Merimbula Lake and Back Lake Floodplain Risk Management Plan

Final FRMP

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Document Control

Ver	Effective Date	Description of Revision	Prepared by:	Reviewed by:
Stage 4 FRMP Report				
0	September 2020	Draft for Council Review	Sarah Parton Julia Sa Luke Evans	Emma Maratea
1	October 2020	Draft for Public Exhibition	Luke Evans	Emma Maratea
Stage 5 FRMP Report				
0	December 2020	Final FRM Plan	Luke Evans	Emma Maratea
1	January 2021	Revision to Final FRM Study for Council Adoption (Adopted by Council 17 February 2021)	Luke Evans	Emma Maratea

Prepared For: Bega Valley Shire Council

Project Name: Merimbula Lake and Back Lake Floodplain Risk Management Plan

Rhelm Reference: J1148

Document Location: C:\Dropbox (Rhelm)\Jobs\J1148 - Merimbula and Back Lake FRMSP\4. Reports\Stage 5 - Final Reports\J1148_R05_Final-FRM-Plan_Rev1.docx

Cover Image Source: http://www.environment.nsw.gov.au/images/estuaries/stats/169merimbula9.jpg

Foreword

The primary objective of the New South Wales (NSW) Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible.

Through the NSW Department of Industry, Planning and Environment (DPIE), and the NSW State Emergency Service (SES), the NSW Government provides specialist technical assistance to local government on all flooding, flood risk management, flood emergency management and land-use planning matters.

The *Floodplain Development Manual* (NSW Government 2005) is provided to assist councils to meet their obligations through the preparation and implementation of floodplain risk management plans, through a staged process. **Figure F1**, taken from this manual, documents the process for plan preparation, implementation and review.

The *Floodplain Development Manual* (NSW Government 2005) is consistent with Australian Emergency Management Handbook 7: *Managing the floodplain: best practice in flood risk management in Australia* (AEM Handbook 7) (AIDR 2017).

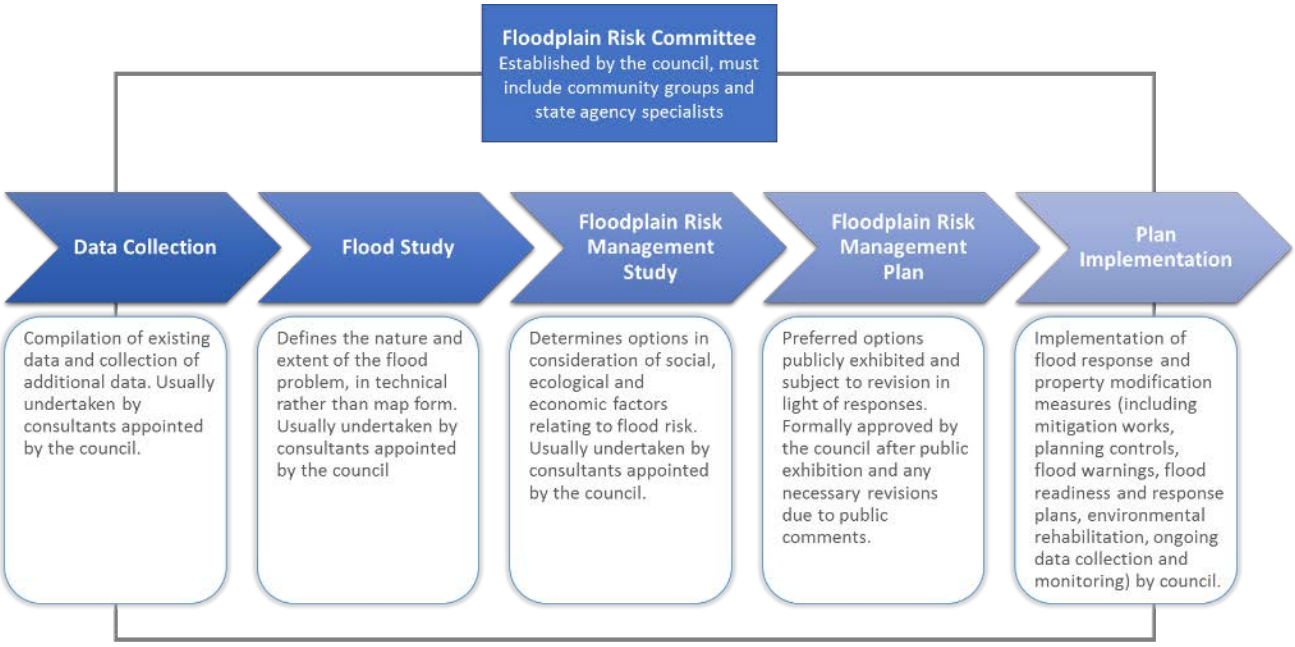

Figure F1 The Floodplain Risk Management Process (source: NSW Government, 2005)

Bega Valley Shire Council is responsible for local land use planning in its service area, including in the Merimbula Lake and Back Lake catchments and their floodplains. Through its Floodplain Risk Management Focus Group, Council has committed to prepare a comprehensive Floodplain Risk Management Plan (this document) for the study area in accordance with the NSW Government's *Floodplain Development Manual* (2005).

Executive Summary

Study Overview and Purpose

The Merimbula and Back Lake Floodplain Risk Management Plan (FRMP) has been prepared for Bega Valley Shire Council (Council) in accordance with the New South Wales (NSW) Flood Prone Land Policy and the principles of the Floodplain Development Manual (NSW Government, 2005).

This FRMP is to be considered in conjunction with the Floodplain Risk Management Study (FRMS), prepared as a separate document to this FRMP. The FRMS (Rhelm, 2020), examined options for managing flood risk in the Merimbula and Back Lake catchments. This FRMP outlines the floodplain management measures recommended along with the implementation strategy associated with those measures.

The overall objective of this FRMP is to document and convey the decisions on the management of flood risk into the future. Drawing on the investigations undertaken as part of the FRMS, this plan outlines a range of measures to manage existing, future and residual risk effectively and efficiently. This document also presents a prioritised implementation strategy, to guide the implementation of the proposed measures.

Study Area

Merimbula Lake is located in the Bega Valley Shire Council Local Government Area (LGA), which is approximately 450 km south of Sydney via the Princes Highway, and approximately 250 km south-east of Canberra via the Monaro Highway and Snowy Mountains Highway. Back Lake is located adjacent to Merimbula Lake, in a north-east direction.

The Merimbula Lake and Back Lake catchments including their tributaries of Millingandi Creek, Boggy Creek, Bald Hills Creek and Merimbula Creek converge at the township of Merimbula where they drain into the Tasman Sea.

Flood Risk

The study area can be impacted by two mechanisms of flood risk, which can be characterised as follows:

- **Lake and Creek Flooding:**
  The foreshore areas of Merimbula Lake and Back Lake are exposed to inundation risk resulting from a combination of both catchment rainfall and ocean storms. The flooding impact on properties in the study area is relatively low, with no properties experiencing over-flood flooding up to the 10% AEP event and a relatively low number being affected in rarer flood events. However, flooding can significantly impact critical infrastructure, including key access roads.
- **Overland Flooding:**
  Overall, the wider catchment is not heavily impacted by overland flows. However, the Merimbula CBD is considerably affected by this mechanism of flooding, with significant flood depths being identified in roads and commercial properties.

Lake and Creek flooding behaviour and risk was defined in the Merimbula and Back Lake Flood Study (Cardno, 2017) and was further assessed as part of the FRMS (Rhelm, 2020).

The flood risks associated with overland flows in the study areas has been examined as part of the FRMS.

Consultation

Public consultation is an important element of understanding and managing flood risk. The approach undertaken to community engagement as part of this study was in accordance with the IAP2 framework and the requirements of the NSW Government's Floodplain Development Manual (2005).

The community engagement strategy undertaken as part of this FRMSP includes the following components:

- Community newsletter and questionnaire
- Project website
- Publication of media releases
- Community information (drop-in) sessions
- Workshops with Risk Management Focus Group
- Stakeholder meetings
- Public Exhibition.

The community and stakeholders provided valuable insights about the flooding issues experienced in the Merimbula and Back Lake floodplains and how they can be addressed. The flood risk management measures were identified and assessed as part of the FRMS attempted to address the reported issues as far as reasonably possible, considering potential impacts, technical constraints, and the current understanding of the local flood behaviour.

A more detailed description of the community consultation strategy adopted in this FRMSP is provided in **Section 2.4** of this document.

Floodplain Risk Management Study

The Merimbula and Back Lake Flood Risk Management Study (Rhelm, 2020) provided a comprehensive evaluation of the flood risks in the Merimbula and Back Lake catchments and identified potential options to mitigate these risks.

The main outcomes of the FRMS include:

- Evaluation of flood risk to the community based on the outcomes of the Flood Study (2017). This analysis included flood hazard and emergency response mapping, and economic damages assessments.
- Review of flood planning policy, including flood-related development controls covered by the LEP, DCP, and Council policies and plans. The actions and updates proposed as an outcome of this review are presented in this FRMP.
- Identification of a range of flood mitigation measures to address existing and future flood risk and evaluation of these measures with the use of a Multi-Criteria Assessment (MCA) approach. The MCA enabled the comparative assessment of all options based on their economic, social, and environmental aspects, as well as on their effectiveness in mitigating flood risk.

This flood risk management plan will draw from the conclusions of the analysis undertaken in the FRMS and present the recommended measures for managing flood risk around Merimbula Lake and Back Lake, as well as the strategy to implement these measures.

Recommended Floodplain Risk Management Measures and Implementation Program

The outcomes of the options analysis undertaken in the FRMS form the basis of this FRMP. A detailed description of the recommended floodplain risk management measures is provided in **Section 3.2**.

Table E-1 and **Map G901** summarises the measures recommended as part of this FRMP.

Table E-1 Summary of Recommended Floodplain Risk Management Measures

Type of flood Risk Management	Option ID	Option Name
Flood Modification Measures (Section 3.2.1)	E-3	Review of Back Lake Entrance Management Plan
	RI-1-a	Raising of Fishpen Road by 0.4m (5% AEP immunity)
Emergency Response Modification Measures (Section 3.2.2)	EM-1	Emergency response for Acacia Ponds
	EM-2	Emergency Response Plan for Sapphire Coast Caravan Park
	EM-3	Flood Warning System
	EM-4 and PM-2	Flood Education (including information on flood proofing properties)
	EM-6	Information Transfer
	RI-3	Raising of access road to Acacia Ponds Village
	RI-5	Green Point Road Raising and Culvert Augmentation
	RI-7	Millingandi Road Raising and Culvert Augmentation
	RI-8	Arthur Kaine Drive Road Raising
Property Modification Measures (Section 3.2.3)	PM-1	Land use planning and building control updates

In order to achieve the implementation of relevant management actions, a program of implementation has been developed. The proposed implementation strategy is presented in **Section 4**.

The developed program provides information on the estimated costs of each measure, the agency/ organisation responsible for the action, as well as the priority and timeline for implementation.

It is noted that several flood modification works were assessed in the FRMS (including entrance works, dredging, levees, and vegetation management). However, none of these measures had flood benefits of enough significance to justify the cost and other impacts associated with implementing them.

Conclusions and Recommendations

This FRMP provides a practical framework and implementation plan for managing existing, future and continuing flood risk within the study area.

Overall, it is considered that existing risks to the Merimbula Lake and Back Lake floodplains can be managed appropriately through the implementation of development controls, emergency response measures and selected ground works. The effective implementation of development controls will be of key importance in reducing the damages and risk to life associated with flooding into the future through the construction of flood compatible buildings and assets. While improving emergency response through flood free access, and

improved community awareness of flooding, is critical to reducing the risks associated with flooding in the study area.

This FRMP fulfils its objectives accordance with the New South Wales (NSW) Flood Prone Land Policy (NSW Government, 2001) and the principles of the Floodplain Development Manual (NSW Government, 2005).

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Glossary

Annual exceedance probability (AEP)	The chance of a flood of a given size (or larger) occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 m^3/s has an AEP of 5%, it means that there is a 5% chance (i.e. a 1 in 20 chance) of a peak discharge of 500 m^3/s (or larger) occurring in any one year. (See also average recurrence interval).
Australian Height Datum (AHD)	National survey datum corresponding approximately to mean sea level.
Attenuation	Weakening in force or intensity.
Average recurrence interval (ARI)	The long-term average number of years between the occurrence of a flood as big as (or larger than) the selected event. For example, floods with a discharge as great as (or greater than) the 20 year ARI design flood will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event. (See also annual exceedance probability).
Catchment	The catchment, at a particular point, is the area of land that drains to that point.
Chart Datum	The level of water that charted depths displayed on a nautical chart are measured from. A chart datum is generally a tidal datum; that is, a datum derived from some phase of the tide. Common chart datums are lowest astronomical tide and mean lower low water.
Design flood	A hypothetical flood representing a specific likelihood of occurrence (for example the 100 year ARI or 1% AEP flood).
Development	Is defined in Part 4 of the AP&A Act as: - Infill Development: development of vacant blocks of land that are generally surrounded by developed properties. - New Development: development of a completely different nature to that associated with the former land use. - Redevelopment: Rebuilding in an area with similar development.
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s).
Flood	Relatively high river or creek flows, which overtop the natural or artificial banks, and inundate floodplains and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.
Flood Awareness	Awareness is an appreciation of the likely effects of flooding and knowledge of the relevant flood warning, response ad evacuation procedures.
Flood Education	Education that seeks to provide information to raise awareness of the flood problem to enable individuals to understand how to manage themselves and their property in a flood event.

Flood fringe	Land that may be affected by flooding but is not designated as floodway or flood storage.
Flood hazard	The potential risk to life and limb and potential damage to property resulting from flooding. The degree of flood hazard varies with circumstances across the full range of floods.
Flood level	The height or elevation of floodwaters relative to a datum (typically the Australian Height Datum). Also referred to as “stage”.
Floodplain	Area of land which is subject to floods up to and including the probable maximum flood.
Floodplain risk management plan	A document outlining a range of actions aimed at improving floodplain management. The plan is the principal means of managing the risks associated with the use of the floodplain. A floodplain risk management plan needs to be developed in accordance with the principles and guidelines contained in the NSW Floodplain Development Manual. The plan usually contains both written and diagrammatic information describing how particular areas of the floodplain are to be used and managed to achieve defined objectives.
Flood planning levels (FPLs)	Flood planning levels selected for planning purposes are derived from a combination of the adopted flood level plus freeboard, as determined in floodplain management studies and incorporated in floodplain risk management plans. Selection should be based on an understanding of the full range of flood behaviour and the associated flood risk. It should also consider the social, economic and ecological consequences associated with floods of different severities. Different FPLs may be appropriate for different categories of land use and for different flood plans. The concept of FPLs supersedes the “standard flood event”. As FPLs do not necessarily extend to the limits of flood prone land, floodplain risk management plans may apply to flood prone land beyond that defined by the FPLs.
Flood prone land	Land susceptible to inundation by the probable maximum flood (PMF) event. Under the merit policy, the flood prone definition should not be seen as necessarily precluding development. Floodplain Risk Management Plans should encompass all flood prone land (i.e. the entire floodplain).
Flood storage	Floodplain area that is important for the temporary storage of floodwaters during a flood.
Floodway	A flow path (sometimes artificial) that carries significant volumes of floodwaters during a flood.
Freeboard	A factor of safety usually expressed as a height above the adopted flood level thus determining the flood planning level. Freeboard tends to compensate for factors such as wave action, localised hydraulic effects and uncertainties in the design flood levels.
Gauging (tidal and flood)	Measurement of flows and water levels during tides or flood events.
Hazard	A source of potential harm or a situation with a potential to cause loss.
Historical flood	A flood that has actually occurred.

Hydraulic	The term given to the study of water flow in rivers, estuaries and coastal systems, in particular the evaluation of flow parameters such as water level and velocity.
Hydrograph	A graph showing how a river or creek's discharge changes with time.
Hydrologic	Pertaining to rainfall-runoff processes in catchments.
Hydrology	The term given to the study of the rainfall-runoff process in catchments, in particular, the evaluation of peak flows and flow volumes. .
Isohyet	Equal rainfall contour.
Peak flood level, flow or velocity	The maximum flood level, flow or velocity that occurs during a flood event.
Pluviometer	A rainfall gauge capable of continuously measuring rainfall intensity.
Probable maximum flood (PMF)	An extreme flood deemed to be the maximum flood that could conceivably occur.
Probability	A statistical measure of the likely frequency or occurrence of flooding.
Riparian	The interface between land and waterway. Literally means "along the river margins".
Runoff	The amount of rainfall from a catchment that actually ends up as flowing water in the river or creek.
Stage	See flood level.
Stage hydrograph	A graph of water level over time.
Topography	The shape of the surface features of land.
Velocity	The speed at which the floodwaters are moving. A flood velocity predicted by a 2D computer flood model is quoted as the depth averaged velocity, i.e. the average velocity throughout the depth of the water column. A flood velocity predicted by a 1D or quasi-2D computer flood model is quoted as the depth and width averaged velocity, i.e. the average velocity across the whole river or creek section.

Terminology in this Glossary has been adapted from the NSW Government Floodplain Development Manual, 2005, where available.

Abbreviations

1D	One Dimensional
2D	Two Dimensional
AHD	Australian Height Datum
ARI	Average Recurrence Interval
AR&R	Australian Rainfall and Runoff
BoM	Bureau of Meteorology
BVSC	Bega Valley Shire Council
DCP	Development Control Plan
DEM	Digital Elevation Model
DPE	Department of Planning and Environment
DPIE	Department of Planning, Industry and Environment
FPL	Flood Planning Level
FRMP	Floodplain Risk Management Plan
FRMS	Floodplain Risk Management Study
FPRMSP	Floodplain Risk Management Study & Plan
ha	hectare
km	kilometres
km^2	Square kilometres
LEP	Local Environment Plan
LGA	Local Government Area
LiDAR	Light Detection and Ranging
m	metre
m^2	Square metres
m^3	Cubic metres
mAHD	metres to Australian Height Datum
mm	millimetres
m/s	metres per second
NSW	New South Wales
OEH	Office of Environment and Heritage (NSW)
PMF	Probable Maximum Flood
RMS	Roads and Maritime Services
SES	State Emergency Service (NSW)

1 Introduction

Rhelm was commissioned by Bega Valley Shire Council (Council) to undertake the Floodplain Risk Management Study and Plan (FRMSP) for the Merimbula Lake and Back Lake catchments within Council's Local Government Area.

The Floodplain Risk Management Study (FRMS) was undertaken to define the existing flooding behaviour and associated hazards of the study area, and to investigate possible mitigation options to reduce flood damage and risk.

This report, the Floodplain Risk Management Plan (FRMP), details a proposed implementation strategy for the flood risk management options identified in the FRMS.

The FRMS and FRMP have been prepared in accordance with the New South Wales (NSW) Government's *Floodplain Development Manual* (2005), and the process has involved stakeholder and community consultation to ensure that stakeholder and community inputs and concerns have been addressed appropriately.

Bega Valley Shire Council received financial support from the State Floodplain Management program, managed by the Department of Planning, Industry and Environment (DPIE), to undertake this FRMS and FRMP of the Merimbula Lake and Back Lake catchments.

1.1 Plan Background and Context

Council completed the Merimbula Lake and Back Lake Flood Study in March 2017. The Flood Study identified the flood risk associated with mainstream catchment flows and ocean storms within both catchments. Key flooding issues identified in the Flood Study included foreshore inundation of properties along Merimbula Lake. Property and road flooding were also identified along Merimbula Creek, particularly when then entrance to Back Lake is closed prior to a large storm event.

The Bega Valley Shire Coastal Processes and Hazards Definition Study (BMT WBM, 2015) describes coastal processes and coastal hazards that have a major impact on the Council LGA. This enabled a qualitative assessment to be undertaken, which concluded hazard probably zones defined by a likelihood ranging from rare to almost certain. It should be noted that the analysis of flood behaviour undertaken in the hazard definition study and the flood study are different in nature. The flood study focuses on the flooding as a result of a catchment storm and it considers a "likely" coincident ocean level as a downstream boundary condition. The coastal hazards study, on the other hand, investigates the impact extreme ocean conditions, with a focus on the open coast. The coastal hazards study did not consider the effects of catchment flows and estuary entrance scour.

The FRMS (Rhelm, 2020) provided a comprehensive evaluation of the flood risks within the study area and investigated options to mitigate these risks. The FRMS focused on the flood risk identified in the Flood Study (Cardno 2017). Community Consultation was also undertaken as part of the study, which provided key insights on the local flood issues and potential measures to address them.

This flood risk management plan draws from the conclusions of the analysis undertaken in the FRMS and presents a strategy to implement the recommended measures for managing flood risk in the Merimbula and Back Lake study areas.

1.2 Plan Objectives

The overall objective of this Floodplain Risk Management Plan is to document and convey the decisions on the management of flood risk into the future. Drawing on the investigations undertaken as part of the floodplain risk management study, this plan outlines a range of measures to manage existing, future and residual risk effectively and efficiently. This includes a prioritised implementation strategy, describing what measures are proposed and how they will be implemented.

The primary objectives of this Flood Risk Management Plan are:

- Reduce the danger to safety and flood damage (and associated losses) to property and infrastructure
- Manage the risk to critical infrastructure during and after flood events, to guarantee they will remain serviceable when needed
- Ensure future development is controlled in a manner compatible with the flood risk and associated danger to personal safety
- Protect and where possible enhance the floodplain environment
- Manage the risk to future infrastructure to reduce potential damages
- Be fully integrated with the local flood plan, catchment management planning, and council's existing corporate, business and strategic plans and existing and proposed Environmental Planning Instruments. It also needs to meet Council's obligations under the Local Government Act and have the support of the local community
- Propose measures that are sustainable social, environmental, cultural and economic terms
- Establish a program for implementation and a mechanism for funding the management plan, including priorities, staging, funding, responsibilities, constraints and monitoring
- Develop/Update the local flood risk management policy for the study area
- Consider how to best incorporate plan findings into councils' Environmental Planning Instruments, development control plans and policies.

1.3 Study Location Catchment Description

Merimbula Lake is located in the Bega Valley Shire Council (BVSC) Local Government Area (LGA), which is approximately 450 km south of Sydney via the Princes Highway, and approximately 250 km south-east of Canberra via the Monaro Highway and Snowy Mountains Highway. Back Lake is located adjacent to Merimbula Lake, in a north-east direction.

The Merimbula Lake and Back Lake catchments including their tributaries of Millingandi Creek, Boggy Creek, Bald Hills Creek and Merimbula Creek converge at the township of Merimbula where they drain into the Tasman Sea (see **Figure 1-1**). Their catchment areas to the west and north west of Merimbula are generally heavily forested with some small areas of rural land in the Merimbula Lake catchment. The combined catchment area of the two drainage systems is approximately 75 km^2. The Merimbula Lake catchment is the larger of the two drainage systems contributing a catchment area of some 43 km^2. The remaining catchment area is contributed by the Back Lake catchment.

Merimbula Creek flows through the Merimbula township before flowing into the Tasman Sea at Back Lake which is intermittently closed at the southern end of Short Point Beach near Mirador Estate. Millingandi Creek, Boggy Creek and Bald Hills Creek drain into the Merimbula Lake before draining into the Tasman Sea through a sandbar entrance at the northern end of Merimbula Bay at Merimbula Beach. Critical infrastructure such as

the regional airport, Princes Highway, Merimbula Sewage Treatment Plant and Merimbula CBD may be affected by creek, lake or ocean water levels.

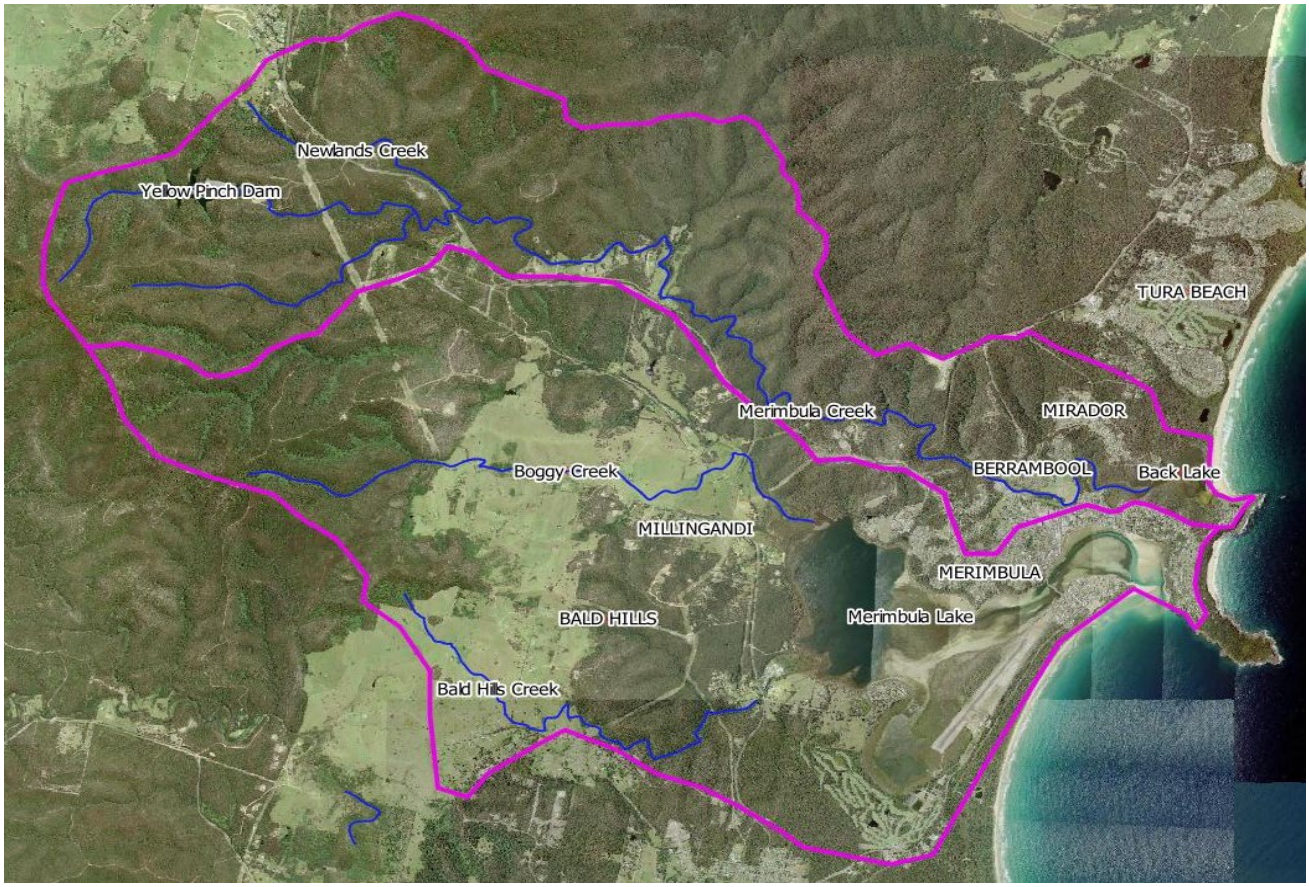

Figure 1-1 Study Area

2 Flood Risk

2.1 Flood Behaviour

The Merimbula and Back Lake catchments can be impacted by two mechanisms of flood risk:

- Lake and creek flooding, which is a result of the combined effects of catchment flooding and coastal flooding.
- Overland flow flooding, as a result of local rainfall in urban areas.

Flooding has been observed and recorded within the study area dating back to 1898. Observations and recordings have varied from creek flooding, lake foreshore flooding and overland flooding.

Results from the community survey questionnaire undertaken during the Merimbula Lake and Back Lake Flood Study revealed recent flooding experiences during April 2010, May 2011 and December 2014. Overland flow flooding has been reported in Merimbula in September 2014 and in 1996.

2.1.1 Lake and Creek Flooding

Merimbula Lake and Back Lake are exposed to inundation risk from both catchment and coastal flooding. Catchment flooding is driven by the increased inflow into the creeks and lakes due to large storm events and will tend to be the dominant source of flooding in the upper reaches of the floodplain. Coastal flooding is the inundation caused by the elevation of ocean levels as a result of storm surges or tidal events. This mechanism of flooding will tend to dominate in the lake foreshore areas, closer to the ocean.

Inundation risk at any given location within the floodplain will depend on the balance of coastal and catchment flood processes. Flood levels around Back Lake are also influenced by the entrance of the Lake. When this entrance is closed prior to a large storm event, the impact of the flooding in the lake surroundings is significantly increased.

The Flood Study (2017) focused on assessing the flood risk associated with catchment and ocean flooding in the study area. This study has adopted the requirements of the Floodplain Risk Management Guide (OEH, 2015), which provides guidelines for the modelling of the interaction of catchment flooding and oceanic inundation in coastal waterways.

Lake and Creek flooding within the Merimbula and Back Lake floodplains is largely contained to creeks and open space. However, some properties adjoining the Merimbula Lake are subjected to considerable flooding, with flood depths exceeding 1 m in the 1% AEP event.

In the Back Lake catchment there is a number of low-lying properties that become partially inundated in relatively frequent flood events (20% AEP). Nonetheless, all affected properties retain open road access in events up to the PMF.

The number of properties that are subjected to over floor flooding in the modelled flood events is summarised in **Table 2-1**. The economic damages associated with catchment flooding in the study areas are discussed in **Section 2.3**.

Table 2-1 Properties subjected to over floor flooding in catchment flooding events

Flood Event	Over Floor Flooding	Average Over Floor Flooding Depth (m)
PMF	36	**0.3**
0.5% AEP	24	**0.2**
1% AEP	17	**0.2**
2% AEP	9	**0.2**
5% AEP	3	**0.1**
10% AEP	0	**-**

As shown on **Table 2-1**, the flooding impact on properties in the study area is minimal, with no properties experiencing over-flood flooding up to the 10% AEP event and a relatively low number being affected in rarer flood events.

However, flooding significantly impacts critical infrastructure within the study area, including key access roads. **Map G902** illustrates the impacts of Lake and Creek flooding in the Merimbula and Back Lake and highlights key roads and infrastructure affected.

Key locations affected by flooding in the study area include:

- Regional airport - site remains flood free in more frequent flood events (smaller than 5% AEP). Inundation of buildings and infrastructure begin to occur in the 2% AEP event, with flood depths around 0.15 m in the 1% AEP. The airport runway first becomes overtopped in the PMF event.
- Berrambool Sports Field buildings - become inundated with depths ranging from 0.49m in relatively frequent flood events (20% AEP) to 1.03m in the 1% AEP and 2.03m at the PMF events.
- Sapphire Valley Caravan Park - becomes inundated in the 10% AEP with site access being cut at the 10% AEP event. Caravans and buildings become inundated with depths ranging from 0.17m in the 5% AEP to 0.48m in the 1% AEP and 2.23m at the PMF.
- Marine Rescue Merimbula – the site is first inundated in the 20% AEP event by depths of up to 0.6m. These depths increase to 1.1m in the 1% AEP and 1.3m in the PMF. Marine Rescue has advised that rescue vessels are located on airberths on a floating pontoon next to the base.
- Acacia Ponds Retirement complex - the retirement complex was classified as a high hazard zone in the 1% AEP and the PMF, and a low flood island in the emergency response classification.

2.1.2 Overland Flooding

Overall, the catchment is not heavily impacted by overland flow, with the majority of overland flowpaths restricted to open space corridors and roadways.

However, the Merimbula CBD is significantly affected by overland flow flooding. The following roads are particularly impacted:

- Park Street and Market Street (**Figure 3-2**) and,
- Main Street between Henwood Street and Cliff Street (**Figure 3-3**).

Figure 3-2 illustrates the Overland flow flooding in the CBD. Significant flooding in this area was noted prior to the construction of the Merimbula Bypass. Although the bypass has delivered some benefits with regard to flood behaviour, overland flow remains an issue. Much of the flooding occurs across the carpark on Merimbula

Drive, however flow that breaks out of the carpark then passes through commercial buildings to the east. Ponding along Market Street also affects adjacent businesses. While depths in the carpark reach 0.7 metres in the 1% AEP event, depths at commercial properties are lower, typically within 0.4 – 0.6 metres. The duration of flooding is short, with depths dropping to below 0.1m across the region within 1 hour of the peak flood level.

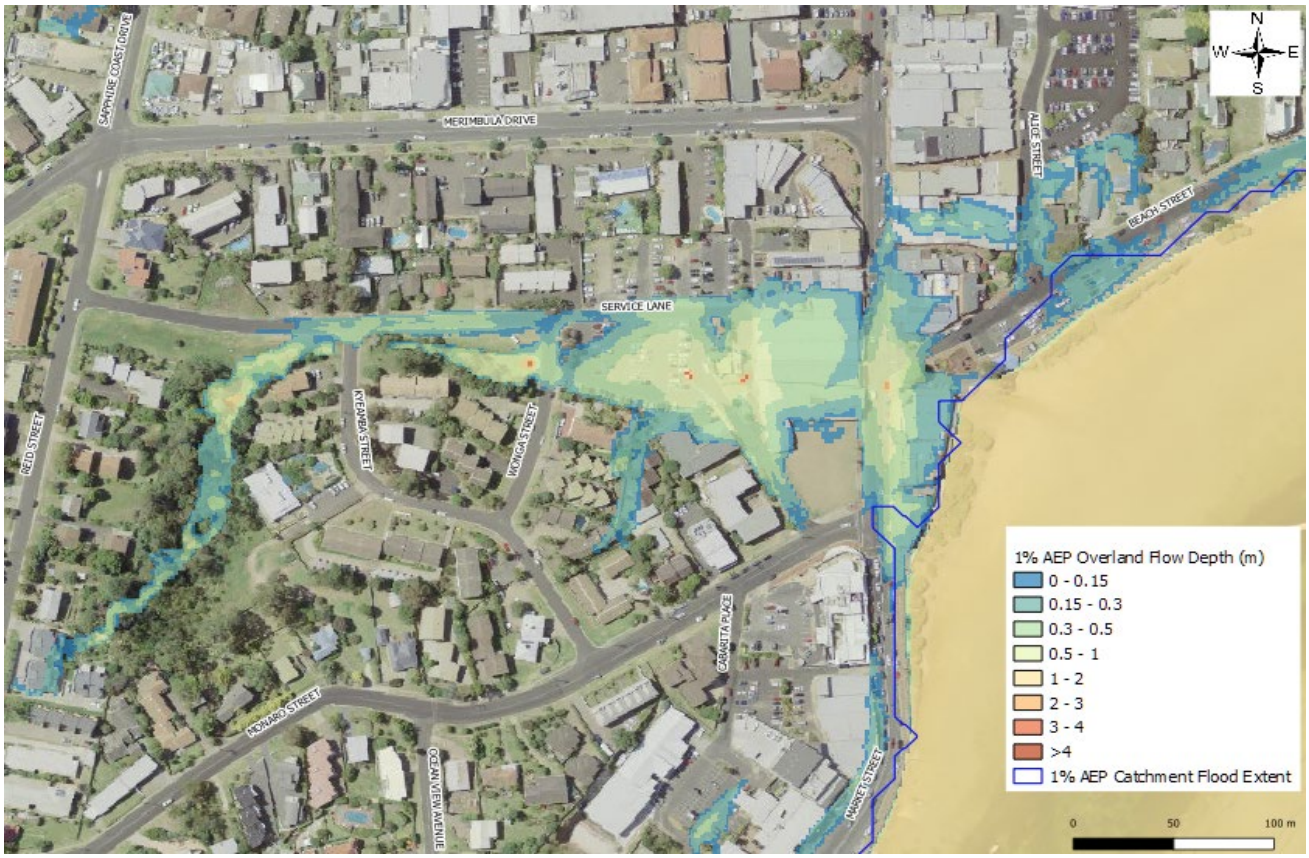

Figure 3-1 Overland Flooding in the Merimbula CBD

Figure 2-2 Overland Flooding in Main Street

2.2 Climate Change

Sea levels are rising globally and around the Australian coastline and will continue to rise through this century and beyond. Consistent with global increases, sea levels have risen in Australia at an average rate of 2.1 mm/ year over the past half century, with annual rises of 3.4mm observed from satellite altimetry data for the period 1993 – 2018) (CSIRO 2020). Council's recently adopted *Climate Resilience Strategy 2050* notes that the RCP 8.5 pathway or "business as usual" scenario models significant sea level rise for south east Australia. The *Climate Resilience Strategy 2050* also notes that this projection is supported by observed rates of recent sea level rise which highlights the ocean of south eastern Australia as having one of the largest increases in sea level rise across the globe. Sea level rise under the RCP 8.5 pathway by 2050 is projected to be 0.22m and 0.94m by 2100 above current levels.

In 2009 the NSW Government issued the NSW Sea Level Policy Statement and the Draft Sea Level Rise Planning Guidelines. The policy cited that national and international projections of sea level rise along the NSW coast are for a rise of 0.4 m by 2050 and 0.9 m by 2100. The policy statement set these levels as benchmarks for councils across the state to use in their planning instruments and processes to assess development applications. In February 2013, the NSW Government commenced Stage 1 of the NSW Coastal Reforms which included a significant change in their policy position on sea level rise. Underpinning these reforms was the decision to rescind the 2009 NSW Sea Level Policy Statement in September 2012. From this time, the NSW Government no longer recommended state-wide sea level rise projections. Instead it decided to provide information on available sea level rise projections to assist councils to develop projections relevant to their local area (Eurobodalla Shire Council, 2018).

Based on the now repealed NSW Government Guidelines (2009), Bega Valley Shire Council included sea level rise values of 0.4m and 0.9m in its flood studies at the time. For consistency, and in consideration of RCP 8.5 projections, these values have also been incorporated in subsequent flood studies, including for Merimbula.

Climate change modelling undertaken in the Flood Study (2017) and FRMS (2020) assessed the impacts of sea level rise and rainfall increases of flood behaviour. The modelling found that

- A 10% increase in rainfall (assumed for 2050 conditions) led to a 0.1m increase in peak Merimbula Lake and Back Lake levels, and a 30% increase in rainfall (assumed for 2100 conditions) led to a 0.2 to 0.25m increase in lake levels.
- Flooding increases as a result of sea level rise vary significantly across properties. As would be expected, those properties near the lake edges are most prone to affectation by sea level rises, while the impacts are reduced for those properties located further upstream. While the average flood increase across affected properties was 0.22m in 2050 (0.4m sea level rise) and 0.45m in 2100 (0.9m sea level rise), peak impacts were almost double these heights; 0.38m and 0.87m in 2050 and 2100 respectively.

The results of the climate change modelling are shown in **Map G903**.

2.3 Economic Flood Damages

In order to quantify the economic impacts of flooding, an economic flood damage assessment has been undertaken. A property may suffer economic impacts from flooding through several ways. These are broadly grouped into three categories, as summarised in **Table 2-2**.

Table 2-2 Flood Damages Categories

Type of Flood Damages		Description
Tangible	**Direct**	Building contents (internal) Structure (building repair and clean) External items (vehicles, contents of sheds etc.) Infrastructure
	Indirect	Clean-up (immediate removal of debris) Financial (loss of revenue, extra expenditure) Opportunity (non-provision of public services)
Intangible		Social – increased levels of insecurity, depression, stress General inconvenience in post-flood stage

Damage dealt directly to a property or its contents (direct damages) are only component of the total damages accrued during a flood event. Indirect costs, while also tangible, arise as a result of consequences of the flood event, such as clean-up costs, opportunity costs, and other financial impacts.

In addition to tangible damages, there are also a category of damages referred to as intangible damages. Intangible costs relate to social impacts, such as insecurity and depression, that arise as a result of major flood event, or general inconveniences that occur during the post-flood stage. The intangible costs are difficult to calculate in economic terms.

The damage assessment undertaken for this study has examined the tangible damages only. Assessment of the tangible flood damages is based on residential damage curves, which were generated based on the curves prepared by the Department of Natural Resources (now DPIE) in 2007. The magnitude of damage attributed to a property is dependent upon its number of storeys and the depth of inundation experienced for all design flood events assessed.

The damages calculated for each of design event are used to estimate the Annual Average Damages (AAD). The AAD is the typical method that is adopted in economics to annualise damage costs such as those in flooding based on their probabilities. This allows for the conversion of the different flood event damages into a singular annual average that represents (based on the overall probabilities of events) the most likely damage that is likely to be experienced in any given year. This process is described in detail in the Floodplain Development Manual (2005). **Table 2-3** summarised the Average Annual Damage calculated for the study area, as well as the damage values obtained for each of the analysed design events. The Average Annual Damages (AAD) for the study area under existing conditions is $54,251.

Table 2-3 Merimbula and Back Lake Flood Damages Summary

	Over Ground Flooding	Over Floor Flooding	Max Over Floor Depth (m)	Total Damages ($2019)
PMF	57	36	0.94	$2,764,963
0.5% AEP	36	24	0.48	$1,636,976
1% AEP	31	17	0.42	$1,271,603
2% AEP	17	9	0.27	$718,089
5% AEP	9	3	0.14	$360,481
10% AEP	1	0	-	$12,675
Average Annual Damage				$54,251

2.4 Consultation

The community plays an important role in assisting Councils with the preparation of FRMSPs. A webpage was created as part of Council's website in November 2018. The webpage contains information relating to the FRMSP, its context and purpose. The webpage was updated at key project milestones.

The community has also been informed of key project updates and how they can be involved in the FRMS process through several media releases throughout development of the FRMS.

A community newsletter and survey containing information on the FRMS was sent out to residents and property owners within the study area, with feedback closing on 16 December 2018. The newsletter was mailed to approximately 207 properties. This same information was also available on Council's Have Your Say website where an online feedback survey could be completed.

Additional community input was sought through a series of community drop-in sessions. Two community drop-in sessions were held at the Merimbula Regional Learning Centre on 6 and 7 December 2018.

A total 9 responses from the feedback survey were received, representing a return rate of 4.3%. A return rate of 10% is typical for these types of mail-outs. An additional 10 people attended drop-in sessions to provide input face to face. This represents a total engagement rate of 9%, which is considered low.

However, it should be noted that the Flood Study engagement (drop-in sessions, newsletters, surveys and public exhibition) was undertaken relatively recently and engagement in that process was high. The outcomes of the Flood Study engagement process were also considered in the preparation of this FRMP.

The submissions that were received from the community survey identified that:

- The respondents were generally aware of flooding issues within the study area
- Flooding had impacted roads, access, property and assets in the past
- Information on road closures was the most common information that respondents were looking for during a flood
- Respondents used a variety of sources to get flood updates and information including websites, radio, television, social media and word of mouth.

The community members that responded to the survey and attended the drop-in information sessions provided valuable insights about the flooding issues experienced in the study area and how they can be addressed. The inputs from the community generally included:

- flooding issues reported at specific roads, properties, and public locations

- need for management works at Merimbula Creek and Back Lake to remove accumulated debris
- potential raising of Green Point Road and upgrading of existing culvers
- implementation of additional flood protection/drainage infrastructure
- potential road access issues during flooding events
- lake entrance management procedures.

The options that were identified and assessed as part of the FRMS attempted to address the reported issues as far as reasonably possible, considering potential impacts, technical constraints, and the current understanding of the local flood behaviour.

Following the preparation of the draft Floodplain Risk Management Study the report was placed on Public Exhibition to allow the community and other stakeholders to review and comment on the report prior to it being finalised and adopted by Council.

The public exhibition period was undertaken from 31 October 2020 to 29 November 2020. During the public exhibition period:

- The reports were made available on Council's website;
- A community survey was hosted on Council's "Have Your Say" page to collect feedback from the community; and,
- Two community workshops were held to discuss the study with the community on:
    - Session 1: Tuesday 10 November from 12.30pm to 2.30pm; and,
    - Session 2: Wednesday 11 November from 2.30pm to 4.30pm,

Over the course of the public exhibition period, Council received:

- 5 survey response via "Have Your Say";
- 2 email responses to Council's project manager; and,
- Approximately 24 attendees across the two workshops.

The responses received are summarised in Table 2-4.

Table 2-4 Community Responses from Public Exhibition Period

Source	Comment	Action Undertaken
Email	Issue with completing the survey due to broken links	Links corrected and no further issues recorded during exhibition.
	The Study does not seem to take into account the dam that is the Princess Highway southern road approach to the Millingandi Bridge.	The road embankment and the cross drainage have been incorporated into the model. Model results show that ponding does occur upstream of the highway due to the embankment and culvert capacity. Overtopping of the highway was observed to occur in extreme events, as well as in the 2100 climate change scenario.

	The whole study seems to avoid any consideration of silt entering the Lakes and specifically its impact on the oyster industry.	The investigation of any siltation occurring within the lakes, and its consequent impacts, was not the focus of this study, which was to identify and address flood risk. Council is considering other estuary issues such as siltation as part of its estuary management program.
Survey	Back Lake silt build up needs attention.	As discussed above, the assessment of siltation and its impacts was beyond the scope of the study.
Discussion at Workshop	Overland flows down Sapphire Coast Drive have been noted to cause flooding of properties on Berrambool Drive.	The overland flow modelling undertaken as part of this study (refer Section 7.4) showed a local depression that runs through properties upstream of the intersection of Sapphire Coast Drive and Berrambool Drive. Council currently has a project in planning phase to modify the intersection. The overland flow modelling will be used to inform planning and assist in managing flows better.
	Flooding has been observed on Millingandi Road, just North-West of the model extent.	SES has been advised of this issue.
	Significant concern was raised regarding the sediment build up and aquatic weed growth in Merimbula Lake near Fish Pen.	Flood modelling found that sediment build up in the entrance and dredging of this sediment does not impact flood behaviour during large flood events, as the flows during a flood event are enough to scour the sediment. However, environmental and recreational impacts of the sedimentation in this area are being assessed by Council as part of the Estuary Management Program.
	It looks like Fish Pen is cut of by flooding across the Market Street Bridge, and also across Arthur Kaine Drive (south of the airport).	The bridge and causeway are flood free in all events up to and including the PMF. The depths shown on the mapping are for flows under the bridge. A note has been added to the mapping to this effect. Access is lost along Market Street, between the bridge and Short Street and along Arthur Kaine Drive. An option has been added to raise Market Street and Arthur Kaine Drive (see Option RI-9 and RI-9).

	Fish Pen drainage works well. Any ponding of water during rainfall events appears to drain away quickly	Noted.
	2016 East Coast Low impacted Fish Pen but only with waves washing over the foreshore.	This confirms what the flood modelling showed.
	Several attendees supported the raising of Fish Pen Road.	Fish Pen Road option is recommended for implementation in the FRMP.
	Support for raising of Green Point Road option (RI-5).	This option has been recommended for implementation in the Risk Management Plan.
	Resident on Henwood Street said there had been no flooding of their property since the entrance management policy had been adopted by Council.	Noted.
	Back Lake water backs up onto the pedestrian track near the school.	This is reflected in the model results and mapping.
	An attendee was happy that the study was in place and that Council and SES had a proves to prepare for and respond to flooding.	Support noted.

3 Floodplain Risk Management

3.1 Floodplain Risk Management Options

Flood risk is a combination of the likelihood of occurrence of a flood event and the consequences of that event when it occurs. It is the human interaction with a flood that results in a flood risk to the community. This risk will vary with the frequency of exposure to this hazard, the severity of the hazard, and the vulnerability of the community and its supporting infrastructure to the hazard. Understanding this interaction can inform decisions on which treatments to use in managing flood risk.

As defined in the *Australian Disaster Resilience Handbook 7 – Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR, 2017), there are three types of flood risk:

- Existing flood risk – the risk associated with current development in the floodplain. Knowing the likelihood and consequences of various scales of floods can assist with decisions on whether to treat this risk and, if so, how
- Future flood risk – the risk associated with any new development of the floodplain. Knowing the likelihood and consequences of flooding can inform decisions on where not to develop and where and how to develop the floodplain to ensure risks to new development and its occupants are acceptable. This information can feed into strategic land-use planning
- Residual flood risk – the risk remaining in both existing and future development areas after management measures, such as works and land-use planning and development controls, are implemented. This is the risk from rarer floods like the PMF, which may exceed the management measures. Residual risk can vary significantly within and between floodplains. Emergency

management and recovery planning, supported by systems and infrastructure, can assist to reduce residual risk

The alternate approaches to managing risk are outlined in **Table 4-1**.

Table 4-1 Flood Risk Management Alternatives

Alternative	Examples
Preventing/avoiding risk	Appropriate development within the flood extent
Reducing the likelihood of risk	Structural measures to reduce flooding risk such as drainage augmentation, levees, and detention
Reducing the consequences of risk	Development controls to ensure structures are built to withstand flooding
Transferring risk	Via insurance – may be applicable in some areas depending on insurer
Financing risk	Natural disaster funding
Accepting risk	Accepting the risk of flooding because of having the structure where it is

Measures available for the management of flood risk can be categorised according to the way in which the risk is managed. There are three broad categories of management:

- Flood modification measures – options aimed at preventing/avoiding or reducing the likelihood of flood risks through modification of flood behaviour in the catchment
- Property modification measures – options focused on preventing/avoiding or reducing the consequences of flood risks. Rather than necessarily modify flood behaviour, these options aim to modify existing properties (e.g. by house raising) and/or impose controls on property and infrastructure development to modify future properties. Property modification measures, such as effective land use planning and development controls for future properties, are essential for ensuring that future flood damages are appropriately contained, while at the same time allowing ongoing development and use of the floodplain
- Emergency response modification measures – options focused on reducing the consequences of flood risks, by generally aiming to modify the behaviour of people during a flood event.

A comprehensive range of possible flood risk management measures for the Merimbula and Back Lake catchments were examined, as part of the Floodplain Risk Management Study (2020). The identified measures were a product of an extensive investigation of the flood risks in the study area, which considered:

- Outcomes of the Food Study (Cardno, 2017);
- Flood hazard and emergency response mapping, and economic damages assessments undertaken as part of the FRMS; and
- Inputs obtained through workshops with stakeholders and community engagement activities.

The identified measures were than evaluated with the use of a Multi-Criteria Assessment (MCA) approach, which enabled the comparative assessment of all options based on their economic, social, and environmental aspects, as well as on their effectiveness in mitigating flood risk. Flood modelling and flood damages analysis were also undertaken as part of the evaluation process and provided key inputs for the Multi-criteria assessment.

As an outcome of this assessment, the options that were identified as being the most advantageous have been recommended as part of this FRMP and are further discussed in **Section 3.2**.

A summary of all the flood risk management options that were assessed for the study area is provided in **Appendix A.** This appendix presents a brief description of each option, the flooding issues they aim to address and how the options were identified. Map **G901** provides an overview of the identified measures (where a location is relevant).

3.2 Recommended Flood Risk Management Measures

Taking into consideration the assessment described in **Section 3.1**, a range of flood risk management measures are recommended as part of this FRMP. These measures are shown on Map **G901** (where a location is relevant).

The recommended measures are presented in **Sections 3.2.1 to 3.2.3**. For each floodplain risk management measure, the following general information has been provided:

- Description
- Associated costs (implementation and maintenance)
- Agency responsible for implementation

3.2.1 Flood Modification Measures

The purpose of flood modification measures is to modify the behaviour of the flood itself by reducing flood levels of velocities or by excluding floodwaters from areas under threat.

A range of flood modification measures were assessed that sought to improve the conveyance of the lake entrances and creek channels through dredging, structures and vegetation removal. None of these options had flood benefits of enough significance to justify the cost and other impacts associated with implementing them. Other options sought to exclude flood waters from flood prone areas through the creation of levees, including an option proposing the raising of Fishpen Road. This option (ID RI-3) is described in more detail in **Section 3.2.2** (Emergency Response Modification Measures) due to the improvement in flood access provided.

The details of the recommended actions are provided below.

<table>
<tr><th colspan="3">Review of Back Lake Entrance Management Policy</th></tr>
<tr><td colspan="2">Flood Management Type: Flood Modification Option (ID: E-3)</td><td>Responsibility: Council/DPIE</td></tr>
<tr><td colspan="2" rowspan="2">MCA Ranking: 10</td><td rowspan="2">Associated Costs:</td><td>Initial Cost: $ 75,000</td></tr>
<tr><td>Recurrent Cost: $ 0</td></tr>
<tr><td colspan="3">Overview:
As an outcome of the FRMS, it was concluded that the entrance management at Back Lake has a direct influence on the impact of the flooding in the lake surroundings.
The existing policy determines that the entrance should be artificially opened when lake levels reach 1.4mAHD. The results of the flood modelling found that this policy was effective at reducing peak flood levels. However, the results also indicate that, if these management works are not undertaken, the flooding impacts will be significantly worsened.
The ability to manually open the lake entrance can be inhibited by ocean conditions, making it unsafe to deploy machinery and access the berm. This could prevent Council from being able to open the entrance in advance of the flood.</td></tr>
</table>

Review of Back Lake Entrance Management Policy	
The modelling undertaken in the FRMS found that if the berm height has built up beyond 2.5mAHD when a flood event occurred and Council were unable to open the entrance, the impacts of flooding in a 1% AEP event are significantly higher than when the entrance has been opened in accordance with the entrance management policy. However, the modelling also found that if berm height can be maintained at a level of 2mAHD, and Council are unable to open the entrance prior to or during a flood event, the peak flood levels in a 1% AEP event are actually slightly lower than allowing the berm to build up higher even if the entrance is opened manually. The outcomes of the analysis undertaken in the FRMS would indicate that there is merit in Council reviewing the way it manages the entrance of Back Lake to consider: • Maintaining the trigger level at 1.4mAHD; and • Managing the berm height to ensure it does not exceed 2mAHD. Managing the berm height at 2mAHD would involve "scraping" sand that has built up on the berm above 2mAHD and moving it to an appropriate location on the beach nearby. This process would likely result in more frequent mobilisation of machinery than only opening the entrance when the water level trigger is exceeded, as well as regular periodic monitoring. As such, appropriate environmental impact assessments would need to be undertaken of any proposed berm management works.	
Flooding issue addressed: The results of the flood modelling show that entrance management has a direct influence on the peak 1% AEP flood levels along the Back Lake foreshore. The results also indicate that the existing policy is effective at reducing the flooding impact. However, the ability to open the lake entrance in accordance with the policy may be inhibited by ocean conditions. There are a number of reasons that could prevent Council from effectively implementing opening works during flood events, including safety, personnel or equipment issues. Therefore, a reactive entrance management policy might not be the most reliable strategy to mitigate flooding risks.	
Expected Mitigation Outcomes: A proactive entrance management policy is considered to be a more reliable strategy to mitigate flooding impacts in the Back Lake surroundings. If the Back Lack entrance dune height is maintained at a constant level (lower then 2mAHD) and entrance opening is not possible at 1.4mAHD, the 1% AEP flood levels will not be any higher than if an entrance opening had occurred.	**Considerations:** • Prior to adoption, the proposed entrance management strategy would need to be assessed against the full range of issues raised within the REF supporting the current EMP. • It is noted that any revision to the entrance management policy would need to be undertaken within a Coastal Management Program, in line with the Coastal Management Act.

Raising of Fishpen Road by 0.4m (5% AEP immunity)		
Flood Management Type: Emergency Response Modification (ID:RI-1-a)	**Responsibility: Council**	
MCA Ranking: #8	**Associated Costs:**	**Initial Cost:** $855,400
		Recurrent Cost: $5,000 p/ year
Overview:		

Raising of Fishpen Road by 0.4m (5% AEP immunity)	
Fishpen Road is an 800 metre arc running along the Merimbula Lake foreshore between the southern end of the Merimbula Bridge (Market Street) to the roundabout with Ocean Street at Mitchies Jetty. Under existing conditions, access to properties along Fishpen Road is lost during flood events, due to the road submerging at various points. Although many properties are not inundated, appropriate evacuation procedures still need to be undertaken to ensure the safety of all individuals. It is proposed raising Fishpen Road by 0.4m, which would guarantee flood immunity for the road up to the 5% AEP flood event. A raised road would improve access during flood events, and also function as a flood wall to protect adjacent properties from lake inundation. Several road raising options were analysed for Fishpen Road as part of the FRMS. The options looked at raising the road by 0.4m, 0.5m or 0.6m, relating to flood immunity at the 5%, 2% and 1% AEP event respectively. The final design level of the road would need to consider access issues for adjacent houses, aesthetic impacts and constructability. However, it is recommended that road raising be undertaken by at least 0.4m. The design level would be verified as part of the detailed design process. It is noted that if access is not considered critical, property benefits and flood damage reductions could still be achieved via levee or flood wall.	
Flooding issue addressed: Access along Fishpen Road is cut by floodwaters before the surrounding properties are inundated. This potentially results in evacuation and emergency access issues. Properties adjacent to the Fishpen Road are also flooded from elevated lake levels. If the road is raised, these properties would benefit from increased flood protection.	
Expected Mitigation Outcomes: Raising Fishpen Road would enhance its flood immunity and mitigate the risk of blocked access to properties along it. This would increase the benchmark for flood evacuation and also act as a flood wall to further protect properties from inundation. The floodwall could be constructed in isolation adjacent to the road if access issues were not considered critical.	**Considerations:** • Maintaining connections to adjacent roads and properties would need to be considered as part of any design for the road raising.

3.2.2 Emergency Response Modification Measures

Emergency response modification measures aim to reduce the consequences of flood risks by:

- Increasing the effective warning time, such as via the use of flood warning systems
- Planning the evacuation of an area so that it proceeds smoothly during a flood event
- Preparing for a flood event (e.g. stockpiling sand and sandbags for future deployment)
- Enabling recovery following a flood event.

These types of measures are typically incorporated into the local flood plan, and education of the community on the contents of the plan is very important. These measures effectively modify the response of the community at risk to better cope with a flood event.

Of all the floodplain risk management options available for consideration, it is only emergency management modifications (which includes community planning) that addresses the residual flood risk after all the flood and property modification options have been implemented. Emergency management and education measures are an effective ongoing flood risk management tool.

The following emergency response modification options are recommended for the Merimbula and Back Lake floodplains.

- Flood warning system
- Emergency response plan for Acacia Ponds
- Emergency response plan for Sapphire Coast Caravan Park
- Flood Education (including information on flood proofing properties)
- Information Transfer
- Raising of Fishpen Road by 0.4m (5% AEP immunity) or construction of a floodwall to a similar height
- Raising of access road to Acacia Ponds Village
- Green Point Road Raising and Culvert Augmentation
- Millingandi Road Raising and Culvert Augmentation

<table>
<tr><th colspan="3">Flood Warning Systems</th></tr>
<tr><td>Flood Management Type: Emergency Response Modification (ID: EM-3)</td><td colspan="2">Responsibility: Council</td></tr>
<tr><td rowspan="2">MCA Ranking: #1</td><td rowspan="2">Associated Costs:</td><td>Initial Cost: $25,000</td></tr>
<tr><td>Recurrent Cost: $1,500 p/ year</td></tr>
<tr><td colspan="3">Overview:
A flood warning system provides Council and the community with advance notice of potential flood events based either on rainfall or lake levels.
There is already flood warning system in place for dangerous weather conditions, based on BoM advice of potential and actual east coast low events, as well as weather warnings related to high rainfalls. These warnings are typically provided for large regions of the eastern coast, rather than on a per township basis.
Warnings for the local catchment, based on local conditions could be tied to either rainfall or lake levels. Given the fact that the most significant flood impacts in the catchment are driven by lake flooding, the existing MHL gauges installed for both Merimbula and Back Lake could be utilised for this purpose.
The critical duration of the lake system is in the order of 6 hours, which is sufficient to provide a reasonable warning time of lake flooding. Mainstream flooding in the upper catchment typically responds most strongly to 2 or 3 hour storms, reducing available warning times. Local overland flow was found to be critical for the 90 minute event, and as such, warning would not be suitable for this type of flooding.
At a minimum, the operators of the Sapphire Coast Holiday Park and Acacia Ponds, and the properties along Fishpen Road should be made aware of this data. An automated alert could also be created to warn these locations if lake levels are approaching, or have reached, the trigger levels within any flood response plans that are developed.</td></tr>
<tr><td colspan="3">Flooding issue addressed:
Flood warnings and alerts have the potential to reduce the flood risks in the Merimbula and Back Lake floodplains, by increasing community readiness.
Currently there is not an official system in place to warn the community of potential flood events.</td></tr>
</table>

Flood Warning Systems	
Expected Mitigation Outcomes: Increasing the community's readiness for a flood event will reduce flood risk to property and life by allowing them time to take actions such as: • Moving possessions within their home or business to higher levels • Moving parked cars to safe locations • Ensuring flow paths are not blocked by debris, or other moveable items • Evacuating, if appropriate • Checking on neighbours.	**Considerations:** • The effectiveness of flood warnings and alerts will be increased through a concurrent flood education program. • The wording of the issued flood warnings would be critical to increase responsiveness, without creating unnecessary alarm. • Based on the responses from the community survey (**Section 2.4**) the respondents would use a variety of sources to get flood updates and information including websites, radio, television, social media and word of mouth. Therefore, it is recommended that these avenues be targeted when releasing information related to weather and flood warnings. • Warning could also be sent using SMS messages and e-mails. However, this approach needs to be considered with caution, as a few false alarms could deteriorate the community's trust in the system and negatively affect future emergency responses.

Emergency response plan for Acacia Ponds		
Flood Management Type: Emergency Response Modification (ID: EM-1)	**Responsibility: Owners of Acacia Ponds – Council to assist by providing technical support**	
MCA Ranking: #2	**Associated Costs:**	*Costs would be responsibility of Acacia Ponds*
Overview: The Acacia Ponds retirement complex was identified as a high flood risk zone, based on the results of the FRMS. The area was also classified as a low flood island in the emergency response classification, which means the access to the site would be cut by floodwaters before the retirement complex itself is inundated. Given that residents at this location are elderly, the timely evacuation of these residents is critical to ensure it occurs before access from the site is lost. It is recommended that the retirement village prepare a flood response plan that includes: • Details of roles and responsibilities in the case of a flood event • Sources of information to inform when actions detailed in the plan are required • Trigger levels for lake levels and / or rainfall for implementing the plan • Identifies alternative meeting / accommodation locations for residents during and after a flood event.		
Flooding issue addressed: The Acacia Ponds retirement complex was classified as a high hazard zone in the 1% AEP and the PMF, and a low flood island in the emergency response classification.		

Emergency response plan for Acacia Ponds	
The site is first inundated in the 5% AEP event, although depths are low (0.02m). Depths of 0.16m occur in the 1% AEP and increase further to 0.56m in the PMF. The duration of flooding is typically dependent on the tidal cycle of the lakes, with flood water receding as the tide drops.	
Expected Mitigation Outcomes: It is expected that the preparation of the Emergency Response Plan will enable a more agile and coordinated emergency reaction from the residents and employees of the retirement complex. An effective response has the potential to significantly reduce the risk to life during a flood event. Additionally, it can attenuate the traumatic effects the event might have on people.	**Considerations:** • It is noted that the responsibility for the preparation of this plan lies with the retirement village. However, it is recommended that Council communicate the outcomes of this study with the owners, and attempt to work with them, and SES in developing a flood plan for this site. It is recommended that at a minimum, Council make the park owners aware of the outcomes and recommendations of this study, and provide the owners with example flood plans for consideration. Should the park owners agree to implement a plan, Council and SES should look to review the plan to ensure it is appropriate for the flood behaviour present prior to it being adopted by the park.

Emergency response plan for Sapphire Coast Caravan Park		
Flood Management Type: Emergency Response Modification (ID: EM-2)	**Responsibility: Caravan Park Owners – Council to assist by providing technical assistance**	
MCA Ranking: #4	**Associated Costs:**	*Private Property*
Overview: The caravan park was identified as a high flood risk zone, based on the results of the FRMS. The site is considered as a low flood island, as access along the driveway would be cut by floodwaters before the caravans themselves are inundated. Therefore, timely evacuation of the residents of the caravan park is critical to ensure it occurs before access from the site is lost. As per the retirement village above, it is recommended that the caravan park prepare a flood response plan that includes: • Details of roles and responsibilities in the case of a flood event • Sources of information to inform when actions detailed in the plan are required • Trigger levels for lake levels and / or rainfall for implementing the plan • Identifies alternative meeting / accommodation locations for residents during and after a flood event.		
Flooding issue addressed: The caravan park experiences flooding at the edge of the site over internal roadways in the 20% AEP. Access along the entrance road is lost in the 10% AEP and caravans and buildings are first affected in the		

Emergency response plan for Sapphire Coast Caravan Park	
5% AEP event, with depths of 0.17m occurring onsite. These depths increase to 0.48m in the 1% AEP and to 2.23m in the PMF. The site is a high-risk area as it operates as a low flood island, losing access along the driveway before the caravans themselves are inundated. The duration of flooding is typically dependent on the tidal cycle of the lakes, with flood water receding as the tide drops.	
Expected Mitigation Outcomes: It is expected that the preparation of the Emergency Response Plan will enable a more agile and coordinated emergency reaction from the residents of the caravan park. An effective response has the potential to significantly reduce the risk to life during a flood event. Additionally, it can attenuate the traumatic effects the event might have on people.	**Considerations:** • It is noted that the responsibility for the preparation of this plan lies with the retirement village. However, it is recommended that Council communicate the outcomes of this study with the owners, and attempt to work with them, and SES in developing a flood plan for this site. It is recommended that at a minimum, Council make the park owners aware of the outcomes and recommendations of this study, and provide the owners with example flood plans for consideration. Should the park owners agree to implement a plan, Council and SES should look to review the plan to ensure it is appropriate for the flood behaviour present prior to it being adopted by the park.

Flood Education (including information on flood proofing properties)		
Flood Management Type: Emergency Response Modification (ID: EM-4) and Property Modification (PM-2)	**Responsibility: Council / SES**	
MCA Ranking: #5	**Associated Costs:**	**Initial Cost:** $50,000
		Recurrent Cost: $2,500 p/ year
Overview: Community awareness and behaviour is an important aspect of reducing flood risk within a catchment. If a community is aware of how flood risks develop within their local area, and the correct ways in which to respond, risk to life can be substantially reduced. It is recommended that Council take the adoption of this study as an opportunity to engage with the community in discussions relating to flood risk, management, and responses. At a minimum, it is recommended that Councils website be updated with the outcomes and recommendations of the study. Further community awareness could be raised by issuing media releases, either through social media or in local papers. Furthermore, a number of the emergency response options proposed as part of this FRMP require the works to be undertaken by a third party (caravan and aged care providers, crown lands, RMS, etc). It is recommended that a focused engagement process be undertaken with these parties to inform them of the outcomes and recommendations of this study, in particular, as they relate to their business and/or asset.		

Flood Education (including information on flood proofing properties)	
Additionally, flood education programs can provide guidance to residents on how to flood proof their property, between flood events or during emergency preparation when a flood/weather warning is received. The NSW SES Business Flash Flood Tool Kit provides business with tools and information to assist in flood proofing their premises. The tool may also assist residential properties with flood proofing their property, however not all factors may be as relevant. Examples of flood proofing measures include: • Any construction below the FPL to be of flood compatible materials • Electrical wiring and other services to be waterproofed and protected below the FPL • Raise belongings on shelves or move to a second storey • Secure loose objects • Re-locate electrical or dangerous goods to a flood-free area.	
Flooding issue addressed: Lake and Creek flooding significantly impacts critical infrastructure within the Merimbula and Back Lake floodplain, including key access roads. Therefore, during a major flood event, residents may be cut off from transport routes and isolated. In this situations, the community's readiness and preparedness could have a substantial impact in preventing loss of life. Additionally, a number of emergency response options proposed as part of this FRMP require the works to be undertaken by a third party (caravan and aged care providers, crown lands, RMS, etc). Therefore, it is important that these parties are informed of the outcomes and recommendations of this study, in particular, as they relate to their business and/or asset.	
Expected Mitigation Outcomes: If the members of the community understand their role in the overall floodplain management strategy for the study area, they are able to respond quickly and effectively to an emergency. A flood ready community are more likely to take actions to protect life and property such as: • Moving possessions within their home or business to higher levels • Moving parked cars to safe locations • Ensuring flow paths are not blocked by debris, or other moveable items • Evacuating, if appropriate • Checking on neighbours.	**Considerations:** • The involvement of NSW SES members in community engagement and educations programs has been successful in engagement activities undertaken by Council and across NSW. SES members could be invited to participate in face to face education activities at community events, pop up stalls, or even door knocking of key locations. • Another aspect that needs to be considered is that the terminology used in the flood awareness program is accessible and that it effectively communicates the level of flood risk.

Information Transfer		
Flood Management Type: Emergency Response Modification (ID: EM-6)	**Responsibility: Council / SES**	
MCA Ranking: #6	**Associated Costs:**	**Initial Cost:** $2,500
		Recurrent Cost: $0

Information Transfer	
Overview: The flood data developed as part of this study should be transferred to the SES for incorporation into their own flood intelligence database. This would be facilitated by the NSW Government Flood Data Portal. The key data sets for transfer to SES would be the GIS layers showing: • Hazard and flood function mapping (as per **Map G801** and **Map G802** from the FRMS) • Flood emergency response classifications (as per **Map G803** from the FRMS) • Location and depth of road inundation within the study area for the modelled flood events (as per **Map G804** from the FRMS) • Map of flooded properties, including the events in which the properties are inundated, and events in which over floor flooding occurs (is applicable) – this data is not provided within this FRMS and will be provided to SES as a GIS layer. The provision of the hazard mapping and flood emergency response classifications would also assist the SES is prioritising and scheduling actions as a flood event progresses through the catchment	
Flooding issue addressed: The flood data developed as part of the FRMS could potentially assist the SES to plan and carry out emergency actions. However, currently there is not a procedure in place to guarantee the SES will have facilitated access to the flood risk information generated as part of the FRMS.	
Expected Mitigation Outcomes: The flood data developed as part of the FRMS will assist the SES in prioritising and scheduling actions, as a flood event progresses through the Merimbula and Back Lake floodplains.	**Considerations:** • The provision of flood intelligence to the SES should also be ongoing. For example, if Council collects any post-flood survey, or receives reports of local flooding issues, this should also be passed to the SES for their consideration.

Raising of access road to Acacia Ponds Village		
Flood Management Type: Emergency Response Modification (ID: RI-3)	**Responsibility: Private**	
MCA Ranking: #9	**Associated Costs:**	*Private Property*
Overview: Acacia Pond Village is located on the western foreshore of Merimbula Lake, with access from the Princes Highway. The village is a senior living development. Development on this site is controlled under the State Environmental Planning Policy (Housing for Seniors and People with a Disability) 2004. Being a private property with State Government development controls (rather than Council) means that managing flood risk on the site by Council may be limited. However, this study has identified that the access road to Acacia Ponds (off Princes Highway, opposite Stringy Bark Place) is inundated in 2% AEP and greater events. It is recommended that Council liaise with the Acacia Ponds management to ensure that they are aware of this issue. It should be recommended to the village management that the access road be raised to improve access during a flood event.		

Raising of access road to Acacia Ponds Village	
Flooding issue addressed: Based on the outcomes of the FRMS, it was identified that in flood events grater than the 1% AEP, the access to the Acacia Ponds Village would be cut by floodwaters, which means the residents could potentially become isolated. In the PMF event, the development itself would also be impacted by considerable flood depths, which means that the residents would need to be evacuated promptly, before the inundation occurs.	
Expected Mitigation Outcomes: Rising the access road to Acacia Ponds Village would guarantee flood-free access to the development during flood events up to and including the PMF. This would prevent potential evacuation and emergency access issues and, consequently, reduce the risk to life.	**Considerations:** • Consultation with TfNSW during this study identified that an additional left turning lane is being proposed on Princes Highway for turning into Green Point Road, it may be useful for Acacia Ponds Village to liaise with TfNSW to see if any upgrades to the access road can be done in conjunction with the Princes highway works

Green Point Road Raising and Culvert Augmentation		
Flood Management Type: Emergency Response Modification (ID: RI-5)	**Responsibility: Crown Lands (DPIE)**	
MCA Ranking: #13	**Associated Costs:**	**Initial Cost:** $676,200
		Recurrent Cost: $5,000 p/ year
Overview: Residents living on Green Point Road attended the community drop-in sessions in December 2018. They raised the issue of flooding of Green Point Road approximately 240m from Princes Highway due to flows from the small unnamed creek. This flooding was observed by residents as occurring after 'heavy rain' and effectively cutting off access to properties on Green Point Road for up to 6 hours. Since this location was not included in the original flood modelling undertaken in the Flood Study (2017), a local hydraulic model was developed to assess the flooding impacts on Green Point Road. The flood modelling results show that Green Point Road is subjected to overtopping in flood events. Since Green Point Road is an important access route, the following road improvement works are proposed: • Three 1200 * 600 box culverts to convey the flow; and • Raising the roadway by 0.5 metres which provides a 0.5 metre freeboard in the 1% AEP, and provides some capacity to manage future increases in flow arising from climate change. The improvements proposed as part of this measure would guarantee flood immunity for Green Point Road up to the 1% AEP flood event.		
Flooding issue addressed: The low point in Green Point Road is significantly affected by flooding in major flood events, cutting off the access to approximately all the properties located along the road. According to residents, Green Point road can remain flooded for up to 6 hours, following 'heavy rain'.		

Green Point Road Raising and Culvert Augmentation	
Expected Mitigation Outcomes: The proposed road improvements would guarantee flood immunity for Green Point Road up to the 1% AEP flood event. This would prevent potential evacuation and emergency access issues.	**Considerations:** • The road is owned by Crown Lands (DPIE) so any works would need to be undertaken by them. Council should liaise with Crown Lands to provide them with the hydraulic design inputs produced by the FRMS.

Millingandi Road Raising and Culvert Augmentation (at Boggy Creek Road Intersection)		
Flood Management Type: Emergency Response Modification (ID: RI-7)	**Responsibility: Council**	
MCA Ranking: #16	**Associated Costs:**	**Initial Cost:** $861,700 **Recurrent Cost:** $500 p/ year
Overview: Millingandi Road provides a key access route for a number of rural properties. There is access to Millingandi Road via Princes Highway in the South, Millingandi Short Cut Road, and Princes Highway to the North (outside of the study area). Millingandi Road is flooded at the causeway in all design events assessed as a result of upstream catchment flows exceeding the cross-drainage capacity. This flooding is considered high hazard (H5) in all events. To address this issue, the following road improvement works are proposed: • Three 2400 *1500 box culverts to convey the flow; and • Raising the roadway by 1.1 metres which provides a 0.5 metres freeboard in the 1% AEP, and provides some capacity to manage future increases in flow arising from climate change. The improvements proposed as part of this measure would guarantee flood immunity for Millingandi Road up to the 1% AEP flood event.		
Flooding issue addressed: Millingandi Road is subjected to high hazard flooding even during relatively frequent flood events. Since this road is an important access route for a number of rural properties, this could potentially result in evacuation and emergency access issues.		
Expected Mitigation Outcomes: The proposed road improvements would guarantee flood immunity for Millingandi Road up to the 1% AEP flood event. This would prevent potential evacuation and emergency access issues.	**Considerations:** • It is noted that Millingandi Short Cut Road is also flooded, and that Millingandi Road is likely to flood at other locations for short periods of time due to local flows from small creeks. However, this location poses the greatest impact on access.	

Arthur Kaine Drive Road Raising		
Flood Management Type: Emergency Response Modification (ID: RI-8)	**Responsibility: RMS**	
MCA Ranking: #15	**Associated Costs:**	**Initial Cost:** $1,232,700
		Recurrent Cost: $5,000 p/ year
Overview: Arthur Kaine Drive is the sole access route south for the Fishpen Road precinct and Merimbula Airport, should access be lost across the causeway. The road is first inundated in the 2% AEP by depths of up to 0.15m. These depths increase to 0.3m in the 1% AEP and 0.7m in the PMF. The proposed option would see an approximately 500m section of road raised to the 1% AEP flood level. The improvements proposed as part of this measure would guarantee flood free access for Fishpen Road and Merimbula Airport Road up to the 1% AEP flood event. Coupled with the option below, this would provided a flood free route from Pambula to Merimbula and Berrambool.		
Flooding issue addressed: Aurther Kaine Drive is subjected to flooding in the 2% AEP event and larger. Since this road is an important access route for Fishpen Road and Merimbula Airport, this could potentially result in evacuation and emergency access issues.		
Expected Mitigation Outcomes: The improvements proposed as part of this measure would guarantee flood free access for Fishpen Road and Merimbula Airport Road to the south in events up to the 1% AEP flood event. This would prevent potential evacuation and emergency access issues.	**Considerations:** • Consideration should be given to sea level rise when undertaking detailed design of this option. As the area is located immediately adjacent to Merimbula Lake, changes in lake levels will affect the level of flood immunity offered by any road raising undertaken.	

Market Street Road Raising		
Flood Management Type: Emergency Response Modification (ID: RI-8)	**Responsibility: Council**	
MCA Ranking: #12	**Associated Costs:**	**Initial Cost:** $646,450
		Recurrent Cost: $5,000 p/ year
Overview: Market Street is the sole access route North for the Fishpen Road precinct and Merimbula Airport, should access be lost along Arthur Kaine Drive. Market Street is flooded between the bridge abutment and Short Street, and is first inundated in the 1% AEP event by depths of up to 0.15m. These depths increase to 0.3m in the PMF event. The proposed option would see an approximately 250m long section of road raised to the 1% AEP flood level. The improvements proposed as part of this measure would guarantee flood free access to the north for Fishpen Road and Merimbula Airport Road up to the 1% AEP flood event.		

Market Street Road Raising	
Coupled with the option above, this would provided a flood free route from Pambula to Merimbula and Berrambool.	
Flooding issue addressed: Market Street, between Short Street and the bridge is subjected to flooding in the 1% AEP event and larger. Since this road is an important access route for Fishpen Road and Merimbula Airport, this could potentially result in evacuation and emergency access issues.	
Expected Mitigation Outcomes: The improvements proposed as part of this measure would guarantee flood free access to the north for Fishpen Road and Merimbula Airport Road up to the 1% AEP flood event. This would prevent potential evacuation and emergency access issues.	**Considerations:** • Consideration should be given to sea level rise when undertaking detailed design of this option. As the area is located immediately adjacent to Merimbula Lake, changes in lake levels will affect the level of flood immunity offered by any road raising undertaken.

3.2.1 Property Modification Measures

Property modification measures refer to modifications to existing development and / or development controls on property and community infrastructure for future development. These are aimed at steering inappropriate development away from areas with a high potential for damage and ensuring that potential damage to development likely to be affected by flooding is limited to acceptable levels by means of measures such as minimum floor levels, and flood proofing requirements.

The land use planning and building controls recommended for updates are summarised below.

Land use planning and building control updates		
Flood Management Type: Property Modification (ID: PM01)	**Responsibility: Council**	
Type of flood Risk: Catchment Flooding	**Associated Costs:**	**Initial Cost:** $25,000
MCA Ranking: #3		**Recurrent Cost:** 0
Overview: Council's existing land use planning and building controls were reviewed in the FRMS. As an outcome of this review a series of recommendations have been made to assist Council in achieving best practice flood planning in the Merimbula and Back Lake catchments and across the LGA.		

Flood Planning Recommendations		
Issue		**Recommendation**
1	Under the SEPP (Exempt and Complying Development Codes) 2008, complying development cannot be undertaken on land defined as: • Flood storage • Floodway • Flow path	Consideration of Flood Planning Constraint Categories (FPCC) may assist with reducing ambiguity relating to where complying development can or cannot be undertaken. FPCC analysis is undertaken in Section 6.4 can be used to inform the application of complying development.

Land use planning and building control updates		
	• High Hazard • High risk. Whilst flood storage and floodways are clearly defined in the analysis of Flood Function (Section 8.3), flood hazard is not specifically defined as "high" or "low", instead is provided across 6 hazard categories that link hazard to consequence (Section 8.2). Additionally, areas that are "high risk" are not specifically set out and mapped and would require interpretation of the study outputs.	It is considered reasonable that complying development is permitted in FPCC 3 and 4. This approach excludes development within the following areas from complying development: • Flood storage for the 1% AEP event, • Floodway in all events up to and including the PMF event, • H5 Hazard classification for the 1% AEP event, • H6 Hazard classification for all events up to and including the PMF event, and Isolated areas in events up to the PMF event.
2	The LEP requires proposed development to consider the impacts of climate change on flooding (Clause 6.3(b)). However, the definition of the FPL does not give consideration to climate change.	The LEP be updated to provide the ability to include climate change in the definition of Flood Planning Levels. This may consist of an additional clause under 6.3. This is consistent with the recommendations made in *Bega River and Brogo River FRMP (Cardno, 2017)*.
3	Clause 6.3(2) identifies that the flood planning clause applies only to land at or below the FPL (1%+0.5m). The *Bega River and Brogo River FRMP (Cardno, 2017)* recommends that sub clause 6.3 (2) be amended to apply to all flood prone land (i.e. all land at or below the PMF) and land mapped in the FRMS as being high flood island, rather than just land at or below the flood planning level.	The LEP be updated to identify that the flood planning clause applies to: • The flood planning area mapped in the relevant Flood Study or Floodplain Risk Management Plan; or • Land at or below the Flood Planning Level. This provides Council with the flexibility to identify within each catchment the appropriate design flood upon which to base the FPL, an appropriate freeboard and whether climate change should be incorporated. It is not recommended that the FPA mapping is included in the LEP. It is noted that the recommendation in Cardno (2017) to include all land below the PMF and high flood island areas would require 'exceptional circumstances' to be sought under PS 07-003. Based on the flood risk, the FPA and the PMF within the Merimbula and Back Lake study area, it is not considered necessary to apply 'exceptional circumstances' within the study area. The inclusion of flood planning provisions above the FPL (up to the PMF) has been considered in recommendation 4. It is also noted that PS-07-003 will be repealed once the *Draft Flood Prone Land Package* is adopted.
4	The LEP only provides for flood planning provisions below the FPL.	Within the study area there is only a small area outside the recommended FPA that falls within the

Land use planning and building control updates		
		PMF extent (see **Map G602**). However, this may not be the case in other floodplains within the LGA. The recommendations in the *Draft Flood Prone Land Package* seek to address flood planning outside of the FPA through the application of the Special Flood Considerations (SFC). The SFC seeks to control certain types of vulnerable and hazardous development within the floodplain in its entirety (i.e. potentially up to the extent of the Probable Maximum Flood).
5	Section 5.8.1 of the DCP 2013 provide flood related development controls for development below the FPL (see Section 5.8.1.2 of the DCP). However, no flood related development controls are provided for development above the FPL but below the PMF.	It is recommended that the DCP be updated to include appropriate flood related development controls to ensure the LEP objectives in recommendation 4 (above) are met. This is of relevance to the Merimbula Lake Study Area which has seniors living, caravan parks and an airport that can be impacted by flooding.
6	DCP 2013 does not provide specific controls relating to overland flow, with the exception of Section 2.6.1.2 that requires fencing not to obstruct overland flows.	A preliminary assessment of overland flow has been undertaken for the urban areas of Merimbula (see **Section 7.4**). It is recommended that Council consider the results of the overland flow assessment when assessing proposed development within the affected flow paths. The key objective should be keeping overland flow paths free of obstructions. It is recommended that the DCP be amended to incorporate controls to achieve this objective.
7	Defining the Flood Planning Level for the study area.	It is recommended that the FPLs proposed in the Flood Study (Cardno, 2017) be adopted for mainstream flooding: • For re-development of existing residential properties, FPLs should be set at the 1% AEP plus freeboard of 0.5 m; • For major re-developments of existing residential properties and new residential developments, FPLs should be set at the 1% AEP plus a freeboard of 0.5 m, taking into account climate change as appropriate to the design life of the development; • FPLs for development of new critical infrastructure, or re-development of existing critical infrastructure be set at the PMF; and • FPLs for new vulnerable developments be set at the PMF, unless the proponent can demonstrate evacuation via rising road egress route is possible within the effective

Land use planning and building control updates		
		warning time, in which case the FPL can be set at the 0.2% AEP plus a freeboard of 0.5 m. These are consistent with the recommendations made in the *Bega River and Brogo River FRMP*.
8	Defining the Flood Planning Area for the study area.	It is recommended that the FPA for mainstream flooding be defined as the land below the 1% AEP flood event (based on 0.9m sea level rise) plus a freeboard of 0.5m.

4 Implementation Program

The actions listed in **Table 4-1** are recommended for implementation as an outcome of the NSW Government Floodplain Risk Management Process. In order to achieve the implementation of relevant management actions, a program of implementation has been development.

Table 4-1 provides the following information relevant to the implantation of the management actions:

- An estimate of capital and recurrent costs for each action (this may, in some cases, include existing staff and funding)
- The agency or organisation likely to be responsible for the action
- The timeline for implementation (immediate or staged) and priority for implementation (high, medium or low).

The following provides further detail on the implementation timelines:

- Immediate – this indicates actions that could be implemented in the short term if funding and resourcing permits. Feasibility of the action is generally high and additional investigations or further development of the management strategy would be minimal. Short term would be considered to be from immediately (for options such as information transfer to the SES) through to 1 or 2 years.
- Staged – this indicates actions that could be undertaken in the short to medium term. However, additional investigations, feasibility studies or further development of the management strategy are likely to be required. Where appropriate, interim policy and planning measures could be employed in the intervening time. Medium term would be considered to be within the lifetime of the Plan (around 5 years) and before the study is revisited.

The following provides further detail on the priorities:

- **High priority:**
  - Require relatively low implementation effort and cost.
  - Achieved a high rank in the MCA (rank higher than 7).
- **Medium Priority:**
  - Achieved a medium score in the MCA (rank higher than 15).

Table 4-1 Implementation Action List

Option ID	Recommended Action	Indicative Costs		Potential Funding Sources/Responsibilities	Implementation Time Frame	Priority	Performance Measures
		Capital Cost	Recurrent Cost				
E3	Review of Back Lake Entrance Management Policy	$75,000	$0	**Council / DPIE**	Staged	Medium	Documented review of Back Lake Entrance Policy is completed.
EM-1	Emergency response for Acacia Ponds	*Private Property*		**Private**	Immediate	High	Emergency Response Plan is prepared.
EM-2	Emergency Response Plan for Sapphire Coast Caravan Park	*Private Property*		**Private**	Immediate	High	Emergency Response Plan is prepared.
EM-3	Flood Warning System	$25,000	$1,500	**Council / DPIE**	Immediate	High	Documented development of flood warning systems is completed.
EM-4 and PM-2	Flood Education (including information on flood proofing properties)	$50,000	$2,500	**Council / SES**	Staged	High	Flood education program is undertaken and documented.
EM-6	Information Transfer	$2,500	$0	**Council / SES**	Immediate	High	Relevant flood data developed as part of the FRMS is successfully transferred to SES and via the Flood Portal Database
RI-1-a	Raising of Fishpen Road	$855,400	$5,000	**Council / DPIE**	Staged	Medium	Road raising works are completed.
RI-3	Raising of access road to Acacia Ponds Village	*Private Property*		**Private**	Staged	Medium	Road raising works are completed.
RI-5	Green Point Road Raising and Culvert Augmentation	$676,200	$5,000	**Crown Lands (DPIE)**	Staged	Medium	Road raising and culvert augmentation works are completed.
RI-7	Millingandi Road Raising and Culvert Augmentation	$861,700	$5,000	**Council**	Staged	Medium	Road raising and culvert augmentation works are completed.
RI-8	Arthur Kaine Drive Road Raising	$1,232,700	$5,000	**RMS**	Staged	Medium	Road raising works are completed.
RI-9	Market Street Road Raising	$646,450	$5,000	**Council**	Staged	Medium	Road raising works are completed.
PM-1	Land use planning and building control updates	$25,000	$0	**Council**	Immediate	High	Land Use Planning documents are updated.

5 Conclusions

This FRMP provides a practical framework and implementation plan for managing existing, future and continuing flood risk within the study area.

Overall, it is considered that existing risks to the Merimbula Lake and Back Lake floodplains can be managed appropriately through the implementation of development controls, emergency response measures and selected ground works. The effective implementation of development controls will be of key importance in reducing the damages and risk to life associated with flooding into the future through the construction of flood compatible buildings and assets. While improving emergency response through flood free access, and improved community awareness of flooding, is critical to reducing the risks associated with flooding in the study area.

The steps in progressing the floodplain risk management process from this point onwards are:

- Council will adopt the final Plan and submit applications for funding assistance to relevant State and Commonwealth agencies, as appropriate.
- The flood management actions will be prioritised for funding through the Integrated Planning and Reporting Process.
- As funds become available from DPIE, the Commonwealth, other state government agencies and/or from Council's own resources, recommended management actions will be implemented in accordance with the established priorities.

This FRMP fulfils its objectives accordance with the New South Wales (NSW) Flood Prone Land Policy (NSW Government, 2001) and the principles of the Floodplain Development Manual (NSW Government, 2005).

6 References

AIDR (2017) Australian Emergency Management Handbook 7: Managing the floodplain: best practice in flood risk management in Australia (AEM Handbook 7)

Bega Valley Shire Council (2016) Back Lake Entrance Management Policy

Cardno (2017) Merimbula Lake and Back Lake Flood Study

Cardno (2018) Bega and Brogo Rivers Floodplain Risk Management Study and Plan

DECC (2007) Practical Consideration of Climate Change

NSW Government (2005) Floodplain Development Manual

NSW Government (2009) Sea Level Rise Policy Statement (now repealed)

NSW Planning & Infrastructure (2013) The NSW Planning System and the Building Code of Australia 2013: Construction of Buildings in Flood Hazard Areas

Queensland Government (1983) ANUFLOOD: Flood Damages Estimation Program, developed by the Centre for Resource and Environmental Studies at the Australian National University for the Queensland Government

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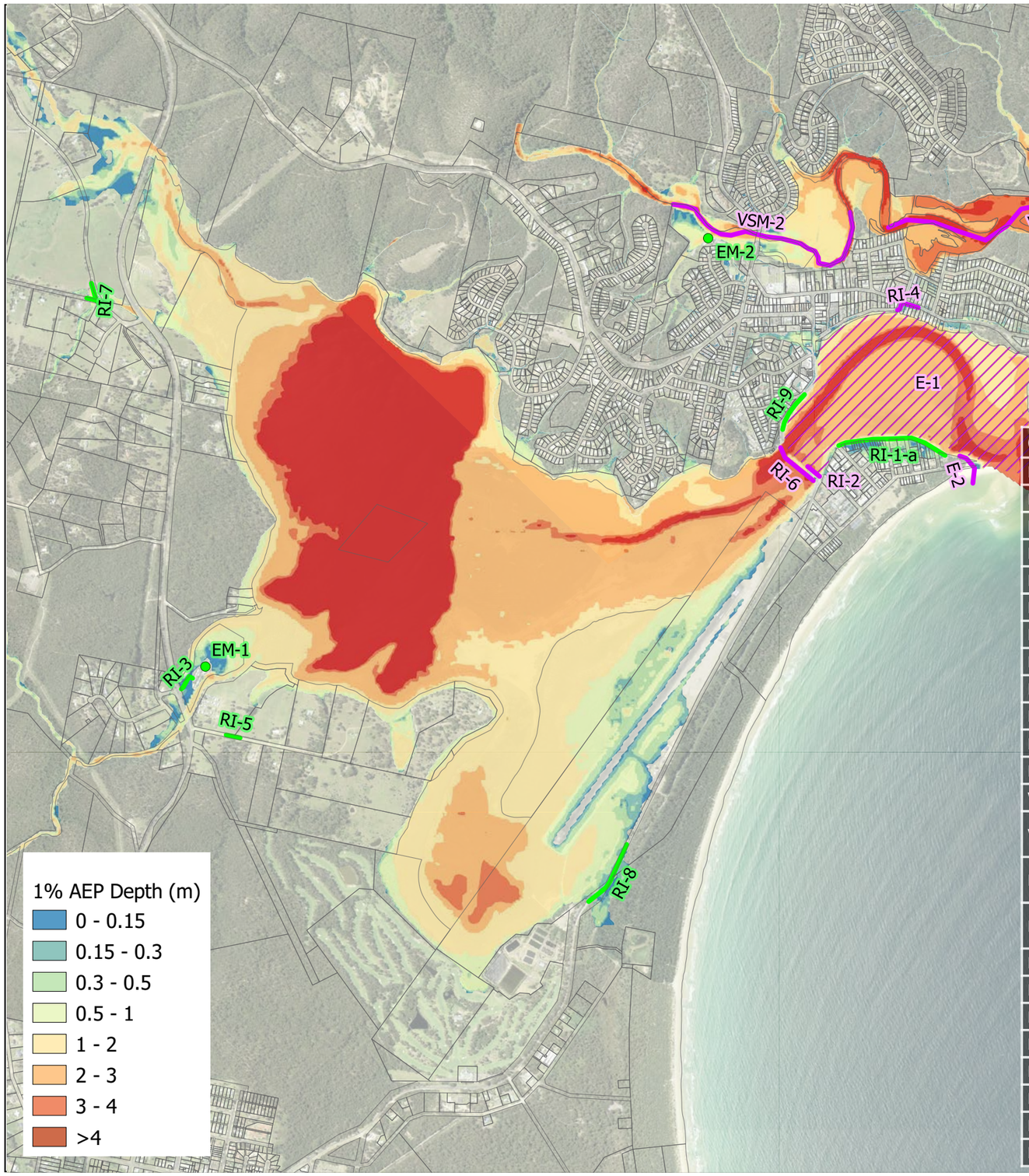
MAPS



Option ID	Name	Recommendation
RI-1-a	Raising of Fishpen Road by 0.4m (5% AEP immunity)	Recommended
RI-1-b	Raising of Fishpen Road by 0.5m (2% AEP immunity)	Not Recommended
RI-1-c	Raising of Fishpen Road by 0.6m (1% AEP immunity)	Not Recommended
RI-1-d	Raising of Fishpen Road by 0.2m (10% AEP immunity)	Not Recommended
RI-2	Provision of second bridge (or opening) on Market Street causeway.	Not Recommended
RI-3	Raising of access road to Acacia Ponds Village	Recommended
RI-4	Raising of footpath at Main St - Beach St intersection (raised 0.2m to achieve 1% AEP level)	Not Recommended
RI-5	Green Point Road Raising and Culvert Augmentation	Recommended
RI-6	Replace the causeway with an open span bridge	Not Recommended
RI-7	Millingandi Road Raising and Culvert Augmentation	Recommended
RI-8	Arthur Kaine Drive Road Raising	Recommended
RI-9	Market Street Road Raising	Recommended
VSM-1	Removal of sediment from within Merimbula Creek	Not Recommended
VSM-2	Vegetation management along Merimbula Creek (between Sapphire Valley Caravan Park and Munn Street)	Not Recommended
E-1	Wide scale dredging across Merimbula Lake entrance - reduce bed levels by 0.5m across whole area downstream of Market Street Bridge.	Not Recommended
E-2	Permanently open the entrance of Merimbula Lake (e.g. training wall along western side of channel)	Not Recommended
E-3	Review of Back Lack Entrance Management Policy	Recommended
EM-1	Emergency response for Acacia Ponds	Recommended
EM-2	Emergency Response Plan for Sapphire Coast Caravan Park	Recommended
EM-3	Flood Warning System (No location associated with option)	Recommended
EM-4	Flood Education (No location associated with option)	Recommended
EM-6	Information Transfer (No location associated with option)	Recommended
PM-1	Land use planning and building control updates (No location associated with option)	Recommended
PM-2	Flood proofing guidelines (No location associated with option)	Recommended

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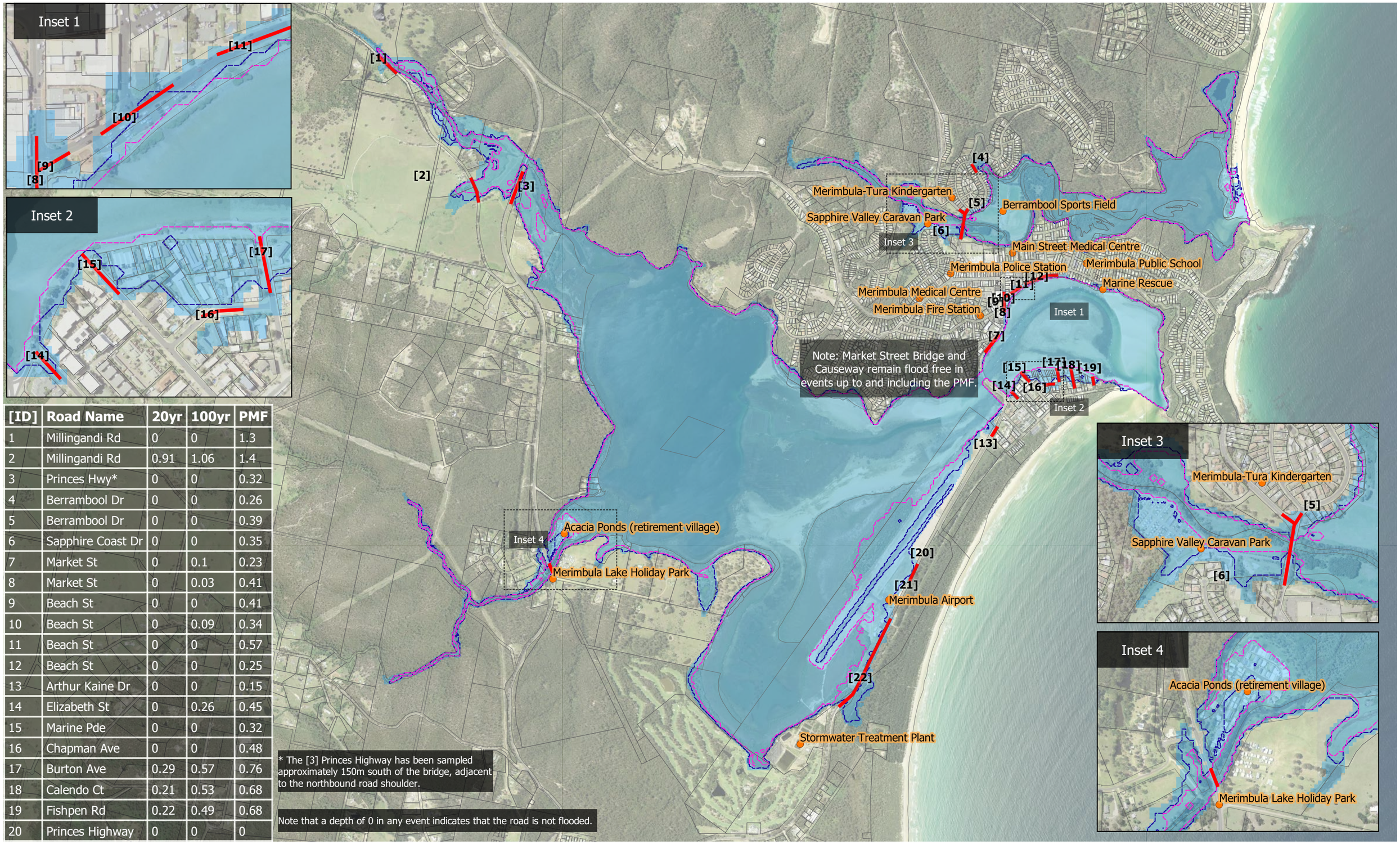
Scale : 1:25000@A3
Date : 10 December 2020
Revision : D
Created by : LRE
Coordinate System : MGA94 Z55

0 250 500 750 1000 m

Flood Risk Management Options
Recommended
Recommended
Not Recommended
Not Recommended

N
W E
S

Map G901
Flood Risk Management Options



[ID]	Road Name	20yr	100yr	PMF
1	Millingandi Rd	0	0	1.3
2	Millingandi Rd	0.91	1.06	1.4
3	Princes Hwy*	0	0	0.32
4	Berrambool Dr	0	0	0.26
5	Berrambool Dr	0	0	0.39
6	Sapphire Coast Dr	0	0	0.35
7	Market St	0	0.1	0.23
8	Market St	0	0.03	0.41
9	Beach St	0	0	0.41
10	Beach St	0	0.09	0.34
11	Beach St	0	0	0.57
12	Beach St	0	0	0.25
13	Arthur Kaine Dr	0	0	0.15
14	Elizabeth St	0	0.26	0.45
15	Marine Pde	0	0	0.32
16	Chapman Ave	0	0	0.48
17	Burton Ave	0.29	0.57	0.76
18	Calendo Ct	0.21	0.53	0.68
19	Fishpen Rd	0.22	0.49	0.68
20	Princes Highway	0	0	0

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Scale : 1:10000@A3
Date : 02 September 2020
Revision : A
Created by : JS
Coordinate System : MGA 55

0 250 500 750 1000 m

Legend
- Cadastre
- Key Infrastructure
- Overtopped Roads (with ID)
- PMF (Probable Maximum Flood) Extent
- 1% AEP Extent
- 20% AEP Extent

N W E S

Map G902
Flood Impact on Transport and Infrastructure

Scale : 1:25000@A3
Date : 02 September 2020
Revision : A
Created by : JS
Coordinate System : MGA 55

0 250 500 750 1000 m

Legend

- Cadastre
- 1% AEP
- 1% AEP - 0.4m Sea Level Rise
- 1% AEP - 0.4m Sea Level Rise + 10% Increase in Rainfall
- 1% AEP - 0.9m Sea Level Rise
- 1% AEP - 0.9m Sea Level Rise + 30% Increase in Rainfall

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Map G903
Climate Change Scenarios

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APPENDIX A

Floodplain Risk Management Options Identified in the FRMS

Option ID	Option Description	Brief description	Primary Flood Issue addressed	Capital Cost	Recurrent Cost	Reduction in AAD	BCR	Multi-Criteria Assessment Rank	Recommendation of FRMP
RI-1-a	Raising of Fishpen Road by 0.4m (5% AEP immunity)	Raising of Fishpen Road by 0.4m, to guarantee flood immunity up to the 5% AEP flood event. A raised road would improve access during flood events, and also function as a flood wall to protect adjacent properties from lake inundation.	Access along Fishpen Road is lost before properties are inundated, create evacuation and emergency access issues. Adjacent properties are also flooded from elevated lake levels	$855,400	$5,000	$11,237	0.17	9	**Recommended**
RI-1-b	Raising of Fishpen Road by 0.5m (2% AEP immunity)	Raising of Fishpen Road by 0.5m, to guarantee flood immunity up to the 2% AEP flood event. A raised road would improve access during flood events, and also function as a flood wall to protect adjacent properties from lake inundation.	As per RI-1-a	$1,425,200	$10,000	$22,756	0.20	13	**Not Recommended** The construction costs of this option significantly outweigh the flood damage benefits.
RI-1-c	Raising of Fishpen Road by 0.6m (1% AEP immunity)	Raising of Fishpen Road by 0.2m, to guarantee flood immunity up to the 10% AEP flood event. A raised road would improve access during flood events, and also function as a flood wall to protect adjacent properties from lake inundation.	As per RI-1-a	$2,089,150	$15,000	$29,516	0.18	14	**Not Recommended** The construction costs of this option significantly outweigh the flood damage benefits.
RI-1-d	Raising of Fishpen Road by 0.2m (10% AEP immunity)	Raising of Fishpen Road by 0.6, to guarantee flood immunity up to the 1% AEP flood event. A raised road would improve access during flood events, and also function as a flood wall to protect adjacent properties from lake inundation.	As per RI-1-a	*The results of a preliminary assessment showed that this option would not deliver any benefits to flood behaviour. Therefore, this option has not been assessed further.*					**Not Recommended**
RI-2	Provision of second bridge (or opening) on Market Street causeway.	Provision of second bridge (or opening) on Market Street causeway. This would improve conveyance through the structure, with a possible reduction in peak levels upstream.	Community submission noted that the channel used to run adjacent to Fishpen Road. It was perceived that the relocation of the channel has resulted in a reduction in lake flushing.	*The results of a preliminary assessment showed that this option would not deliver any benefits to flood behaviour. Therefore, this option has not been assessed further.*					**Not Recommended**
RI-3	Raising of access road to Acacia Ponds Village	Raising of access road to Acacia Ponds Village. This would provide rising road access from the development up to and including the PMF	Development is currently isolated in the 1% AEP event, and a low flood island in the PMF	*Private Property*		N/A	N/A	8	**Recommended**
RI-4	Raising of footpath at Main St - Beach St intersection (raised 0.2m to achieve 1% AEP level)	The option proposes the construction of an earthern bund for approximately 100 metres between the gutter and the footpath along side Main Street to better contain overland flows within the road reserve. The raising would contain flows up to and including the 1% AEP within the road corridor and preventing overland flow through adjacent properties.	Overland flows currently breakout of the road reserve upstream of the intersection and flow through downstream properties to lake.	$142,450	$1,500	N/A	N/A	15	**Not Recommended** The benefits associated with this measure were found to be relatively low when compared to other options. Detailed information about this measure can be found in the FRMS, if Council wishes to implement it.
RI-5	Green Point Road Raising and Culvert Augmentation	It is proposed raising the roadway by 0.5 metres, which provides a 0.5 metre freeboard in the 1% AEP, and allows for some capacity to manage future increases in flow arising from climate change The option also includes three box culverts (1200mx600m) to convey the flow.	Residents have raised a concern with the crossing. The low point of the road cuts off all properties along Green Point Road. Residents noted that this can be for up to 6 hours.	$676,200	$5,000	N/A	N/A	10	**Recommended**

Option ID	Option Description	Brief description	Primary Flood Issue addressed	Capital Cost	Recurrent Cost	Reduction in AAD	BCR	Multi-Criteria Assessment Rank	Recommendation of FRMP
RI-6	Replace the causeway with an open span bridge	Replace the causeway with an open span bridge. This will Increase flushing of upstream regions, with a possible reduction in peak upstream levels.	Community observation has suggested that flushing has been reduced since the causeway has been constructed.	*The results of a preliminary assessment showed that this option would not deliver any benefits to flood behaviour. Therefore, this option has not been assessed further.*					**Not Recommended**
RI-7	Millingandi Road Raising and Culvert Augmentation	It is proposed raising the roadway by 1.1 metres, which provides a 0.5 metre freeboard in the 1% AEP, and allows for some capacity to manage future increases in flow arising from climate change The option also includes three box culverts (2400mx1500m) to convey the flow.	Local catchment flows upstream of Millangandi Road result in loss of access in 20% AEP and greater events, with depths of up to 0.45m occurring in the 1% AEP.	$861,700	$5,000	N/A	N/A	11	**Recommended**
RI-8	Arthur Kaine Drive Road Raising	Raising of Arthur Kaine Drive by 0.3m, to provide immunity in the 1% AEP event.	Access for Fishpen Road precinct and Merimbula Airport	$1,232,700	$5,000	N/A	N/A	15	**Recommended**
RI-9	Market Street Road Raising	Raising of Market Street between the bridge and Short Street by 0.15m, to provide immunity in the 1% AEP event.	Access for Fishpen Road precinct and Merimbula Airport	$646,450	$5000	N/A	N/A	12	**Recommended**
VSM-1	Removal of sediment from within Merimbula Creek	Removal of sediment from within Merimbula Creek. This may result in improved conveyance, and lower upstream flood levels.	Residents have noted a build up on sediment within the lower portion of Merimbula Creek and are concerned that it is impacting flood behaviour.	*The results of a preliminary assessment showed that this option would not deliver any benefits to flood behaviour. Therefore, this option has not been assessed further.*					**Not Recommended**
VSM-2	Vegetation management along Merimbula Creek (between Sapphire Valley Caravan Park and Munn Street)	Vegetation management along Merimbula Creek (between Sapphire Valley Caravan Park and Munn Street). This will increase conveyance and reduce channel and bridge blockages, reducing the flooding.	Dense riparian vegetation growth and fallen trees lying across the channel have been observed by residents to cause blockage during high flow events, causing road overtopping and flooding of overbank areas.	*The results of a preliminary assessment showed that this option would not deliver any benefits to flood behaviour. Therefore, this option has not been assessed further.*					**Not Recommended**
E-1	Wide scale dredging across Merimbula Lake entrance - reduce bed levels by 0.5m across whole area downstream of Market Street Bridge.	During a flood event, the whole mouth of the estuary is active flow. Targeted dredging (e.g. along the deeper channel) is unlikely to improve conveyance. This option aims to evaluate the impacts of large scale entrance conveyance increase.	The community has raised concerns about the impact of deposited sediments within the Merimbula Lake Entrance and the impact of these on flooding.	*The results of a preliminary assessment showed that this option would not deliver any benefits to flood behaviour. Therefore, this option has not been assessed further.*					**Not Recommended**
E-2	Permanently open the entrance of Merimbula Lake (e.g. training wall along western side of channel)	A training wall at the entrance may improve conveyance through the entrance during a flood event. This could allow catchment flows to drain into the ocean more effectively, or it may allow additional flow into the lake during a storm surge event.	The community has raised concerns about the impact of deposited sediments within the Merimbula Lake Entrance and the impact of these on flooding.	*The results of a preliminary assessment showed that this option would not deliver any benefits to flood behaviour. Therefore, this option has not been assessed further.*					**Not Recommended**
E-3	Review of Back Lack Entrance Management Policy	A reduced berm height and starting water levels would be reviewed to assess the impacts of changing the entrance management plan (i.e. reducing the trigger level).	Flooding during more frequent events appears to be driven by the water level at which the entrance is mechanically or naturally opened. The community have questioned the impact of the opening level on more significant flood events.	$75,000	$0	N/A	N/A	12	**Recommended**
EM-1	Emergency response for Acacia Ponds	It is recommended that the retirement village prepare a flood response plan. The plan would include key information on emergency response, such as: trigger flood levels, roles and responsibilities, meeting/accommodation locations and where to find supporting information.	The Acacia Ponds retirement complex was classified as a high hazard zone in the 1% AEP and the PMF, and a low flood island in the emergency response classification.	*Private Property*		N/A	N/A	2	**Recommended**
EM-2	Emergency Response Plan for Sapphire Coast Caravan Park	It is recommended that the Sapphire Coast Caravan Park prepare a flood response plan. The plan would include key information on	The Caravan park is significantly affected by flooding. The site is a high-risk area as it operates as a low flood island, losing access	*Private Property*		N/A	N/A	4	**Recommended**

Option ID	Option Description	Brief description	Primary Flood Issue addressed	Capital Cost	Recurrent Cost	Reduction in AAD	BCR	Multi-Criteria Assessment Rank	Recommendation of FRMP
		emergency response, such as: trigger flood levels, roles and responsibilities, meeting/accommodation locations and where to find supporting information.	along the driveway before the caravans themselves are inundated.						
EM-3	Flood Warning System	Development of a flood warning system to provide Council and the community with advance notice of potential flood events. The system could be based either on rainfall or lake levels	Currently there is not an official system in place to warn the local community of potential flood events.	$25,000	$1,500	N/A	N/A	1	**Recommended**
EM-4	Flood Education	Education program to promote flood awareness in the community	It cannot be assumed that all residents are sufficiently aware of the flood risk their properties are subjected to and of how respond in a flood emergency.	$50,000	$2,500	N/A	N/A	5	**Recommended**
EM-6	Information Transfer	The flood data developed as part of this study should be transferred to the SES for incorporation into their own flood intelligence database. This would be facilitated by the NSW Government Flood Data Portal	Currently there is not a procedure in place to guarantee the SES will have facilitated access to the flood risk information generated as part of the FRMS.	$2,500	$0	N/A	N/A	6	**Recommended**
PM-1	Land use planning and building control updates	Council's existing land use planning controls were reviewed as part of this study. As an outcome of this review a series of recommendations have been made to assist Council in achieving best practice flood planning in the Merimbula and Back Lake catchments	Issues identified in the existing planning and building controls that could potentially compromise floodplain risk management in the study area	$25,000	$0	N/A	N/A	3	**Recommended**
PM-2	Flood proofing guidelines	The NSW SES Business Flash Flood Tool Kit provides business with tools and information to assist in flood proofing their premises. The tool may also assist residential properties with flood proofing their property, however not all factors may be as relevant.	Significant damages due to over-floor flooding in commercial and residential properties	$20,000	$0	N/A	N/A	7	**Recommended** This measure was recommended in conjunction with option EM-4.
PM-3	Voluntary House Purchase	Properties in high flood hazard areas (areas with high flood depths and velocities) would be purchased to permanently remove flood risk people. The dwelling would then be removed (for relocation, if suitable) or demolished and the property would be back zoned to a more flood compatible land use, such as recreational park.	Properties subjected to high flood risk from Catchment flooding in Davistown and Empire Bay	*No properties qualify for a Voluntary House Purchase Program*					**Not Recommended** There are no residential dwellings located in 1% AEP high hazard flood locations (H4 – H6) within the study area. As such, VP is not considered a suitable property modification option for the Merimbula region.
PM-4	Voluntary House Raising	Under the NSW Floodplain Management Program, DPIE provides funding to assist home owners raise the floor level of their house to reduce the damages and trauma caused by flood water inundating their house.	Properties subjected to high flood risk from flooding in the Merimbula and Back Lake catchments	*The results of a preliminary assessment showed that this option would be economically advantageous. Therefore, this option has not been assessed further.*					**Not Recommended** It was found that it would not be economically advantageous to raise the floor levels of existing dwellings for the purpose of floodplain management.

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