a significant challenge for drainage and stormwater in the future as the downstream tailwater levels in the channel slowly increase due to sea level rise. Also, contemporaneous with sea level rise will be increases in groundwater levels. An increase in the groundwater table will create significant difficulties for continuing land use well before the more obvious impacts of permanent surface water inundation.

2.5.10 Planned Retreat

Planned retreat allows for the progressive sacrifice of land and assets as they become impacted and damaged by hazards. Where affected assets are likely to increase risks to the community, assets may need to be pro-actively decommissioned and removed prior to impact occurring.

In the context of Swansea Channel, planned retreat may be considered for long-term channel evolution, especially if the cost of maintaining existing foreshore revetments becomes prohibitive, the land affected has already lost some value to the community due to frequent tidal inundation and/or land is already reserved for public open space or recreation. Some areas of Swansea Flats and Blacksmiths are particularly vulnerable to increased flooding from ocean storm surge and lake flooding as sea levels rise, and planned retreat may have to be considered as a future option if the hazard cannot be managed by protective measures or accommodated through development controls. Further investigation is required, through the development of local adaptation plans before the preferred management approach (Protect, Accommodate, Retreat) is determined.

2.5.11 Monitoring and Investigation

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 threshold level) before acting. Monitoring of key indicators is necessary in order to determine when this threshold has been reached. It may be important that a trigger for action is set before impacts to assets and infrastructure actually occur i.e. before the threshold is reached, to enable sufficient prior-planning and the implementation of alternatives, especially in terms of community-dependent infrastructure.

Monitoring of thresholds and triggers at specific critical assets should be reviewed regularly to determine how quickly they are being approached. The results of monitoring should also be analysed and published, for example, in yearly State of the Environment reports and with reviews of the CZMP (every 5 – 10 years).

Monitoring and investigation should cover:

- Frequency and depths/extents of tidal inundation;
- Erosion and recession of beach profiles, and dune condition at Salts Bay / Black Neds Bay;
- Channel bathymetry from the offshore ebb tide shoal to the dropover shoals in the lake;
- Condition of the existing revetments and foreshore structures;

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- Bank erosion/recession along the channel foreshores;
- Local adaptation plans for urban foreshore areas; and
- Investigation of barriers to and opportunities for wetland retreat.

Assessment of monitoring results should involve trend analysis and proximity to pre-defined ‘triggers’. Monitoring results should also inform future re-analysis of hazards and risks as part of on-going risk management programs.

2.5.12 Option ‘Suites’

There is no single solution that represents best-practice coastal zone management and adaptation to future climate change. Rather, maintaining a balance between value perspectives (natural and built) and consideration of both existing and future demands on the coastal zone, is essential to achieve a more climate-resilient coastal environment.

Effective management of Swansea Channel in the future will require implementation of multiple options across the breadth of the study area. These options will need to be mutually reinforcing and/or complementary to each other, and will need to be implemented over time as the demand emerges. As such, it is prudent to consider and plan for these options as packages of work, or ‘suites’ of integrated measures.

Local Adaptation Plans, recommended in the *Lake Macquarie Waterway Flood Risk Management Study and Plan* (WMA Water, 2012), are a way to assess suites of management options suitable for managing risks to community and natural assets, within a planning framework that includes thresholds, triggers, responsibilities, and costs.

2.6 Options Assessment

The most extensive risks considered as part of this study are those associated with storm inundation flooding and also tidal inundation flooding. These risks will mostly be managed by Council through their existing Flood and Tidal Inundation Policy and associated management initiatives, although it is worthwhile considering the range of other options discussed above.

The assessment of options carried out for this study has involved a first pass analysis using a multi-criteria assessment approach.

The criteria used in the first pass assessment are:

- Capital Cost and Recurrent Cost, with “high” to “low” limit values based upon an order of magnitude difference in expenditure, which would require investigations and approvals by Council before proceeding;
- Environmental or Social Impact, to identify where the option may have trade-offs upon the surrounding environment, including beach amenity and access;
- Community Acceptability, which shall also depend on direct community feedback during consultation;
- The ability for the option to be Reversible / Adaptable in the Future, which is particularly relevant where there is considerable uncertainty and or long time frames for a future impact;

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- Effectiveness over time, to consider where an option presents a long term solution or a short term solution that would require additional management action or upgrades in the future;
- Legal / Approval Risk, to highlight the legislative and other approval requirements (or impediments) to implementing an option, which may include a lack of government programs to support implementation of the option; and
- The technical viability, to highlight where certain options may or may not be technically feasible but would require significant engineering investigations and construction capabilities, or other investigations e.g. suitable land availability for relocation.

As part of the assessment, each criteria has been scored using a ‘traffic light’ framework (refer Table 2-2) to indicate:

- **“GO”** where an option is suitable with minimal trade-offs, and so will be recommended for further consideration with no further cost-benefit analysis required;
- **“SLOW”**, where an option may be suitable at specific sites or under specific circumstances, but should be subject to a more detailed assessment at individual assets / locations (‘fine’ filtering); and
- **“STOP”** where an option is likely to encounter a significant obstacle. If the obstacle cannot be overcome, further consideration of the option will be on the basis of an acceptable compromise when considered against other significant benefits that will be gained through implementation of the option.

The overall results of the multi-criteria assessment for management options to address hazard risks within Swansea Channel are provided in Table 2-3.

Table 2-2 First Pass (Traffic Light) Assessment Criteria

	Capital Cost	Recurrent Costs	Environmental or Social	Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Technical Viability
STOP	Very Expensive (\$300K to millions)	Very Expensive (\$300K to millions)	Will impact negatively on environment, community or beach amenity	Unlikely to be acceptable to community and politically unpalatable. Extensive community education, endorsement by Minister(s) and Council required.	Option is irreversible once implemented; option limits alternative options in future.	Option does not provide a long term solution, only effective over short term	Will require an EIS to implement and / or new Government Program to implement. There is a residual risk that approval will not be able to be obtained for the proposed works/strategy	Is unlikely to be technically viable or otherwise implemented without substantial engineering or other investigations and capabilities for implementation.
SLOW	Moderately expensive (e.g. \$30,000 - \$300,000)	Moderately expensive (e.g. \$30,000 - \$300,000)	No net impact	Would be palatable to some, not to others (50/50 response). Briefing by Councillors, GM and community education required	Option is reversible or adaptable but at considerable cost/effort	Option is only a short term solution but has other benefits; or option requires further resources / changes to be effective over long term	Will require Government approvals to be implemented, or require assistance through existing government program. Generally these approvals / assistance are likely to be granted assuming requirements are met.	Is likely to be technically viable at the site or is likely to be able to be implemented, but would require further investigations to clarify
GO	Little to no cost (< \$30,000)	Little to no cost (< \$30,000)	Will benefit environment, community or beach amenity (e.g. improve beach access, recreation, habitats etc)	Is very politically palatable, acceptable to community. Minimal education required	Option can be easily adapted for future circumstances or should impacts not occur, option would not negatively impact future generations.	Option provides a long term solution	No or minimal government approvals required to implement.	Is technically or otherwise viable at the site / location

Table 2-3 Coarse Filtering of Management Options

Option	Treats Extreme Storm Flooding	Treats Tidal Inundation	Treats Wave Recession	Treats Channel Evolution	Capital Cost	Recurrent Costs	Environmental or Social Impact	Likely Community Acceptability	Reversible / Adaptable in Future	Effectiveness over time	Legal / Approval Risk	Technical Viability	Suitable Locations
Existing Controls: Flood and Tidal Inundation Policy	✓	✓			GO	GO	GO	SLOW	GO	SLOW	GO	GO	All locations affected by extreme storm flooding and tidal inundation
New Development Controls	✓	✓	✓	✓	GO	GO	GO	SLOW	GO	SLOW	SLOW	GO	All locations affected by wave recession and channel evolution, and locations affected by increased storm flooding and tidal inundation due to rising sea levels
Beach Management			✓		GO	SLOW	GO	GO	GO	SLOW	GO	GO	Black Neds Bay foreshore
Dune Rehabilitation			✓		GO	GO	GO	GO	GO	SLOW	GO	GO	Salts Bay / Black Neds Bay foreshores and sand islands
Beach Nourishment			✓		STOP	SLOW	GO	GO	GO	GO	SLOW	GO	Salts Bay foreshores
Revetments			✓	✓	STOP	SLOW	SLOW	GO	STOP	SLOW	SLOW	GO	Replacement/extension of existing once failed
Groynes			✓	✓	STOP	SLOW	SLOW	GO	STOP	SLOW	SLOW	GO	Replacement/extension of existing once failed
Asset Management Planning	✓	✓	✓	✓	GO	GO	GO	GO	GO	SLOW	GO	GO	All existing assets within hazard zones
Asset Redesign or Retrofit	✓	✓	✓	✓	SLOW	SLOW	SLOW	GO	SLOW	SLOW	GO	SLOW	All existing assets within hazard zones
New Infrastructure Design	✓	✓	✓	✓	GO	GO	GO	GO	SLOW	SLOW	GO	GO	All areas affected by hazards
Planned retreat (natural areas)		✓	✓	✓	GO	GO	SLOW	GO	STOP	GO	GO	GO	Natural areas affected by tidal inundation with significant environmental value
Planned retreat (developed areas)		✓	✓	✓	STOP	GO	SLOW	SLOW	STOP	GO	SLOW	GO	Developed areas affected by tidal inundation and behind failing revetments
Monitoring and Investigation		✓	✓	✓	GO	SLOW	GO	GO	GO	SLOW	GO	GO	All hazard zones

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2.7 Summary of Assessment and Recommendations

All options considered have considerable merit for one or more locations. The options considered cover a range of approaches including planning controls, on-ground works, rehabilitation and monitoring. Whilst some options would have some significant obstacles (notably cost), the resulting benefits would be substantial (i.e. preservation of significant existing values) and therefore the action could be justified.

Overall, a mix of management options will be required to adequately manage the risks associated with hazards within Swansea Channel. These options should be implemented as part of an overall adaptation planning process whereby planned actions are initiated by pre-defined triggers (refer Section 2.8 for details). This way, actions are not implemented prematurely and are able to capitalise on any additional relevant information gathered in the future. Notwithstanding, some options are considered 'no regrets', meaning that they can and should be implemented as soon as practical with little or no trade-off (see Table 2-4).

A summary of key management options, as applied to different areas within the study area, is discussed below.

2.7.1 Salts Bay Foreshore

To maintain the existing alignment and to prevent the loss of the dune barrier, dune rehabilitation and beach nourishment will be required in the future. Although costly, it is anticipated that beach nourishment will be required to prevent substantial shoreline recession in this section of foreshore. Shoreline recession due to sea level rise, combined with event-based storm erosion of the beach will be the main drivers for hazards at this location.

Maintenance of groynes at Salts Bay will also be required to maintain the stability of the shoreline. Sand from the dredging of Swansea Channel (upstream of Swansea Bridge) could be placed opportunistically on the Salts Bay shoreline or along the channel foreshore from Mats Point to Black Neds bay to build up the beach between the groynes. This would also reduce the net cost of beach nourishment activities. Any sand placement areas should be planted with Spinifex runners (or other suitable coastal vegetation) to help stabilise the sand.

At some stage the foreshore and hind-dune wetlands will be overwhelmed by rising sea levels, so planned retreat of the beach and wetlands should be considered as a long-term option, although this may require works to protect assets along Ross Street and other settled areas fringing the wetland.

Regular monitoring of the rates of recession and investigation of the effect on the wetland is required, so suitable thresholds and triggers can be set for protective works.

2.7.2 Black Neds Bay Foreshore

This shoreline is subject to longshore transport by oblique swell waves, causing shoreline erosion and recession. Beach management, combined with dune rehabilitation, will be required in the future to preserve existing dune barriers. It is recognised that these dunes are low and are already overtopped from time to time. Construction of revetments, groynes or tombolo could slow recession, but sea level rise may still compromise the preservation of these dunes.

Risk Management Options

Consideration of planned retreat, and monitoring and investigation of the rates and effects of recession, should be carried out in conjunction with similar actions at Salts Bay (refer Section 2.7.1).

2.7.3 Black Neds Bay Wetland

Sea level rise will result in a transformation of this existing estuarine wetland. Planned retreat will therefore be the only practical option available. In accordance with the Ecosystem Resilience Study (Umwelt, 2010), management should focus on allowing for migration of habitats up-slope wherever possible, and preserving the ecological value of the wetland as long as possible. However, the settlements surrounding the wetland constrain the opportunities for long-term wetland retreat.

Monitoring and investigation of the rates and effects of recession should be carried out in conjunction with similar actions at Salts Bay (refer Section 2.7.1).

2.7.4 Blacksmiths Northern Revetment, Downstream of Bridge

This revetment trains tidal flows into and out of Lake Macquarie. Failure of this revetment could lead to significant impacts throughout the channel as well as for lands behind the revetment. Management should involve the retrofit and/or replacement of the revetment as required in the future to maintain its existing function. While the on-going maintenance and retrofitting of the revetment will be a high cost action, the loss to private and public land should the revetment fail would be even more significant. At this stage there are no practical alternatives to retaining the current revetment alignment through on-going maintenance and retrofitting.

2.7.5 Blacksmiths – Behind Northern Revetment

This area is very low-lying and will be subject to future inundation impacts due to sea level rise. In the short-term this area could be managed through development controls, specifically targeting tidal inundation impacts.

A Local Adaptation Plan is recommended for Blacksmiths to assess suites of management options suitable for managing risks to community and natural assets, within a planning framework that includes thresholds, triggers, responsibilities, and costs.

2.7.6 Blacksmiths Urban

This area is significantly affected by storm inundation flooding, which will be exacerbated under the influence of future sea level rise. Management of this area should be centred on development controls. In addition, existing asset management planning and incorporation of revised design requirements for any new or replacement infrastructure would be appropriate.

A Local Adaptation Plan is recommended for Blacksmiths (refer Section 2.7.5).

2.7.7 Swansea Urban

The main urban area of Swansea is affected by storm inundation flooding, and also tidal inundation in the longer term. Management of this area would be best through development controls as per the existing Council flood policy.

Risk Management Options

A Local Adaptation Plan is recommended for Swansea to assess suites of management options suitable for managing risks to community and natural assets, within a planning framework that includes thresholds, triggers, responsibilities, and costs.

2.7.8 Swansea Revetment Foreshore

The existing Swansea Revetment should be retrofitted or replaced to manage the on-going channel evolution hazard. This would include new design criteria to account for changing channel conditions (notably depths). As for the revetment downstream of the bridge, given the value of public and private lands located behind the shoreline, there are no practical alternatives to retaining the current revetment alignment through on-going maintenance, retrofitting and replacement as required.

2.7.9 Land behind Swansea Revetment Foreshore

If the Swansea Revetment cannot be retrofitted or replaced following failure of the wall, then additional development controls should be implemented for the land immediately behind the revetment to limit risks. If the revetment fails, then the land would need to be managed through future (>50 years) planned retreat, to allow for channel evolution. The costs associated with planned retreat would be very high. A detailed benefit cost analysis should be conducted to support a decision to maintain the existing shoreline alignment, or to allow for some degree of planned retreat, which would inform a future Local Adaptation Plan for Swansea.

2.7.10 Swansea – Lake-side

This area is particularly sensitive to tidal inundation under sea level rise conditions. In the short term this area should be managed through development controls and increased protection from inundation and small but frequent floods. However, in the longer term (>50 years), the lack of effective drainage, rising groundwater levels and cost of protection works could mean that planned retreat may be a more appropriate option in the most heavily affected areas. Planned retreat from these low-lying areas will also be a high cost option, and would require more detailed economic justification. A co-ordinated and consistent approach will be required to manage these future risks effectively, which will be facilitated through development of a Local Adaptation Plan.

2.7.11 Pelican Foreshore

This area contains various foreshore structures (groynes and revetments). These structures should be retrofitted or replaced to manage existing and future hazards. Given the value of the public and private land behind the shoreline, the relatively high costs of maintaining, retrofitting and replacing these structures is expected to be justified. The area from Pelican Marina to Naru Point is particularly affected by channel migration, and foreshore erosion is already affecting structures and foreshore access. The design and maintenance of new and existing structures should allow for the effects of the continuing tendency of this foreshore to migrate and the future effects of rising sea levels.

At the same time, planning controls and design guidelines should be implemented to minimise the use of foreshore structures that restrict ecological transition (in estuarine and open coast situations), and existing barriers to wetland migration should be removed wherever possible.

Risk Management Options

A Local Adaptation Plan is recommended for Pelican to assess suites of management options suitable for managing risks to community and natural assets, within a planning framework that includes thresholds, triggers, responsibilities, and costs.

2.7.12 Land behind Pelican Foreshore

Retrofitting and replacement of Pelican foreshore structures will be costly. If these structures fail or cannot be maintained, the risk to the land and built assets behind the foreshore should be managed through additional development controls. Without foreshore protection, the land would need to be managed through future (>50 years) planned retreat to accommodate expected inundation and channel evolution. Costs associated with loss of this land (public and private) should be considered when deciding if, when, and where a 'protect' or 'retreat' strategy is best for this section of the foreshore.

This assessment will be part of the Local Adaptation Plan that is recommended for Pelican (refer Section 2.7.11).

2.7.13 Pelican Wetland

As for the Black Neds Bay wetland, this area will best be managed as Planned Retreat, but proactively managing the up-slope migration of habitat to allow for continuing wetland function as recommended for Black Neds Bay wetland. As affected land is under public ownership, the costs associated with Planned Retreat are considered tolerable.

A program of monitoring and investigation of the rate of recession and its ecological effect, and an assessment of the opportunities and barriers to retreat, is required.

A Local Adaptation Plan, including planning for natural assets, is recommended for Pelican (refer Section 2.7.11).

2.7.14 Coon Island Wetland

Sea level rise will result in a change in habitat. The wetland is likely to be best managed by planned retreat, with surrounding areas preserved to facilitate the up-slope migration of estuarine habitats. Again, as affected land is under public ownership, the costs associated with planned retreat are considered tolerable.

A program of monitoring and investigation of the rate of recession and its ecological effect, and an assessment of the opportunities and barriers to retreat, is required.

A Local Adaptation Plan, including planning for natural assets, is recommended for Swansea (refer Section 2.7.7).

2.7.15 Marks Point Urban

As for Blacksmiths urban area, this area is significantly affected by storm inundation flooding, which will also be exacerbated under the influence of future sea level rise. Management should be based on existing and, if and when required in future, new development controls (including revised design requirements), with appropriate management planning of assets and infrastructure.

A Local Adaptation Plan is currently under preparation for the Marks Point area.

2.8 Triggers for Implementation

Unacceptable risks under present day conditions (e.g. the frequent flooding of homes) are managed to reduce the risk to acceptable levels (e.g. by raising floor levels in new buildings above frequent floods). However, new risks will materialise at some point in the future, principally due to future sea level rise. In the latter case, implementing particular management actions now, especially those that may be costly or unattractive to the community, may be premature as they cannot account for the uncertainty of future conditions in terms of extent of impacts and also the timeframe for impact.

Fisk and Kay (2010) provide a method for setting triggers and thresholds for climate change adaptation actions along a time continuum. The trigger points are set to flag the 'level of acceptable change' where more aggressive or decisive actions must be implemented in order to avoid an undesirable impact. The trigger setting method is demonstrated in Figure 2-1.

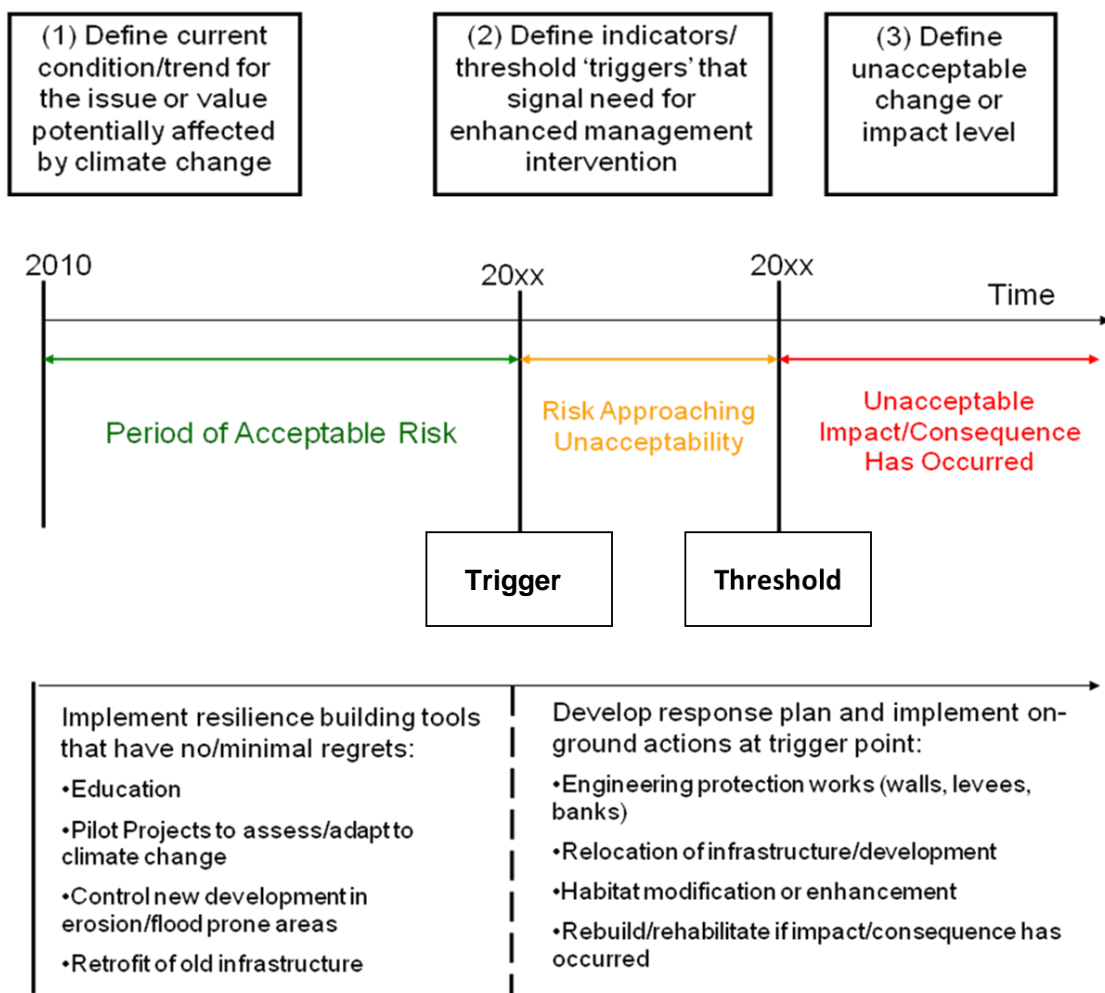


Figure 2-1 Continuum Model for Climate Change Adaptation Action (adapted from Fisk & Kay, 2010)

Risk Management Options

While storm inundation and flooding hazards may occur at any time, the hazards associated with tidal inundation, wave-driven recession and channel evolution tend to manifest over a period of years. Such time warnings can be used to advantage for implementing management options, particularly where the action may be costly or difficult for the community to accept or implement.

A triggered approach avoids actions being implemented until it becomes necessary, with time in the interim to improve data regarding the impact, source funding and prepare approvals, designs etc. It also recognises that some hazard or climate change impacts may not eventuate. If this is the case, then the community has not been unnecessarily burdened by having to adopt costly management responses. Suggested threshold for implementation of the key management options for Swansea Channel hazards are presented in Table 2-4.

Table 2-4 Threshold for Implementation

Option	Suitable Threshold for Implementation
Existing Controls: Flood and Tidal Inundation Policy	Already being implemented. Review of development controls should be carried out as part of periodic planning reviews (approx. 10 years) to ensure that controls remain appropriate for emerging hazards
New Development Controls for areas potentially subject to channel evolution	If / when it is decided that the function of existing foreshore structures will not be maintained in the future
Beach Management	No regrets action – can be implemented now to help improve resilience of Black Neds Bay wetlands
Dune Rehabilitation: Black Neds Bay barrier dunes and sand islands	No regrets action – can be implemented now to help improve resilience of Black Neds Bay wetlands
Beach Nourishment for Salts Bay foreshore	To be based on a measured recessionary trend of the beach profile
Revetments: retrofit and replacement	When the integrity of the existing structure becomes compromised dramatically increasing risk of substantial structure failure.
Groynes: retrofit and replacement	When the integrity of the existing structure becomes compromised dramatically increasing risk of substantial structure failure. Replacement may involve a different type of foreshore structure (e.g. revetment) subject to design and impact assessment
Asset Management Planning Asset Re-design and Retrofit	No regrets action – can be implemented now to help improve the efficiency of asset management
New Infrastructure Design	No regrets action – any new infrastructure within the study area should be designed taking into consideration the expected hazards over the design life of the structure.
Planned Retreat	For natural areas already in public ownership, this can be an immediate action. For other public lands, the threshold will depend on the uses and assets on the land. For private lands, the threshold would be that the hazard has increased and that all other potential options are not suitable or cost-effective to manage the increased risk.
Monitoring and Investigation	No regrets action – can be implemented immediately to start checking thresholds and to gauge the rate of change (and thus provide estimated timeframes before triggers may be reached).

3 Management Action Plan

3.1 Implementation of Actions: Existing and Future Risks

The management options summarised by the Option Assessment (see Section 2.6) are presented here in the form of a comprehensive Management Action Plan. Management actions are grouped according to their management approach, namely ‘Structural Works’, ‘Beach Management, Nourishment and Rehabilitation’, ‘Planning and Development Control’ and ‘Monitoring’.

There are a total of 28 management actions within the Action Plan. Details of the recommended actions that require implementation over the next 5-10 years (i.e. until the Plan’s next review) have been provided in the implementation tables below, including applicable location(s), the timing / triggers, responsibilities, estimated costs / resources required and cross referencing to other related actions. Maps showing the location and scale of the recommended management actions are provided in Appendix B (see Figure B-1 to Figure B-3).

As part of the actions to be undertaken, a detailed monitoring program that prescribes regular cross-checking of trigger levels has been prepared. This will ensure Council keeps track of the need to implement action for existing or future risks. The monitoring program also enables collection of data to review the risk analysis for currently low risks at the next review of the Plan document.

Monitoring and data collection will assist investigations and research, to assess the response of ecosystems to foreshore erosion and inundation (e.g. at Black Neds Bay). It will also assist in the preparation and implementation of Local Adaptation Plans, particularly in the assessing the relative cost and benefits of different suites of management options, and in determining the triggers and thresholds for actions.

Potential funding programs or sources for each of the management options are provided in Table 3-1. It is acknowledged that the potential funding pool from the sources identified in Table 3-1 is limited. Further, whilst options may be eligible for funding under these existing programs, grants are competitive and based on merit applications. The programs may also subject to change in the future. Therefore, there is no certainty that these programs would be able to provide funding as and when needed.

Alternative funding mechanisms should be investigated as a means of sourcing the necessary investment for implementation. Early triggers should be used to commence a process of securing finances for implementation of specific measures so that existing values and assets do not become compromised by future funding challenges.

Table 3-1 Management Approach, Actions and Potential Funding Sources

Management Approach	Management Options	Actions	Potential Funding Sources
On-ground Works	Revetment and groyne re-design / retrofit Capital Work Upgrades	W.1 to W.7	<ul style="list-style-type: none"> Council’s routine asset maintenance, replacement and new capital works programs Crown Lands routine asset maintenance, replacement and new capital works programs NSW Government Coastal Management Program Allocation from Council general or special rate State and Federal Government Grants (especially climate change adaptation and resilience building funds)
Beach Management, Nourishment and Dune and Wetland Rehabilitation	Beach Management and Nourishment	B.1 to B.3	<ul style="list-style-type: none"> Council’s parks and reserves maintenance works program Crown Lands land maintenance and channel dredging programs Allocation from Council general or special rate NSW Government Coastal and Estuary Management Program (for one-off beach scraping / dune building episodes)
	Dune Protection & Wetland Rehabilitation	B.4	
	Planned Wetland Retreat	B.5 to B.6	
Planning and Development Control	Development Controls	P.1 to P.3	<ul style="list-style-type: none"> Council Departments including Integrated Planning, Development Assessment and Compliance, Sustainability, Asset Management and City Design Council Departments (Asset Management City Projects, CiviLake), Hunter Water etc Grant Programs with natural disaster management and climate change adaptation focus State Government support for climate change adaptation Council general or special rate Infrastructure owners and providers such as Hunter Water
	Asset Management and Planned Retreat	P.4 to P.7	
	New Infrastructure Design Criteria	P.8 to P.10	
Monitoring	Monitoring, Evaluation and Reporting	M.1 to M.7	<ul style="list-style-type: none"> NSW Government Coastal and Estuary Management Programs (particularly for re-evaluation of risks in future) Council’s routine monitoring and works program
Communications	Communications and Collaboration	C.1 to C.2	<ul style="list-style-type: none"> Council Departments including Sustainability, Community Planning and Communications

Management Action Plan

On-ground Works

Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
W.1	<p>The ownership and responsibility for most assets in the Channel or along the foreshore falls to either Crown Lands or LMCC. However, ownership of and responsibility for some assets in Swansea Channel is uncertain and requires clarification.</p> <p>Crown Lands and LMCC are in the process of clarifying and formalising ownership of and responsibility for public assets in Swansea Channel if it is in doubt, especially protective works such as revetments and groynes. LMCC and Crown Lands should agree on a process to ensure ownership and responsibility of new structures is formally recorded at the time of construction, and this is reflected in the respective assets registers of the two organisations.</p>	Specifically foreshore revetments, and groynes located along the eastern and western banks of Swansea Channel upstream of Swansea Bridge.	No regrets action - 2015 or as soon as practical	LMCC / Crown Lands	Staff time only.	W.2 to W.6.	See Sections 6.1.1 and 6.1.3 of the other CZMP volume (Swansea Channel Hazards Study and Risk Assessment report).
W.2	<p>Retrofit or replace the existing revetment to manage the on-going channel evolution hazard. The timeline for implementation of this action would be dependent on the condition of existing infrastructure and the trigger for replacement/retrofit.</p> <p>In general, the following steps would be appropriate for implementation of the action:</p> <ul style="list-style-type: none"> Conduct audit (dilapidation survey) of existing structures and revetments, to determine their ownership, current condition, effectiveness, expected functional life, and future potential to mitigate storm erosion and wave overtopping under higher sea levels. The audit should be used to guide subsequent decisions including future replacement/retrofit or "manage to fail" 	Swansea Channel western revetment, upstream from bridge to Thomas Humphrey's Reserve (approximate length is 1650 metres). Replacement of existing revetment along Coon Island foreshore to the north of Thomas Humphreys Reserve would be subject to further	<p>To be determined following initial condition assessments.</p> <p>Condition assessment repeated on a 5 – 10yr cycle (or shorter for structures nearing the end of their functional life).</p> <p>Trigger to include sufficient lead time to source and secure necessary funding.</p>	LMCC / Crown Lands	<p>Condition assessment approximately \$20,000.</p> <p>1:1 funding under NSW Government Coastal Management Program for any LMCC component.</p> <p>Approximate cost for construction of new foreshore revetment is \$4000/m plus contingencies of between 25%-50% for technical investigation /</p>	<p>Combine with P.5. If action is not to be applied refer to P.6.</p> <p>Action is reliant on outcomes of W.1.</p>	See 'Revetment and Seawalls' Option in Section 2.5.5.

Management Action Plan

Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
	<p>(planned retreat) options;</p> <ul style="list-style-type: none"> Investigate threshold triggers for when replacement/retrofit needs to happen. This would be reliant on the outcomes of the condition assessment and the value of land and assets in proximity to the revetment; Implement new infrastructure design process that addresses both existing and future hazards; Development of a holistic long term strategy for the assets located in the channel; and Construct/retrofit new revetment for segment of foreshore following detailed design and development approval. 	<p>investigation and consideration of specific costs and benefits.</p>			<p>approvals and detailed design.</p> <p>Total approximate cost to replace the entire revetment based on above estimates is \$8.2M to \$10M.</p>		
W.3	<p>Retrofit or replace existing protective structures to manage existing and future hazards (similar to process outlined for W.2).</p> <p>Consider beach nourishment to protect and maintain sandy foreshore areas (similar process to B.2 at Salts Bay).</p>	<p>Pelican foreshore 1 – reserve south from Soldiers Road (approx. length 300 metres)</p>	<p>To be determined following initial condition assessments (see Actions W.2 and B.2 above).</p> <p>Trigger to include sufficient lead time to source and secure necessary funding.</p>	<p>LMCC / Crown Lands</p>	<p>Same cost rate as for Action W.2 above.</p> <p>Total approximate replacement cost is \$1.5M to \$1.8M.</p> <p>Actions would include maintenance of small groynes and beach nourishment as required.</p>	<p>Combine with P.5. If action is not to be applied refer to P.6.</p> <p>Action is reliant on outcomes of W.1</p>	<p>See ‘Revetment and Seawalls’ Option in Section 2.5.5.</p>
W.4	<p>Investigate new protective works or other strategies to manage eroding foreshores and retrofit or replace existing protective structures to manage existing and future hazards.</p>	<p>Pelican foreshore 2 -north from Soldiers Road to Swan Bay entrance (approx. length 240 metres)</p>	<p>To be determined following initial condition assessments and detailed studies for any proposed new works (see Action W.2)</p> <p>Trigger to include sufficient lead time to source and secure</p>	<p>LMCC / Crown Lands</p>	<p>See Action W.2 above.</p> <p>Total approximate cost to replace the entire revetment is \$1.2M to \$1.5M.</p> <p>Estimated cost for new protective works at airport is \$800K.</p>	<p>W.5. Combine with P.5. If action is not to be applied refer to P.6.</p> <p>Action is reliant on outcomes</p>	<p>See ‘Revetment and Seawalls’ Option in Section 2.5.5</p>

Management Action Plan

Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
			necessary funding.			of W.1	
W.5	Investigate options to manage existing and future hazards. The same steps for implementation described in Action W.2 would be appropriate. Retrofit may involve just 'topping up' groyne structure providing top width is sufficient to accommodate additional material.	Pelican foreshore (total of 8 groynes with total length ~200 metres) Salt Bay foreshore (total of 3 groynes with total length of ~140 metres)	To be determined following initial condition assessments. Trigger to include sufficient lead time to source and secure necessary funding.	LMCC / Crown Lands	Groyne construction cost \$8000/m (upper limiting cost for a new structure) plus contingencies of between 25%-50% for technical investigation / approvals and detailed design. Total approximate cost to replace Pelican foreshore groynes is \$2M to \$2.4M. Total approximate cost to replace Salts Bay foreshore groynes is \$1.4M to \$1.7M.	Combine with P.5. If action is not to be applied refer to P.6. Action is reliant on outcomes of W.1	See 'Groynes' Option in Section 2.5.6.
W.6	Retrofit and/or replacement of the revetment as required in the future to maintain its existing function. This revetment trains tidal flows into and out of Lake Macquarie. Failure of this revetment could lead to significant impacts throughout the channel as well as for lands behind the revetment. Crown Lands undertake condition assessment of major coastal infrastructure every 1 or 2 years. The steps for implementation of Action W.2 described above would be appropriate here as well.	Swansea Channel northern revetment, downstream of bridge (approximate length including northern breakwater is 2300 metres)	As required following annual maintenance reviews by Trade and Investment – Crown Lands or in response to significant coastal storm damage. Trigger to include sufficient lead time to source and secure necessary funding.	LMCC / Crown Lands	See Action W.2 above. Total approximate cost to replace the entire revetment based on above estimates is \$11.5M to \$13.8M.	Combine with P.5. If action is not to be applied refer to P.6. Action is reliant on outcomes of W.1	See 'Revetment and Seawalls' Option in Section 2.5.5.
W.7	Restore the recreational amenity of Grannies Pool by removing accumulated sand build-up in	Grannies Pool, Swansea Channel	In accordance with works priorities in the	LMCC / Crown	Depending on scope of works, but	Nil.	

Management Action Plan

Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
	consultation with the local community. Sand could be removed using land based equipment and transported to nearby Blacksmiths Beach for beach nourishment or similar. As part of this action, upgrade and improve maintenance of existing access and public facilities and adjacent reserve areas to improve aesthetics and provide a safe swimming enclosure.	Northern Breakwater and adjacent reserve areas.	Blacksmiths Beach/North Swansea Channel Reserves Masterplan. Trigger to include sufficient lead time to source and secure necessary funding.	Lands	expected to be in the order of \$0.25M including design and approvals plus on-going maintenance costs (est. \$70,000/five years in Masterplan)		

Beach Management, Nourishment and Dune and Wetland Rehabilitation

Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
B.1	Implement dredging and sand placement in accordance with the Sustainable Framework for Navigation in Swansea Channel. Smaller episodes of navigational dredging may be required at other locations, such as the entrances to Swan Bay or Black Neds Bay, which could supply sand for local nourishment. Sand dredged from Swansea Channel is a suitable source for nourishment of soft foreshores such as Salts Bay, Black Neds Bay and Pelican.	Salts Bay Black Neds Bay foreshore Pelican foreshore Sand islands	In conjunction with future maintenance dredging	Led by Crown Lands with assistance from LMCC as required	Staff time. Funding for dredging from NSW Government. Additional cost for placement at Salts Bay to be negotiated or shared via Estuary Management Program.	Combine with P.3	See 'Beach Nourishment' Option in Section 2.5.4.
B.2	Maintain a sufficient amount of sand on the Salts Bay foreshore between the groynes. This would involve placement of additional sand (i.e. nourishment), on a one off basis to rebuild a frontal dune along Salts Bay as the foreshore slowly erodes. Any sand placement areas should be planted with Spinifex runners to help stabilise the sand dune.	Salts Bay	To be based on a measured recessionary trend of the beach profile. Monitoring of beach profile to begin in 2015 or as soon as practical.	LMCC / Crown Lands Should works be pursued, approval would be required from the Crown Lands Trust Manager(s) as part of REF.	Staff time to undertake maintenance and conduct investigation. Nourished sands typically \$25/m ³ (with volumes required to be determined through	M.1 and P.3	See 'Beach Nourishment' Option in Section 2.5.4.

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Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
					investigation). Costs will be reduced if carried out in conjunction with navigational dredging (see B1 above).		
B.3	Undertake beach scraping, re-contouring, sand transfer and dune revegetation to increase sand volumes and height of frontal dunes.	Salts Bay Black Neds Bay barrier dunes	No regrets action – can be implemented opportunistically when monitoring shows that beaches are accreted following recovery from storm erosion.	LMCC. Should works be pursued, approval would be required from the Crown Lands Trust Manager(s) as part of REF.	\$10,000 per episode.	Nil	See 'Beach Management' Option in Section 2.5.2.
B.4	Work with bush regeneration teams, landcare, or establish a formal dune care program, to undertake dune and wetland rehabilitation in priority locations, which shall also incorporate weed and pest management. Note: This action would complement beach nourishment episodes to reduce loss of sand by wind. The dune care and wetland programs should be accompanied by community education on their role in providing a buffer to storms, ecological benefits, and improvements in water quality. Dune rehabilitation also helps manage sand drift.	Salts Bay Black Neds Bay Sand islands Pelican Wetland Coon Island	2015 or as soon as practical, then regular maintenance as required. Immediately following beach scraping and re-contouring and beach nourishment episodes.	LMCC / Crown Lands	\$2,000 per episode for materials/resources in addition to voluntary labour. State and Federal grant programs supporting threatened species and natural resource management	Combine with B.1 and B.3	See 'Dune Protection and Wetland Rehabilitation' Option in Section 2.5.3.
B.5	Investigate long term options for managing the risk of sea level rise to the transformation of existing estuarine wetlands at Black Neds Bay and Pelican. Planned retreat is likely to be the only practical option available for the wetland if future inundation hazards are realised. The effect of	Black Neds Bay Wetland Pelican Wetland Coon Island wetland	Without intervention, retreat is already happening. Monitoring of recession rates and investigation of	LMCC / Crown Lands	Staff time only. External consultancy costs up to \$100,000 for full investigation and monitoring.	P.4 and B.6	See 'Planned Retreat' Option in Section 2.5.10.

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Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
	<p>long-term wetland retreat on surrounding settlements will need to be investigated and the risks managed.</p> <p>The investigation shall include consultation with the various asset owners affected by the option. Wetland management should focus on allowing for migration of habitats up-slope wherever possible, although this will be constrained by surrounding settlements.</p>		ecological responses should begin immediately.				
B.6	<p>Undertake pilot projects for re-establishing estuarine wetland communities, such as saltmarsh and sea grass, which will be affected by higher lake levels.</p> <p>This action will provide knowledge for application later as the need becomes more urgent.</p>	<p>Within relevant sections of Swansea Channel such as Black Neds Bay Wetland, Pelican Wetland and Coon Island Wetland</p>	<p>Short to medium term, i.e. a 1 to 4 year timeframe, with consideration for on-going demand.</p>	LMCC	\$5,000 - \$10,000 per episode.	Combine with B.5 and M.2	See 'Planned Retreat' Option in Section 2.5.10.

Planning and Development Controls

Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
P.1	<p>Review Development Controls to address storm inundation flooding and increased tidal levels in these areas. Review and update Council's existing Flood policy, as required.</p> <p>The controls should be applicable to the type of development (e.g. high density residential, alterations/additions, public facilities) and level of risk (extreme, high, medium, low). Criteria / controls in the DCP may include:</p> <ul style="list-style-type: none"> Setbacks for development behind a specified 	<p>Study Area, but specifically, Blacksmiths Beach and Marks Point urban area</p> <p>Swansea urban area</p> <p>Swansea – lake side</p>	No regrets action - 2015 or as soon as practical.	LMCC / NSW Department of Planning and Environment	Staff time only, or minor consultancy if required (\$25,000 - \$50,000, funding may be available through NSW Coastal Program or Floodplain Management Program).	Nil.	See 'Development Controls' Option in Section 2.5.1.

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Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
	<p>hazard zone (e.g. “unlikely” hazard line), proposed seawall alignment or Foreshore Building Line;</p> <ul style="list-style-type: none"> • Foundation capacity requirements; • Applicability of using structures with shorter design life; • Alternative locations for the structure (especially public assets); • Trigger-Based Development Approvals (with trigger potentially tied to water levels in the lake or proximity of foreshore to development); and • Minimum floor levels. 	Land behind Swansea Revetment foreshore					
P.2	Work with affected communities, infrastructure providers, and other stakeholders to develop Local Adaptation Plans (LAP) to identify strategic pathways for adaptation to changing levels of hazard and risk as a result of rising sea levels. LAPs will include many of the management options recommended elsewhere in this Plan, but will apply them to the specific conditions of each locality, and link them into an integrated plan.	Blacksmiths, Pelican, Swansea, Marks Point	Commenced at Marks Point. Other LAPs to be completed over the next 5 years.	LMCC	\$60,000 for external consultancies and studies per Plan. Staff time.	P1,P3, P6,	See Section 2.7 Summary of Assessment and Recommendations
P.3	Update internal checklists, procedures, guidelines and policies to facilitate the consideration of coastal hazard zones and timeframes by Council in the preparation or revision of: <ul style="list-style-type: none"> • Community & Crown Land Plans of Management; • Masterplans; • Review of Environmental Factors (REF) for works not requiring development consent; • At the early stages of planning new infrastructure and conducting strategic 	Study Area	2015 or as soon as practical	LMCC / Crown Lands and the NSW Department of Planning and Environment	Staff time only.	Nil.	See ‘Development Controls’ Option in Section 2.5.1, ‘Asset Management Planning’ Option in Section 2.5.7.

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Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
	<p>planning (e.g. designing new road networks, sewer networks etc) (i.e. prior to preparation of development applications), and</p> <ul style="list-style-type: none"> Any other works not requiring development consent or assessment 						
P.4	<p>Establish a protocol with Crown Lands about how and when sand dredged from Swansea Channel to maintain navigation could be used for beach nourishment and placed for future use for beach protection works at Salts Bay or elsewhere as required.</p> <p>Sand could be stored in dunes constructed landward of the existing frontal dune system.</p> <p>Note: Swansea Channel is continuing to adjust to the construction of the training walls and bridge abutments.</p>	<p>Swansea Navigation Channel Salts Bay Black Neds Bay foreshore</p>	<p>Short to medium term planning consideration, i.e. a 1 to 4 year timeframe.</p>	<p>LMCC / Crown Lands</p>	<p>Staff time.</p> <p>In the longer term, significant costs savings and project efficiencies are expected if a reliable source of sand can be obtained for beach nourishment purposes.</p>	<p>Combine with B.2</p>	<p>See 'Development Controls' Option in Section 2.5.1, 'Beach Nourishment' Option in Section 2.5.4.</p>
P.5	<p>Use planning controls and design guidelines to minimise the use of foreshore structures that restrict ecological transition.</p> <p>Planning controls would seek to remove existing barriers to wetland migration wherever possible, and provide clear guidance to waterfront land owners and managers about how to design and install waterfront structures so that ecological impacts are minimised.</p>	<p>Study Area foreshores</p>	<p>Medium to long term planning consideration, i.e. a 4 to 8 year timeframe.</p>	<p>LMCC</p>	<p>Staff time to update planning controls and guidelines.</p> <p>Expect some community resistance to increased development/construction costs.</p>	<p>Combine with B.5 and B.6</p>	<p>See 'Development Controls' Option in Section 2.5.1, 'Dune Protection and Wetland Rehabilitation' Option in Section 2.5.3 'New Infrastructure Design' Option in Section 2.5.9.</p>
P.6	<p>Consider measures such as tidal flaps on drains to manage increasing tidal inundation of low lying areas exposed to ocean tides.</p>	<p>Swansea urban area, Black Neds Bay, Blacksmiths behind northern</p>	<p>Medium to long term planning consideration i.e. 4 to 8 year timeframe</p>	<p>LMCC</p>	<p>Staff time and external expertise</p>	<p>P.1, P.3 and M.4</p>	

Management Action Plan

Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
		revetment					
P.7	Investigate and implement strategic planning to prevent and remove barriers to the planned retreat of low-lying public lands, where they are not needed for asset protection. Investigate and implement strategic planning to allow for the future possible (>50years) planned retreat of low-lying private lands if other measures such as foreshore protection and development controls prove insufficient to manage the increased risk.	Swansea – lake side Land behind Swansea revetment foreshore Land behind Pelican foreshore Blacksmiths – behind northern revetment	To be included in local adaptation planning as recommended in the Lake Macquarie Waterway Flood Risk Management Plan (likely to be completed in 5 year timeframe). Trigger for planned retreat on private land, if necessary, is likely beyond 50 year timeframe.	LMCC	Staff time only.	W.5, P2	See 'Development Controls' Option in Section 2.5.1, 'Planned Retreat' Option in Section 2.5.10.
P.8	Progress with existing asset management planning and the incorporation of revised design requirements for any new infrastructure. Work with infrastructure providers and owners to ensure existing infrastructure continues to function and provide services safely and for as long as practical.	Study Area	No regrets action – any new infrastructure within the study area should be designed taking into consideration the expected hazards over the design life of the structure.	LMCC / Hunter Water Jemena Ausgrid Telstra	Staff time only.	Nil.	See 'Asset Management Planning' Option in Section 2.5.7, 'New Infrastructure Design' Option in Section 2.5.9.
P.9	Investigate and prepare new design criteria to account for changing channel conditions (notably depths). Progress implementation of the "Towards a Sustainable Framework for Navigation in Swansea Channel". Such design criteria would be required for any new revetments or upgrades to existing foreshore protection structures which are likely to be required to mitigate against existing and future coastal hazards, particularly rising sea levels.	Swansea Channel foreshore	2015 or as soon as practical. Required before any new infrastructure design is undertaken	LMCC / Crown Lands and Roads and Maritime Service	Staff time.	Combine with W.1 to W.4	See 'New Infrastructure Design' Option in Section 2.5.9.

Management Action Plan

Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
P.10	<p>Maintain the entrance breakwaters in accordance with defined asset management framework to provide for continued navigability, recreational and public safety.</p> <p>This would involve:</p> <ul style="list-style-type: none"> • Conducting a detailed risk assessment of the breakwaters at the entrance to Lake Macquarie; • Maintain the entrance training walls to continue functionality; and • Undertaking necessary structural works, taking into account potential redesign and strengthening in the context of sea level rise and possible altered wave climate. 	Northern and Southern Breakwaters of Swansea Channel	Short to medium term planning consideration, i.e. a 1 to 4 year timeframe.	Crown Lands	<p>Staff time only, or minor consultancy if required to undertake the risk assessment.</p> <p>Maintenance and construction of new design options (if required) will be expensive.</p>	W.5	

Management Action Plan

Monitoring

Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
M.1	<p>Survey the beach in cross section at regular profiles along the beach.</p> <p>Survey profiles should be established at 50 to 100 metre intervals along the beach. Preferably, the beach profiles should align with any existing photogrammetric profiles at the beaches, to enable the new data to be assessed in context with the historical data.</p> <p>Where considered useful, install a marker (e.g. stake with signage in the dunes seaward of a significant beach position / assets), as a community education tool to illustrate the natural fluctuations in beach position with storms, and potential recession in the future with sea level rise.</p> <p>The monitoring program and installation of markers / sighting poles could investigate the use of assistance from local dune care groups (e.g. as a pilot program, utilising basic survey techniques such as the Emery method).</p>	<p>Salts Bay</p> <p>Black Neds Bay barrier dunes</p> <p>Sand islands – those known to be eroding and/or with high recreational or habitat value.</p>	<p>2015, then every 6-12 months, plus immediately after major storm events (i.e. $H_s > 4-5$ m)</p>	<p>LMCC / Crown Lands</p>	<p>Staff time only (internal cost of about \$30,000 per year for survey work).</p> <p>Establish priorities for monitoring if funds preclude the full suite suggested in this Plan.</p> <p>LiDAR or other technologies may make survey cheaper in future.</p>	<p>Nil</p>	<p>See 'Monitoring' Option in Section 2.5.11, 'Dune Protection and Wetland Rehabilitation' Option in Section 2.5.3.</p>
M.2	<p>Monitor wetlands to evaluate the performance of protection activities and/or pilot projects for re-establishing estuarine wetland communities.</p> <p>Wetland monitoring, evaluation and reporting should include both desktop and field based investigations to:</p> <ul style="list-style-type: none"> • assess vegetation condition and change; • inundation depth and extent; and • wetland health using macroinvertebrate indices. 	<p>Black Neds Bay Wetland</p> <p>Pelican Wetland</p> <p>Coon Island Wetland</p>	<p>2015, then every 18-24 months</p>	<p>LMCC</p>	<p>Staff time only, or minor sub-consultancy (up to \$25,000) per monitoring episode</p>	<p>Combine with B.5 and B.6</p>	<p>See 'Monitoring' Option in Section 2.5.11, 'Dune Protection and Wetland Rehabilitation' Option in Section 2.5.3.</p>
M.3	<p>Collect or otherwise obtain bathymetric hydrosurvey (or equivalent survey) data for</p>	<p>Swansea Channel</p>	<p>2015, then annually in accordance with</p>	<p>Crown Lands / Roads and</p>	<p>Staff time shared between agencies.</p>	<p>Combine with B.2</p>	<p>See 'Monitoring' Option in</p>

Management Action Plan

Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
	Swansea Channel and process the data to identify significant changes to channel bathymetry (particularly scour holes) at the toe of foreshore revetment and groynes. Data should be used to inform the preparation of asset condition assessments and assist with new infrastructure design related actions.		the Sustainable Framework for Navigation in Swansea Channel.	Maritime Service, NSW Office of Environment and Heritage		and M.6	Section 2.5.11, 'New Infrastructure Design' Option in Section 2.5.9.
M.4	Monitor frequency, depth and spatial extents of storm inundation, tidal inundation, and lake flooding events. Monitor and analyse data from tidal gauges to assess local trends in lake and sea levels.	Study Area	Event-based monitoring Ongoing monitoring of water levels with up-dated analysis at least every 5 years.	LMCC NSW Office of Environment and Heritage	Staff time. \$5,000 - \$10,000 for analysis of water level data.	Nil.	See 'Monitoring' Option in Section 2.5.11
M.5	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).	Study Area	After approximately 5 to 10 years of monitoring.	LMCC / NSW Office of Environment and Heritage	Staff time only, or minor sub-consultancy (up to \$25,000)	M.1 to M.4	See 'Monitoring' Option in Section 2.5.11
M.6	Monitor condition of foreshore assets including revetments, footpaths and groynes. This would involve undertaking an initial conditions assessment to establish baseline conditions for subsequent monitoring and for assisting with retrofitting/replacement actions. Undertake annual monitoring and reporting of asset condition to identify those assets that require immediate attention.	Swansea Channel Western revetment upstream of bridge Pelican foreshore Northern revetment downstream of bridge	2015, then every 12 months or in response to major storm events	LMCC / Crown Lands	Staff time.	Combine with W.1 to W.4	See 'Monitoring' Option in Section 2.5.11, 'New Infrastructure Design' Option in Section 2.5.9.
M.7	Develop a tsunami emergency response plan for evacuation of susceptible areas within Swansea and Blacksmiths and implement plan as triggered by advice from Bureau of Meteorology and Pacific Tsunami Warning Centre (PTWC).	Swansea Blacksmiths	2015 or as soon as practical	SES / LMCC	Staff time only, or minor sub-consultancy (up to \$40,000)	Nil.	See Section 5.6.1 of the other CZMP volume (Hazards Study and Risk Assessment)

Management Action Plan

Ref.	Action	Location(s)	Timing / Trigger	Primary Responsibility / Supporting Partners	Estimated Cost / Resources Required	Related Actions	Further Info.
							report).

Communications

Ref.	Action	Location(s)	Timing / Trigger	Responsibilities	Estimated Cost / Resources Required	Related Actions	Further Info.
C.1	Conduct community engagement programs focussing on Swansea Channel and coastal processes.	Swansea Channel and nearby communities	Commencing 2015 and ongoing	LMCC	Staff time only	Nil	Nil
C.2	Consult with Awabakal Traditional Owner and other relevant aboriginal groups when undertaking works or engagement activities relating to the indigenous heritage issues associated with Swansea Channel.	Swansea Channel, including Black Neds Bay	Commencing 2015 and ongoing	LMCC	Staff time only	Nil	Nil

3.2 Plan Evaluation and Review

3.2.1 Performance Evaluation

The Plan requires evaluation and reporting regarding the success of its implementation, and thus the success of managing existing and future coastal risks in Swansea Channel. Where implementation performance is sub-optimal, contingencies should be put in place to remedy the situation. A series of performance measures to assist in the evaluation process are discussed below.

3.2.1.1 Primary Performance Measures

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

Organisations 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 or trigger for implementation is being achieved. Indeed, monitoring actions within the plan are important for investigating this performance measure with respect to when triggers for action implementation are being met.

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

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

If it is determined that actions 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 organisation to coordinate implementation of the action(s); and
- Modify and update the 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.

3.2.1.2 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 hazards in Swansea Channel. That is, ‘how has the Plan made a difference? Has the level of risk been reduced?’

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 this initial 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 and associated coastline responses (including erosion, recession and coastal inundation).

There are two specific questions to be answered here:

- Has the level of risk changed? (including for those risks in this Plan that are currently assessed as low)?; and
- Have the identified intolerable risks been adequately managed / mitigated? (i.e., has the level of risk been reduced to a tolerable level through management?).

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

- Carry out a formal review of the implemented management actions, identifying possible avenues for increasing their effectiveness in managing the risks along Swansea Channel (including new risks);
- Commence implementation of additional management actions that may assist in meeting the objectives of the Plan (possibly 'fast-tracking' some longer term strategies as necessary); and
- Reconsider the objectives of the risk management actions. Any such changes to the Plan would need to be endorsed by the stakeholders and relevant government agencies, as well as the public.

3.2.2 Factors for Success

The success of the Management Action Plan can be improved by the following factors:

- Adoption by Council and Certification by the Minister;
- Broad stakeholder and community agreement on the overall Plan actions and objectives for risk management;
- Understanding and agreement on implementation responsibilities and funding opportunities by Council (particularly across its various departments) and other government agencies, stakeholders and the general community;
- Commitment by organisations and departments involved to dedicate appropriate time and resources to achieve the objectives and timeframe of the Plan; and
- Actively sourcing appropriate resources and funds, through grants, user contributions, and in-kind commitments from 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 management works when considering the full range of Council assets and lands requiring attention in the future.

3.2.3 Plan Review

It is recommended that progress implementing the actions in this Swansea Channel Risk Management Study and Plan be reviewed annually, 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 Action Plan to ensure the document remains current, and relevant to the changing land use and community demands in the vicinity of Swansea Channel.

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4 References

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Appendix A Legislative Requirements of the CZMP

A.1 Coastal Management Legislation

Coastal management in New South Wales is guided by the *NSW Coastal Protection Act 1979 (CP Act)* and amendments, NSW Coastal Policy (NSW Government, 1997), *State Environment Planning Policy No. 71 – Coastal Protection*, *Local Government Act 1993* and *Environmental Planning and Assessment Act 1979*. Guidance for land use planning in the coastal zone is also given by the *Coastal Design Guidelines for NSW* (Coastal Council of NSW, 2003).

Current requirements for the preparation of Coastal Zone Management Plans are outlined in Part 4A of the *Coastal Protection Act 1979* and the supporting *Guidelines for Preparing Coastal Zone Management Plans* (OEH, 2013) (the CZMP Guidelines – refer Section A.2).

The objectives of the *Coastal Protection Act 1979* provide for the protection of the coastal environment of the State for the benefit of both present and future generations. Specific objects of the Act, along with details of how these objects have been addressed by the Swansea Channel CZMP, are presented in Table A-1.

Table A-1 Coastal Protection Act 1979 Objectives

Specific Objectives of the CP Act	Addressed by this CZMP
(a) to protect, enhance, maintain and restore the environment of the coastal region, its associated ecosystems, ecological processes and biological diversity, and its water quality	Environmental values have been considered and actions developed for restoration and rehabilitation of important habitats.
(b) to encourage, promote and secure the orderly and balanced utilisation and conservation of the coastal region and its natural and man-made resources, having regard to the principles of ecologically sustainable development	The CZMP balances natural and anthropogenic demands on the environment and resources. Sustainability and conservation of environmental, social and economic values is paramount in the development of actions and works.
(c) to recognise and foster the significant social and economic benefits to the State that result from a sustainable coastal environment, including: <ul style="list-style-type: none"> (i) benefits to the environment, (ii) benefits to urban communities, fisheries, industry and recreation, (iii) benefits to culture and heritage, (iv) benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water, 	All relevant values have been considered as part of the risk assessment process, with consequences related to environmental, social and economic factors. Actions within the CZMP include protection and restoration of important habitat areas as well as preservation of social and cultural values.
(d) to promote public pedestrian access to the coastal region and recognise the public's right to access	Extensive existing parklands along the channel foreshore are protected in the CZMP, with associated social values including pedestrian access maintained in the future
(e) to provide for the acquisition of land in the coastal region to promote the protection, enhancement, maintenance and restoration of the	All significant estuarine habitat areas within the Swansea Channel area are already in public ownership, and are proposed to be preserved and

Risk Management Plan Maps

Specific Objectives of the CP Act	Addressed by this CZMP
environment of the coastal region	restored.
(f) to recognise the role of the community, as a partner with government, in resolving issues relating to the protection of the coastal environment	Community engagement is to be undertaken as part of the integrated CZMP process incorporating Parts A and B.
(g) to ensure co-ordination of the policies and activities of the Government and public authorities relating to the coastal region and to facilitate the proper integration of their management activities	The gazettal of the CZMP enables local planning instruments to become more aligned and integrated with the relevant State Government policies and directives, reflecting these policies and directives within applicable heads of consideration for future development assessment.
(h) to encourage and promote plans and strategies for adaptation in response to coastal climate change impacts, including projected sea level rise	The Lake Macquarie sea level rise policy has been included within relevant analyses (see other volume – Hazards Study and Risk Assessment) and outcomes therefore account for such changes in the future.
(i) to promote beach amenity	Existing amenity of Swansea Channel foreshores is maintained within the CZMP.

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

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

Specific matters to be dealt with in CZMPs	Addressed by this CZMP
a. <i>protecting and preserving beach environments and beach amenity,</i>	Foreshore amenity is to be maintained through protection of significant recreation areas and long-term planned retreat (see Action Plan, Chapter 3).
b. <i>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,</i>	No emergency works are required as areas subject to erosion are public lands. Proposed dune rehabilitation works should improve resilience to storm activity.
c. <i>ensuring continuing and undiminished public access to beaches, headlands and waterways, particularly where public access is threatened or affected by accretion,</i>	Access along existing public lands is to be maintained and protected through upgrading of shoreline protection works on an as-required basis (see Action Plan, Chapter 3).
d. <i>where the plan relates to a part of the coastline, the management of risks arising from coastal hazards,</i>	Open coastal hazards have been considered for Salts Bay area (see other volume – Hazards Study and Risk Assessment)
e. <i>where the plan relates to an estuary, the management of estuary health and any risks to the estuary arising from coastal hazards,</i>	The risks of coastal hazards to estuary health have been considered with respect to impacts on environmental values (see other volume – Hazards Study and Risk Assessment).
f. <i>the impacts from climate change on risks arising</i>	Climate change, and in particular, sea level

Risk Management Plan Maps

Specific matters to be dealt with in CZMPs	Addressed by this CZMP
<i>from coastal hazards and on estuary health, as appropriate,</i>	rise, has been included in the assessment of coastal hazards (see other volume – Hazards Study and Risk Assessment).
g. <i>where the plan proposes the construction of coastal protection works (other than temporary coastal protection works) that are to be funded by the council or a private landowner or both, the proposed arrangements for the adequate maintenance of the works and for managing associated impacts of such works (such as changed or increased beach erosion elsewhere or a restriction of public access to beaches or headlands).</i>	No new coastal protection works are proposed, however, the as-required retrofitting and replacement of existing structures is included to maintain existing environmental, social and economic values. Maintenance of such structures is to be the responsibility of the asset owner. The Plan requires clarification on ownership for foreshore structures (see Action Plan, Chapter 3).

A.2 CZMP Guidelines

The CZMP Guidelines replace the former Coastline Management Manual and the Estuary Management Manual, and have been notified in the gazette as a manual suitable for management of the coastline under Section 733(5) of the *Local Government Act 1993*. Councils are afforded exemption of liability under Section 733 of the Act if works and activities are undertaken in accordance with any coastal zone management plan that has been prepared following the CZMP guidelines.

The CZMP guidelines require that coastal zone management plans should:

- Support the goals and objectives of the NSW Coastal Policy 1997;
- Address the principles for coastal management, as outlined in the guidelines; and
- Satisfy the minimum requirement for coastal zone management plans, as outlined in the guidelines.

The CZMP guidelines also require coastal zone management plans to meet the NSW Government's Sea Level Rise Policy Statement, however, this Policy Statement was repealed subsequent to the publishing of the guidelines. Notwithstanding, the Coastal Protection Act 1979 and the Coastal Policy 1997 still require consideration of climate change, including sea level rise. As Lake Macquarie City Council has adopted its own sea level rise policy, this Coastal Zone Management Plan takes into account Council's policy for sea level rise.

A.2.1 Meeting the NSW Coastal Policy goals and objectives

This Swansea Channel Coastal Zone Management Plan meets the goals and objectives of the NSW Coastal Policy as outlined in Table A-3.

Table A-3 NSW Coastal Policy goals and relevance to this CZMP

Coastal Policy Goals	Addressed by this CZMP
To protect, rehabilitate and improve the natural environment	Environmental values are to be protected and important areas rehabilitated through proposed actions of the CZMP
To recognise and accommodate natural processes and climate change	Strategic planning actions that support planned retreat are to be considered and investigated further as a response to future climate change and sea level rise once triggers for further action have been reached.
To protect and enhance the aesthetic qualities	Environmental and recreational features of Swansea Channel are to be preserved by maintaining and protecting foreshore lands and facilities, including associated aesthetic values.
To protect and conserve cultural heritage	Cultural heritage is recognised through the environmental and social values that have formed essential components of the coastal risk assessment.
To promote Ecologically Sustainable Development (ESD)	The four principles of ESD have been considered in development of the CZMP. ESD is promoted through the preservation of existing environmental and social values and taking a longer-term sustainable focus for strategic planning.
To provide for ecologically sustainable human settlement	Future urban expansion is restricted due to existing development and environmental constraints. The CZMP includes strategic planning for consideration of planned retreat to maintain ecological sustainability in the future.
To provide for appropriate public access and use	Public access and use of facilities along public foreshore lands are to be maintained and protected, with foreshore structures retrofitted and replaced on an as-needed basis to preserve existing amenity. PoMs for community land and Local Adaptation Plans will include actions to preserve access with up to 0.9m of sea level rise.
To provide information to enable effective management	CZMP includes monitoring of environmental conditions and asset conditions to inform future decision making (linked to triggers for further actions). Future re-assessment of risks is included in CZMP to ensure currency in response to monitoring outcomes.
To provide for integrated planning and management	CZMP includes actions for improving the integration of coastal hazards into Council's planning framework, including development controls, policies and plan-making/reviews.

A.2.2 Addressing the coastal management principles

This Swansea Channel part of the CZMP addresses the coastal management principles, as espoused in the CZMP guidelines, as outlined in Table A-4.

Table A-4 Coastal Management Principles addressed by the Swansea Channel part of the CZMP

	Coastal Management Principles (OEH, 2013)	Addressed by this Channel part of the CZMP
Principle 1	Consider the objectives of the <i>Coastal Protection Act 1979</i> and the goals, objectives and principles of the NSW Coastal Policy 1997 and the NSW Sea Level Rise Policy Statement (2009) ¹	Refer to Sections A.1 and A.2.1 of this document
Principle 2	Optimise links between plans relating to the management of the coastal zone	This document is Part C of the overall Lake Macquarie Coastal Zone Management Plan, which provides consistency and integration in management of the open coast, the lake and Swansea Channel.
Principle 3	Involve the community in decision-making and make coastal information publicly available	Council has elected to undertake community consultation concurrently for all parts of the integrated CZMP (coast, lake and channel). Notwithstanding, stakeholder organisations have been consulted individually, while community consultation undertaken as a part of previous studies has been considered.
Principle 4	Base decisions on the best available information and reasonable practise; acknowledge the interrelationship between catchment, estuarine and coastal processes; adopt a continuous improvement management approach	The risk based approach is an internationally recognised framework for natural resources management because it incorporates the best available information and its uncertainty. Management options recognise the overlap between flooding and oceanic processes through estuaries, streamlining management into one approach. The adopted Risk Management Framework intrinsically requires ongoing monitoring of risks and review and tailoring of risk treatments (management options).
Principle 5	The priority for public expenditure is public benefit; public expenditure should cost effectively achieve the best practical long-term outcomes	High level cost benefit analysis for management options has recognised the public benefit as priority for management options.

Risk Management Plan Maps

	Coastal Management Principles (OEH, 2013)	Addressed by this Channel part of the CZMP
Principle 6	Adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risk where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions to manage high risks while long-term options are implemented	The Channel part of the CZMP has been prepared using the ISO 31000:2009 Risk Management Principles and Guidelines. Risks to public safety and assets have been analysed and mapped. Evaluation of the tolerability of risks has been evaluated. In certain cases risks that cannot be reasonably treated must be accepted. A trigger based approach to implementation has been applied.
Principle 7	Adopt an adaptive risk management approach if risks are expected to increase over time, or to accommodate uncertainty in risk predictions	The adaptability of management options to future circumstances was a consideration in selection of preferred options. A triggered based approach has been applied that recognises risks that are expected to increase over time.
Principle 8	Maintain the condition of high value coastal ecosystems; rehabilitate priority degraded coastal ecosystems	The Channel part of the CZMP includes actions for rehabilitation of degraded coastal ecosystems, and provision to improve resilience of existing high value ecosystems.
Principle 9	Maintain and improve safe public access to beaches and headlands consistent with the goals of the NSW Coastal Policy	Limited applicability to this Channel part of the CZMP, however Section 2.7 sets out options to protect foreshore areas and facilities, while allowing retreat of natural areas where feasible. Protection of foreshore facilities such as boat ramps, parks and beaches will be detailed in Local Adaptation Plans and PoMs.
Principle 10	Support recreational activities consistent with the goals of the NSW Coastal Policy	Gazettal of the CZMP will provide mechanism for inclusion of coastal hazards and the outcomes of this CZMP when planning for recreational activities within and around the waterway.

¹ This is no longer official NSW Government Policy. However, for this study, the sea level rise policy of Lake Macquarie City Council has been adopted.

A.2.3 Satisfying the minimum requirements for plan preparation






The minimum requirements for preparation of coastal zone management plans have been satisfied by this Swansea Channel part of the CZMP as outlined in Table A-5.

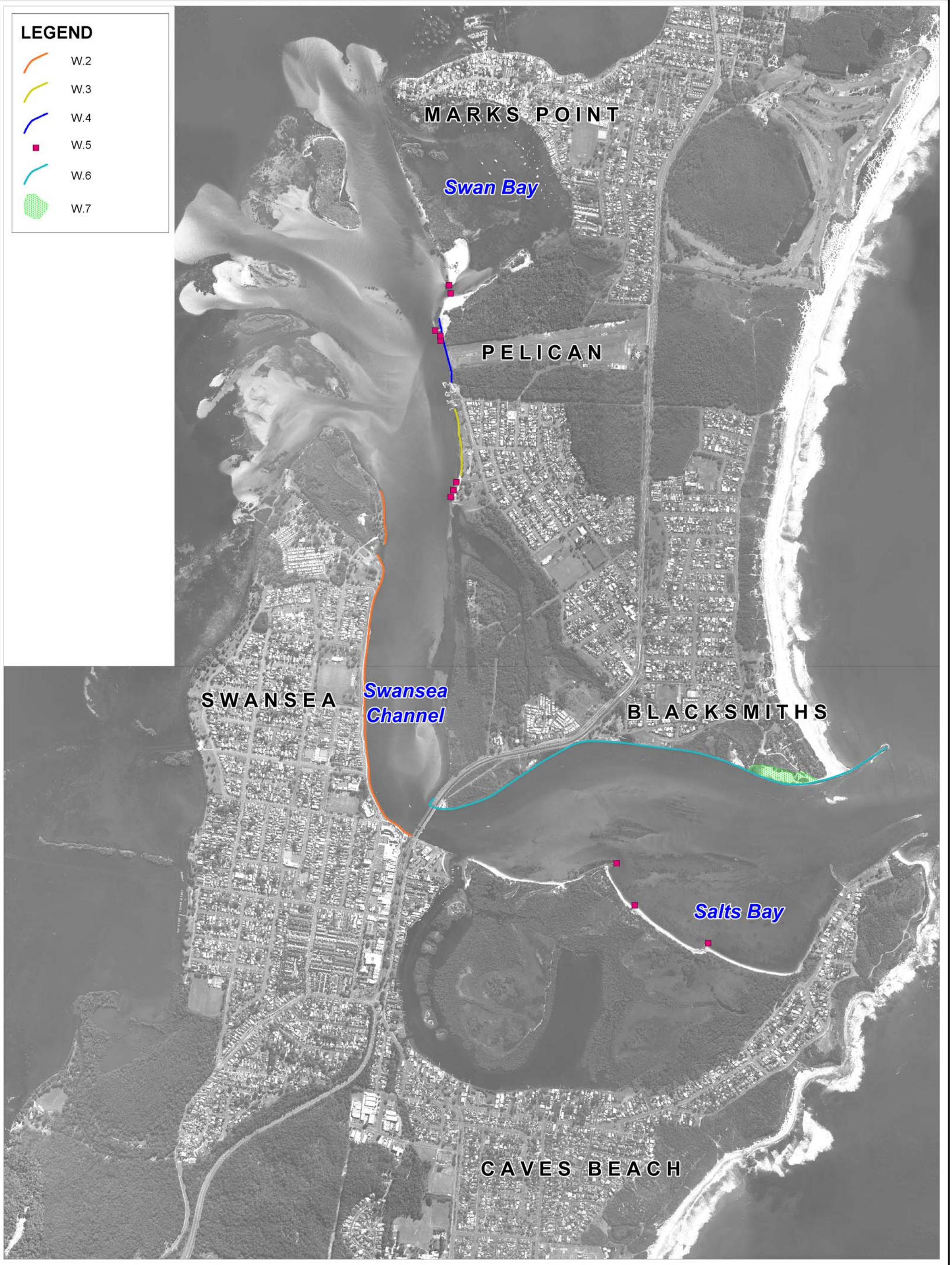
Table A-5 CZMP Minimum Requirements

Minimum Requirement	Addressed by this Channel part of the CZMP
A description of how the relevant Coastal Management Principles have been considered in preparing the plan	Refer to Section A.2.2 of this document
A description of the community and stakeholder consultation process, the key issues raised and how they have been considered	Community and stakeholder consultation is to be completed as part of the integrated CZMP process (incorporating Parts A and B). An Experts Workshop was used to help establish hazards, mechanisms and associated risks within Swansea Channel
A description of how the proposed management options were identified, the process followed to evaluate management options, and the outcomes of the process	Refer to Section 2 of this document
<p>Proposed management actions over the CZMP's implementation period in a prioritised implementation schedule which contains:</p> <ul style="list-style-type: none"> • proposed funding arrangements for all actions, including any private sector funding • actions to be implemented through other statutory plans and processes • actions to be carried out by a public authority or relating to land or other assets it owns or manages, where the authority has agreed to these actions (section 55C(2) (b) of the <i>Coastal Protection Act 1979</i>) • proposed actions to monitor and report to the community on the plan's implementation, and a review timetable 	Refer to Section 3 of this document
<p>Plan to be prepared using a process that includes:</p> <ul style="list-style-type: none"> • evaluating potential management options by considering social, economic and environmental factors, to identify realistic and affordable actions • consulting with the local community and other relevant stakeholders. The minimum consultation requirement is to publicly exhibit a draft plan for not less than 21 days, with notice of the exhibition arrangements included in a local newspaper (section 55E of the <i>Coastal Protection Act 1979</i>) • considering all submissions made during the consultation period. The draft plan may be amended as a result of these submissions (section 55F of the <i>Coastal Protection Act 1979</i>). 	<p>Refer to Sections 1.5 and 2.6 of this document.</p> <p>Community consultation has been conducted for the integrated CZMP incorporating Parts A , B and C.</p>
CZMPs are to achieve a reasonable balance between any potentially conflicting uses of the coastal zone	The CZMP has sought to manage all high priority risks to environmental, social and economic values of Swansea Channel as a result of coastal hazards.

Appendix B Management Action Plan Maps

LEGEND

-  W.2
-  W.3
-  W.4
-  W.5
-  W.6
-  W.7

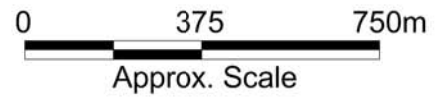


Title:
Summary of On-ground Work Actions






Figure:
B-01

Rev:
B

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LEGEND

-  B.1
-  B.2
-  B.3
-  B.4
-  B.5 & B.6

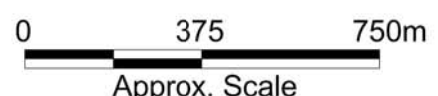


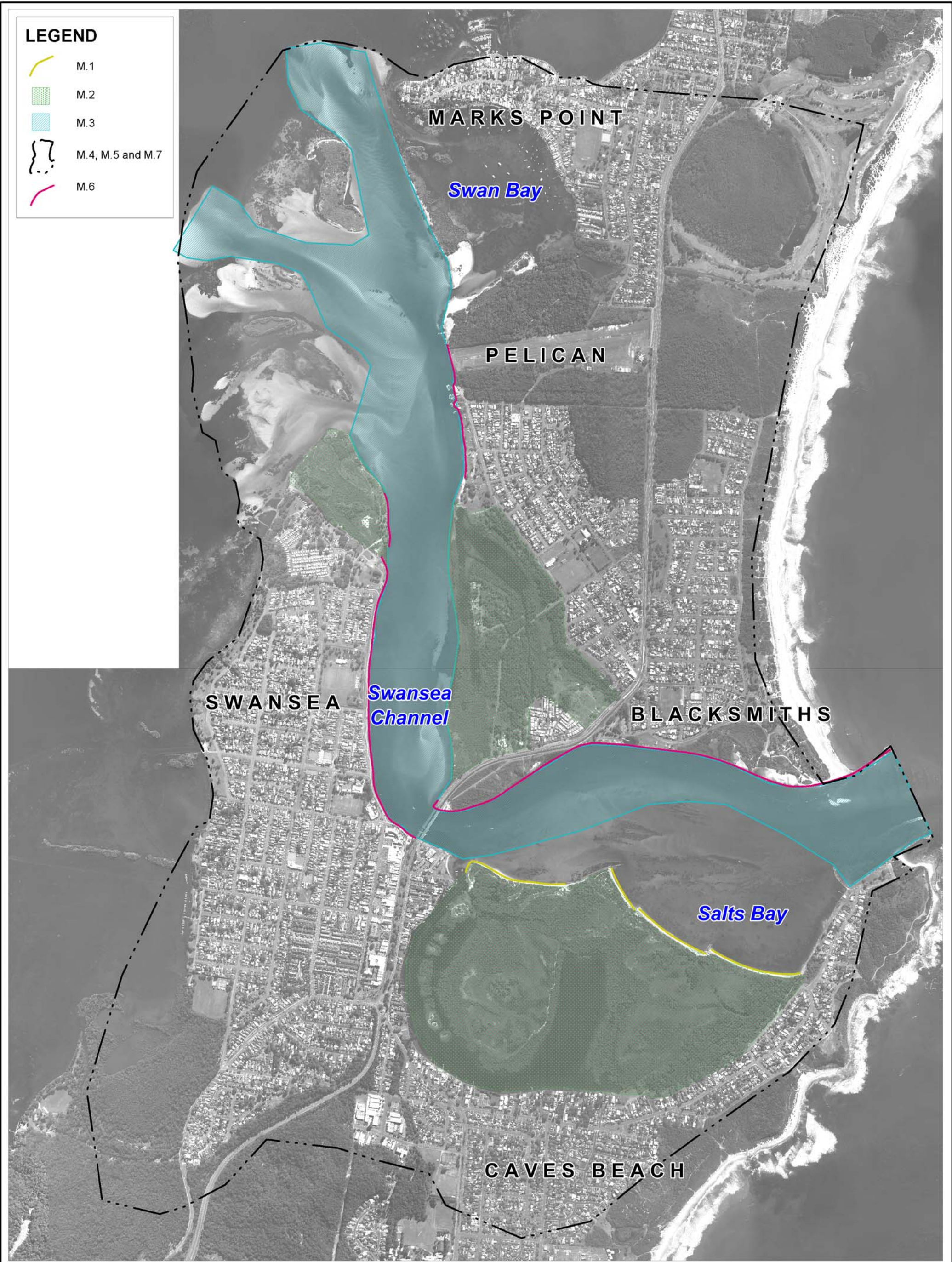
Title: **Summary of Beach Management, Nourishment and Rehabilitation Actions**

Figure: **B-02**

Rev: **B**

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Title:
Summary of Monitoring Actions

Figure:
B-03

Rev:
B

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0 375 750m
Approx. Scale





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