



GLENELG HOPKINS

REGIONAL FLOODPLAIN MANAGEMENT STRATEGY





*Photo: Treloar Roses, Bolwara, August 2013
Source: Linda Jemmett*

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*Cover Photo (top): Major flooding of Skipton township as seen from the air, 15 January 2011
Source: Corangamite Shire Council*

*Cover Photo (bottom): Casterton in Flood, 1906.
Source: J. T. Sommerville*

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Executive Summary

About the Strategy

The Glenelg Hopkins Regional Floodplain Management Strategy (RFMS) builds on the extensive work that has been undertaken over the past decade to improve management and reduce flood risks across the region.

Glenelg Hopkins Catchment Management Authority (GHCMA) led the development of the strategy in collaboration with Local Government Authorities (LGAs), the Victoria State Emergency Service (VICSES), Traditional Owners, other agency partners and the community.

This strategy interprets and applies the policies, actions and accountabilities of the Victorian Floodplain Management Strategy (VFMS) in managing flood risks at the regional and local level. It provides a single regional planning document for floodplain management and a high-level list of regional priorities to guide future investment.

The primary role of the RFMS is to assist agencies that have floodplain management and flood emergency management functions to align their priorities and maximise community benefits with available funding. Regional strategies represent future business cases for investment by government in floodplain management. The new regional strategies replace the previous regional strategies prepared by CMAs between 1998 and 2001.

Flooding in the Glenelg Hopkins Region

Floods are natural and inevitable events. Fortunately, the location, the scale of effects and the probability of occurrence can be estimated with reasonable accuracy for a range of floods events.

There is a history of flooding along the Glenelg, Hopkins and Merri Rivers, and flash flooding has occurred in urban centres, most recently in Coleraine in 2016. The most significant regional floods on record occurred in 1946, when major flooding occurred within the Portland Coast basin, and to a lesser degree in the lower Glenelg and Hopkins basins, significantly impacting the communities of Portland, Port Fairy and Warrnambool.

Compared with some other areas of Victoria, flooding in the Glenelg Hopkins region happens relatively quickly, with most floods draining from the top of the catchment to the estuaries within a week.

Floods can sometimes result in significant economic and social consequences for towns and communities and can impact key agricultural areas located on floodplains. Based on the detailed damages assessment undertaken as part of local flood investigations, total damages for the ten regional towns subject to the highest flood risk (with at least a 1% chance per year) has been estimated at over \$25 million. A key future challenge will be to ensure the protection of life and property, while allowing rivers to maintain their natural flooding processes.

Development Approach

The RFMS was developed in accordance with guidelines from the Department of Environment, Land, Water and Planning (DELWP). These guidelines are aligned with the principles of the National Emergency Risk Assessment Guidelines and outline consistent methods for assessing flood risks and determining community tolerance for such risks.

The development process involved undertaking an assessment of flood risks across the region, assessing and ranking these risks, then determining how well the existing planning schemes, flood mitigation infrastructure, Municipal Flood Emergency Plans and flood warning arrangements are aligned with the flood risk ranking for each management unit. This process informed the establishment of regional floodplain management priorities.

Community and Stakeholder Consultation Process

The development of this strategy involved an extensive community consultation process. Public consultation sessions were held at 10 locations at Harrow, Casterton, Heywood, Hamilton, Port Fairy, Warrnambool, Ararat, Beaufort, Skipton and Miners Rest. In addition, more than 2000 letters advising residents how they could be involved in the development of the strategy were sent out in areas at risk of flooding.

Many lessons arose from the major regional floods of 2016 and 2010 – 11. The community consultation process provided the opportunity to draw on community knowledge relating to these and other flood events that have occurred across the region.

Consultation was also undertaken with Traditional Owners across the region, and workshops were held with LGAs including Ararat Rural City Council, Ballarat City Council, Corangamite Shire Council, Glenelg Shire Council, Moyne Shire Council, Pyrenees Shire Council, Southern Grampians Shire Council, Warrnambool City Council, and West Wimmera Shire Council.

A steering committee was established to oversee the development of the project with representation from VICSES, LGAs, Glenelg Hopkins CMA and the Glenelg Hopkins Community Advisory Group.

Local knowledge is critical to understanding flood behaviour and options for flood mitigation. Communities know their area best, and input from the community during the consultation process was integral to understanding flood behaviour and local options for flood mitigation.

The Strategy for Floodplain Management in the Glenelg Hopkins Region

Vision and Objectives

This strategy sets out the following vision for floodplain management in the Glenelg Hopkins region:

To create an environment where communities, businesses and government are aware, prepared and resilient to flooding. Flood risks are well understood, and managed appropriately.

Four objectives and a series of supporting actions have been established to deliver the vision. The four objectives of the strategy are as follows:

1. Communities are encouraged to act responsibly to manage their own risks.
2. Flood risks are reduced through improved flood intelligence and mitigation.
3. Not making things worse.
4. Emergency agencies are provided with the support to manage flooding.

Preferred management actions have been identified following consideration of the results of a regional risk assessment process, and stakeholder and community consultation. Priority has been given to measures that do most to narrow the difference between existing flood risks, and the community's willingness to accept these risks.

The strategy recognises that identified priority actions may not align with existing planning and funding cycles of delivery agencies. Strategic actions that can be delivered using current available resources or under the cost-sharing principles outlined in the VFMS during the initial three years of the strategy have been identified in a regional work plan. The regional work plan will be updated annually.

Key Areas of Focus

The RFMS seeks to aid continual improvement in how flood risks are managed and reduced across the region. It builds on the extensive work that has been undertaken regionally to increase the provision of reliable flood information for settlements, incorporate flood controls into planning schemes, and develop and update Municipal Flood Emergency Plans.

Management actions relating to these priority areas will continue to be a focus of this strategy. Flood investigations for Ararat and Harrow have recently been completed, and incorporation of information from these studies into planning schemes and MFEPS has been identified as a priority.

Additional priorities include to:

- improve flooding information for the seven regional townships known to have a flood risk, but require improved flood information: Allansford, Cudgee, Chetwynd, Coleraine, Dartmoor, Dunkeld, Panmure and Raglan. Detailed flood studies are currently underway for Coleraine, Chetwynd and Cudgee
- complete regional flood investigations to inform regional transport planning, possible future agricultural uses and costs of flooding to industry through a damages assessment
- improve understanding of the impacts of coastal flooding under a changing climate and rising sea levels. Priority areas for investment in coastal inundation studies will be identified through the Port Fairy Local Coastal Hazard Assessment, Port Fairy Coastal and Structure Planning Project and the Barwon South West Regional Local Coastal Hazard Assessment
- increase Traditional Owner involvement in flood investigations, flood response and recovery arrangements, to improve understanding of cultural values within the floodplain
- provide emergency service agencies with high-quality information to inform flood response planning and flood warning
- investigate opportunities to improve flood warning, particularly for catchments subject to flash flooding.

PART 1 – STRATEGIC CONTEXT

Chapters

Relationship to the Victorian Floodplain Management Strategy
Policies and Strategies Influencing Flood Management
Purpose and Scope of Regional Floodplain Management Strategy
How was the Strategy Developed?
Consultation Process
Regional Overview
Exposure to Flooding
Cultural Significance of Floodplains for Traditional Owners
Climate Change
Working with the Environment to Hold and Slow Floodwater
Vision and Objectives for Floodplain Management within the Region
Review of Previous RFMS

Overview

Part 1 provides an overview of the relationship between the Victorian Floodplain Management Strategy and the Regional Floodplain Management Strategy.

The purpose and scope of the regional strategy are outlined and a description of the region and its exposure to flooding is provided.

This section also provides an overview of broad issues relating to floodplain management and the vision and supporting objectives for floodplain management within the region.

A review of the previous regional strategy and its achievements is also provided.

PART 2 – REGIONAL RISK ASSESSMENT

Chapters

Integrated Catchment Management Threats and Opportunities
Consideration of Stormwater Management Issues
Consideration of Rural Drainage Issues
Flood Risk for Coasts and Estuaries
Regional Risk Assessment Results
Stakeholder Engagement
Important Regional and Community Infrastructure

Overview

Part 2 presents the results of DELWP's Rapid Appraisal Methodology, and details the public consultation program.

The outcomes of stakeholder engagement are presented including the identification of community-identified risks and important regional and community infrastructure.

PART 3 – ANALYSING RISK TREATMENT SERVICE LEVELS

Chapters

Planning Scheme Controls
Structural Flood Mitigation Works and their Management Arrangements
Municipal Emergency Management Plans
Total Flood Warning System
Cultural Heritage Assessment and Protection
Vegetation

Overview

Part 3 provides a review of the existing risk treatments against defined Risk Treatment Service Levels for each of the listed themes. (e.g. Planning Scheme controls, Structural flood mitigation works and their management arrangements, Existing Significant Flood Mitigation Infrastructure, Municipal Emergency Management Plans, Total Flood Warning System, Cultural Heritage assessment and protection, and Vegetation).

PART 4 – DEVELOPMENT AND IMPROVEMENT PLAN

Chapters

Regional Risk Levels
Determining Preferred Management Actions
The Strategy for Floodplain Management in the Glenelg Hopkins Region

Overview

Part 4 provides a description of the method for determining regional priorities, a list of regional priorities, and the Regional Work Program.

PART 5 – MONITORING, EVALUATION, REVIEW AND IMPROVEMENT PLAN

Chapters

Program Logic	Evaluation
Assumptions	Reporting
MER stages	Improvement
Monitoring	Governance and Accountability

Overview

Part 5 outlines the plan for monitoring, evaluating, reviewing and improving the regional strategy and updating the Regional Work Program.

Part 1 – Strategic Context

Relationship to the Victorian Floodplain Management Strategy

The Victorian Floodplain Management Strategy¹ (VFMS) sets the direction for floodplain management in Victoria. The VFMS aligns with the Victorian Government's responses to the Victorian Floods Review and the Parliamentary inquiry into flood mitigation infrastructure. It also aligns with the broader emergency management framework set out in the Victorian Government's Emergency Management Act 2013 and helps integrate floodplain management with the Victorian Waterway Management Strategy 2013 and the Victorian Coastal Strategy 2014.

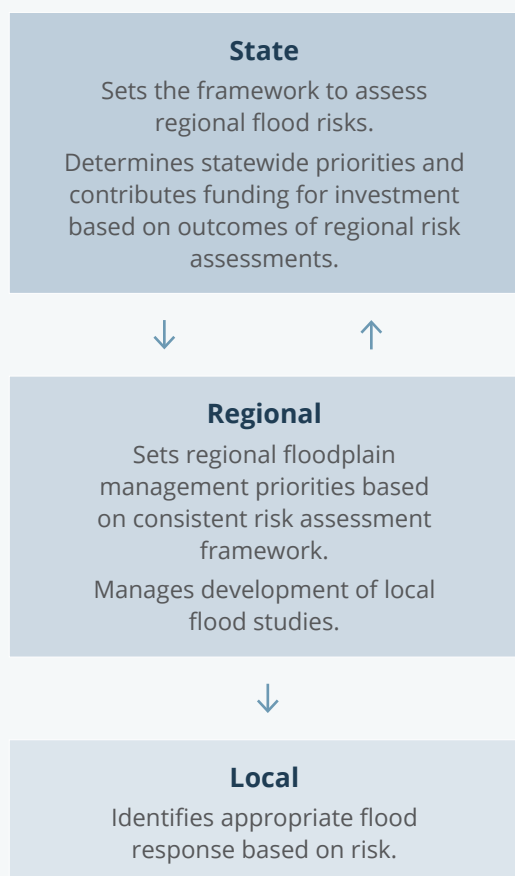
The Victorian Waterway Management Strategy² focuses on the management of rivers, their associated estuaries and floodplains (including floodplain wetlands) and non-riverine wetlands. It refers collectively to these systems as waterways.³ The VFMS focuses on flood prevention and mitigation activities aligned with water portfolio functions under the Water Act 1989 (Vic) and specifies how these activities will link with activities under other portfolios.⁴

The VFMS requires Catchment Management Authorities (CMAs) and Melbourne Water to develop and periodically review Regional Floodplain Management Strategies (RFMS) in partnership with Local Government Authorities (LGAs), the Victoria State Emergency Service (VICSES) and local communities. The intent of regional strategies is to interpret and apply the policies, actions and accountabilities of the VFMS at the regional and local level. They align the efforts of various agencies and communities to deliver the outcomes in the VFMS.

The primary function of regional floodplain management strategies will be to help all agencies with floodplain management and flood emergency management functions to align their priorities. Through this process, Victoria's statewide priorities for floodplain management investment can be determined.

The new regional floodplain management strategies will replace the previous regional strategies prepared by CMAs between 1998 and 2001. Regional floodplain management strategies are a key component of the risk assessment framework (Figure 1) outlined in the VFMS.

Figure 1:
State, Regional and Local
Risk Assessment Framework



Policies and strategies influencing floodplain management

This regional strategy sits within a framework of related policies and strategies as shown in Table 1. These policies and strategies work together to help prevent and manage flooding, and support response and recovery. Many organisations are involved in delivering these policies and strategies.



Photo: Alexanders Rd, Windemere,
1:10 pm, 14 January 2011
Source: Ballarat City Council

Table 1: Floodplain Management and Related Policies and Strategies

	Climate Change	Land and Infrastructure	Water and Waterways	Floodplain Management	Emergency Management	
	←	→	←	→	←	→
State	<ul style="list-style-type: none"> Victorian Climate Change Adaptation Plan 	<ul style="list-style-type: none"> Victorian Coastal Strategy Victoria Planning Provisions 	<ul style="list-style-type: none"> Victorian Waterway Management Strategy 	<ul style="list-style-type: none"> Victorian Floodplain Management Strategy 	<ul style="list-style-type: none"> Victorian Emergency Management Strategic Action Plan 	↑
Regional	<ul style="list-style-type: none"> Glenelg Hopkins Climate Change Strategy 	<ul style="list-style-type: none"> Great South Coast Regional Growth Plan South West Regional Coastal Plan 	<ul style="list-style-type: none"> Glenelg Hopkins Waterway Strategy 	<ul style="list-style-type: none"> Glenelg Hopkins Regional Floodplain Management Strategy 	<ul style="list-style-type: none"> South West Region Flood Emergency Plan 	↑
Local	<ul style="list-style-type: none"> Municipal climate change planning 	<ul style="list-style-type: none"> Municipal planning Policies Structure Plans Coastal Management Plans 	<ul style="list-style-type: none"> Municipal stormwater and drainage strategies 	<ul style="list-style-type: none"> Municipal Flood Management Plans Local flood investigations 	<ul style="list-style-type: none"> Municipal Flood Emergency Plans 	↓



Purpose and Scope of Regional Floodplain Management Strategy

The Glenelg Hopkins RFMS is the primary document for identifying floodplain management priorities within the Glenelg Hopkins region and provides the basis for assessing flood risk and setting regional priorities.

It provides a single, regional planning document for floodplain management and a high-level regional work program to guide future investment priorities within the Glenelg Hopkins region. The RFMS is the starting point for operationalising the policies, actions and accountabilities of the VFMS to manage local flood risks.

The main role of regional floodplain management strategies is to help all agencies with flood emergency management functions to align priorities. This process enables partner agencies to work together in identifying the potential to source and allocate the funds required to undertake priority actions over a three-year rolling implementation plan.

Regional strategies are not expected to cover:

- rural drainage matters
- stormwater management matters
- assessment of the impacts of insurance within the region.

How was the strategy developed?

This is the region's second regional floodplain management strategy. The Department of Environment, Land, Water and Planning (DELWP) has developed guidelines for the preparation and review of regional floodplain management strategies. These guidelines outline consistent methods for assessing flood risks and assessing the community's tolerance for these risks. This strategy has been developed to align with these guidelines. Development has also been guided by a series of RFMS development guidance notes that have been prepared by DELWP.

Glenelg Hopkins CMA has led the development of the RFMS in collaboration with local communities, LGAs, VICSES and other partner agencies.

The regional strategy processes started with an assessment of flood risks across the region. These risks were then assessed against the regional community's tolerance for these risks. Consultation sessions were held with stakeholders to identify potential structural and non-structural mitigation measures, and a prioritised list of actions was then developed. At the regional level, mitigation measures include flood investigations, improvements to flood warning and response arrangements, and floodplain management plans.

At the local level, where practicable, flood mitigation measures have been or will be investigated and assessed through detailed flood investigations. Local mitigation measures have included flood mitigation infrastructure, land use planning controls, and regular review and revision of Municipal Flood Emergency Plans. An overview of the RFMS within the context of the floodplain management strategic framework is provided in Figure 2.

The regional floodplain management strategy has prioritised the actions necessary to put preferred mitigation measures in place. Actions have been developed in consultation with stakeholders, and reflect community and agency priorities.

A steering committee was established to guide the development of the strategy and comprised representatives from the CMA, DELWP, LGAs, VICSES and the Glenelg Hopkins Community Advisory Group.



Photo: Albert St, Miners Rest,
11.50 am, 14 January 2011
Source: Ballarat City Council

Figure 2: RFMS Within the Context of the Floodplain Management Strategic Framework



Source: Victorian Floodplain Management Strategy

Consultation process

The strategy has been developed in consultation with regional floodplain management stakeholders. The Glenelg Hopkins Community Advisory Group was also consulted during the development of the strategy.

A series of open house sessions and workshops were held at several locations across the catchment to seek community input and feedback on various elements of the strategy. Details of the stakeholder consultation process are provided in Part 2.



Regional Overview

The Glenelg Hopkins region lies south of the Great Dividing Range in Victoria's south west. It covers approximately 26,910 square kilometres, extending from Ballarat in the east to the South Australian border in the west, and from the southern coast of Victoria to the townships of Harrow and Ararat in the north.

The region supports a permanent population of around 130,000 with year-round tourism adding significantly to this number. Major cities and towns include Warrnambool, Hamilton, Portland, Ballarat, Ararat, Casterton, Port Fairy and Beaufort. More than 33,000 of the region's residents reside in Warrnambool, and strong population growth is forecast for this area and Ballarat.

The Glenelg Hopkins region has a rich resource base that supports diverse and growing industries. The main economic drivers are agriculture, fisheries, retail, manufacturing, health and community services, education and construction. Agriculture, forestry and fishing are the major employers, providing nearly 25 per cent of total employment. Around 80 per cent of the region is used for agricultural production.

There are four main basins that occur within the region: Glenelg, Hopkins, Portland Coast and Millicent Coast (Figure 3). The boundaries of the region include marine and coastal waters out to the state limit of three nautical miles. The region is characterised by flat volcanic plains in the south, while the Grampians, Dundas Tablelands and Central Highlands are dominant in the north (Figure 4).

*Photo: Possum escaping the
Mount Emu Creek in flood,
Carngham – Streatham Rd
Bridge, Mt Emu, 13 August 2010
Source: Marcus Little, GHCA*

Figure 3: Basins of the Glenelg Hopkins Management Region

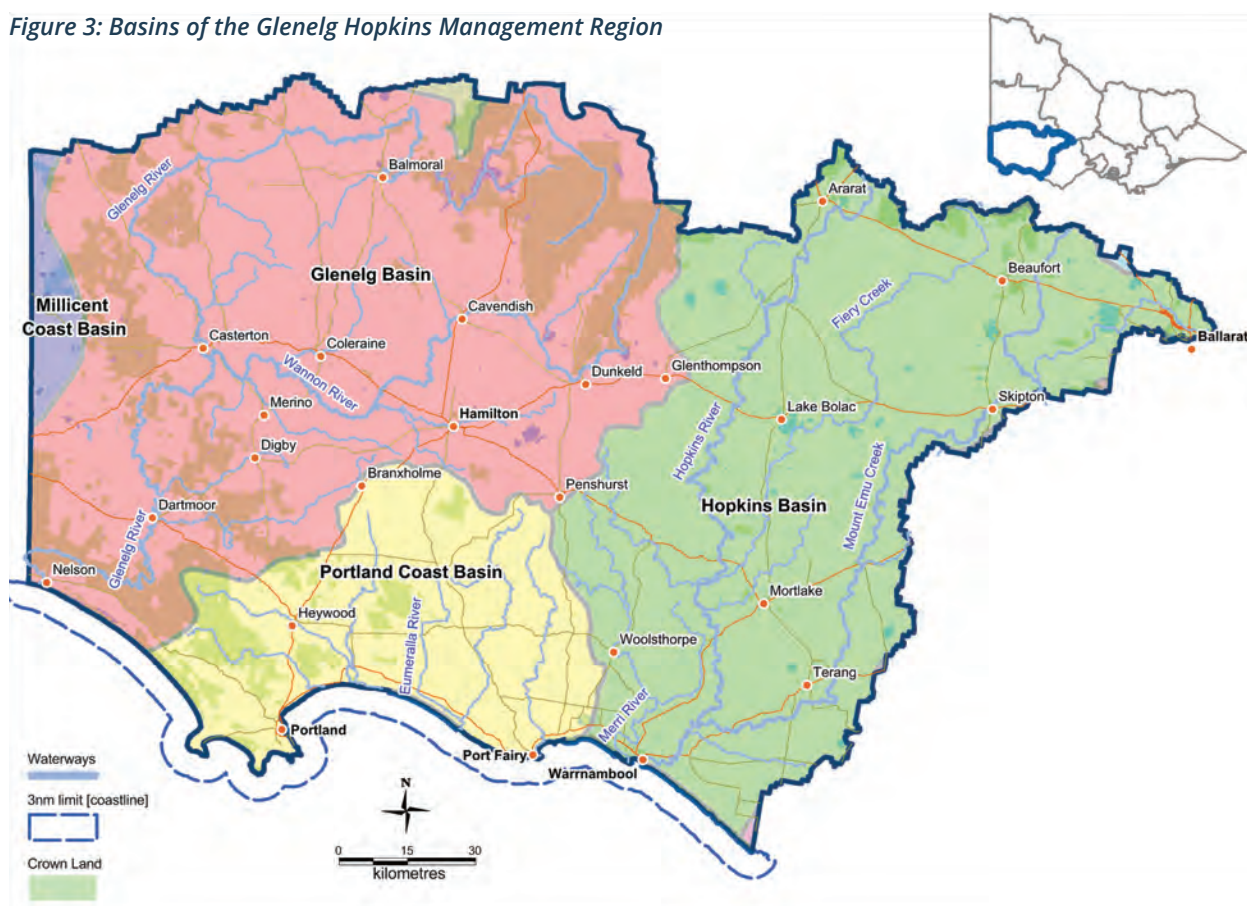
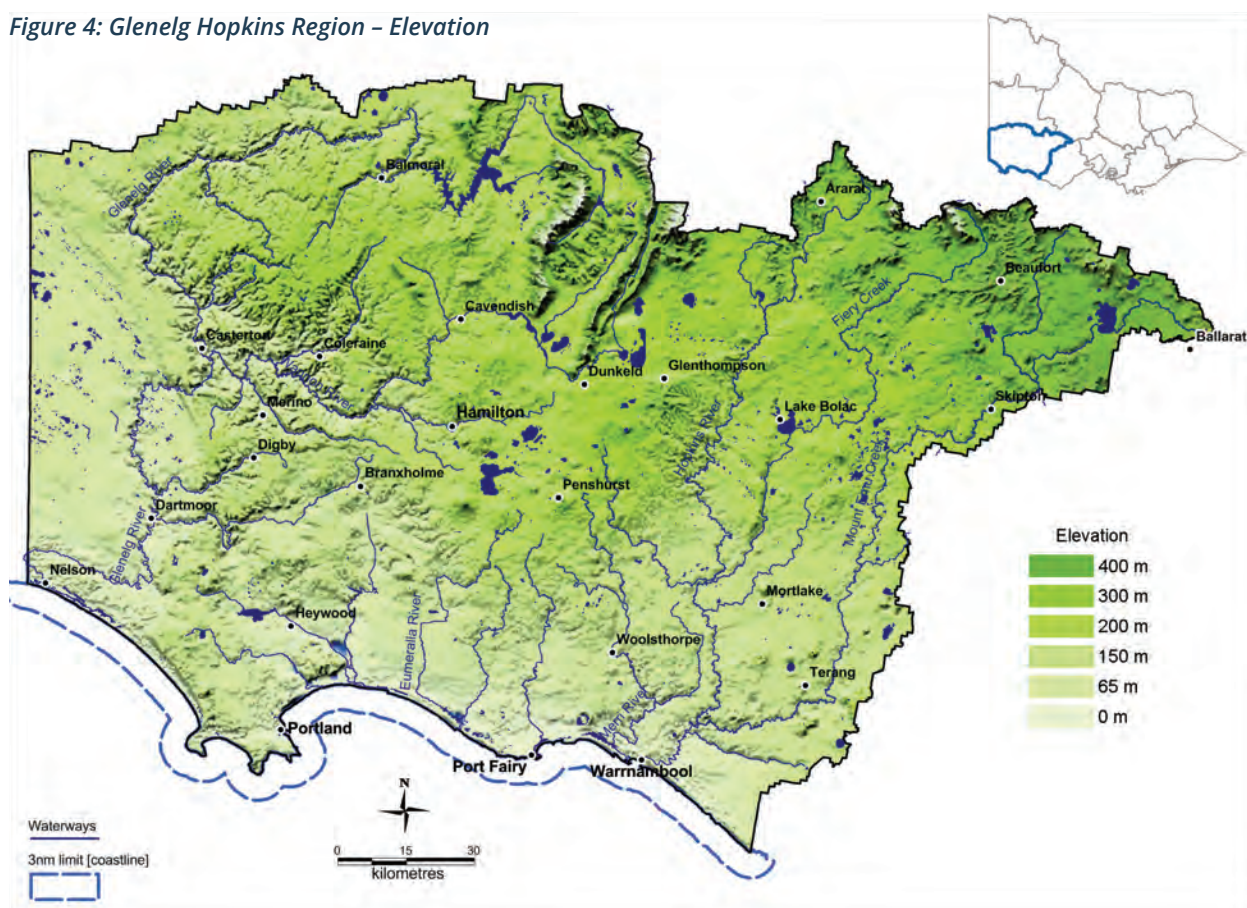


Figure 4: Glenelg Hopkins Region – Elevation





A summary of the main river systems that occur within the Glenelg, Hopkins and Portland Coast basins and their major tributaries is provided in Table 2. The Millicent Coast basin does not contain any major river systems within the Glenelg Hopkins catchment management region and consists of series of ephemeral wetlands and swamps over a flat expanse of land. There are no actions or priorities of the strategy located within the Millicent Coast basin.

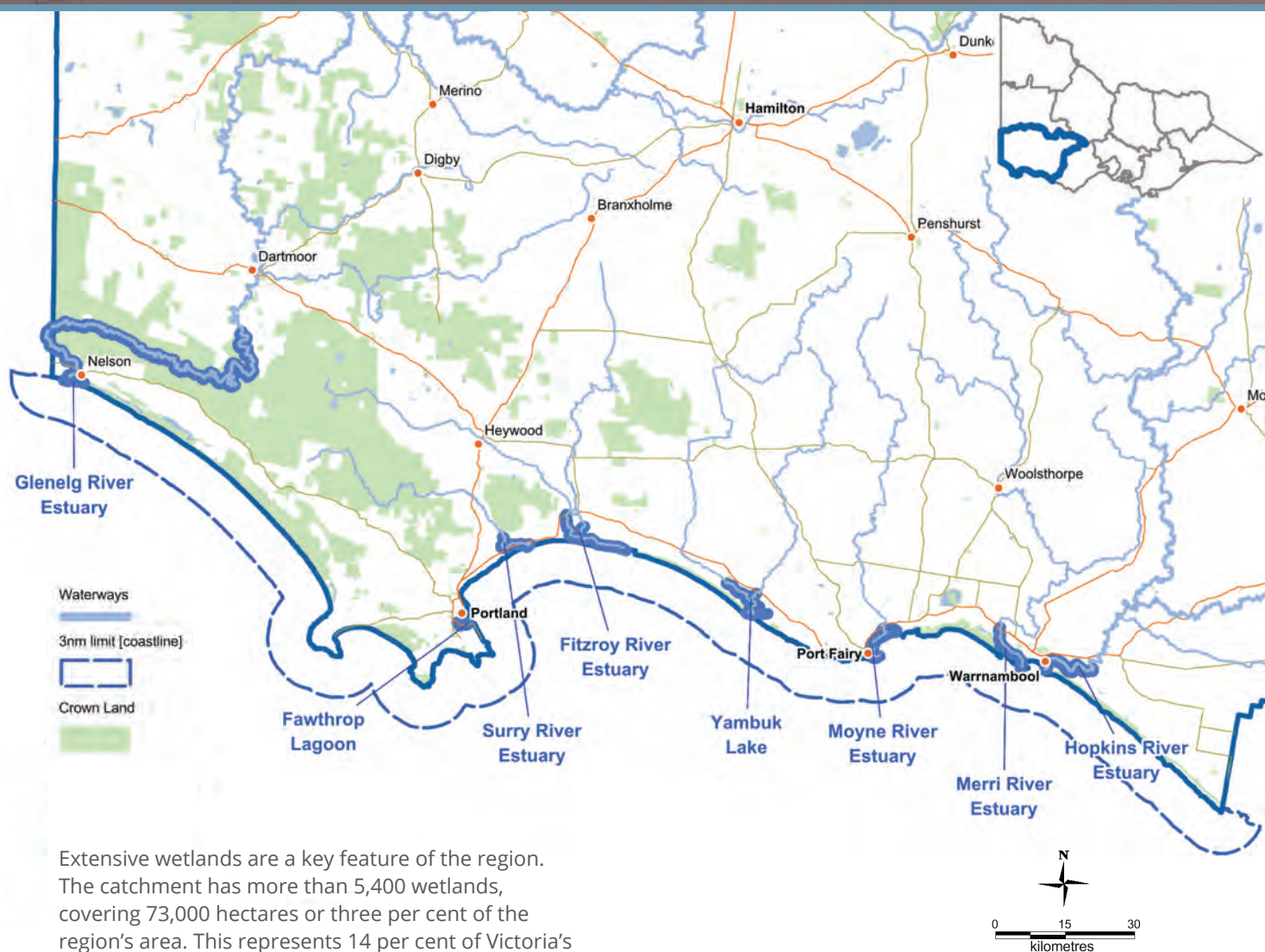
The Glenelg River is the largest river in south west Victoria. Significant tributaries of the Glenelg River include the Wannon, Chetwynd, Stokes, Crawford and Wando rivers. The four main catchments within the

Portland Coast basin are the Moyne River, Eumeralla–Shaw River system, Darlot Creek – Fitzroy River system and the Surry River. These are relatively short rivers, which drain the immediate inland areas and flow to the Southern Ocean.

The Hopkins River is a major waterway draining the eastern part of the region and enters the Southern Ocean at Warrnambool. The Fiery and Mt Emu creeks are other significant waterways within the Hopkins basin. The Merri River is also located within the Hopkins basin, although it does not connect to the Hopkins and has its own estuary.

Table 2: Main River Systems and Major Tributaries in the Glenelg Hopkins Region

Basin	Glenelg	Hopkins	Portland Coast
Main River Systems	<ul style="list-style-type: none"> • Glenelg River • Wannon River 	<ul style="list-style-type: none"> • Hopkins River • Mount Emu Creek 	<ul style="list-style-type: none"> • Wattle Hill Creek/ Fawthrop Lagoon • Surry River • Fitzroy River • Eumeralla River • Moyne River
Major tributaries	<ul style="list-style-type: none"> • Mathers Creek • Chetwynd River • Wando River • Bryan Creek • Konong Wootong Creek • Grange Burn • Stokes River • Crawford River 	<ul style="list-style-type: none"> • Burrumbeet Creek • Fiery Creek • Merri River • Spring Creek • Muston Creek • Deep Creek • Russell Creek 	<ul style="list-style-type: none"> • Darlot Creek • Shaw River • Back Creek • Drysdale Creek



Extensive wetlands are a key feature of the region. The catchment has more than 5,400 wetlands, covering 73,000 hectares or three per cent of the region's area. This represents 14 per cent of Victoria's total area of wetlands and 44 per cent of the state's total number of wetlands.⁵ Wetlands are integral to healthy ecosystems in the region's landscape, receiving runoff, absorbing and filtering floodwaters, and replenishing groundwater reserves.

Eight major estuaries occur in the Glenelg Hopkins region: Glenelg River Estuary, Fawthrop Lagoon, Surry River Estuary, Fitzroy River Estuary, Yambuk Lake, Moyne River Estuary, Merri River Estuary and the Hopkins River Estuary. Their location is shown in Figure 5.

Figure 5: Location of Major Estuaries in the Glenelg Hopkins Region

Exposure to Flooding

Floods are natural and inevitable events. Fortunately, the location, the scale of effects and the probability of occurrence can be estimated with reasonable accuracy for a range of floods events.

There is a history of flooding along the Glenelg, Hopkins and Merri Rivers, and flash flooding has occurred in urban centres, most recently in Coleraine in 2016. The most significant regional floods on record occurred in 1946, when major flooding occurred within the Portland Coast basin, and to a lesser degree in the lower Glenelg and Hopkins basins, significantly impacting the communities of Portland, Port Fairy and Warrnambool.

Compared with some other areas of Victoria, flooding in the Glenelg Hopkins region happens relatively quickly, with most floods draining from the top of the catchment to the estuaries within a week.

Floods can sometimes result in significant economic and social consequences for towns and communities and can impact key agricultural areas located on floodplains. Based on the detailed damages assessment undertaken as part of local flood

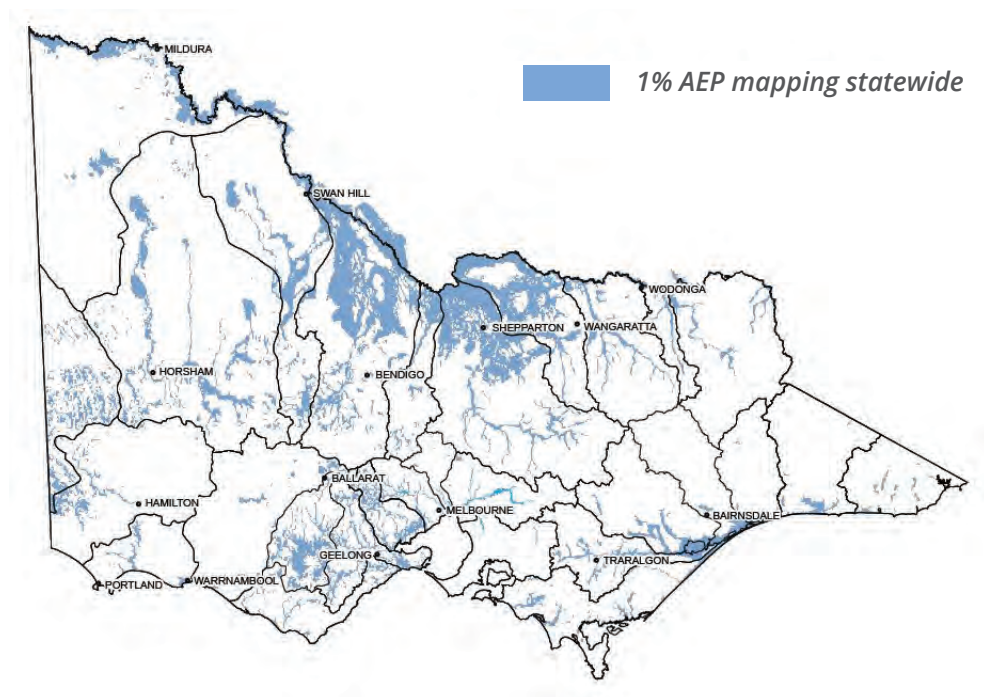
investigations, total damages for the ten regional towns subject to the highest flood risk (with at least a 1% Annual Exceedance Probability or a 1% chance of occurring in any year) has been estimated at over \$25 million. A key future challenge will be to ensure the protection of life and property, while allowing rivers to maintain their natural flooding processes.

Understanding flood behaviour enables the likely consequences of flooding to be assessed. It also enables an assessment of the benefits of different mitigation options for managing the community's exposure to flood risk.

During periods of prolonged heavy rainfall, storm surges or high tides, water levels along rivers rise, often causing inundation of the surrounding landscape. While flooding can become a serious problem for the community if not adequately managed, it is a natural process and is important for the maintenance of biological diversity.

Areas of the Glenelg Hopkins region and Victoria that are affected by significant riverine flooding based on current mapping are shown in Figure 6.

Figure 6: Proportion Of Victoria Affected By Significant Riverine Flooding Based On Current Mapping⁶



Flash flooding is typical of many catchments in the region where significant flooding occurs in 6 hours or less from the time of major rainfall.

The coastline of the Glenelg Hopkins region is subject to coastal erosion, sea level rise, storm surge, and coastal flooding. With a changing climate, these impacts will be exacerbated with increases in wind speed, storm and rainfall intensity and frequency.⁷ Approximately 220 km of coastline within the Glenelg Hopkins region is susceptible to coastal flooding.

The cities of Warrnambool and Portland, and the townships of Port Fairy and Narrawong have been historically affected by coastal flooding as a result of storm tides.

A timeline of the occurrence of major floods within the region is shown in Table 3. Anecdotally, the largest flood event to have occurred in the region was the 1870 flood; however, limited information is available to confirm this.

Table 3: Major Flood Events in the Glenelg Hopkins Region

Catchment	Largest recorded flood ⁱⁱ	Other notable floods
Glenelg Basin		
Glenelg River	March 1946	August 1909, September 1910, August 1983, August 1991, September 1992, July 1995, October 1996, September 2010, December 2010, January 2011, September 2016
Wannon River	January 2011	October 1923, March 1946, September 1960, September 2016
Bryan Creek	March 1946	October 1870, September 1893, September 1960, September 1975, September 1983, August 1991, September 2016
Hopkins Basin		
Hopkins River	January 2011	August 1909, October 1975, August 1983, October 1986, September 2016
Mount Emu Creek	January 2011	August 1909, August 1921, July 1923, August 1924, December 1933, September 2010
Burrumbeet Creek	January 2011	September 1993, September 1997, October 2000, September 2010
Fiery Creek	January 2011	November 1924, December 1933, September 2010, September 2016
Merri River	March 1946	August 1978, September 1983, September 1984, August 2001, August 2010
Portland Coast Basin		
Fitzroy River	March 1946	August 1951, August 1955, September 1960, October 1975, September 1983, November 2007, September 2010, October 2013
Moyne River	March 1946	August 1951, November 1953, August 1955, October 1976, August 1978, August 2001
Wattle Hill Creek/ Fawthrop Lagoon	March 1946	1954 (anecdotal evidence only), October 1992
Eumeralla River	March 1946	October 1976, August 1978, September 1983, September 1984

In 1946, between 16 and 18 March, south west Victoria experienced an average of 203 mm rainfall. This resulted in catastrophic flooding within the Portland Coast basin, and to a lesser degree in the lower Glenelg and Hopkins basins. It is estimated that within the cities of Portland, Port Fairy and Warrnambool, the flood reached a magnitude of 0.5% AEPⁱ or higher. Information and photographs are available to verify the extent of this flood.

In more recent years the region has been subject to widespread flooding during 2010, 2011 and 2016.

The region was impacted by a series of flood events from August to December 2010 which affected both the Glenelg and Hopkins basins, with minor flooding observed in the Portland Coast basin. Further rainfall in January 2011 resulted in widespread flooding which exceeded the 2010 flows in the Hopkins basin, but was less severe in the Glenelg basin.

A wet winter in 2016 primed the catchments for the flooding that occurred in September after heavy and intense rainfall. This flooding heavily affected the mid-Glenelg basin, particularly the town of Coleraine, which experienced a greater impact than that of the 2010 and 2011 floods. The 2016 flood also exceeded the 2010 and 2011 events at Casterton.

i. Based on streamgauge records where available.

ii. AEP refers to the Annual Exceedance Probability which is defined as the likelihood of occurrence (expressed as a percentage) of a flood of given size or larger occurring in any one year. A flood with a 1% AEP has a one in a hundred chance of occurring or being exceeded in any year. A flood with a 0.5% AEP has a one in two hundred chance of occurring or being exceeded in any year. May wish to make these consistent with the way these figures are written in text, but may prefer to leave them as is if this is a referenced definition etc.



*Photo: Dunkeld caravan park,
8:40 am, 14 January 2011
Source: Phil Perret*

Cultural Significance of Floodplains for Traditional Owners

Waterways and floodplain areas have always been important places for Aboriginal people to come together as families and communities for cultural, social and recreational activities. Access to floodplain areas is important for this to continue and for future generations of Aboriginal people to learn about and practice their culture.

Indigenous communities possess intimate knowledge of their local environments and have complex value systems in connection with water and biodiversity. This knowledge is integral to the holistic management of waterway health. Traditional ecological knowledge can help to improve contemporary natural resource management. In this way, it can also help to develop more resilient social-ecological systems. The Victorian Floodplain Management Strategy identifies the need to better engage with Aboriginal Communities. It also aligns with the policy direction set out in the Victorian Waterway Management Strategy⁸ which explicitly recognises the Aboriginal cultural values associated with waterways, and requires floodplain managers and other emergency management agencies to undertake activities in ways that recognise and respect Aboriginal cultural values.

The Aboriginal Heritage Register is a valuable resource; however, Traditional Owners have a much broader information base about Aboriginal cultural heritage than is currently available to government. Therefore, it is essential to consult with Traditional Owners in assessing and mapping flood risks.

The Victorian Floodplain Management Strategy⁹ recognises that floods and floodplain management activities can present risks to Aboriginal cultural heritage. Regional flood assessments, local flood studies and flood mitigation works must take into account significant places, sites and landscapes. Processes are needed to ensure that significant Aboriginal cultural values are considered as part of the incident control arrangements during emergency events. Aboriginal cultural heritage concerns will be integrated into the Prevention, Response, Recovery emergency management structure through the implementation of policy 23a and action 23a of the Victorian Floodplain Management Strategy as detailed below:

- Policy 23a: Emergency service agencies will work with Traditional Owners to help ensure Victoria's emergency management arrangements take into account the risks to Aboriginal cultural heritage. They will do this in ways that are consistent with the state strategic control priorities (which form the basis of the Incident Strategy and Incident Action Planning processes), which make explicit reference to cultural values.
- Action 23a: DELWP will work with the Emergency Management Commissioner and the Office of Aboriginal Affairs Victoria to develop a process for the involvement of Traditional Owner representatives during the management of flood emergencies to consider risks to Aboriginal cultural heritage.

Climate Change

Climate change is expected to have a significant impact on future flood events with projected decreases in annual rainfall and increases in storm frequency and intensity. There is limited information available on how climate change is expected to affect the spatial and temporal patterns of rainfall which lead to flooding.

The Glenelg Hopkins Climate Change Strategy¹⁰ presents the most recent projections for climate change for the Glenelg Hopkins region, which were prepared by CSIRO and the Australian Bureau of Meteorology in 2012–2014.

Projections were based on scenarios that calculate emissions growth through to the year 2100, compared with the 1986–2005 levels. Key projections for the region are listed below:¹¹

- average temperatures will continue to increase by 1.1–4.0 °C by 2030 in all scenarios
- more hot days and warm spells, and fewer frosts
- up to 15% less rainfall in the cool season by 2090, but changes to summer rainfall are less clear
- increased intensity of extreme daily rainfall events
- mean sea level will continue to rise between 0.39 and 0.89 m by 2090, and the height of extreme sea level events will also increase
- a harsher fire-weather climate
- natural climate variability will either enhance or mask long-term trends from year to year, particularly in the near future, and for rainfall.

The climate change strategy also identifies strategic initiatives and adaptation pathways for the management of floodplains and rivers under a changing climate.

The release of the 2016 Australian rainfall and runoff (ARR) guidelines¹² resulted in updated recommendations in relation to best practice climate change rainfall considerations within floodplain management. The ARR guidelines recommend that a 5% increase in rainfall (intensity or depth) is modelled for every projected degree of warming. It should be noted that this climate change factor applies to rainfall (intensity or depth) only and does not consider the impacts to the frequency of floods.

The 2014 Victorian Coastal Strategy (VCS) outlines the requirements for sea level rise planning within Victoria. Included in the VCS are policies relating to how flooding is expected to be impacted by projected sea level rise. The following actions are highlighted within the strategy.¹³

- In planning for possible sea level rise, an increase of 0.2 metres over current 1-in-100-year flood levels by 2040 may be used for new developments in close proximity to existing development (urban infill).
- For new greenfield development, outside of town boundaries, plan for not less than 0.8 metre sea level rise by 2100.

There are no current policies or guidelines in place to address the combined impacts of coastal flooding, storm surge and coastal erosion on floodplains.

Working With the Environment to Hold and Slow Floodwater

As outlined in the Victorian Floodplain Management Strategy¹⁴, wetlands on floodplains reduce the impacts of flooding by holding and slowing floodwater. The vegetation in and adjacent to waterways and in wetlands also acts as a sediment trap that filters nutrients from catchments and helps to protect the water quality of rivers, estuaries and marine areas. The benefits of storing (detaining) flood water upstream are demonstrated through the Fitzroy River/Darlot Creek & Heywood Regional Floodplain Mapping project completed by DEWLP in 2017. The flood modelling undertaken during this project indicated that Condah Swamp and Lake Condah wetland areas provide significant flood storage and slow the passage of floodwater downstream.

By aligning with both the Victorian Floodplain Management Strategy and the Victorian Waterway Management Strategy¹⁵ (VWMS), this strategy adopts the principle that waterways should, wherever possible, be allowed to flood naturally, maintaining connectivity to floodplains and associated wetlands. This strategy aims to integrate the management of flood risks with the protection of priority high-value waterways identified in the Glenelg Hopkins Waterway Strategy.¹⁶

Vision and Objectives for Floodplain Management Within the Region

The strategy's vision and objectives are described in Figure 7, along with expected outcomes. A list of priority management actions required to achieve the objectives has been developed as part of this strategy. Actions identified as being high priority, and as achievable with current resources, have been incorporated into a regional work plan.

Figure 7: Vision, Objectives and Expected Outcomes of the Regional Floodplain Management Strategy



Review of previous RFMS and progress against floodplain management objectives in the Regional Catchment Strategy

The management of floodplains within Victoria is conducted within an adaptive management framework. At the core of adaptive management is the ability to learn from previous experience and update management approaches to reflect knowledge gained during implementation.

As part of the development process for the current RFMS, a review of the previous RFMS was undertaken. The results of this review are summarised below. An overview of progress against the Glenelg Hopkins Regional Catchment Strategy (RCS) floodplain management objectives and associated management measures is provided in Appendix I.

Review of Previous RFMS

The previous Glenelg Hopkins Regional Floodplain Management Strategy was developed in 1999 and provided the basis for prioritisation of floodplain management actions within the region. Priorities in the 1999 RFMS were structured into six main action programs: asset management; local flood studies and floodplain management plans; statutory planning; emergency response and flood warning; information management; education, training and community awareness.

Since the regional strategy was developed, the majority of identified priority actions have been implemented, including:

- completion of approximately 85 per cent of identified local flood studies and floodplain management plans
- completion of 75 per cent of statutory planning actions, including planning scheme amendments.

A number of additional projects were identified and implemented over the life of the 1999 strategy, including:

- flood investigations in high-risk areas that were not previously identified such as Skipton, Wickliffe and Narrawong
- regional flood modelling of the Upper Glenelg River, and the Fitzroy and Darlot Creek floodplains
- the construction of mitigation works identified through flood investigations for North Warrnambool and Beaufort
- sea level rise mapping to align with current policies.

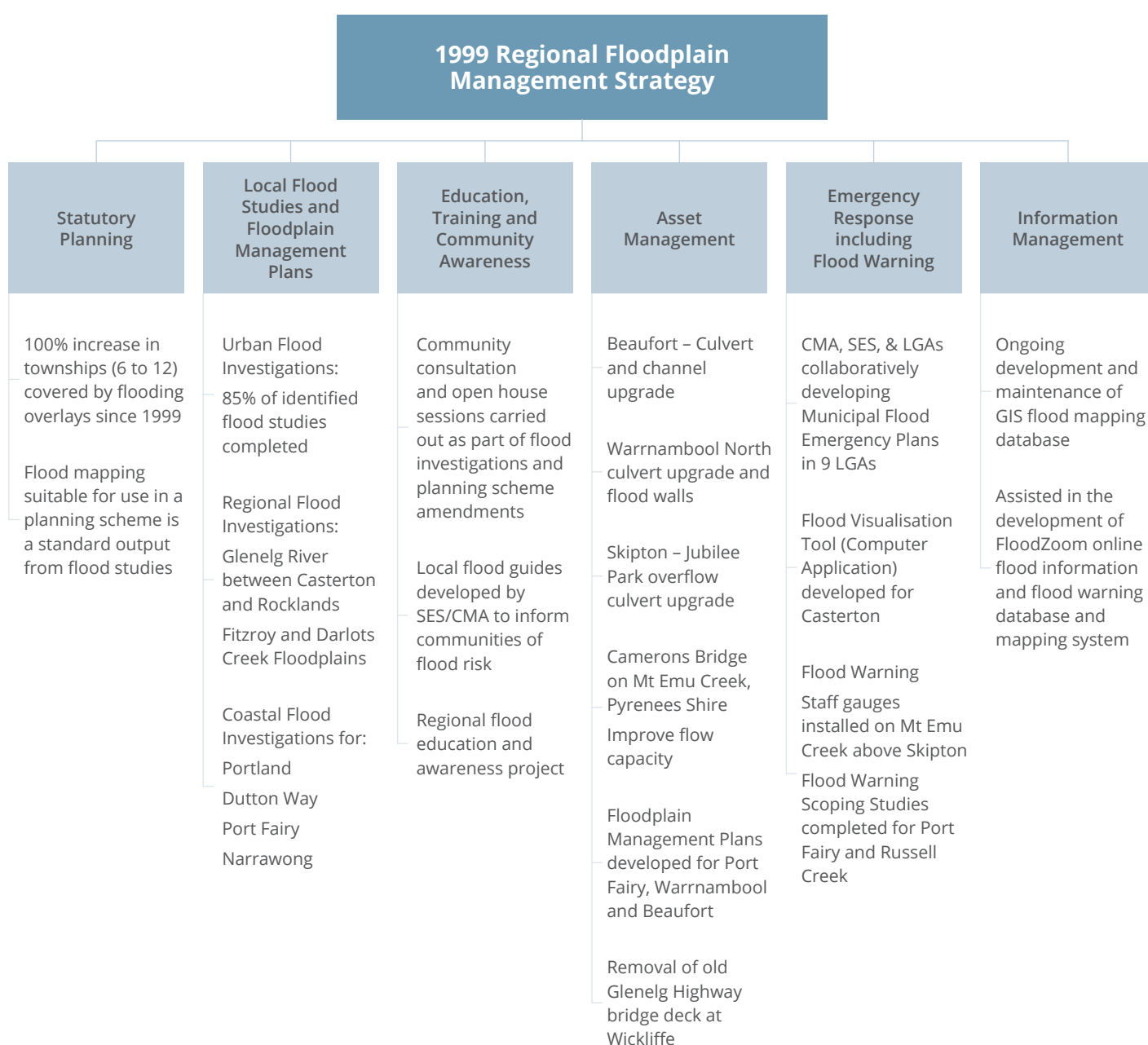
The completion of regional flood investigations was identified as an important element in progressing other floodplain management actions identified in the strategy. Knowledge of the region's flood risks has improved with the completion of this work and several new floodplain priorities have been identified. Additional priorities were also identified following the 2010–11 floods, and subsequent flood events.

Substantial progress has been made over the past 17 years in implementing priorities identified in all six action programs identified in the RFMS, with significant additional works carried out in regional flood modelling, emergency management plans and coastal inundation. Although not identified as priorities in the original strategy, these areas were identified as contemporary priorities by partners.

Achievements

A summary of the key actions implemented under each program, including those identified post-strategy, is provided in Figure 8.

Figure 8: Summary of Key Actions Implemented Under Each Program of Previous RFMS



Asset Management

The asset management program aimed to reduce flood risk and damage through structural mitigation works. Investment by the Victorian and Australian governments was driven by the merits of individual proposals that often occurred following the completion of detailed flood investigations. These investigations provided the pre-requisite information required for the development of business cases for investment.

Local Flood Studies and Floodplain Management Plans

Major progress has been achieved in relation to the conduct of regional flood studies (flood investigations). Approximately 85 per cent of identified flood investigation priorities have been completed, representing around \$2.3 million in local, state and Australian government investment.

Since the development of the region's first floodplain management strategy, several additional flood investigation priorities have been identified and progressed. These include regional (broad scale) flood investigations to improve management of risks to agriculture and the rural community in priority areas of the catchment, and investigations to manage the risks of coastal inundation.

Regional flood modelling has now been completed for the Glenelg River between Casterton and Rocklands Reservoir and the Fitzroy and Darlot Creek floodplains, funded by the Victorian Government. The outputs from these projects provide a basis for reducing the impact of future flooding on agriculture in these areas.

Coastal inundation was not recognised as a risk in the 1999 strategy. Understanding of the potential risks to coastal communities from storm tide events has improved significantly over the past 17 years, and several studies have now been completed for at-risk locations at Portland (Dutton Way), Narrawong and Port Fairy.

Local floodplain management plans have been produced for North Warrnambool and Beaufort.

Statutory Planning

There has been significant improvement in coverage of flood-related overlays and zones within the region's planning schemes since 1999. Of the eight identified priority actions in the strategy, six have been completed and two are in progress. Flood related zones and/or overlays now cover 52 per cent of flood-prone townships identified in the 1999 strategy, as opposed to 26 per cent covered prior to this period.

Emergency Response Including Flood Warning

Minor progress has been achieved with regard to flood warning since 1999. Casterton remains the only township in the region with a formal flood warning service provided by the Bureau of Meteorology. Installation of staff gauges just downstream of the confluence of Baileys Creek with Mt Emu Creek (approximately 14 kilometres by river upstream of Skipton) has resulted in a minor improvement in flood warning for Skipton; however, this relies on the availability of resources to read the gauges. State government investment in stream gauge telemetry improvement and additional rain gauges following the January 2011 flood event has improved access to real-time river height and rainfall data. This data can be used to further improve formal flood warning arrangements for townships at risk.

The CMA has supported VICSES and councils in the development and review of nine Municipal Flood Emergency Plans (MFEPs) across the region. The MFEPs are subplans of Municipal Emergency Management Plans and include detailed information on flood risks within LGA regions for use in an emergency.

The CMA has also worked closely with VICSES in developing the Casterton Flood Visualisation Tool to assist VICSES in making logistical and tactical decisions in a flood emergency.

Information Management

This program focused on ensuring that the best available flood information is used in the statutory planning process and information is maintained in a Geographic Information System (GIS). A GIS system has been established by the CMA for capturing best available information, and this system requires ongoing support and maintenance. The CMA also participated in the development of the Floodzoom online database and flood mapping application for emergency management and response, developed by the Victorian Government.

Education and Community Awareness

Much of the progress made through implementation of the previous strategy has stemmed from community consultation associated with the delivery of flood investigations (CMA and local government), local flood guides (VICSES), planning scheme amendments (CMA and local government) and the CMA's flood information service.

Local flood guides are available on the VICSES website.¹⁷

The CMA completed a Regional Flood Education & Awareness Project in 2014. This small-scale project invested \$32,000 of funds provided by the National Disaster Resilience Grants Scheme in community engagement focused on obtaining historical flood information from the Warrnambool and Port Fairy communities.



Photo 1: Flood level peg marking the peak of the August 2013 flood in Fawthrop Lagoon, Portland.
Source: GHCMA

Photo 2: Marking the peak level of the August 2013 flood in Fawthrop Lagoon, Portland.
Source: GHCMA

Photo 3: Marking the peak of the December 2010 flood in Harrow.
Source: GHCMA

Case Study:

Floodplain Management in Action – Reducing the Risk for Skipton

Skipton township is downstream of a large (1249 km²) catchment. Most of the township has been built within the steep-sided banks of Mt Emu Creek, and flood impacts over the years have been severe. The Glenelg Hopkins CMA delivered a detailed flood investigation for Skipton in March 2013 following a successful bid to the National Disaster Resilience Grants Scheme (NDRGS). Corangamite Shire Council contributed financially to the project and was a key member of the project reference group, in addition to the VICSES and local community representatives.

The result of this investment has reduced the flood risks faced by the residents of Skipton and shows how improved floodplain management outcomes are being delivered in the Glenelg Hopkins Region. Financial commitment from the three tiers of government is enabling the delivery of improved floodplain management outcomes. The completion of a detailed flood investigation provides a strong foundation for investment in risk reduction projects. Financial commitment from the three tiers of government is enabling the delivery of improved floodplain management outcomes. The success of projects such as this relies on effective regional partnerships between the Glenelg Hopkins CMA, LGAs, VICSES and the local community.

Outcomes stemming from the Skipton flood investigation include:

- improved control on future land development via amendment C34 of the Corangamite Shire Planning Scheme – March 2014 (ensuring that new development accounts for the risk of flooding)
- completion of a Municipal Flood Emergency Plan by VICSES, identifying which properties are likely to flood and when. This enables a more effective tactical response to flood events
- the development of a Local Flood Guide by VICSES that was distributed via a direct doorknock consultation with the local community
- upgrade of Jubilee Park Lake overflow pipes including the culvert upgrade shown in Figure 9.

Improved flood warning for the township remains a significant element of the overall risk reduction process for Skipton. Corangamite Shire Council is now working with other agencies to consider how a Total Flood Warning System may be effectively delivered for the township.

Figure 9: Skipton Culvert Upgrade – Before Upgrade (left) and Operating During 2016 Floods (right)



Part 2 – Regional Risk Assessment

Part 2 of this document outlines the regional risk assessment process and the results of the regional risk assessment using DELWP's rapid appraisal methodology. This section includes an overview of themes relating to the risk assessment, including the consideration of stormwater and rural drainage. Integrated catchment management threats and opportunities are also discussed.

The outcomes of the stakeholder engagement and public consultation program, undertaken to highlight community-identified risks, is provided as well as a list of the important regional and community infrastructure ascertained as part of this process.

Integrated Catchment Management Threats and Opportunities

Integrated Catchment Management (ICM) is the coordinated involvement of agencies, stakeholders and the community in policy making, planning and management of catchments. ICM recognises the intrinsic links between land use and environmental impacts and aims to promote the sustainable use of natural resources.

The concept of ICM is established under the Catchment and Land Protection Act 1994 (Vic) and underpins the sustainable management of land and water resources, and contributes to biodiversity management.

At a strategic level, the following ICM approach is recommended for the management of floodplains in Victoria (adapted from Our Catchments Our Communities¹⁸):

- strengthen community engagement in regional planning and priority setting
- clarify roles and responsibilities of key agencies in floodplain and catchment management
- strengthen coordination between key management partners
- improve accountability of partners implementing the regional strategies
- improve state and regional floodplain management reporting using a consistent set of indicators.

The identification of threats to floodplain management is a critical step in determining appropriate management responses. Key threats to floodplain management within the Glenelg Hopkins region include:

- climate change and resulting reduction in overall rainfall, increased severity of flooding and sea level rise
- residential and commercial development
- changes to natural flow, channel modification and construction of levees
- industrial development, including mining
- agricultural and forestry activities that result in land clearing, modification of land form, changes to runoff, introduction of chemicals or changes to groundwater
- river regulation.

Key opportunities include:

- environmental water reserve management
- cultural flows
- floodplain wetland restoration and the reversal of historical drainage.



Right Photo: Noss Retreat Road from
Toorak Hill Casterton, August 1991
Source: Murial Wombwell

Consideration of Stormwater Management Issues

The following definitions provide for categorisation of regional flood risks according to the dominant driver of flooding at a particular location.

These definitions enabled regional stormwater flood issues to be clearly identified during the RFMS consultation process.

Stormwater Flooding

- generally occurs when the volume of rainfall runoff from built up areas (urban or peri-urban areas including road networks) exceeds the capacity of stormwater drainage infrastructure to convey the flow of water away from an area
- when stormwater drain outlets are flooded, restricted or blocked in some way, causing water to back up in the stormwater drain network
- when rainfall runoff is ponded in low-lying areas that have no drainage capacity, insufficient drainage capacity or compromised drainage capacity as a consequence of factors such as those mentioned above.

Riverine Flooding

- generally occurs when water flowing out of an inland catchment overflows the natural or artificial banks of a stream, estuary, lake or dam.

Coastal Flooding

- generally occurs when water from the ocean inundates an inland area as a consequence of strong on-shore wind, storm tide (or combination of both) or tsunamis.

While the locations of stormwater management issues have been identified, actions to address these issues need to be developed via municipal stormwater management plans (or capital works programs) as per the guidance provided by the Victorian Floodplain Management Strategy.¹⁹

Stormwater risks identified through the community and stakeholder engagement process have been recorded and provided to the relevant LGA.

Consideration of Rural Drainage Issues

For the purposes of this strategy, rural drainage is defined as the works and functions related to the collection and removal of water generated from local rainfall runoff from rural land prone to natural waterlogging. Rural drainage refers to changes being made to the natural hydraulic capacity of drainage lines and soils to increase the rate at which water

flows through or off the land to increase agricultural production. Management of rural drainage systems falls outside of the scope of this strategy. A Victorian Rural Drainage Strategy is being developed by DELWP, which will set the policy and establish a framework for the management of rural drainage in Victoria.



*Photo: Ocean Drive Port Fairy looking toward Griffith Island during the June 2014 storm tide event
Source: Moyne Shire Council*

Flood Risk for Coasts and Estuaries

Most estuaries in the Glenelg Hopkins CMA region are intermittently closed. The natural closure of river mouths can cause prolonged flooding of land upstream of the river mouth. This can lead to the loss of agricultural land and affect private and public assets such as jetties and recreational facilities. This has both perceived and real economic impacts.

The Estuary Entrance Management Support System (EEMSS) database was developed in 2006 by Glenelg Hopkins CMA in partnership with other agencies to guide estuary managers when deciding whether to artificially open an estuary. The EEMSS considers the social, economic and environmental values of each estuary and the likely impact of opening – and not opening – at different times of the year, and at different water levels.

The following additional issues should be considered when assessing flooding risk for coastal areas, particularly under a changing climate:

- sea level rise
- tidal influence
- storm surge – increased frequency and intensity
- coincidence of fluvial flooding events and coastal water levels in estuarine areas (changing boundary conditions)
- saline intrusions
- consideration of coastal shoreline vulnerability.

Flood risk assessments along the coast tend to focus on townships where the largest potential economic and social impacts are. However, under a changing climate, agricultural land is also likely to become increasingly vulnerable to saline incursion.

The Victorian Coastal Strategy 2014²⁰ has identified the following benchmarks for planning in relation to sea level rise and storm surge:

- Plan for possible sea level rise of not less than 0.8 metres by 2100, and allow for the combined effects of tides, storm surges, coastal processes and local conditions such as topography and geology when assessing risks and coastal impacts associated with climate change.
- In planning for possible sea level rise, an increase of 0.2 metres over current 1-in-100-year flood levels by 2040 may be used for new development in close proximity to existing development (urban infill).
- For new greenfield development outside of town boundaries, plan for not less than 0.8 metre sea level rise by 2100.

Regional Risk Assessment Results

The Glenelg Hopkins Regional Flood Risk Assessment²¹ outlines the results of the DELWP's rapid appraisal of flood risk methodology. The rapid appraisal methodology has been designed to support priority setting through the development of a relative measure of riverine flood risk between discrete management units. Regional floodplains were broken down into 41 urban and 53 rural management units. Each management unit was assessed using the following three metrics for flood damage:

- **Damage density** = flood risk calculated as average annual damage (AAD) divided by the flood extent for the 1% annual exceedance probability (AEP) event.
- **Absolute damage** = AAD.
- **Town resilience** = the average annual population affected (AAPA) divided by the town population, indicating the proportion of the town that is flooded.

Flood metrics are presented on a scale of 1.0 to 6.0, where 6.0 is extreme and 1.0 is low (a value of 0 indicates no flood risk such as in areas where there is no flood extent). Overall risk is calculated as the sum of the three metrics and is therefore represented as a value out of a total of 18.

Considering all three metrics, towns with the 20 highest risk rankings are provided in Appendix II and include:

- Beaufort
- Miners Rest
- Ararat
- Warrnambool North
- Allansford.

Within the rural management units, the highest rankings were for the Mid-Glenelg River, followed by Burrumbeet Creek Catchment and Lower Wannon River Glenelg.

For coastal areas, although all risks were rated as low, Port Fairy has the highest risk rating within the region. When sea level is considered (0.8 m rise) the greatest increase in risk is associated with Warrnambool South, Dennington and Narrawong; however, the overall risk remains low for each of these locations.

While this rapid assessment provides a useful first-pass ranking of management units, the limitations of the data must be recognised. As outlined in the Regional Flood Risk Assessment²² the methodology does not capture:

- critical infrastructure such as hospitals and roads
- vulnerable populations such as the elderly, disabled and socially isolated
- areas for which flood hazard data is unavailable
- potential risk to life
- potential regional growth
- possible future scenarios under a changing climate
- flooding due to coastal erosion, storm surge and sea level rise
- community resilience to flooding.

In addition to the above limitations, the method used to calculate the risks was based on any available existing flood information. It must be noted there was no consideration on the reliability of the available flood information, and it was assumed that all flood information was of the same standard.

The method is also unable to consider the full complexity of interacting social, cultural and environmental values. A range of these values has been captured via the extensive stakeholder and community consultation process and are included in the following sections.

Due to the limitations of the rapid risk assessment process, management units were re-assessed taking into account local knowledge regarding known flood risks and detailed damages assessments undertaken as part of flood investigations. The top 10 management units by risk resulting from this re-assessment are presented in Part 4.



*Photo: Burrumbeet Creek flooding agricultural land at Pound Hill Rd near Powells Rd, 2:30 pm, 14 January 2011
Source: Ballarat City Council*

Stakeholder Engagement

An extensive community consultation program was undertaken to collate local knowledge and record community-identified risks. Ten Community Open House drop-in sessions were held across the nine key LGAs within the Glenelg Hopkins region. Advertising for the Open Houses was undertaken via the CMA website, social media and local print media (newspapers and community newsletters). In addition, targeted mailouts were made to over 2000 community members who reside within the known floodplains across the region. Communities directly impacted by flooding have strong awareness of the flooding issues in their area and provide high-quality intelligence on causes of flooding and a community perspective on floodplain management priorities. For those unable to attend, an email mailbox was set up to allow people to send through information or concerns about flooding.

Community Open House session locations are mapped in Figure 10 and were conducted over an eight-week period between 15 March and 2 May 2017. Meetings were typically held between 4-7 pm, and were attended by 99 people. Members of the community were encouraged to bring along any information on flooding in the region and one-on-one discussions were held with the help of printed maps showing flooding across each municipality. Information provided by the community was marked on the printed maps.

Community Identified Risks

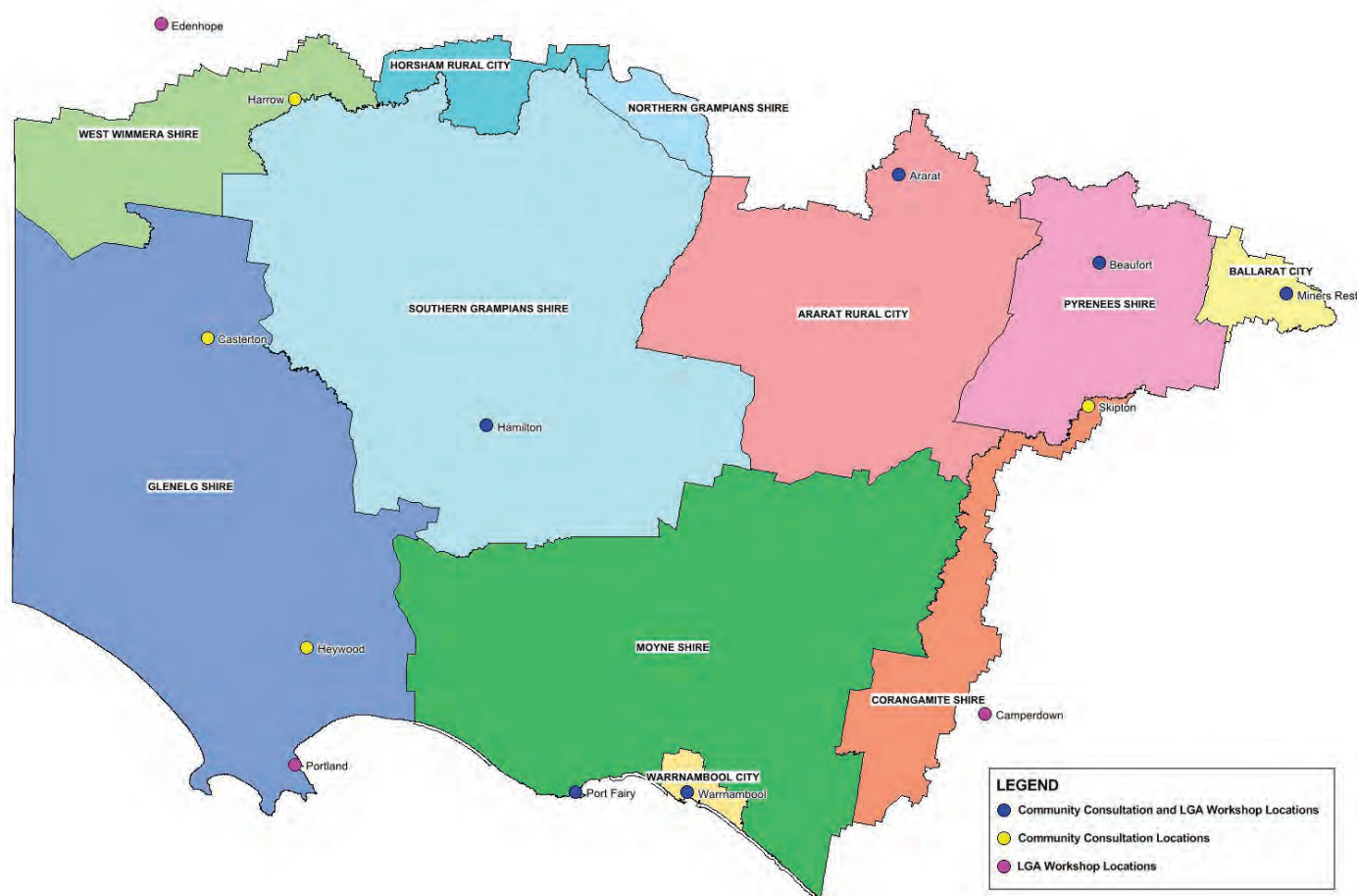
Risks identified through the community and stakeholder consultation process can be grouped into the following themes:

- loss of cultural heritage
- vegetation exacerbating flooding
- loss of, or reduced access to, important regional and community infrastructure
- insufficient planning scheme controls
- insufficient flood warning
- reduced effectiveness of structural flood mitigation
- lack of flood response planning
- lack of clarity around floodplain management roles and responsibilities
- clarification on process for determining insurance premiums (this is being addressed through the Victorian Floodplain Management Strategy).

Community-identified risks were discussed at the relevant LGA workshop (see below). Each of these themes is addressed in Part 3 – Regional Risk Analysis.

Additional risks identified relating to stormwater do not fall into the scope of this document. They have been documented and passed on to the relevant LGA.

Figure 10: GHCMA and LGA Boundaries with Location of Consultation Events



Local Government Authorities

Following each of the open house sessions, CMA staff met with representatives from the following LGAs (as shown in Figure 11) to discuss floodplain management priorities and investment opportunities within their region:

- Ararat Rural City Council
- Ballarat City Council
- Corangamite Shire Council
- Glenelg Shire Council
- Moyne Shire Council
- Pyrenees Shire Council
- Southern Grampians Shire Council
- Warrnambool City Council
- West Wimmera Shire Council.

Workshops were not held within Horsham Rural City or Northern Grampians Shire as no significant flood risk was identified for areas within the overlap with these Shires and the CMA region.

The results of the stakeholder and community engagement sessions were used to inform the development of the regional work plan. Discussions with other agencies such as water authorities were arranged, as appropriate, based on issues raised by the community and LGAs.



*Photo: Lake Condah Indigenous Protected Area,
16 November 2015
Source: GHCMA*

Traditional Owner Groups

Meetings were held with Traditional Owners to discuss the development of the strategy, Traditional Owner floodplain management priorities, cultural values of floodplains, and potential risks of floods to Aboriginal cultural heritage. These discussions informed the development of the regional workplan. Meetings were held with the following groups:

- Barengi Gadjin Land Council
- Eastern Maar Aboriginal Corporation
- Gunditj Mirring Traditional Owners Aboriginal Corporation
- Martang Pty Ltd
- Wathaurung Aboriginal Corporation
– Wadawurrung.

Consultation was also undertaken with Kuuyang Maar Aboriginal Corporation in collaboration with Corangamite CMA.

For more information regarding Registered Aboriginal Parties, see the Aboriginal Victoria website: <http://www.vic.gov.au/aboriginalvictoria/heritage/registered-aboriginal-parties.html>

Important Regional and Community Infrastructure

During the stakeholder and community engagement process important regional and community infrastructure was identified and is summarised in Table 4. The table only identifies important community infrastructure at risk of flooding, identified through community consultation and LGA workshops.

Table 4: Important Regional and Community Infrastructure

LGA	Important community infrastructure identified through stakeholder consultation
Ararat Rural City Council	<ul style="list-style-type: none"> • Parts of Western Highway inundated during large flood events • Above floor flooding occurs in the Ararat Retirement Village
Ballarat City Council	<ul style="list-style-type: none"> • Parts of Sunraysia Highway are inundated during large flood events in the vicinity of Ballarat • Sewer pump station impacted by flooding
Corangamite Shire Council	<ul style="list-style-type: none"> • Glenelg Highway inundated at Skipton during large flood events
Glenelg Shire Council	<ul style="list-style-type: none"> • APEX Park in Heywood affected during flood events • Bowls Club in Casterton is affected by flooding
Moyne Shire Council	<ul style="list-style-type: none"> • Properties on Griffiths Street, Port Fairy and arterial roads are isolated during flood events
Pyrenees Shire Council	<ul style="list-style-type: none"> • Beaufort Reservoir can overtop during flood events, exacerbating flooding downstream • The Langi Kal Kal prison may be at risk of isolation during large flood events inundating Langi Kal Kal Road
Southern Grampians Shire Council	<ul style="list-style-type: none"> • Branxholme football oval septic tank can overflow during flood events, resulting in the potential contamination of flood waters • Fire Station at Byaduk impacted by floodwaters during minor events
Warrnambool City Council	<ul style="list-style-type: none"> • Russell Creek walking path inundated during low-level events • Access to St Joseph's Primary School affected during low-level events • Warrnambool Rowing Club's storage impacted during high river levels
West Wimmera Shire Council	<ul style="list-style-type: none"> • Freight and school bus routes affected by flooding • Mooree Bridge on Kadnook-Connewirricoo Road at risk of overtopping during large events • The RSL and Johnny Mullagh Reserve at Harrow are impacted during medium to large events

It is also recognised that many agricultural assets within the region may be at risk of flooding. Flooding may result in loss of livestock, saline intrusion and potential increase in land being subject to waterlogging events, existing infrastructure impeding or redirecting flows impact agriculture, and loss of business continuity due to interrupted productivity and/or transport routes. Currently there is little

knowledge of the extent of these impacts within the region. It is expected that knowledge will improve through the development of regional flood studies.

Further detail on flood-affected important regional and community infrastructure can be found in the relevant authority's Municipal Flood Emergency Plan.



Part 3 - Analysing Risk Treatment Service Levels

Part 3 provides a review of the existing risk treatments against defined risk treatment service levels for:

- planning scheme controls
- structural flood mitigation works and their management arrangements
- municipal emergency management plans
- flood warning systems.

This section includes an overview of current risk treatment service levels for each of the above themes. The results of the Total Flood Warning Assessment Tool are then presented, providing a list of priority management units for flood management with the region.

The term 'risk treatment service level' refers to all the information and support provided (or available) to agencies and/or the community before and during a flood.

The review of existing risk treatment service levels in Part 3 is based on the risks identified in Part 2. By reviewing existing service levels, gaps can be highlighted for managing identified risks.

This section also provides an overview of relevant policies and plans in relation to management of cultural heritage and vegetation. These issues were identified as being of significance through the community engagement process.



*Photo: Lake Goldsmith Steam Preservation Society
Rally site flooded by Mt. Emu Creek, 14 January 2011
Source: Mark Greenbank*

Planning Scheme Controls

The state planning policy for floodplain management (Clause 13.02) provides the broad framework for the integration of flood policy and provisions into planning schemes.²³ The policy brings together policies and strategic plans from all areas of government that have a bearing on floodplain management. It also aims to provide consistency in planning controls for flood-affected regions.

The objective of the state planning policy for floodplain management is to assist in the protection of:

- life, property and community infrastructure from flood hazard
- the natural flood-carrying capacity of rivers, streams and floodways
- the flood storage function of floodplains and waterways
- floodplain areas of environmental significance or of importance to river health.

The policy states that flood risk must be considered in the preparation of planning schemes and in land use decisions, to avoid intensifying the impact of flooding through inappropriately located uses and developments. It also states that land affected by flooding should be shown on planning scheme maps and recognises that land affected by flooding is land inundated by the 1-in-100-year flood event (also known as the 1% AEP) or as determined by the floodplain management authority.

The CMA considers the flood risk associated with depth and velocities of the modelled 1% AEP flood and applies the best-practice flood management methods to apply controls that will reduce flood damages and risk to life. In some council areas, the CMA has worked with the council to develop local floodplain development plans that include criteria to guide development within the 1% AEP floodplain. Completed plans include:

- Beaufort Local Floodplain Development Plan
- Glenelg Shire Local Floodplain Development Plan
- Skipton Local Floodplain Development Plan
- Port Fairy Local Floodplain Development Plan.

Structural Flood Mitigation Works and their Management Arrangements

Historically, flood mitigation infrastructure within the region has taken the form of levees that have been constructed without formal management arrangements, protection standards, or maintenance schedules. As a result, flood mitigation structures may be ineffective during flood events despite the perception of protection.

Flood mitigation infrastructure is formally managed if:

- it has been designed and built to a defined standard and a defined level of flood protection, and
- an organisation (usually local government) has accepted responsibility for ensuring the infrastructure is kept in good condition, by routine inspection and maintenance.

Flood mitigation infrastructure that is not formally managed can be maintained or repaired after flood events, but there is no assurance of flood protection.

Existing Significant Flood Mitigation Infrastructure

Principles that guide government investment in flood mitigation infrastructure are outlined in Section 17.2 of the Victorian Floodplain Management Strategy and include:

- due process
- due diligence
- cost effectiveness
- supporting analysis
- community benefits
- accountability for ongoing management.

The three tiers of government will only invest in upgrading flood mitigation infrastructure if the accountability arrangements for ongoing management, maintenance and assurance are agreed and clearly documented. These arrangements should allow for measurable outcomes to be established, evaluated and reported.

Existing significant flood mitigation infrastructure requiring formal maintenance is summarised in Appendix III. This includes a high-level assessment of the condition of the infrastructure. For earthen levees, an assessment of the condition is based on the following definitions:

- poor – bare dirt, unstable banks, lots of trees on the bank, animal holes or burrows
- moderate – looks in reasonable shape, with a few trees growing in the bank, and few if any sections of bank worn down; some signs of cracking and small sink holes

- good – looks in good shape, with few, if any trees growing in the bank, and no sections of bank worn down; no evidence of pugging or rilling
- very good – evidence of being designed and constructed properly, and maintained to some degree. Reasonable grass cover on banks, crest top sheeted with gravel or bitumen, stable banks, no trees on the crest
- excellent – evidence of being designed properly (e.g. keyed in) and regularly maintained, good grass cover on banks, crest top sheeted with gravel or bitumen, stable banks, no trees on the crest.

Other mitigation structures include high-flow bypass channels and culvert structures, sea walls and detention basins. Assessments of condition are based on whether the structures are performing their function as designed, and general structural condition.

The same principles for deciding whether to upgrade existing flood mitigation infrastructure apply to the establishment of new flood mitigation structures. Detailed flood studies are required to meet the criteria for government investment in flood mitigation infrastructure. Large-scale flood mitigation infrastructure is no longer considered best practice for rural areas.²⁴ The asset manager should undertake regular assessments to ensure that mitigation structures are operating as designed and are in good structural condition.



*Photo: Flooding at the Skipton Hotel from Mount Emu Creek, 1:07pm, 15 January 2011
Source: Corangamite Shire Council*

Municipal Emergency Management Plans

LGAs are responsible for facilitating the development of Municipal Emergency Management Plans (MEMP) in partnership with other agencies via the Municipal Emergency Planning Committee. MEMPs are required under the Victorian Emergency Management Act 1986 Part 4 Section 20 (1). Within these plans are flood-related sub-plans referred to as Municipal Flood Emergency Plans (MFEPs) that include flood history and any flood-related information to assist councils and agencies to prepare, respond to and recover from flood events within a municipality.

MFEPs are required to contain information on:

- description of the flood threat
- areas and populations affected by flooding
- flood history
- flood intelligence cards – detailing the relationship between flood magnitude and flood consequences
- flooding consequences and required actions
- evacuation plans
- local flood warning system arrangements
- mapping, including hazard and/or inundation mapping
- roles and responsibilities of agencies
- control arrangements
- plan activation trigger points
- liaison and communications.

Within the Glenelg Hopkins region only Corangamite and Pyrenees Shires have endorsed MFEPs. Remaining LGAs have draft plans, with the exception of Glenelg Shire Council and West Wimmera Shire Council.

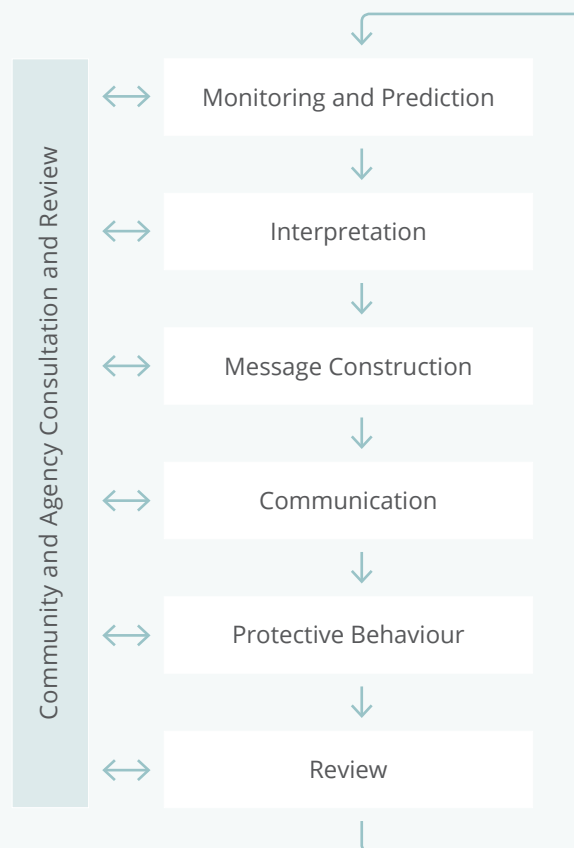
Total Flood Warning System

As described in the Australian Emergency Management Manual Series, Manual 21 Flood Warning²⁵, a flood warning system is made up of several components which must be integrated if the system is to operate effectively. Collectively, these components are referred to as a Total Flood Warning System (TFWS). Components include:

- monitoring of rainfall and river flows that may lead to flooding
- prediction of flood severity and the time of onset of particular levels of flooding
- interpretation of the prediction to determine the likely flood impacts on the community
- construction of warning messages describing what is happening and will happen, and the expected impact and what actions should be taken
- dissemination of warning messages
- response to the warnings by the agencies involved and community members
- review of the warning system after flood events.

As shown in Figure 11 the components of the TFWS are interdependent and linked. To be fully effective, all components must be present and operating appropriately. In addition, the system must include an inbuilt feedback loop that integrates the lessons learned from episodes of flooding. Reviewing the performance of the system (including the responses by agencies and the community) is a vital component of the system allowing improvements to be made.

Figure 11:
Components of the Total Flood Warning System



Total Flood Warning System Assessment Tool

A TFWS assessment tool was developed by DELWP to assist in determining how the identified risk for a management unit compares to the existing level of service for mitigating that risk. This information highlights whether further work is required within the management unit to achieve effective flood warning.

The tool evaluates the seven factors outlined in Table 5. The first six components determine an existing service level of flood warning which is then compared to the seventh component (social impacts) to determine the minimum level of warning required for each management unit.

Table 5: Factors Evaluated in the Total Flood Warning System

Factors	What did the Total Flood Warning System assess?
Data Collection Network	The network of rain and stream gauges within the catchment
Forecasting	Whether forecasting is provided for the area and how the forecast is provided
Dissemination and communication	How flood forecasts, flood information and evacuation warnings are forecast, and how information is provided to the community
Flood awareness and education	How aware the community is about flood information. For example, recent floods, availability of local flood guides etc.
Interpretation	How warnings or flood gauge heights are translated into a risk for the community
Response planning	Whether a plan is in place for flood emergencies (MFEP)
Social impacts	The impacts of flooding including population affected, community groups, road blockages, key infrastructure at risk etc.

The TFWS assessment tool is based on available data; however, it does not assess the quality of the data available, assuming that all elements of the system work perfectly. The results of the tool/assessment are only intended to provide an overview of where further work may be required to lessen the severity of flood impacts on the community.

Table 6 lists the management units where the service level has been identified as not being sufficient when compared with the risk. This list is consistent with the top ten highest risk management units identified using the rapid risk assessment. However, with the additional factors considered, this list also contains Coleraine, Hamilton and Portland. Management units for which the difference between the service level and the risk is greatest are Beaufort, Port Fairy and Hamilton.

The main causes of the service level not being considered sufficient for the risk include:

- the absence of a Municipal Flood Emergency Plan
- a lack of flood data as represented by the presence of rain and stream gauges
- a lack of documented arrangements regarding the provision of flood warnings to at-risk communities (the tool does not consider the effectiveness of arrangements).

Table 6: Total Flood Warning Assessment Tool Results

Management Unit	LGA	Service Level	Risk Level	Difference
Beaufort	Pyrenees Shire Council	2	4	2
Port Fairy	Moyne Shire Council	1	3	2
Hamilton	Southern Grampians Shire Council	1	3	2
Miners Rest	Ballarat City Council	2	3	1
Casterton	Glenelg Shire Council	2	3	1
Ararat	Ararat Rural City Council	1	2	1
Portland	Glenelg Shire Council	1	2	1
Sandford	Glenelg Shire Council	1	2	1
Coleraine	Southern Grampians Shire Council	1	2	1
Warrnambool North	Warrnambool City Council	1	2	1
Warrnambool South	Warrnambool City Council	1	2	1
Allansford	Warrnambool City Council	1	2	1
Harrow	West Wimmera Shire Council	1	2	1

Cultural Heritage Assessment and Protection

Consultation with local Aboriginal communities is essential in assessing and mapping flood risks. Glenelg Hopkins CMA is committed to ensuring cultural values are appropriately reflected in floodplain management. In working with Traditional Owners to incorporate Indigenous Cultural Heritage into floodplain management, Glenelg Hopkins CMA will follow the consultation and engagement processes outlined in the Victorian Waterway Management Strategy²⁶ and in the Aboriginal Participation Guideline for Victorian CMAs.²⁷

The Victorian Floodplain Management Strategy²⁸ recognises that processes are needed to ensure that significant Aboriginal cultural values are considered as part of the incident control arrangements during emergency events.

Vegetation

As outlined in the Victorian Water Management Strategy²⁹, large wood and native instream vegetation are important habitat in rivers. They provide shelter, food sources and breeding sites for a variety of instream animals, including threatened fish species. They also contribute to biological processes within the river channel.

Large woody habitat is an important structural component of rivers. It assists in the formation of scour pools and channel bars and in stabilising the river channel. In large lowland rivers, large woody habitat may be the only stable substrate and an important instream source of nutrients.

From the late 1800s to late 1990s extensive removal of large woody habitat and instream vegetation clearing occurred in Victoria under the assumption that it would increase the movement of flood water. Research has shown that large woody habitat has negligible impact on channel capacity, and removal does little to increase the flow of flood waters. In addition, instream vegetation and large woody habitat have been found to reduce bed erosion. The removal of large woody habitat and instream vegetation results in riverbed degradation, channel enlargement and loss of important instream habitat.

The Victorian Floodplain Management Strategy³⁰ indicates that where individuals, groups of landholders, infrastructure managers, LGAs or other authorities propose small-scale activities, CMAs will use risk assessment guidelines prepared by DELWP to help determine whether these activities can be authorised without the need for a flood investigation.

Unless they are formally exempt, individuals or groups of landholders, infrastructure managers, LGAs or other authorities proposing small-scale activities on waterways must obtain authorisation from the relevant CMA. When determining whether to grant authorisation for proposed activities, Glenelg Hopkins CMA must consider potential risks to waterway health. Glenelg Hopkins may require the proponent to undertake alternative activities to minimise any risks.

In some cases, the removal of large woody habitat or instream vegetation may be necessary to maintain social or economic values, reduce an immediate threat to public infrastructure or reduce public risk. In such cases, habitat benefits need to be balanced against the level of risk, and the costs and benefits of proposed large-scale activities must be demonstrated through a flood investigation.

Alternatives to habitat removal may exist, such as anchoring large wood. Re-establishment of large woody habitat and native instream vegetation may be needed to improve the condition of the river channel and support environmental values.

The Victorian Water Management Strategy³¹ (Policy 11.3) states that large woody habitat or native instream vegetation will not be removed from river channels unless it is demonstrated to pose a serious risk to public safety or public infrastructure. Where programs to reinstate large woody habitat or instream vegetation are planned to improve the condition of the river channel, the benefits and risks will be assessed in consultation with the community. Action 11.3 within the policy indicates that guidelines on the assessment of flood risk posed by large woody habitat and instream vegetation will be developed.

Case Study:

Russell Creek

The Russell Creek floodplain through Warrnambool is bound by residential land. The narrow creek corridor is considerably confined in several sections, with many dwellings and commercial buildings situated within the floodplain. The creek corridor is considered an important natural asset for the residents of Warrnambool, providing open space and paths for walking, running and cycling.

The 2010 North Warrnambool Flood Investigationⁱⁱⁱ indicated that 773 properties and 146 buildings are likely to be impacted during 1% AEP floods, and that the nature of flooding allows for very little warning time for residents. As such, structural works were considered necessary, and a detailed flood mitigation assessment was undertaken.

It was determined that the installation of a concrete wall structure was the most appropriate action. The concrete walls have enabled Warrnambool City Council to maintain the public open space provided by the creek corridor and reduces privacy issues that could arise out of public access to a raised embankment abutting private property. Maintaining pedestrian access to the creek corridor over and around these walls was an important design consideration (Figure 12). These access points can be rapidly closed off in the event of a major flood (Figure 13).

A detailed flood mitigation assessment determined that the designed flood walls will result in:

- a reduction in average annual damage (AAD) of approximately \$294,000
- a reduction in the number of buildings flooded above floor from 146 to 30 (during a 1% AEP flood).



Figure 12: Flood Wall with pedestrian access at Russell Creek (photo by Johanna Theilemann)



Figure 13: Blue boards on left of access can be inserted to fill the gap in the flood wall (photo by Johanna Theilemann)

ⁱⁱⁱ Cardno Victoria, Design of North Warrnambool Floodplain Management Plan Implementation Works, Prepared for City of Warrnambool, October 2010



Part 4 – Development and Improvement Plan

Part 4 of the RFMS presents the strategy for floodplain management in the Glenelg Hopkins region. This section provides an overview of the method for determining regional floodplain management priorities, identifies preferred management actions; and prioritises management actions for completion in the short term based on existing plans and available resources. These actions are presented in the form of a regional works program, which will be updated annually.

*Photo: Mt Emu Settlement Rd,
14 January 2011
Source: Leigh Ditchfield, Pyrenees Shire*

Regional Risk Levels

Table 7 shows the revised list of management units identified as having significant flood risk. Based on the rapid risk assessment, this ranking also takes into account known impacts of flooding within the region as identified through flood studies and investigations.

The rapid risk assessment process makes the following assumptions when calculating the number of properties impacted:

- For a property to have a building and/or be suited for development, the cadastre must be > 100 m² and < 10,000 m².
- One rural building is inundated for every two features of interest (points) inundated.

These assumptions can have the effect of counting more buildings within the floodplain than there are. This is particularly the case for small rural townships, such as Sandford, where there are a substantial

number of lots within the size range, but few actual buildings present within the floodplain. This has the effect of skewing the damages upward from the expected range and is reflected in the higher risk ratings of some of these small townships.

Contemporary flood investigations include a detailed damages assessment on property and infrastructure. These assessments are based on survey data of actual properties impacted. While the assessments are not comprehensive across the region, most major centres impacted by floods have been assessed.

When these damage assessments are considered, the result is a re-ordering of the management units; however, the top four areas by risk remain the same. This demonstrates that the rapid risk assessment process is a quick, effective method of assessing flood risk. Within the top ten flood risk areas the only notable change is the removal of Sandford from the list and the inclusion of Narrawong.

Table 7: Revised List of Management Units Identified as Having a Significant Flood Risk

Location	LGA	Rapid Risk Assessment total	1% Total damages	1%AAD calc. year
Warrnambool North	Warrnambool City Council	12.6	\$8,823,422	2010
Miners Rest	Ballarat City Council	14.0	\$3,086,886	2013
Beaufort	Pyrenees Shire Council	14.2	\$2,494,000	2008
Ararat	Ararat Rural City Council	13.1	\$2,305,000	2016
Hamilton	Southern Grampians Shire Council	8.3	\$2,217,917	2011
Port Fairy	Moyne Shire Council	11.9	\$1,775,149	2008
Skipton	Corangamite Shire Council	6.7	\$1,625,093	2013
Portland	Glenelg Shire Council	8.4	\$1,613,750	2011
Warrnambool South	Warrnambool City Council	9.4	\$667,000	2007
Narrawong	Glenelg Shire Council	2.0	\$450,000	2008

In addition, the following locations have been identified as experiencing flooding and requiring improved flood information to be able to accurately assess risk:

- Allansford
- Dartmoor
- Cudgee
- Dunkeld
- Chetwynd
- Panmure
- Coleraine
- Raglan

The above locations were not identified as priorities during the rapid risk assessment process as there is no – or limited – existing flood information available for the townships on which to determine a risk. Of the seven townships identified as experiencing flooding and requiring improved flood information, Coleraine, Cudgee and Chetwynd are currently the focus of investigation.

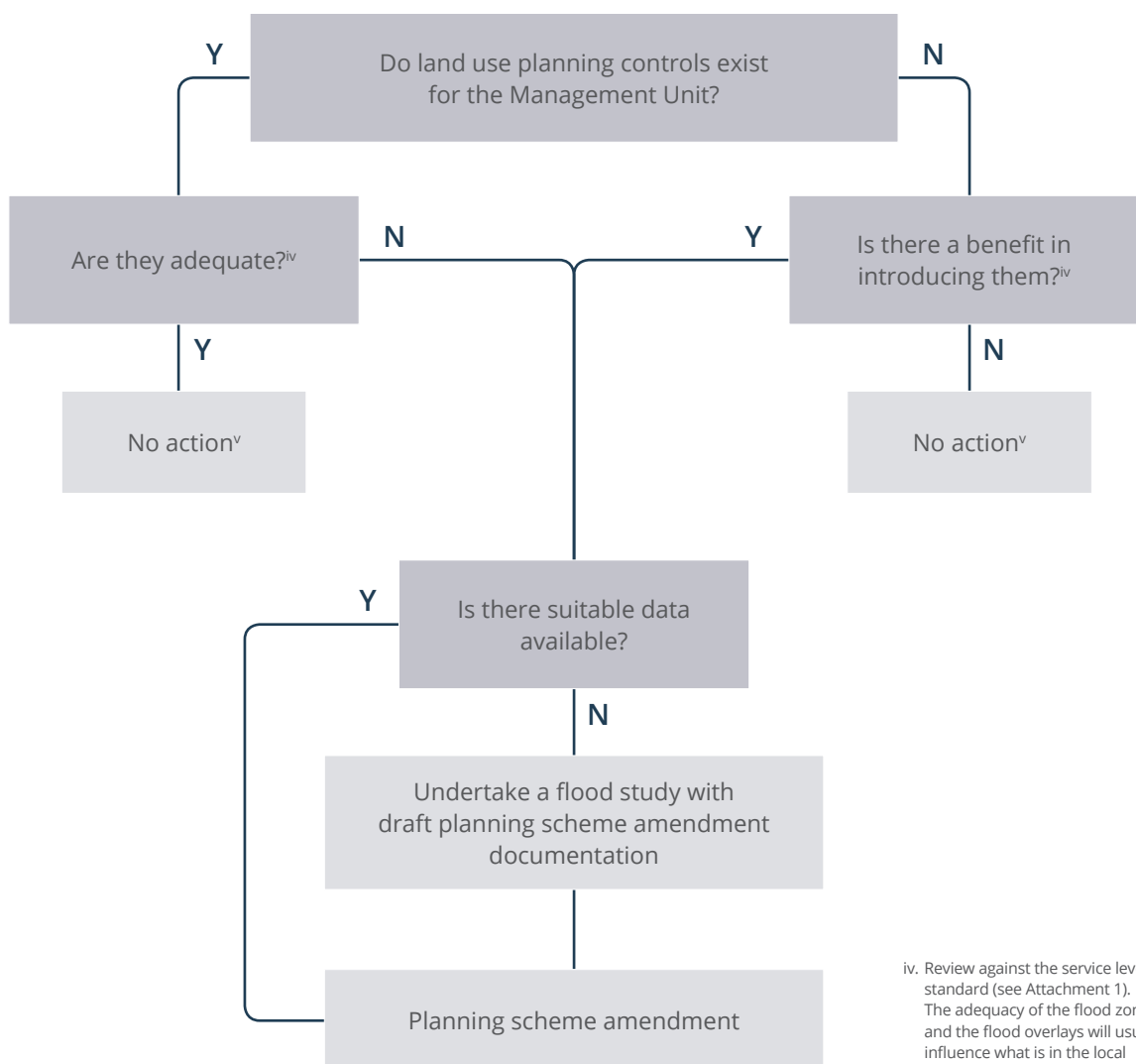
Determining Preferred Management Actions

Floodplain management actions seek to address gaps between existing flood risk and the level of acceptable risk that communities can plan and prepare for. Actions fall into three main categories:

1. Land use planning
(to avoid or minimise existing risks).
2. Flood mitigation infrastructure
(to reduce existing risks).
3. Flood warning (to reduce existing risks)
and emergency management
(to manage residual risks).

Preferred management actions relating to land use planning were determined using the decision tree presented in Figure 14.

Figure 14: Determining Preferred Management Actions



iv. Review against the service level standard (see Attachment 1). The adequacy of the flood zone and the flood overlays will usually influence what is in the local planning policies and municipal strategic statement.

v. Planning schemes are reviewed periodically and will still need to be updated if required.

The Strategy for Floodplain Management in the Glenelg Hopkins Region

This Strategy builds on the extensive work that has been undertaken over the past decade to improve management and reduce flood risks across the region. While flood information is an important first step, its value is limited unless it is used to manage or reduce flood risk. This is achieved by incorporating flood controls into planning schemes, by investigating (and, if viable, constructing) flood mitigation infrastructure and by developing and updating Municipal Flood Emergency Plans. Management actions that relate to these priority areas will continue to be a focus of this strategy.

The regional risk assessment and analysis process has identified priority areas in the region where further investment is needed to reduce the existing risks based on detailed flood information. Priority areas have been re-assessed resulting in the list presented in Table 7.

Many of the preferred management actions reflect an increased focus on understanding regional flooding risk through regional flood studies, such as the recently completed Fitzroy-Darlot Creek Regional Flood Study and the soon-to-commence Mt Emu Creek Regional Flood Study. Regional flood investigations will inform regional transport routes impacted, future rural development and costs to industry through a damages assessment.

Preferred management actions focus on the following areas:

- incorporating the outcomes of flood investigations into planning schemes as flood studies are completed
- improving flooding information for the seven regional townships known to have a flood risk, but require improved flood information: Allansford, Cudgee, Chetwynd, Coleraine, Dartmoor, Dunkeld, Panmure and Raglan.^{vi}
- completing regional flood investigations to inform regional transport planning, future rural development and costs of flooding to industry through a damages assessment
- improving understanding of the impacts of coastal flooding under a changing climate and rising sea levels. Priority areas for investment in coastal inundation studies will be identified through the Barwon South West Regional Local Coastal Hazard Assessment, Port Fairy Coast and Structure Plan Project, and Port Fairy Local Coastal Hazard Assessment
- developing and updating Municipal Flood Emergency plans
- increasing Traditional Owner involvement in flood investigations, flood response and recovery arrangements to improve understanding of cultural values within the floodplain
- the development and sharing of high-quality flood risk information that can be used for improved planning, flood warning and flood response
- investigating opportunities to improve flood warning, particularly for catchments subject to flash flooding.

Preferred Management Actions and Regional Work Plan

Preferred management actions are shown in Appendix IV^{vii} and represent a high-level list of regional priorities to guide future investment. Actions have been identified following consideration of the results of the regional risk assessment process, and have been developed in consultation with stakeholders and the community.

Prioritisation was based on the following time frames:

- **short-term** actions that can be delivered over the next three years, using currently available resources
- **mid-term** actions that are unlikely to be delivered over the next three years but may be delivered within the next three to ten years, depending on funding availability
- **long-term** actions that can be planned to maximise return on future investment.

Strategic actions that are achievable in the short term with existing resources have been summarised in a regional work plan (Table 7). The regional work plan will be updated annually.

vi. Detailed Flood studies are currently underway for three of these locations: Coleraine, Chetwynd and Cudgee.

vii. The contribution of each action to supporting strategic objectives and associated outcomes is also shown.

Table 8: Regional Work Plan

Responsibility		ID	Action	Estimated Cost (Indicative only)	Expected Completion
Lead Agency	Key Partners				
GHCMA	Traditional Owner Groups	16	Undertake Cultural Heritage Due Diligence as part of post-flood remediation works through Natural Disaster Relief and Recovery Arrangements (NDDRA)	\$15k	Jun 2018
GHCMA	Traditional Owner groups, DELWP, Aboriginal Victoria	17	Incorporate cultural values assessment as part of the Coleraine Flood Investigation	\$7k	Jun 2018
GHCMA	VICSES, DELWP, relevant LGAs	25	Complete a regional flood investigation for the Mount Emu Creek catchment	\$160k	Jun 2019
VICSES	Ararat Rural City Council	13	Undertake community flood education engagement activities and develop flood awareness products for Ararat	\$30k	Jun 2019
VICSES	West Wimmera Shire Council	12	Undertake community flood education engagement activities for Harrow and Chetwynd	\$10k	Jun 2019
VICSES	DELWP, GHCMA, all LGAs	7	Develop a State Community Observers Network Website enabling the community to provide local knowledge during flood events	\$70K	Jun 2019
VICSES	DELWP, GHCMA, all LGAs	8	Investigate options to improve community access to website flood risk information to allow people to better plan, prepare and respond to flooding	\$250K	Jun 2019
VICSES	DELWP, GHCMA, all LGAs	9	Install community education signs and gauge boards at high-priority locations within the catchment	\$45K	Jun 2019
VICSES	Warrnambool City Council, DELWP, GHCMA	64	Undertake community flood education engagement activities for Warrnambool	\$35K	Jun 2019
VICSES	Moyne Shire Council, DELWP, GHCMA	43	Undertake community flood education engagement activities for Port Fairy	\$35K	Jun 2019
Ararat Rural City Council	GHCMA, Community, DELWP	22	Undertake planning scheme amendment based on mapping from the Ararat flood investigation	\$60k	Jun 2020
Ballarat City Council	GHCMA, VICSES	28	Undertake detailed design for the Burrumbeet high-flow bypass channel and implement works to mitigate flooding of properties on Burrumbeet Creek	\$1.15 million	Dec 2018
Corangamite Shire Council	GHCMA, VICSES, Community	30	Investigate options for a community flood marker within the township of Skipton	\$7k	Jun 2018

Responsibility		ID	Action	Estimated Cost (Indicative only)	Expected Completion
Lead Agency	Key Partners				
Glenelg Shire Council	GHCMA, VICSES, DELWP, Glenelg Shire, Community	33	Investigate funding opportunities to undertake flood investigations for Dartmoor and Nelson, and subsequent planning controls	\$200k	Jun 2019
Moyne Shire Council	GHCMA, VICSES, DELWP	49	Complete the Cudjee Flood Investigation	\$160k	Jun 2018
Pyrenees Shire Council	GHCMA, VICSES	51	Engage stakeholders in a review of the Pyrenees floodplain management plan	In Kind	Jun 2018
Southern Grampians Shire Council	DELWP, GHCMA, VICSES, Community	56	Complete the Coleraine Flood Investigation	\$120k	Dec 2018
Southern Grampians Shire Council	DELWP, GHCMA, VICSES, Community	60	Investigate risks and potential solutions for dam safety for Hamilton and Dunkeld water storage facilities	\$TBC	Jun 2019
Southern Grampians Shire Council	DELWP, GHCMA, VICSES, Community	61	Investigate opportunities for stream monitoring upstream of Lake Hamilton for additional flood warning	\$TBC	Jun 2019
Warrnambool City Council	DELWP, GHCMA, relevant coastal LGAs, VICSES	32	Identify priority areas for undertaking detailed coastal and storm tide flooding investigations through the Barwon South West Regional Local Coastal Hazard Scoping Project	\$250k	Jun 2018
Warrnambool City Council	GHCMA, DELWP, VICSES	63	Complete flood modelling for 'as constructed' conditions of the Russell Creek flood walls	\$50k	Dec 2017
Warrnambool City Council	GHCMA, Community, DELWP	67	Undertake Part 2 of planning scheme amendment C78 to introduce/modify flood controls in South and North Warrnambool	\$60k	Dec 2018
Warrnambool City Council	DELWP, GHCMA, Bureau of Meteorology, VICSES	66	Consider flood warning options for the Russell Creek catchment	\$50k	Dec 2018
West Wimmera Shire Council	GHCMA, VICSES	70	Undertake flood modelling for Chetwynd	\$20k	Jun 2018
West Wimmera Shire Council	GHCMA, Community, DELWP	71	Amend flood controls in Harrow and Chetwynd through a planning scheme amendment	\$60k	Jun 2019

Part 5 - Monitoring, Evaluation, Review and Improvement Plan

The management of floodplains in the region is conducted within an adaptive management framework. At its core, adaptive management involves flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood.³²

To support this approach, a Monitoring, Evaluation, Review and Improvement (MERI) Plan has been developed, and is outlined below. The MERI Plan:

- presents the program logic underpinning the regional strategy
- clarifies the assumptions associated with the program logic
- identifies the key questions for evaluation and establishes processes to monitor progress within the framework of the statewide monitoring program
- clarifies the communication and reporting needs and identifies the processes required to support these needs
- enables lessons learned from monitoring and evaluation to be gathered and inform improvement.

Program logic

The overarching vision, objectives and expected outcomes of the RFMS, along with actions that support the achievement of these outcomes, are shown in Figure 16.

In addition to priority management actions, a range of supporting actions (or foundational activities) are necessary for the successful implementation of the regional strategy. These include program management, influencing planning, maintenance and engagement of partners. Over time (generally beyond the life of the RFMS), these management actions and outcomes collectively contribute to achieving the RFMS objectives (Figure 16). The effectiveness and success of the strategy will be measured by how well it delivers on these outcomes.

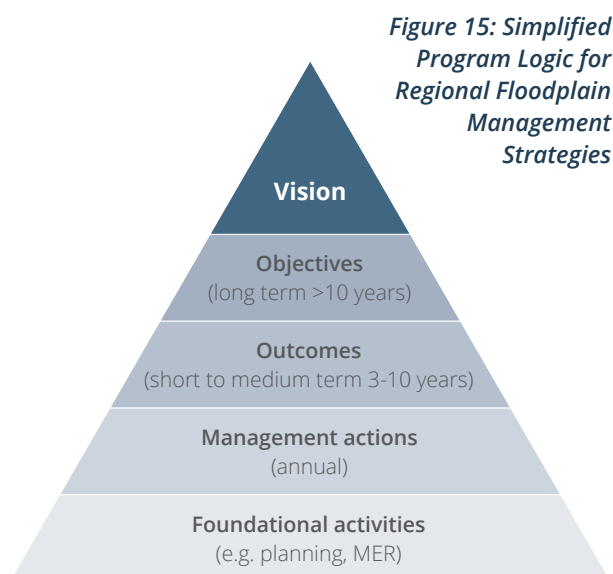
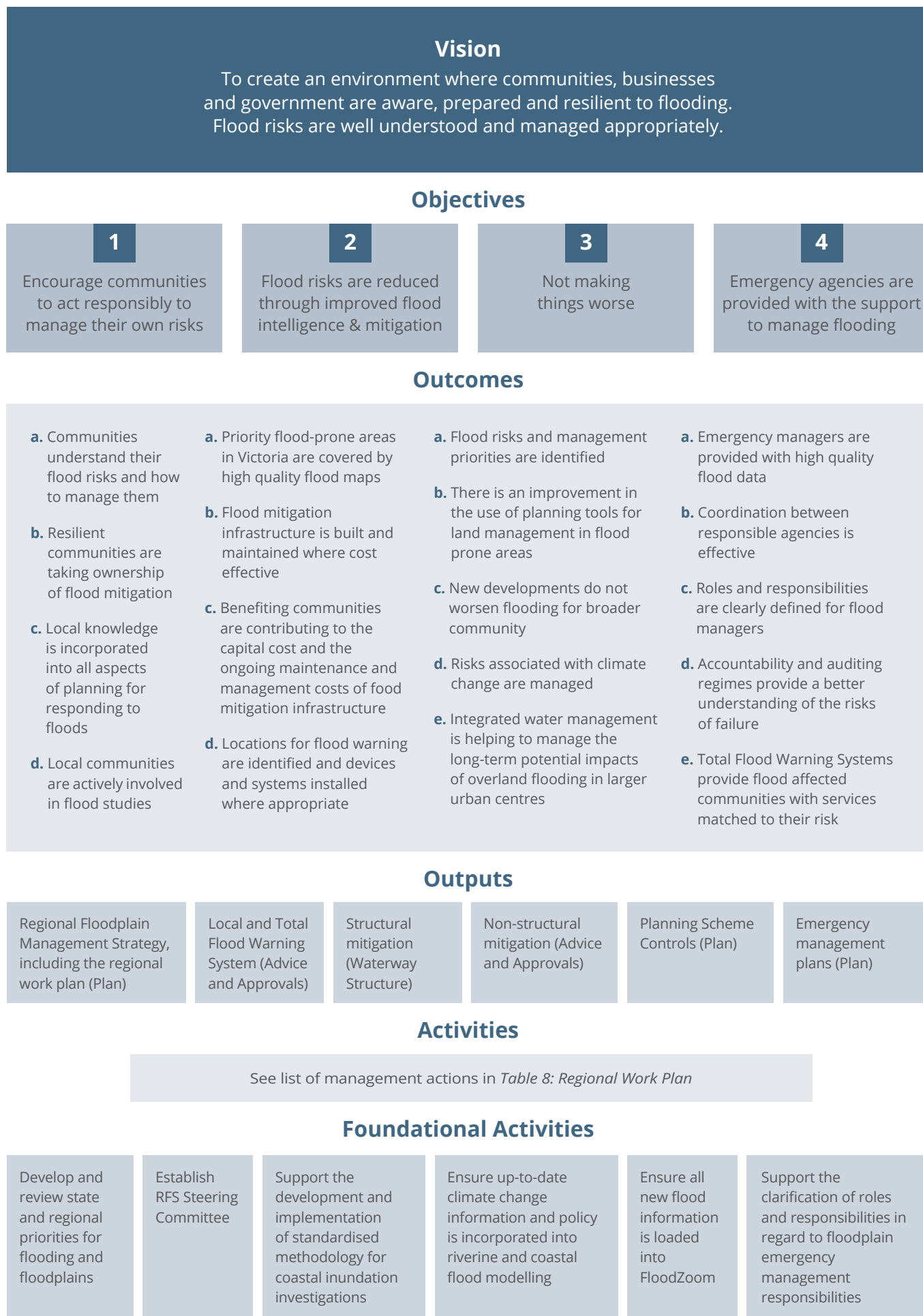


Figure 16: Program Logic for Glenelg Hopkins Regional Floodplain Management Strategy





*Photo: Victoria Valley (Templeton St) Rd overtopping bridge, Dunkeld, 8:40 am, 14 January 2011
Source: Phil Perret*

Assumptions

Assumptions are the expectations, based on current knowledge and experience, about what is important for the strategy's success. The following assumptions have been applied to the program logic:

- data is available and can be meaningfully applied when evaluating and reporting on implementation
- resources are available for monitoring activities, data collection and management
- resources are available to deliver the necessary action outlined in the regional works plan
- funding is available over the longer term to support the achievement of priority management actions.

MER Stages

MER requires a three-phase cycle of planning, implementation and review:

- planning – development of the program logic and using it to develop the MER Plan
- implementation of the MER Plan – includes ongoing monitoring, periodic evaluation and reporting of achievements and impacts including progress towards the targets
- review of the MER Plan – ongoing and occurring annually as a minimum. This will enable assumptions to be reviewed and updated where necessary, activities to be documented and areas for improvement or modification identified.

Monitoring

Monitoring activities will be targeted to inform evaluation and reporting on regional strategy implementation.

Monitoring activities also include the collection of information relating to foundational influences and externalities that impact on regional strategy implementation. Foundational influences include factors such as climatic variability, drought, flood, bushfire and potential impacts of climate change. Externalities include factors such as land use change, population growth, government support, economic conditions, community expectations and landholder attitudes.

Monitoring activities will be consistent with the Victorian Floodplain Management Strategy's MER framework (to be developed). This framework will include:

- processes for monitoring and reporting delivery of actions at the local, regional and state levels
- a process to update the strategy if required
- a five-yearly progress review of the strategy's implementation.

Evaluation

Evaluation questions have been developed to assess the effectiveness of the regional strategy and gain new information.

Evaluation of the regional strategy will include an assessment of the extent to which the outcomes have been achieved. This will be undertaken through the tracking progress against outcomes, management actions and foundational activities. It will also address any assumptions in the program logic and provide direction and improved knowledge for subsequent planning cycles.

The evaluation questions developed for the strategy address the following five categories:³³

- **Impact** – changes to resource condition, management activities or institutions
- **Appropriateness** – addressing the needs of beneficiaries and measuring against best practice
- **Effectiveness** – achievement of desired management outputs and resource condition objectives
- **Efficiency** – value or return from investment
- **Legacy** – after the program/activity ends.

The following key evaluation questions have been identified (Table 9).

Table 9: Key Evaluation Questions

Category	Key Evaluation Questions
Impact	What activities / outputs were delivered through implementation of the strategy? To what extent have strategy outcomes been met? To what extent has implementation of the strategy improved our knowledge? Have there been any unexpected outcomes?
Appropriateness	Are the current actions (activities/outputs) still the most effective for meeting the outcomes or are there other, more effective ways?
Effectiveness	How effective were the priority management actions at meeting strategy outcomes? Are the current actions (activities/outputs) still the most effective for meeting the outcomes or are there other, more effective ways?
Efficiency	To what extent have the priority management actions been completed? To what extent has the works program been implemented? What could be done differently to improve implementation?
Legacy	How are the effects of the regional strategy expected to continue over time, particularly after the strategy has reached the end of its life?

The scale and frequency of evaluation will vary throughout the life of the regional strategy, and will include an annual review cycle and more detailed reviews after three years and in the final year of the regional strategy.

The annual reviews will assess progress towards the planned management activities. These reviews will consider any new information that may require changes to the management activities (via the risk assessment or prioritisation processes). Each annual review will be undertaken by the CMA in collaboration with partners responsible for implementing actions.

The three-year review will also assess progress towards management activities and where possible, review progress towards management outcomes. This review may also provide new information that may lead to an update of the regional strategy to support an adaptive approach.

The final review of the regional strategy will focus on capturing the knowledge gained during implementation, and will include an assessment of achievements and progress towards the objectives. This will ensure that there is a clear record of achievements and lessons learned, and an evidence base for updating or changing programs and management approaches in the future.

Reporting

Reporting is an important tool to ensure accountability for the investment of funds. Over the long term, consistent and effective reporting provides evidence to evaluate and communicate the effectiveness of the regional strategy.

Annual management reporting is a component of the annual review cycle, and includes reporting on the activities and outputs achieved for the year and associated budget. For CMAs, this reporting is delivered through the CMA Annual Report and annual investment reports for existing funding arrangements with the Victorian government.

Partner organisations participating in the delivery of this strategy will have their own budgeting and reporting processes.

Key stakeholders at organisational, community, regional, state and Commonwealth levels who should be kept informed on the progress of the regional strategy will be identified and appropriate communication tools developed.

Improvement

Annual and interim strategy progress reviews and program reporting will be used as a basis for identifying improvement opportunities and where appropriate, alternative pathways to achieve desired outcomes.

Governance and Accountability

An implementation steering committee will be established to oversee the implementation of the RFMS. The steering committee will primarily be comprised of partner agencies with floodplain management responsibilities.

Responsibility for implementing specific actions in the RFMS work plan will rest with the organisation nominated to lead the delivery of that action.



*Top Photo: Glenelg Inn, Casterton, 1906.
Source: Henry A. George*

*Middle Photo: Casterton in flood, 1906.
Source: Henry A. George*

*Bottom Photo: Casterton in Flood, 1906.
Source: J. T. Sommerville*

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Appendix I – Regional Catchment Strategy 2013–2019

RCS Objective	Summary of Progress
<p>3.4 Increase provision of reliable flood information for settlements.</p>	<p>Measure 3.4.1 ‘Complete a Regional Floodplain Management Plan’ has been addressed through the development of this strategy. Several flood studies have been completed or are in progress to improve knowledge of potential flood impacts on settlements (measure 3.4.4). Completed flood studies include Burrumbeet Flood Investigation, Skipton Flood Investigation, Port Fairy Coastal Hazard Assessment, Casterton Flood Warning and Intelligence, Glenelg River Regional Flood Mapping, Harrow Flood Investigation, Ararat Flood Investigation and the Fitzroy-Darlot Creek Regional Flood Investigation. The Coleraine Flood Investigation and Mt Emu Creek Regional Flood Investigation will commence before the end of the 2017–18 financial year.</p> <p>Planning scheme amendments to reflect best available flood information have been adopted for Pyrenees Shire Council, Corangamite Shire Council, Glenelg Shire Council, Moyne Shire Council, Warrnambool City Council and Ballarat City Council (measure 3.4.5).</p>
<p>3.5 Improve river and floodplain management.</p>	<p>Two management measures were associated with this objective: 3.5.1) increase community preparedness for flood events through development of early warning systems and flood awareness programs, and 3.5.2) seek community input during the planning and delivery of strategic management plans.</p> <p>To increase community preparedness for flood events the CMA has supported LGAs and VICSES to develop Municipal Flood Emergency Plans for Warrnambool City, Southern Grampians Shire, Moyne Shire Council, Ararat Rural City Council, Ballarat City Council, Corangamite Shire Council, West Wimmera Shire Council, Glenelg Shire Council and Pyrenees Shire Council. Regional MFEPs are at varying stages of completion.</p> <p>VICSES has developed local flood guides for Wickliffe, Hamilton, Port Fairy, Warrnambool, Beaufort, Miners Rest, Casterton and Skipton. An early flood warning system has been developed for Russell Creek.</p> <p>Measure 3.5.2 is being addressed through the development of this strategy.</p>

Appendix II – Urban Management Units identified as having a significant flood risk

Location	LGA	Density of Damages	AAD	Pop	Sum of Values
Beaufort	Pyrenees Shire Council	4.8	4.7	4.6	14.2
Miners Rest	Ballarat City Council	5.2	4.9	3.8	14.0
Ararat	Ararat Rural City Council	4.9	5.2	3.0	13.1
Warrnambool North	Warrnambool City Council	5.3	5.3	2.0	12.6
Allansford	Warrnambool City Council	4.8	3.5	3.7	12.1
Port Fairy	Moyne Shire Council	3.7	4.7	3.5	11.9
Sandford	Glenelg Shire Council	4.6	1.9	3.9	10.3
Warrnambool South	Warrnambool City Council	3.6	4.5	1.3	9.4
Harrow	West Wimmera Shire Council	3.9	1.7	3.6	9.2
Casterton	Glenelg Shire Council	2.6	3.6	2.8	9.1
Portland	Glenelg Shire Council	3.5	3.5	1.4	8.4
Dartmoor	Glenelg Shire Council	4.6	1.3	2.6	8.4
Wickliffe	Ararat Rural City Council	4.5	1.4	2.5	8.4
Hamilton	Southern Grampians Shire Council	3.5	3.5	1.3	8.3
Coleraine	Southern Grampians Shire Council	4.7	1.4	1.2	7.3
Skipton	Corangamite Shire Council	2.6	1.6	2.5	6.7
Learmonth	Ballarat City Council	3.6	1.1	1.9	6.7
Warrnambool East	Warrnambool City Council	3.0	1.8	1.1	5.9
Heywood	Glenelg Shire Council	1.5	1.9	2.4	5.9
Panmure	Moyne Shire Council	1.2	1.4	2.8	5.3

Appendix III – Existing flood mitigation infrastructure

Name	Location	Description	Condition	Ongoing Management
Holden Street Levee	Hamilton	Levee	Moderate	TBC
Russell Creek Flood Walls	North Warrnambool	Concrete wall/ levee	Excellent	Warrnambool City Council
Mortlake Road Culvert	North Warrnambool	Bridge	Excellent	Warrnambool City Council
Garibaldi Creek concrete lined channel	Beaufort	Flood flow channel	Excellent	Pyrenees Shire Council
Beaufort railway embankment culverts (4)	Beaufort	Afflux attenuation	Excellent	VICTRACK
Jubilee Lake overflow pipes	Skipton	Flood flow pipes	Excellent	Corangamite Shire Council
East Beach Port Fairy Sea Wall	Port Fairy	Rock barrier to storm surge	Substandard	Moyne Shire Council
Pea Soup Seawall	Port Fairy	Rock barrier to storm surge	Unknown	Moyne Shire Council
Dutton Way Sea Wall	Dutton Way	Rock barrier to storm surge	Unknown	Glenelg Shire Council

Appendix IV – Preferred Management Actions

ID #	Location	LGA	Preferred Management Action
1	Glenelg Hopkins Region	As relevant	Undertake regional flood investigations
2	Glenelg Hopkins Region	All	Comply with actions, accountabilities and responsibilities of the 2017 Victorian Rural Drainage Strategy
3	Glenelg Hopkins Region	All	Investigate opportunities for community education on the impact of vegetation in waterways
4	Glenelg Hopkins Region	All	Assist councils to develop animations of flood behaviour that can be used in the development of community flood awareness videos
5	Glenelg Hopkins Region	All	Assist councils to develop property-specific flood information
6	Glenelg Hopkins Region	All	Assist councils to incorporate all flood study information into MFEPs
7	Glenelg Hopkins Region	All	Develop a State Community Observers Network Website enabling the community to provide local knowledge during a flood events
8	Glenelg Hopkins Region	All	Investigate options to improve community access to website flood risk information to allow people to better plan, prepare and respond to flooding
9	Glenelg Hopkins Region	All	Install community education signs and gauge boards at high-priority locations within the catchment to raise community flood risk awareness and to provide links to websites with more detailed flood risk information
10	Glenelg Hopkins Region	All	Update Municipal Flood Emergency Plans (MFEP) to incorporate the latest flood study intelligence and transport routes impacted by flooding
11	Miners Rest	Ballarat City Council	Review of Local Flood Guide to incorporate new housing estates
12	Harrow, Chetwynd	West Wimmera Shire Council	Undertake community flood education engagement activities and develop flood awareness products for Harrow and Chetwynd
13	Ararat	Ararat Rural City Council	Undertake community flood education engagement activities and develop flood awareness products for Ararat
14	Glenelg Hopkins Region	All	Investigate the installation of gauge boards along major waterways at major highways
15	Glenelg Hopkins Region	All	Investigate options for protecting sewer pump stations and sewer pits from flood impacts including reducing the likelihood of sewer contamination to floodwater
16	Glenelg Hopkins Region	As relevant	Undertake Cultural Heritage Due Diligence as part of post-flood remediation works through Natural Disaster Relief and Recovery Arrangements (NDDRA)
17	Glenelg Hopkins Region	Southern Grampians Shire Council	Incorporate cultural values assessment as part of the Coleraine Flood Investigation
18	Glenelg Hopkins Region	As relevant	Incorporate a cultural values assessment as standard practice when undertaking regional flood investigations and assist LGAs in these assessments for urban flood investigations
19	Glenelg Hopkins Region	As relevant	Support DELWP in the development of guidelines to ensure that significant Aboriginal cultural values are considered as part of the incident control arrangements during emergency events
20	Glenelg Hopkins Region	As relevant	Explore opportunities to undertake a project identifying structures in the floodplain that may impact cultural heritage sites

Lead Agency	Timeframe			Resources available	Included in work plan/cost estimates TBA	Objectives and outcomes
	short	med	long			
GHCMA		✓				2-a 3-a
GHCMA	✓					4-c
GHCMA	✓					1-a
GHCMA	✓					1-a
GHCMA	✓					1-a
GHCMA	✓					4-a
VICSES	✓			✓		1-c
VICSES	✓			✓		1-a
VICSES	✓			✓		1-a
VICSES	✓					4-a
VICSES	✓					1-a
VICSES	✓			✓		1-a
VICSES	✓			✓	✓	1-a
VicRoads		✓				2-d
Central Highlands Water and Wannon Water		✓				3-a
GHCMA	✓			✓	✓	1-d 1-c
GHCMA	✓			✓	✓	1-d
GHCMA			✓	✓	✓	1-d
GHCMA		✓				4-b
GHCMA		✓				3-a 3-b

Appendix IV – Preferred Management Actions (continued)

ID #	Location	LGA	Preferred Management Action
21	Glenelg Hopkins Region	As relevant	Ensure Traditional Owners are consulted when floodplain management activities are carried out on areas where Native Title has been determined or where they could impact on cultural heritage
22	Ararat	Ararat Rural City Council	Undertake planning scheme amendment based on mapping from Ararat flood investigation
23	Ararat and Wickliffe	Ararat Rural City Council	Investigate investment opportunities for structure upgrades to alleviate flooding
24	Ararat	Ararat Rural City Council	Investigate options for flood warning in Ararat
25	Mount Emu Creek	Ararat/ Corangamite/ Moyne/Pyrenees Shires	Complete a regional flood investigation for the Mount Emu Creek catchment
26	Wendouree	Ballarat City Council	Investigate undertaking a combined stormwater and riverine flooding investigation for Wendouree
27	Burrumbeet Catchment	Ballarat City Council	Investigate options for potential flood warning for the Burrumbeet catchment
28	Burrumbeet Catchment	Ballarat City Council	Undertake detailed design for the Burrumbeet high-flow bypass channel and implement works to mitigate flooding of properties on Burrumbeet Creek
29	Skipton	Corangamite Shire Council	Upgrade the Guthries Bridge gauge to a telemetered station and investigate flood warning opportunities
30	Skipton	Corangamite Shire Council	Investigate options for a community flood marker within the township of Skipton
31	Corangamite Shire Council	Corangamite Shire Council	Investigate funding for regional flood mapping for the whole shire, identifying key rural flow paths and providing intelligence on where overland flow paths might impact on roads/assets
32	Coastal Areas	Glenelg Shire Council, Moyne Shire Council and Warrnambool City Council	Identify priority areas for undertaking detailed coastal and storm tide flooding investigations through the Barwon South West Regional Local Coastal Hazard Scoping Project
33	Dartmoor and Nelson	Glenelg Shire Council	Investigate funding opportunities to undertake flood investigations for Dartmoor and Nelson, and subsequent planning controls.
34	Casterton	Glenelg Shire Council	Investigate establishment of telemetered stream flow gauge on the Glenelg River at Casterton
35	Heywood	Glenelg Shire Council	Introduce planning controls for Heywood based on flood modelling from the Fitzroy Darlot Flood Investigation
36	Bridgewater	Glenelg Shire Council	Investigate feasibility of sea wall construction at Bridgewater

Lead Agency	Timeframe			Resources available	Included in work plan/cost estimates TBA	Objectives and outcomes
	short	med	long			
GHCMA	✓					1-d
Ararat Rural City Council	✓			✓	✓	3-b
Ararat Rural City Council		✓				2-b
Ararat Rural City Council		✓				2-d
GHCMA	✓			✓	✓	2-a
Ballarat City Council			✓			2-a 3-a
Ballarat City Council		✓				2-d
Ballarat City Council	✓			✓	✓	2-b
Corangamite Shire Council	✓					2-d
Corangamite Shire Council	✓			✓	✓	2-d
Corangamite Shire Council	✓					2-a
Warrnambool City Council	✓			✓	✓	3-a 3-b
Glenelg Shire Council	✓			✓	✓	2-a
Glenelg Shire Council		✓				2-d
Glenelg Shire Council		✓				3-b
Glenelg Shire Council		✓				2-b 3-b

Appendix IV – Preferred Management Actions (continued)

ID #	Location	LGA	Preferred Management Action
37	Heywood	Glenelg Shire Council	Investigate opportunities to explore flood warning options for Heywood
38	Heywood	Glenelg Shire Council	Replace/repair damaged staff flood gauge at the end of Bond Street, Heywood
39	Glenelg Shire	Glenelg Shire Council	Develop a Municipal Flood Emergency Plan for Glenelg Shire
40	Lake Condah and Tyrendarra	Glenelg Shire Council	Explore opportunities for an investigation into water diversion for Lake Condah and the Tyrendarra Indigenous Protected Area to activate eel traps and structures
41	Relevant Council Areas	As relevant	Develop a floodplain management plan for the shire
42	Moyne Shire	Moyne Shire Council	Investigate opportunities for funding for coastal inundation modelling for Moyne Shire Council outside Port Fairy
43	Port Fairy	Moyne Shire Council	Undertake community flood education engagement activities and develop flood awareness products for Port Fairy
44	Port Fairy	Moyne Shire Council	Undertake planning scheme amendment to amend flooding overlays in Port Fairy based on updated flood information
45	Port Fairy	Moyne Shire Council	Investigate viability of raising level of low areas of Griffiths Street to mitigate access issues associated with flooding
46	Port Fairy and Moyne Shire	Moyne Shire Council	Investigate opportunities to implement sea walls in and around Port Fairy
47	Port Fairy	Moyne Shire Council	Investigate mitigation options for flooding on Ocean Drive
48	Moyne Shire	Moyne Shire Council	Install flood depth markers along priority flood-affected roads
49	Cudgee	Moyne Shire Council	Complete Cudgee Flood Investigation
50	Port Fairy	Moyne Shire Council	Investigate alteration to coastal inundation overlays as a result of modelling produced through the Port Fairy Coastal and Structure Planning Project
51	Pyrenees Shire	Pyrenees Shire Council	Engage stakeholders in a review of the Pyrenees floodplain management plan
52	Raglan and Trawalla	Pyrenees Shire Council	Investigate opportunities for flood mapping of Raglan and Trawalla and subsequent planning scheme update to prevent inappropriate development on the floodplain
53	Beaufort	Pyrenees Shire Council	Investigate flood warning options for Beaufort for Yam Holes Creek
54	Beaufort	Pyrenees Shire Council	Investigate alteration of flooding overlays on old school grounds on Garibaldi Creek
55	Pyrenees Shire	Pyrenees Shire Council	Identify priority locations for road closure signage during flood events
56	Coleraine	Southern Grampians Shire	Complete the Coleraine Flood Investigation

Lead Agency	Timeframe			Resources available	Included in work plan/cost estimates TBA	Objectives and outcomes
	short	med	long			
Glenelg Shire Council		✓				2-d
Glenelg Shire Council		✓				2-d
VICSES	✓					4-a
GHCMA			✓			1-c
All except Warrnambool & Pyrenees Shires			✓			3-b
Moyne Shire Council		✓				2-a
VICSES		✓				
Moyne Shire Council	✓					3-b
Moyne Shire Council		✓				2-b
Moyne Shire Council	✓					2-b
Moyne Shire Council		✓				2-b
Moyne Shire Council		✓				2-d
Moyne Shire Council	✓			✓	✓	3-a
Moyne Shire Council	✓					3-b
Pyrenees Shire Council	✓			✓	✓	3-b
Pyrenees Shire Council		✓				3-a 3-b
Pyrenees Shire Council		✓				2-d
Pyrenees Shire Council	✓					3-b
Pyrenees Shire Council		✓				4-a
Southern Grampians Shire Council	✓			✓	✓	2-a 3-a

Appendix IV – Preferred Management Actions (continued)

ID #	Location	LGA	Preferred Management Action
57	Dunkeld	Southern Grampians Shire	Explore funding opportunities to support a Dunkeld Flood Investigation
58	Hamilton, Dunkeld and Coleraine	Southern Grampians Shire	Undertake a planning scheme amendment for Hamilton, Coleraine and Dunkeld incorporating available flood information
59	Hamilton	Southern Grampians Shire	Establish management arrangements for maintenance of the Holden Street levee, Hamilton
60	Hamilton and Dunkeld	Southern Grampians Shire	Investigate risks and potential solutions for dam safety for Hamilton and Dunkeld water storage facilities
61	Lake Hamilton	Southern Grampians Shire	Investigate opportunities for stream monitoring upstream of Lake Hamilton for additional flood warning
62	Branxholme	Southern Grampians Shire	Investigate opportunities to reduce/eliminate contamination from Branxholme oval septic tanks during flood events
63	Russell Creek	Warrnambool City Council	Complete flood modelling for 'as constructed' conditions of the Russell Creek flood walls
64	Warrnambool	Warrnambool City Council	Undertake community flood education engagement activities and develop flood awareness products for Warrnambool
65	Logans Beach and Allansford	Warrnambool City Council	Identify flood prone areas through structure plans for Logans Beach and Allansford and introduce planning controls
66	Russell Creek	Warrnambool City Council	Consider flood warning options for the Russell Creek catchment
67	Merri River and Russell Creek	Warrnambool City Council	Undertake Part 2 of planning scheme amendment C78 to introduce/modify flood controls in South and North Warrnambool
68	Russell Creek Tributary	Warrnambool City Council	Investigate options for flood mitigation and further development within the urban growth boundary north of Wangoom Road
69	Merri River, Woodford	Warrnambool City Council	Explore options for use of Woodford gauge on flood intelligence platforms (either FloodZoom or Ventia Data Vision)
70	Chetwynd	West Wimmera Shire Council	Undertake flood modelling for Chetwynd
71	Harrow and Chetwynd	West Wimmera Shire Council	Amend flood controls in Harrow and Chetwynd through a planning scheme amendment
72	Harrow and Chetwynd	West Wimmera Shire Council	Develop a MFEP, incorporating Harrow and Chetwynd flood information and identifying known road closures, as well as providing any potential alternative routes for school buses and large trucks
73	Mooree	West Wimmera Council and Southern Grampians Shires	Investigate options to increase deck height of Mooree Bridge
74	West Wimmera Shire	West Wimmera Shire	Investigate options for rain gauges to inform of potential flooding in the region

Lead Agency	Timeframe			Resources available	Included in work plan/cost estimates TBA	Objectives and outcomes
	short	med	long			
Southern Grampians Shire Council	✓					2-a 3-a
Southern Grampians Shire Council		✓				3-b
Southern Grampians Shire Council		✓				1-b 4-c
Southern Grampians Shire Council	✓			✓	✓	1-a
Southern Grampians Shire Council	✓			✓	✓	2-d
Southern Grampians Shire Council			✓			3-a
Warrnambool City Council	✓			✓	✓	2-a
VICSES	✓					
Warrnambool City Council	✓					3-c
Warrnambool City Council	✓			✓	✓	4-e
Warrnambool City Council	✓			✓	✓	3-b
Warrnambool City Council		✓				3-c
Warrnambool City Council	✓					4-b
West Wimmera Shire Council	✓			✓	✓	3-a
West Wimmera Shire Council	✓			✓	✓	3-b
VICSES	✓					4-a
West Wimmera Shire Council		✓				2-c 1-b 2-b
West Wimmera Shire		✓				2-d



Glenelg Hopkins



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