# North Central Regional Floodplain Management Strategy

## 2018–2028

Regional Floodplain Management Strategy

Everyone has a role to play in preparing for floods

***Produced by the North Central Catchment Management Authority in collaboration with regional partners***

**Bullock Creek flood waters flowing around Pyramid Hill in January 2011.**
***Photograph: Adrian Martins, North Central CMA***

**Cover photograph: Bullock Creek and Loddon River flood waters converge south east of Serpentine in January 2011.**
***Photograph: Colin Hokin***

North Central Regional Floodplain Management Strategy



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# Contents

# Acknowledgements

The North Central Catchment Management Authority (CMA) acknowledges Aboriginal Traditional Owners within the region, their rich culture and their spiritual connection to Country. We also recognise and acknowledge the contribution and interest of Aboriginal people and organisations in land and natural resource management.

A Steering Committee of experienced representatives of key regional partners oversaw the development of this Floodplain Management Strategy. The committee was chaired by David Clark, then North Central CMA Board Chair, and included representation by Charlie Gillingham and Ron Cosgrave of the North Central CMA, Jason Russell of the Campaspe Shire Council, Jason Taylor of the Mount Alexander Shire Council, Cr Brian Gibson, Mayor of Gannawarra Shire Council, and Mark Cattell of VICSES. The project was supported by the management and staff of the North Central CMA, with technical input from our partners.

VICTORIA State Government | Environment, Land, Water and Planning

The Victorian Government has committed $25 million funding to support implementation of the Victorian Floodplain Management Strategy across Victoria.

Buloke Shire Council

City of Ballarat

City of Greater Bendigo

Campaspe Shire Council

Central Goldfields Shire Council

Gannawarra Shire Council

Hepburn Shire Council

Loddon Shire Council

Macedon Ranges Shire Council

Mitchell Shire Council

Mount Alexander Shire Council

Northern Grampians Shire Council

# Partnership statement

The vast, flat floodplains of the North Central CMA region mean that the impacts of flooding are not local issues confined to our rivers and creeks, but a far-reaching natural hazard that influences the lives of many who live and work across our region.

The North Central CMA has worked diligently to develop this Strategy in consultation with our communities, our local government authorities and various State agencies to ensure the actions within the Regional Work Plan address identified risks and align with our community's expectations.

The Regional Work Plan takes a pragmatic and responsible approach. The actions listed address all issues raised by our communities and authorities, with priorities assigned based on a balanced view of the level of flood risk and the capacity of the action leader to deliver it.

While flood risk can never be entirely removed from our region, the actions within the Regional Work Plan will improve the flood resilience of our communities and facilitate quicker recoveries by individuals and businesses, reducing the social and economic impacts of future flood events.

The North Central CMA is committed to the delivery of the Regional Work Plan in partnership with our local governments, agencies and communities.

**Julie Miller Markoff**

**Chair – North Central CMA**

Pyrenees Shire Council

Swan Hill Rural City

North Central Catchment Management Authority

VICSES North West

Parks Victoria Northern Rivers

Coliban Water

Goulburn Murray Water

VicRoads Northern Region

Bureau of Meteorology

# Executive Summary

The purpose of this strategy is to provide a single, regional planning document for floodplain management within the North Central CMA region and a high-level Regional Work Plan to guide future investment priorities.

The strategy has been developed by the North Central CMA in partnership with local councils, water corporations, Victoria State Emergency Service (VICSES), Traditional Owners, the Department of Environment, Land, Water and Planning (DELWP), Parks Victoria, VicRoads, Bureau of Meteorology and local communities.

Our collective vision for floodplain management in the region is one where North Central Victorian communities are aware of flooding and are actively taking measures to manage their flood risks to minimise the consequences to life, property, community wellbeing, the economy and the environment.

To this end, four objectives have been defined for the strategy:

1. Build resilient communities – through collating and sharing flood risk information.
2. Reduce existing flood risk – by implementing and maintaining flood mitigation infrastructure.
3. Avoid future risk – through effective strategic and statutory land use planning and building controls.
4. Manage residual risk – by improving and coordinating flood warning and response arrangements.

A region-wide risk assessment has been undertaken, based on the probability and magnitude of flooding, and its potential economic and social impact. The North Central CMA region has a general trend of higher risk in the lower rural catchment areas; risks to townships are experienced evenly across the catchment.

The existing treatment service levels have also been assessed. This included planning schemes, mitigation infrastructure and total flood warning systems.

These assessments, alongside the risk profile, have enabled deficiencies to be identified and priorities for floodplain management actions to be determined equitably.

Common floodplain management themes arising throughout this process included:

- inadequate coverage of high-quality flood mapping to inform planning scheme amendments and Municipal Flood Emergency Plans, and provide timely and meaningful warnings to the community
- varying expectations of the management of flood flow distributions and their interaction with the environment
- uncertainty about the roles and responsibilities of both agencies and the community
- management of residual floodwaters (including works by landholders)
- vegetation removal and waterway management
- cultural heritage
- safe access/transport routes.

These issues, along with the risk and treatment service level assessments, have culminated in the seven regional priorities listed on the next page.

**Levees protecting Kerang near the Kerang Caravan and Tourist Park.** ***Photograph: Adrian Martins, North Central CMA***

## Regional priorities:

1. Update planning controls to reflect the best available information.
2. Construct new flood mitigation infrastructure, resolving ownership and maintenance accountabilities, and improving floodplain function.
3. Address gaps in flood knowledge through flood mapping projects.
4. Improve preparedness for flood emergencies.
5. Educate agencies and individuals on the roles and responsibilities in floodplain management.
6. Incorporate Traditional Owner knowledge into floodplain management activities.
7. Create a flood-resilient transport system.

A Regional Work Plan has been developed, assigning local actions that contribute to addressing the regional priorities. The Work Plan addresses actions in three-year intervals. All the actions listed are expected to be carried out over the life of the strategy (nominally 10 years). Actions that do the most to reduce risk have been prioritised.

**Loddon River in flood at Bridgewater in November 2010.**
***Photograph: Adrian Martins, North Central CMA***

# PART 1 – PURPOSE AND SCOPE

## 1.1 Introduction

The purpose of this strategy is to provide a single, regional planning document for floodplain management and a high-level Regional Work Plan to guide future investment priorities.

The strategy has been developed by the North Central CMA in partnership with the region's Local Government Authorities (LGAs), water corporations, Victoria State Emergency Service (VICSES), Traditional Owners, the Department of Environment, Land, Water and Planning (DELWP), Parks Victoria, VicRoads, Bureau of Meteorology and local communities.

Our collective vision for floodplain management in the region is one where North Central Victorian communities are aware of flooding and are actively taking measures to manage their flood risks to minimise the consequences to life, property, community wellbeing, the economy and the environment.

Four objectives for the strategy have been defined:

1. Build resilient communities – through collating and sharing flood risk information.
2. Reduce existing flood risk – by implementing and maintaining flood mitigation infrastructure.
3. Avoid future risk – through effective strategic and statutory land use planning and building controls.
4. Manage residual risk – by improving and coordinating flood warning and response arrangements.

This strategy processed assessed the flood risk of the North Central CMA region and identified actions and accountabilities for managing these risks. Priority has been given to measures that do the most to narrow the gap between existing flood risks and the community's willingness to accept those risks.

## 1.2 Document structure

This document has three parts:

**Part 1:** provides the scope and regional context of the strategy.

**Part 2:** identifies and discusses flood risks and opportunities within the catchment.

**Part 3:** documents the actions, roles and responsibilities in delivering the strategy.

Given the broad reach of the North Central CMA region, the body of this document does not attempt to address the local risks and opportunities for each area. These have been addressed in consultation with communities and each LGA.

## 1.3 The North Central CMA region

The North Central CMA region covers 13% of Victoria's land area and encompasses a diverse range of land types, from the foothill forests of the Great Dividing Range to the riverine plains of the north. The region has four major river catchments: the Campaspe, Loddon, Avoca and Avon-Richardson (see Figure 1). The catchments extend across 14 Local Government Authoities (LGAs) and seven Traditional Owner groups.

The region supports many significant and important natural assets, ranging from internationally recognised wetlands such as the Gunbower Forest to the complex ecosystems of the river floodplains, which support a diversity of native flora and fauna.

Waterways and floodplains are central to Aboriginal cultural identity, and there are many sites of cultural significance throughout the region. Despite extensive changes to the landscape since European occupation, the region holds important physical evidence of Aboriginal activity. Of those places noted in the Victorian Aboriginal Heritage Register, more than half are within 500 metres of a waterway. Aboriginal groups continue to have a strong affiliation with the region's waterways.

The region supports a range of industries, but the predominant land use is agriculture, with extensive areas of irrigation in the north, productive cropping and mixed farming in the west, and cropping and grazing country in the mid and upper catchments.

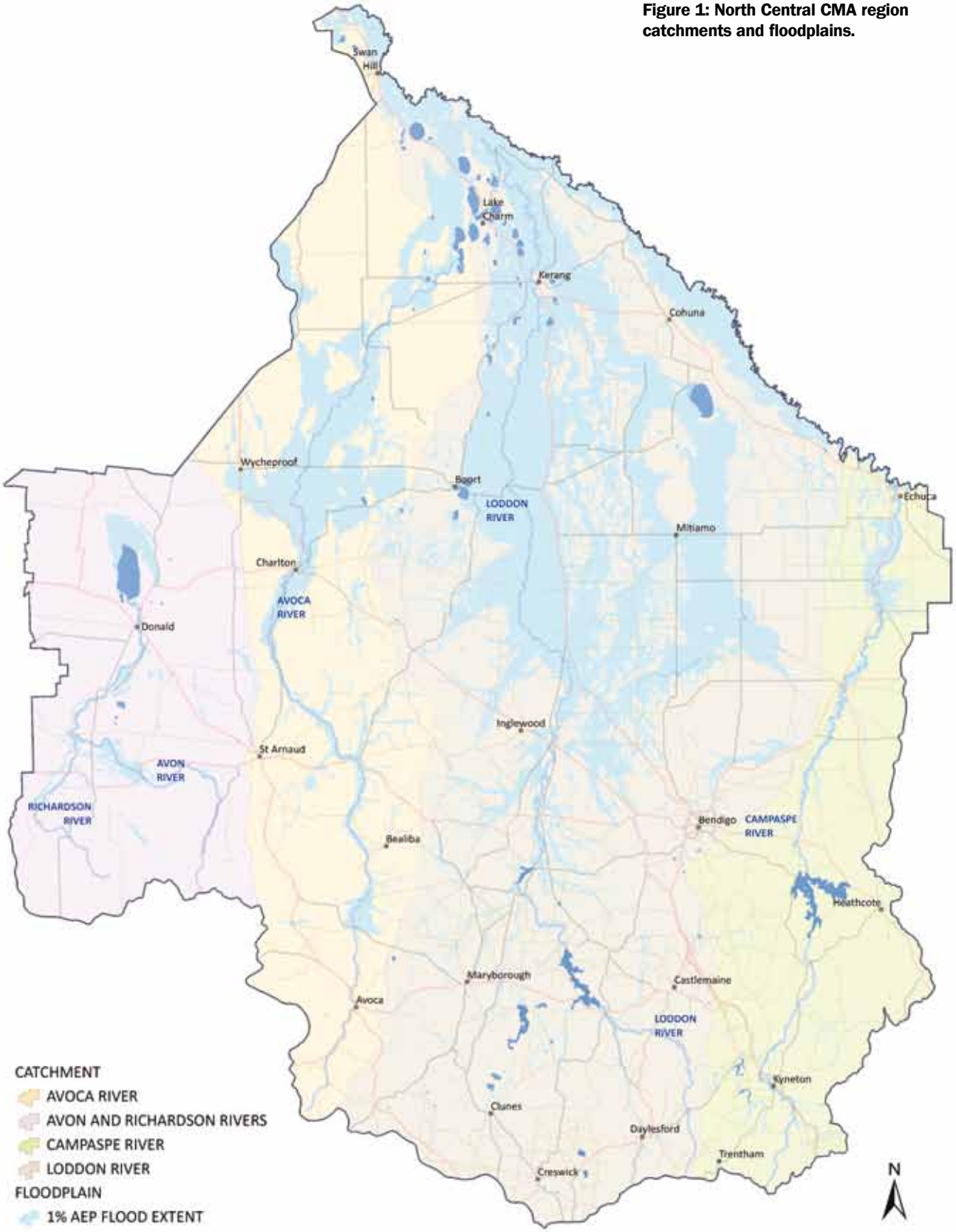
The region's population is roughly 250,000, with continuing population growth expected in urban areas such Bendigo, Castlemaine, Kyneton and Echuca.

Social and economic factors will continue to drive the region's growth and change, but the catchments also include areas where flooding has historically caused substantial damage to both the natural and the built environment. Flooding is a natural hazard in the region. Whether floods are caused by high rainfall, inland storms or inadequate drainage, they can severely disrupt communities, causing injury, loss of life, property damage, personal hardship and disruptions to regional economies.

More than 780,000 hectares of rural and urban land across the region, under both public and private ownership, is subject to inundation by a 1% Annual Exceedance Probability (i.e. a 1–in-100 year average recurrence interval) flood.

River regulation works and inappropriate development in the past have had a significant impact on the natural floodplains by changing the flood frequency and flooding patterns, causing deterioration in the natural riverine, floodplain and wetland environments. The region is threatened both from the absence of flooding to promote ecological and cultural values at specific sites across the landscape, and from the social and economic impacts when floods do occur.

**Figure 1: North Central CMA region catchments and floodplains.**



## 1.4 A short history of flooding in the region

Early river regulation, including river gauging stations, has provided a long history of recorded floods during the region's European occupation, with gauge records as far back as the 1890s for floods on the Loddon River. Major and widespread floods were recorded in 1909, 1916-17, 1923, 1933, 1956, 1973-76, 1983, 1988, 1993, 1998 and, more recently, during the summer of 2010-11 and again in February 2012 and September 2016.

The January 2011 flood was the largest on record for most river systems in the region, inundating an estimated 780,000 hectares (more than 25% of the region). The intensity and amount of rainfall that saturated areas of Victoria in 2010–11 resulted in the largest, or close to the largest, floods recorded on many of the state's major river systems. Water storages and wetlands were filled, minimising opportunities to mitigate flood impacts. Some affected areas had not previously been identified as subject to flooding, while other places had been affected multiple times.

The response to these floods included the Review of 2010-11 Flood Warnings and Response and the Environment and Natural Resources Committee Inquiry into Flood Mitigation Infrastructure in Victoria and was the catalyst for the development of the 2016 Victorian Floodplain Management Strategy, in which the Regional Floodplain Management Strategies are a priority action. Learnings and memories from the 2010-11 floods have had a strong influence on the development of this document and the September 2016 floods reinforced the need for additional action within the region.

**Men sandbagging to protect properties near Lake Boga in 1931.** ***Photograph: J.D. Wallis, District Officer, State Rivers and Water Supply Commission***

**Floods at Donald in August 1909. Area behind Woods Street.** ***Photograph: Prentice Family***

**Looking west down High St Charlton, 1909 flood.** ***Photograph: Charlton Golden Grains Museum***

**Serpentine Weir, Loddon River, 1932.** ***Photograph: Source unknown, from North Central CMA collection***

## 1.5 Roles and responsibilities

Everyone has a role to play in managing the risks associated with the the regions floodplains, and a coordinated and cooperative approach is required.

This strategy is a collaborative document and is intended to help all agencies across the North Central CMA region involved in floodplain and flood emergency management to work towards aligned priorities. It is important to recognise the roles and responsibilities of each agency, and how they function within the broader context of floodplain management. These are summarised in Table 1.

**Table 1: Roles and responsibilities.**

| Partners | Roles and responsibilities |
|---|---|
| **Australian Government agencies** | |
| Bureau of Meteorology (BoM) | BoM is responsible for providing forecasting and warning services for severe weather and riverine flooding. It owns a portion of the data collection network and contributes to the ongoing maintenance of the equipment used for flood warning in Victoria via the Regional Water Monitoring Partnership. |
| Attorney-General's Department – Emergency Management Australia | Emergency Management Australia is responsible for developing national standards and policies for emergency management and assistance to the states and territories. It provides financial assistance under the Natural Disaster Resilience Grants Scheme (NDRGS) and the Natural Disaster Relief and Recovery Arrangements (NDDRA). |
| **Victorian Government agencies and statutory bodies** | |
| Department of Environment, Land, Water and Planning (DELWP) | The Secretary of DELWP (as the body corporate) is the primary owner and manager of Crown land in Victoria. The Secretary delegates management of Crown land to other entities and authorities (such as Parks Victoria and Committees of Management) for management.<br>DELWP is also responsible for the development of flood policy, and coordination and repository of the Victoria Flood Database, and maintaining and continually improving Victoria's Flood Intelligence Platform (FloodZoom). It provides financial assistance through the Natural Disaster Relief and Recovery Arrangements (NDRRA), and technical advice and support to assist Incident Controllers during an emergency. |
| Regional Water Monitoring Partnership | DELWP is the program manager for the Regional Water Monitoring Partnerships, which coordinates the collection of surface water quality and quantity data from about 900 monitoring sites across Victoria. Data collected under the partnerships is used for a variety of purposes including flood warning and flood studies. Members include Catchment Management Authorities, the Bureau of Meteorology, local governments and water corporations. The partnership enables organisations to share the cost of data collection and the operation and maintenance costs at common sites. It also centralises contract management to the benefit of all partners. |
| Victoria State Emergency Service (VICSES) | VICSES is responsible for flood response planning, and is the control agency during significant floods and storms. It manages community education, through engagement exercises, and produces educational material to support flood preparedness. |
| Country Fire Authority (CFA) | During floods, the CFA provides support to the VICSES either within the Incident Control Centre undertaking an Incident Management Team role or providing on-the-ground support. Often VICSES and CFA volunteers will 'cross-crew' to ensure there is one VICSES member per vehicle to guide the CFA volunteers when assisting the community. |
| Victoria Police | Victoria Police provides support to VICSES during flood events. Key roles include managing evacuations and traffic within incident areas. |
| VicRoads | VicRoads is responsible for highways and main roads throughout Victoria. In a flooding context, it is responsible for opening/closing road access, and maintaining an online register of the status of its roads. |

| Partners | Roles and responsibilities |
|---|---|
| Parks Victoria | Parks Victoria is a statutory authority created under the *Parks Victoria Act 1998*. Its functions include providing services to Victoria and its agencies for the management of parks, reserves, and other land delegated to its management by the State.<br>Parks Victoria is the land manager for the majority of Murray River frontage in the North Central CMA region, along with a number of other rivers, wetlands and tributaries, such as the Gunbower and Kerang Ramsar sites that protect important ecological and cultural values of the floodplain. |
| North Central Catchment Management Authority (CMA) | The North Central CMA was established under the *Catchment and Land Protection Act 1994* as the designated responsible manager of waterways, drainage and floodplains. In the context of floodplain management, the North Central CMA's key functions include authorising works on waterways, acting as a referral body for planning applications, identifying regional priorities for floodplain management, collating flood risk information, and providing technical advice and support to assist Incident Controllers during an emergency.<br>The North Central CMA is enabled, through legislation, to undertake priority waterway management activities via its funded programs, but does not have a responsibility to carry out flood mitigation activities or regular maintenance on waterways. |
| **Water corporations** | |
| Goulburn Murray Water, Coliban Water, Central Highlands Water, Lower Murray Water, and Grampians Wimmera Mallee Water | Water corporations in Victoria are established under the *Water Act 1989* and provide a range of water services to customers and stakeholders within their service areas. Water corporations provide a combination of irrigation services, domestic and stock services, bulk water supply services and urban water and wastewater services in the North Central CMA Region.<br>Water corporations have a responsibility to ensure water availability is maximised for entitlement holders and paying customers while protecting their supporting infrastructure.<br>The primary purpose of most reservoirs and water supply dams in the North Central CMA region is to harvest, store and deliver water to meet customer demands. Most storages offer limited flood mitigation due to a range of factors including their designed storage volume, outlet capacity and/or operating rules.<br>It is the primary responsibility of the reservoir or dam operator to protect the integrity of the structure when a flood is passing through. The operator undertakes this action with the aim of maximising water availability for entitlement holders while minimising the flood peak and impacts downstream of the storage. Decisions about releases during a flood are communicated to the Bureau of Meteorology and Incident Controllers to be considered in community flood messaging. |
| **Local Government** | |
| Local Government Authorities (LGAs) (Councils) | LGAs are involved in floodplain management in Victoria through their role as responsible planning authorities, managers of stormwater drainage, land managers and emergency management bodies.<br>LGAs usually lead the preparation of flood studies, with technical support from CMAs. The studies are usually prepared for a particular purpose, such as updating planning schemes or to provide intelligence to emergency services that provide communities with flood warnings and advice.<br>Some existing flood mitigation infrastructure schemes are managed by LGAs on behalf of their communities, e.g. the Kerang township levee. LGAs may elect to build new flood mitigation infrastructure where flood studies determine that the benefits outweigh the costs and where communities are willing to pay the ongoing maintenance for such services, e.g. Creswick levees. LGAs are not obligated to own or maintain any existing levees, but may elect to do so in consultation with their communities where the benefits of doing so can be demonstrated through a flood study.<br>LGAs are accountable for applying the planning requirements of the Victorian Planning Provisions, incorporating flood mapping and controls into their local planning schemes, and the operation and maintenance of local total flood warning service infrastructure.<br>As emergency management bodies, LGAs undertake a range of activities to prevent, respond to and provide relief/recovery from floods, with support from other agencies. Some LGAs have a defined Emergency Management Coordinator to undertake these activities. |

| Partners | Roles and responsibilities |
|---|---|
| **Traditional Owners** | |
| Traditional Owner boards/ councils | The *Native Title Act 1993* and the *Traditional Owner Settlement Act 2010* recognise Traditional Owners' interests and rights in Crown land across Victoria. The Traditional Owner Corporations and/or Registered Aboriginal Parties are the recognised entities representing the Traditional Owners in the area and should be involved in floodplain management activities. |
| **Community** | |
| Flood Observers | Local members of the community can be called on as Flood Observers in recognition of the wealth of historical and local knowledge of flooding that is held within the community. Flood Observers can play an advisory role during a flood event, but have no authority or responsibility in floodplain management. Flood Observers are usually identified through Municipal Flood Emergency Planning. |
| Landholders and Individuals | Landholders and individuals are responsible for their own actions and safety during a flood event. The Victorian Floodplain Management Strategy states clearly that individuals (including communities and businesses) must act to manage their own risks. |
| Landcare | Landcare is a community-based conservation movement. Landcare groups undertake a variety of on-ground activities on both private and public floodplains, including revegetation, fencing waterways, and weed and erosion control. |

**VICSES is the control agency for floods, leading the coordination of multiple emergency management services including the CFA and Victoria Police.** ***Photograph: VICSES***

## 1.6 Scope and policy context

The North Central Regional Floodplain Management Strategy fits within a national and state framework for floodplain management, and has been developed to meet that framework's principles and objectives. The strategy also sits alongside a number of other regional strategies for North Central Victoria, and aligns with their objectives where there is overlap. Table 2 summarises the relevant strategy and policy documents.

**Table 2: National, state and local strategies and policies relating to floodplain management in North Central Victoria.**

| | |
|---|---|
| **Federal strategy and policy** | National Strategy for Disaster Resilience (Council of Australian Governments, 2011)<br>This strategy acknowledges that a coordinated and cooperative approach is needed across the country to withstand and recover from emergencies and disasters (such as floods). Building resilience is a shared responsibility between governments, communities, business and individuals. The strategy focuses on seven priority areas to build disaster-resilient communities, all of which are directly applicable to floodplain management. The seven areas are: leading change and coordinating effort; understanding risks; communicating with and educating people about risks; partnering with those who effect change; empowering individuals and communities to exercise choice and take responsibility; reducing risks in the built environment; and supporting capabilities for disaster resilience. |
| **Victorian legislation** | *Water Act 1989*<br>The *Victorian Water Act 1989* provides the framework for managing Victoria's water resources. In relation to floodplain management, the Act refers to the adoption of flood levels based on a probability of 1% of a flood occurring in any one year. The Act also allows for the declaration of land as liable to flooding as well as land declared a floodway area. |
| | *Planning and Environment Act 1987*<br>The *Planning and Environment Act 1987* establishes objectives for planning in Victoria and outlines the planning process and requirements for planning schemes. One of the objectives of the Act is to "provide for the fair, orderly, economic and sustainable use and development of land". The Act provides for "planning schemes to regulate or prohibit any use or development in hazardous areas or in areas which are likely to become hazardous areas" (e.g. flood-prone land). In this context, land-use planning involves strategic planning, statutory planning and building regulations.<br>CMAs are referral authorities under this Act, however, since 2013, their role has become as a 'recommending authority'. Referral advice is therefore not binding on the LGA. |
| **Victorian strategy and policy** | *Victorian Floodplain Management Strategy* (VFMS)<br>After the devastating 2010-11 floods, the challenges with floodplain management were recognised as institutional rather than technical. The VFMS aims to clarify the roles and responsibilities of government agencies and authorities involved in flood management arrangements to ensure continual improvement in all aspects of floodplain management. It also sets out actions and policies that will help implement the Victorian Government's response to the Victorian Floods Review and the Parliamentary Environment and Natural Resources Committee Inquiry into Flood Mitigation Infrastructure.<br>The VFMS sets out a systematic approach to the evaluation of Victoria's flood risks. It also provides a systematic approach to sharing information between the individuals, communities, government agencies and other organisations responsible for managing the various aspects of flood risk. Most importantly, it clarifies which agency is accountable for each aspect of floodplain management. |
| | *VICSES Community Resilience Strategy 2016-2019*<br>This strategy outlines the way the VICSES will work with communities and partners to achieve more aware, informed and prepared communities; supporting them to understand their risk and the relevance of taking action before, during and after emergency events (including floods). It has the objectives of: building capacity, increasing collaboration and fostering connections to promote positive behaviour change. |
| | *State Flood Emergency Plan – Flood Sub-Plan*<br>The objective of the sub-plan is to provide sources of information and to outline the arrangements for ensuring an integrated and coordinated approach to the state's management of floods in order to reduce the impact and consequences of these events on the community, infrastructure and services. |

| | |
|---|---|
| **Regional strategies and plans** | *North Central Regional Catchment Strategy 2013-2019* (NCRCS)<br>The NCRCS provides the long-term vision for natural resource management in the North Central CMA region. It sets regional priorities for managing natural assets and also the overall direction for investment and coordination. It recognises floodplains as complex ecosystems that support a diversity of native flora and fauna. The vision of the strategy, with respect to waterways and floodplains, is to manage them sustainably to protect and enhance their diversity and ecological function while also supporting the regional community's recreational use. The inherent functions of the floodplains to convey and store floodwater should be recognised and preserved to minimise the deterioration of environmental values and the long-term flood-risk to floodplain production, assets and communities. |
| | *North Central Waterway Strategy 2014-2022* (NCWS)<br>The NCWS is an integrated strategy for managing and improving the region's waterways (rivers, streams and wetlands). |
| | Regional growth strategies/plans provide broad direction for land use and development across the state. They consider the region, economy, environment and heritage and transport and infrastructure. The also direct settlement growth to avoid areas of high risk from natural hazards such as flooding. |
| | Regional flood emergency plans contain information on the coordination of flood responses between municipalities, provision and allocation of resources, operational structure, inter-agency coordination and control arrangements. |
| **Local strategies and plans** | Municipal flood emergency plans contain information on the risk of flooding within a municipality, including what needs to be done to reduce flood impacts, and detail flood prevention, preparedness, response and recovery planning arrangements. |

## 1.7 Review of previous regional strategy

The region's previous Floodplain Management Strategy (April 2000) was formally reviewed to measure the progress of the actions listed and to identify key learnings to inform this new strategy.

The 2000 strategy identified nine programs for flood management and established performance indicators, targets and timeframes to meet the set of detailed objectives against each program over the document's 10-year life. The focus was predominately on developing plans to manage the impacts of rural inundation, with only a small number of towns identified as high priority for flood studies.

With the devastating floods in 2010-11, the focus shifted and led to the development of flood management plans for 11 townships within the region, providing valuable information for input to statutory planning, flood mitigation and response.

A broad review of the objectives and tasks identified in the nine programs identified that 41% of the tasks have been completed, 37% remain outstanding and a further 22% are still ongoing. Two of the tasks related to declaring flood levels and are no longer required.

Of the outstanding actions, most relate to asset management, likely due to the uncertainty around roles and responsibilities for ongoing maintenance and management of floodplain assets prior to 2010-11. The 2016 Victorian Floodplain Management Strategy has provided clarity in relation to the roles and responsibilities and these outstanding issues are addressed in this strategy.

The previous strategy noted that an ongoing review of the strategy was to be undertaken with the stakeholders identified during the development stage. This was to be undertaken at three-yearly intervals, however no formal or ongoing reviews have been undertaken or documented.

Key learnings identified through the review process that are incorporated into this strategy include:

> the importance of defining clear and measurable performance indicators

> documenting a collective agreement of roles and responsibilities among stakeholders, and a willingness to complete management actions allocated in this strategy

> provision for ongoing review of this strategy and the ability to adapt or amend management actions over time as priorities shift.

## 1.8 Floodplain management strategy development

The development of this strategy has been led by the North Central CMA, and overseen by a Steering Committee, made up of executive members of the North Central CMA, VICSES and LGAs.

A technical working group, with representatives from all stakeholder agencies (all 14 LGAs, VICSES North West Region, DELWP Loddon Mallee Region, Parks Victoria – Northern Rivers, VicRoads – Northern Region and the regional water corporations) convened regularly during the development of this strategy to discuss flood risks and define local and regional priorities.

In developing the regional floodplain management strategies across Victoria, a consistent approach has been taken to assess the flood risk and efficacy of existing treatments (i.e. mitigation infrastructure, planning controls and flood warning systems) to ensure an equitable prioritisation of flood management priorities.

A thorough process has been followed to ensure engagement with all stakeholders. This has included public consultation, workshops with stakeholder agencies and Traditional Owner groups.

The release of a draft version of the strategy provided a further opportunity for public comment. All feedback received was considered when developing this final version of the strategy.

**Figure 2: Floodplain management strategy development.**

# PART 2 – ASSESSMENT OF REGIONAL FLOODING

In order to equitably determine priorities for floodplain management actions, we must first understand our flood risk. A region-wide, systematic flood risk assessment and review of the existing risk treatments has been undertaken, following the processes developed by DELWP, as part of its delivery of the Victorian Floodplain Management Strategy (VFMS Action 26a).

The approach has been adopted consistently across Victoria, providing an evidence-base for effective risk management decisions and fostering consistent baseline information collection. Some LGAs extend across multiple catchments and will be subject to multiple regional floodplain management strategies. The flood risk assessment undertaken for this strategy is consistent with that for neighbouring CMA regions so that the risk metrics can be used to prioritise management actions within each area.

This section summarises the flood risk assessment methodology, lists the areas with the highest risk; outlines the stakeholder engagement used to develop the strategy; discusses risk treatment methods and regional performance; identifies key regional issues influencing priority setting; and identifies key risk themes for the region.

## 2.1 Risk assessment methodology

DELWP's rapid appraisal of flood risk methodology was used to assess flood risks at a regional level. The methodology identifies areas of similar land use and flood causation. The assessment then considers existing information for these areas (probability of flooding, potential cost of damages, and population density) as a means of quantifying risk. The result is a relative measure of risk between the areas.

Acknowledging the limitations of this methodology (e.g. the reliance on documented information, and inability to identify local or critical infrastructure), individual workshops were held with relevant officers from each LGA to review the results and identify risks that had not been considered. This involved identifying infrastructure and assets that are essential for the ongoing functionality of a town, locality, region or broader area, whether at risk of inundation or indirectly affected by flooding. For example, many regional industries rely on access to storage or processing facilities. While these facilities themselves may not be at risk of flooding, if access to/from them is impeded, it can have a significant impact on the industry. Additional risks identified at the workshops for consideration included vulnerable populations (e.g. nursing homes, hospitals), floodways with high velocities or depths, and areas earmarked for future growth.

For the assessment, the North Central CMA region was divided into 213 areas of similar land use and flood causation. Of these areas, 16 had no flood risk information, 96 had a low flood risk (predominately rural areas), 67 were considered at moderate risk and 34 were considered at high risk (94% of which were township/urban areas).

The region's risk profile is shown in Figure 3.

Generally, there is a trend of rural areas in the lower catchments having a moderate flood risk. Only the rural areas surrounding Swan Hill and on the Loddon River upstream of Bridgewater are considered high risk. Risks in the upper catchment areas are confined to township areas.

The risk assessment found the 10 areas with the greatest flood risk to be:

- Koondrook
- Rochester
- Charlton
- Quambatook
- Dunolly
- Bendigo / White Hills
- Kangaroo Flat / Golden Square
- Echuca
- Woodend
- Maryborough

A number of these areas have recently been the subject of flood studies and proposed mitigation options that will help reduce these risks. These options include updates to planning schemes, construction of structural mitigation options and development of total flood warning systems.

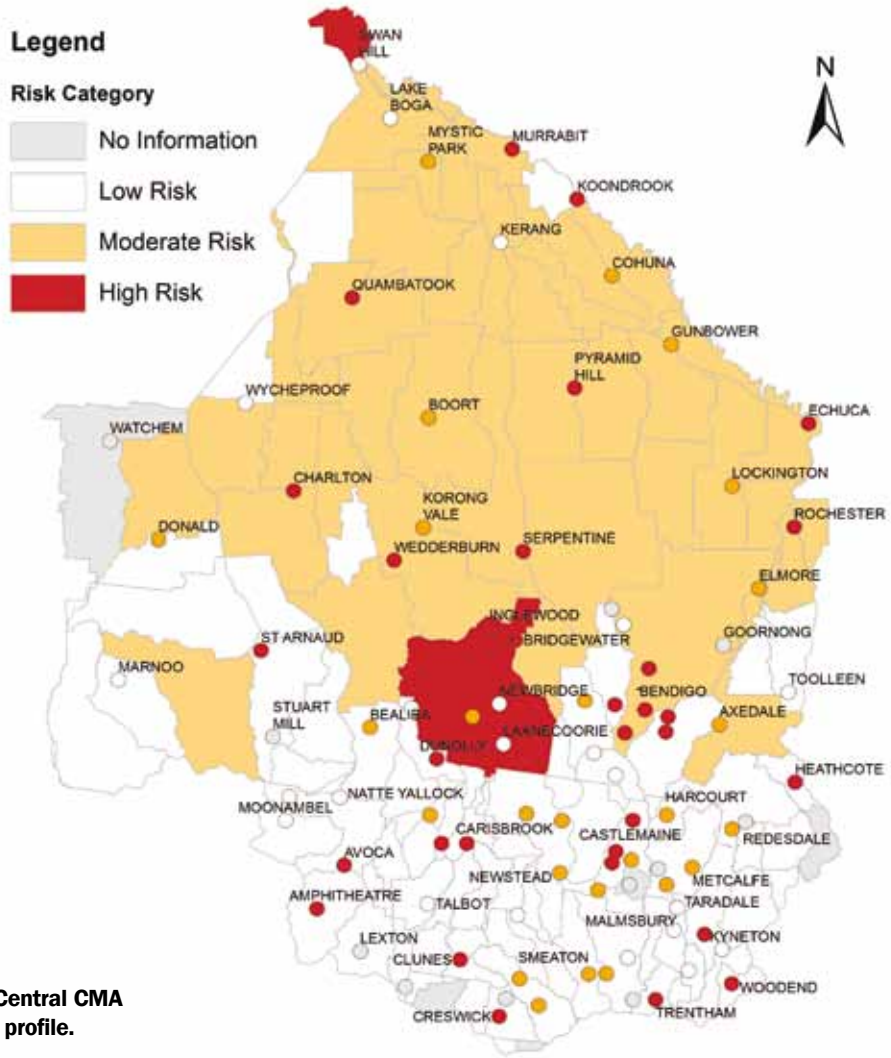



**Figure 3: North Central CMA region flood risk profile.**

## 2.2 Stakeholder engagement

Stakeholder engagement was an important step in determining the local actions required to reduce flood risk across the region and to ensure the alignment of priorities between local governments, agencies and the community.

The following provides a summary of the engagement activities undertaken with local government, key agencies and the community in developing this strategy.

### Local Government Authorities (councils)

> Engagement with LGAs occurred through both their participation in a Stakeholder Working Group for shared issues as well as consistent direct contact on local matters and in the development of Regional Work Plan actions.

> Workshops were held with LGA officers representing infrastructure, planning and emergency management from all 14 LGAs across the region. These workshops followed a set agenda to ensure a consistent methodology for risk assessment was applied across the region. The workshops were also used to brainstorm actions to mitigate the identified flood risks.

> LGAs reviewed the Strategy and support the actions within the Regional Work Plan.

### Key agencies

> Key agencies included DELWP – Loddon Mallee, Parks Victoria – Northern Rivers, VICSES North West Region, VicRoads Northern Region and relevant water corporations.

> Engagement with key agencies occurred through their participation in a RFMS Stakeholder Working Group, a series of focused workshops and via direct contact on specific agency matters.

> Agencies reviewed the Strategy and support the actions within the Regional Work Plan

### Community

> An initial community engagement program was conducted throughout the catchment during October-November 2016 to hear from the community about their flood issues. More than 70 people attended drop-in sessions across the catchment and provided information that has influenced the Strategy. Flood issues were fresh in the memory from the September 2016 floods and community members still recalled issues associated with the 2010-2011 floods. Long-standing issues were reiterated by the community and have now been recorded through the Strategy development process.

> A number of additional site visits were held with landowners in the catchment to better understand local problems on the ground and from community perspectives.

> The Draft Strategy included both regional and local scale actions to address the issues raised by community members (and LGAs and agencies).

> Once the Draft Strategy was developed, the community was provided an additional opportunity to review and provide feedback during October and November 2017.

> It was evident through consultation on the Draft Strategy that some community members could not identify their original issue in some action descriptions. Those actions have been re-written to specifically address community concerns.

Twenty-three submissions were received on the Draft Strategy. Nineteen were received from community members and four submissions were received from agencies. All feedback was reviewed and used to inform the final version of the Strategy, with a number of changes being made to address the content of the submissions received.

## 2.3 Risk treatments and regional performance

Flood risk treatments can be structural (i.e. mitigation infrastructure such as levees) and non-structural (i.e. statutory planning tools, flood education programs, flood warning systems and emergency response). An appropriate mix of structural and non-structural treatments is often required to manage flood risk.

The performance of existing flood risk treatments in the region was assessed based on the methodologies provided by DELWP, which defined the expected service levels of the various risk treatments. The service level of a risk treatment should be compatible with flood risk. Where treatments have been found to be insufficient, an action has been proposed for improvement and incorporated into the work plan.

### 2.3.1 Planning scheme controls

Planning schemes set out the policies and provisions for the use, development and protection of land, and are enabled under the *Planning and Environment Act 1987*. The Victoria Planning Provisions (VPP) contain state, regional and local policies and various controls that guide the use and development of land that is affected by floodwaters. These controls include the Floodway Overlay (FO), the Land Subject to Inundation Overlay (LSIO), the Special Building Overlay (SBO), the Urban Floodway Zone (UFZ) and the Environmental Significance Overlay (ESO). The presence of these flood-related planning overlays triggers a flood assessment of proposed developments.

Flood-related planning controls are typically based on the 1% Annual Exceedance Probability (AEP) design flood extent. This is a flood that has a 1% chance of occurring (or being exceeded) every year. The extent and depth of the 1% AEP flood for an area can be determined through flood modelling, recorded flood extents and levels, and on-ground verification. This information is then used to inform local planning policies and the zones or overlays applying to affected land.

Historically, however, detailed flood modelling has not been available, and planning controls have been based on the best available information at the time. An example is the Design Development Overlay in Avoca, which is based on alluvial soil mapping. The overlay has been effective, in that it provided some control over development within the floodplain, however an update is recommended, based on more accurate information.

Similarly, many of the existing planning controls across the region are based on historic information that may no longer be relevant because of physical changes across the floodplain or because better information is now available. In some instances, a lack of information has meant that no planning controls have been applied, despite sufficient flood risk to warrant them.

The service levels of planning scheme controls across the North Central CMA region have been assessed against the flood risk level. Where the planning controls were inadequate, an action has been identified in the work plan.

A common theme throughout the region is a delay in the development of flood mapping and incorporation into the planning scheme. Detailed information exists for many areas, however it is yet to be incorporated into an overlay, often because LGAs lack the capacity to prepare and carry out the amendment. To assist LGAs in the future, Policy 11a of the VFMS requires all new flood studies to include draft planning scheme amendment documentation and mapping.

In some instances, the existing information has not been sufficient to allow for a planning scheme amendment. In these cases, a flood study has been proposed.

***REGIONAL PRIORITY 1 – Update planning controls to reflect the best available information***

***Updating planning schemes has been identified as a regional priority. DELWP and the North Central CMA will collaborate with LGAs to overcome capacity issues. Further, the CMA will help identify and use any potential economies of scale in the processes that are necessary as part of planning scheme amendments.***

### 2.3.2 Flood mitigation infrastructure

Flood mitigation infrastructure includes treatments such as levees, channel modifications, bypass floodways, retention basins, dams and floodgates. Structural treatments can be effective in reducing flood risk at specific locations, however, if not managed and maintained, they are liable to fail during a flood.

The Victorian Floodplain Management Strategy has provided clarity around maintenance and management arrangements to remove this uncertainty and inconsistency. Section 17 of the state strategy sets out a number of policies relating to flood mitigation infrastructure, including its management and recognition. Of note are the following:

> Existing flood mitigation infrastructure that is not formally managed should remain that way unless the Local Government Authority determines that it should be brought into formal management arrangements.

> Infrastructure that is not formally managed should not be recognised as being functional in planning schemes (including flood overlay mapping) and Municipal Flood Emergency Plans must allow for the potential failure of that infrastructure.

> The three tiers of government will only invest in building or upgrading flood mitigation infrastructure if the accountability arrangements for ongoing management, maintenance and assurance are agreed and clearly documented.

The first step to achieving this clarity, and adopting these arrangements, is to understand the service level provided by existing infrastructure, and assess the appropriateness of existing management.

The North Central CMA region has the highest concentration of levees in the state; there are hundreds of structural works that perform flood mitigation functions. It is impractical to assess the service level for each structure within this strategy, indeed even to document their existence. It was determined during the development of this strategy that there is a need to develop categories of flood mitigation infrastructure and prioritise their future assessment.

As a first step in achieving this, a regional action has been identified to define appropriate categories, in consultation with stakeholders. Various structures throughout the region control the distribution of floodwaters. Many were constructed without that intention (e.g. irrigation channel banks and roads) and many are unknown (e.g. private levees or illegal works). The appropriate categorisation will enable appropriate future management actions to be determined.

The issue of flood mitigation infrastructure within the region is largely concentrated on the lower Loddon, lower Avoca and Murray rivers, where the floodplain is expansive and there is a legacy of undocumented landscape changes that control the distribution of floodwaters. Many levees were built during, or in response to, historical flood events and their benefits and construction standards are uncertain. Irrigation channel banks often act as levees as well, and although they are not legally considered to be flood mitigation infrastructure and are not required to be managed by water corporations for such purpose, any decommissioning of such infrastructure needs to be closely managed to avoid unintended consequences.

The 2010–12 floods revealed serious deficiencies in the management arrangements for flood mitigation infrastructure. Responsibilities were either non-existent or blurred between Catchment Management Authorities and Local Government Authorities, and accountabilities were not assigned consistently across the state. This was particularly relevant in the lower Loddon catchment, where only a small number of assets were subject to appropriate management arrangements and therefore performed effectively (e.g. Kerang Township Levee). A large number of rural levees were breached, resulting in unexpected flooding and contributing to a public narrative of uncertainty and blame.

**Figure 4: Levees of the lower Loddon River floodplain.**

**The map shows a system of levees along the Loddon River downstream of Kerang during the January 2011 floods. The levees are useful for smaller floods but become problematic in major floods like those across the summer of 2010-2011. In larger floods, water can overtop the levees and become trapped behind them, preventing flood water from draining back into the river. This causes flood waters to move through unexpected parts of the catchment, increasing the impact on private properties and creating difficulties for emergency management agencies tasked with managing the flood and dealing with residual flood water. The levee system is a combination of public and privately built levees, and those whose ownership and maintenance remains unresolved.**

Despite the need to appropriately categorise flood mitigation infrastructure (predominately in the northern part of the region), this strategy has identified a number of strategic levees that exist specifically for flood mitigation purposes. The service level and maintenance/management arrangements for these levees have been assessed. The levees include:

- Murray River levees
- Pental Island levees
- Tyntynder Flats levee
- Torrumbarry-Gunbower Creek levee system
- Loddon River levees
- Avoca River levees
- Various urban levee systems, including: Bendigo, Castlemaine, Echuca, Kerang, Koondrook, Woodend, Creswick, Pyramid Hill, Boort, Carisbrook, Donald and Swan Hill.

New flood mitigation infrastructure identified through this strategy must provide both community and environmental benefits. The 'beneficiary pays' principle will determine the management and funding arrangements. Large-scale flood mitigation infrastructure is not considered best practice, but there may be limited circumstances where it may be supported after a thorough evaluation of the social, cultural, economic and environmental costs and benefits.

***REGIONAL PRIORITY 2 – Construct new flood mitigation infrastructure, resolving ownership and maintenance accountabilities, and improving floodplain function***

***The documentation of existing flood mitigation infrastructure and assessment of the associated service level and maintenance and management arrangements will be an ongoing task for the North Central CMA region. Agencies will work together to identify key mitigation infrastructure that needs to be brought into formal maintenance and management arrangements, and improve service levels where warranted. This may include development of a register of flood mitigation infrastructure.***

***It is expected that management actions for flood mitigation infrastructure will fall into one of three categories: (a) no action; (b) investigate the benefits; or (c) confirm management and maintenance arrangements (where benefits are already known).***

**Flood protection levee along Pearman Street, Creswick.** ***Photograph: Shaun Morgan, North Central CMA***

## Case study: Flood mitigation infrastructure at Creswick

An example of a successful flood mitigation infrastructure can be found within the North Central CMA region at Creswick.

Three separate flooding events during late 2010 and early 2011 caused considerable damage to homes, businesses and sporting facilities, and significant distress and hardship to the Creswick community.

Recognising the need to reduce the future risk of flooding in the town, a Flood Mitigation and Urban Drainage Plan was developed by the North Central CMA in partnership with the Hepburn Shire council and the local community. The proposed plan sets out mitigation actions to provide a greater level of protection from future flooding.

The plan protects against a 2% Annual Exceedance Probability flood event, which will provide greater protection than a flood the size of the September 2010 and January 2011 events. Works included increasing the capacity of two bridges, minor channel deepening and levee construction.

A wide range of options was considered during the pre-feasibility stage of the plan's development before five options were analysed in greater detail.

A community-based steering committee was formed to guide the process and engagement activities, and ensure strong community input to the plan. A technical working group of representatives from various key industry stakeholders provided support to the steering committee.

An intensive community engagement process meant that the Creswick community was aware of the available options and their benefits and impacts. A brochure outlining all options considered and highlighting logical reasons for the preferred option was delivered to all Creswick residents.

After several public meetings and additional one-on-one consultation for concerned residents, there was overall strong community support for the plan. The majority of flood-affected residents who made a submission supported the plan.

The management actions from the plan have been implemented and their efficacy was validated in the September 2016 flood. There has been strong positive feedback from the community regarding the plan's success.

It is anticipated that this process can be replicated and similar flood management outcomes can be achieved for the priority areas listed in this strategy.

### 2.3.3 Total Flood Warning System services

Flood warning systems provide a way to gather information about impending floods, communicate information to those who need it (those at risk) and facilitate an effective and timely response. Flood warning systems aim to enable and persuade people and organisations to take action to minimise their risk and reduce the damage caused by flooding.

The Total Flood Warning Systems (TFWSs) for riverine flooding are based around having at least six hours to collect data, run prediction models, interpret flood mapping, determine potential consequences, and construct and disseminate warnings. Within Victoria, the physical components of the flood warning system (i.e. rainfall and streamflow gauges) are owned and maintained through the Regional Water Monitoring Partnerships, with data relayed to the Bureau of Meteorology to provide forecast and warning services. The Victorian Floodplain Management Strategy clearly states that the capital costs for new rain or stream gauges will be shared between the Victorian and Australian governments. The local community, through its LGA, will fund ongoing maintenance costs for gauges.

The TFWS concept encompasses all the elements required to maximise the effectiveness of flood responses by the community and emergency services, and can include:

- data collection network (rain gauges and stream gauges)
- forecast (prediction) services
- lines of communication to disseminate flood warning information to the community
- community flood awareness and education
- interpretation (a means of predicting consequences of forecast floods)
- an action plan for responding to floods (e.g. a Municipal Flood Emergency Plan).

In the North Central CMA region, streamflow gauges have been placed throughout the catchment for water management purposes rather than for flood forecasting and are therefore not optimal for planning and co-ordinating the responses of some communities to predicted flooding.

All communities within the North Central CMA region currently receive the Bureau of Meteorology's Flood Watch and Severe Weather warnings, as well as messaging from VICSES. While these warnings and messages are important, they have been described as too broad and therefore not very useful.

The service levels of the TFWSs within the North Central CMA region have been assessed for adequacy against the associated flood risk level for that area. A number of locations were identified where the flood risk warrants upgrading the TFWS. In most of these locations, it was determined that the service level is low due to the lack of flood mapping, and that the development of detailed flood maps that are disseminated to the relevant communities is the most effective response to address the risk.

***REGIONAL PRIORITY 3 – Address gaps in flood knowledge through flood mapping projects***

***A common theme for inadequate service levels of the TFWS was the lack of available flood mapping. Accurate flood mapping feeds in to many components of the TFWS, as it allows a better understanding of potential flood consequences, enables better communication and awareness, and assists with coordinating emergency response.***

***LGAs, with assistance from the North Central CMA and DELWP, will prioritise flood mapping studies in high-risk areas where information is lacking. Actions have been identified individually and are presented in the Regional Work Plan.***

Flash flooding differs from riverine flooding and can occur in parts of the upper catchment and the larger urban areas such as Bendigo, Echuca, Castlemaine, Maryborough, Kyneton and Woodend. Flash floods require expedited warning processes that differ from the arrangements for riverine flooding described above, however, the key to the effectiveness of both systems is the availability of high-quality flood mapping.

Raising flood awareness is a cost-effective way to reduce the impacts of flooding. Detailed flood risk information will empower individuals to evaluate their options, take action and remove valuables or protect their houses before the flood arrives, reduce confusion, frustration and anxiety. This work will also enable the community to be more aware of flooding so that they can actively take measures to manage their flood risk to minimise damages, leading to faster recovery and more resilient communities.

Priority projects for the VICSES include improving the Emergency Victoria website to include all flood mapping for each Average Recurrence Interval (ARI) and developing a state Community Observers Network website. This website will enable the community to provide local knowledge during a flood event. Using smartphones to collect flood data via an app, photographs can be instantly uploaded to the web page, viewed and shared between agencies and the community. This website will provide a source of valuable information where there are gaps in telemetered stream data.

The VICSES is also working with DELWP, CMAs and LGAs to develop a range of products and community engagement activities to raise flood awareness. These products include:

> property-specific flood warning charts for individual properties that relate forecast peak flood levels to a height above or below an individual floor level

> community education signs at stream gauge board locations that both educate the community and provide an opportunity for the community to provide local knowledge to an Incident Control Centre during a flood event

> use of pre-recorded flood education videos.

The delivery of a series of community education products in conjunction with targeted community engagement activities with people regularly affected by flooding will go a long way to fulfilling key aspects of the Regional Floodplain Management Strategy.

***REGIONAL PRIORITY 4 – Improve preparedness for flood emergencies***

***Raising flood awareness will be enacted through various VICSES priority projects, including improving the Emergency Victoria website to include all flood mapping, and developing a state Community Observers Network website. Where warranted, improved awareness may require the installation/improvement of a Total Flood Warning System service.***

## 2.4 Regional issues

Despite the expansiveness of the region, and the different causes and consequences of flooding across the catchments, several common themes arose during the stakeholder engagement process. These are discussed further below and have been considered in the setting of regional priorities.

### 2.4.1 Flood flow distributions

Community members have expressed concerns regarding the current distribution of floodwaters through the catchment. Private and sometimes illegal levees, neglected flood management schemes, irrigation modernisation, road upgrades and general misinformation have resulted in floodwater flows to locations that do not align with community expectations.

Management of flood flows is often difficult and complex. Re-distribution of flows needs to be managed to ensure that the impacts of flooding aren't moved from one landowner to another.

The impacts of unplanned flows on the environment must also be considered in what are now highly managed and long-term, goal-oriented environmental flow regimes, e.g. managing vegetation growth, bird breeding and international legal obligations (e.g. RAMSAR).

In the development of this strategy, it was evident that agencies and communities share a common goal to manage floodwaters in a way that minimises harm and maximises environmental/cultural benefits. The intentions are the same, but a lack of communication and understanding between agencies and the community has been perceived as poor management. It is important to understand the constraints of the floodplain operating system. Often, natural wetlands can remain dry (or at least not fill) in a flood because the delivery infrastructure to direct flows is limited.

Actions to investigate specific areas of concern have been included in the Regional Work Plan under Regional Priority 2. Management of flows through the catchment will remain an area requiring ongoing reviews and investigation as flood behaviour changes or new impediments are discovered.

### 2.4.2 Residual floodwaters

Residual floodwaters lingering in the landscape pose risks to human health, community wellbeing and the functioning of regional economies. Coordinated management of the removal of floodwaters needs to align with community expectations so as to prevent illegal works (e.g. cutting of banks) and additional damage, and to avoid litigation between individuals. Solutions may be permanent (e.g. new infrastructure) or reactive (e.g. managed interventions such as pumping or cutting banks). DELWP is accountable for maintaining guidelines for managing residual floodwaters to help Incident Controllers and Recovery Managers manage the risks of human intervention in draining the floodplain.

### 2.4.3 Illegal works

Concerned community members have raised the issue of illegal works within our waterways and floodplains. Illegal levees, in particular, and farm channel infrastructure are a constant issue. These structures displace floodwaters to other unexpected locations, damaging housing, agriculture and farm land.

Illegal works often go unnoticed (or unreported) and, after a period of time without any action, become an inherent part of the landscape. These works can greatly alter the course of flood waters affecting those residing both upstream and downstream. For example, in the 2016 floods, areas near Gunbower Forest were said to have suffered flooding greater than the 2011 floods.

**Waterway management works were undertaken at Carisbrook to reduce the impacts of flooding to urban areas.**
***Photograph: Alfred Bouwman, Platypus Environmental Services***

Many community members are unsure as to what works they can do within their own property on a floodplain. Clear specifications are difficult to come by, which results in unpermitted works by some individuals and frustration for other individuals about whether works by a neighbour are legal or not.

Illegal works, upon discovery, can either be permitted or made to be removed using the *Planning and Environment Act 1987* (through LGA compliance processes). Alternatively, neighbours can sue each other for culpability via provisions of the *Water Act 1989* where they are able to prove damages are a result of the works. This latter approach is undesirable. A proactive approach to prevention and mitigation by agencies (and where possible collaborative action) will provide a greater service to the community as it will prevent illegal works that have the potential to divide communities and avoid individuals from the need to pursue legal action.

### 2.4.4 Waterway management

North Central CMA and LGAs consistently receive requests from the community to remove vegetation or debris from waterways to alleviate an actual or perceived risk of flooding. Blockages can be human or environmentally induced. In many situations, the vegetation has little to no impact on the extent of flooding, however, in some circumstances the removal of in-stream vegetation and ongoing regular maintenance may be warranted. This approach was demonstrated, via flood studies, to have benefits in both the Carisbrook and Clunes township areas.

DELWP is also preparing the Victorian Rural Drainage Strategy, which will provide strategic guidance for matters relating to rural drainage but also for management of waterways as 'drains'. This will include consideration of clearing a stream of debris, vegetation or sediment that may have multiple mutual benefits, e.g. flood mitigation, rural drainage and best practice waterway management.

***REGIONAL PRIORITY 5 – Educate agencies and individuals on the roles and responsibilities in floodplain management***

***During the development of this strategy, it has become evident that the roles and responsibilities of agencies and individuals with respect to managing residual floodwaters and waterway management are not well understood. There is a regional action to develop a communication plan and promotional material to assist the education of agencies and individuals on the various roles and responsibilities for floodplain and waterway management activities.***

### 2.4.5 Indigenous cultural values and assets

Waterways and floodplains continue to hold deep physical, social, environmental, spiritual and cultural significance to the Indigenous populations. The vast majority of cultural assets identified in the Aboriginal Heritage Register are within waterways and floodplains.

Historically, floodplain management has been largely independent of cultural heritage management, however, given their interdependence, it would be negligent to maintain these disparate management arrangements.

Issues identified in these existing arrangements include:

> an absence of cultural knowledge in Municipal Emergency Management Plans

> absence of Traditional Owner input to flood management plans

> absence of Traditional Owner roles in the Incident Control structure during emergencies

> impact on cultural heritage by emergency flood works.

Floodplain management should occur in a way that minimises the impact to cultural heritage and provides opportunities to promote cultural values (e.g. by managing flows in a way that benefits the environment that supports cultural values).

As Registered Aboriginal Parties, Traditional Owner groups are entitled to speak on and for Country. In discussion with Traditional Owner groups in the North Central CMA region, the following opportunities were identified:

> fostering a partnership approach to floodplain management activities

> incorporating Cultural Heritage Assessments in flood management plans

> incorporating cultural knowledge into Municipal Emergency Management Plans

> sharing flood risk information with Aboriginal communities

> incorporating cultural knowledge into Incident Control arrangements

> avoiding impacts on cultural heritage by emergency works (e.g. through pre-defining locations for borrow-pits free from cultural heritage sensitivity)

> cultural heritage surveys undertaken in the flood planning phase (e.g. before the flood) to determine sensitive areas (e.g. areas with cultural assets that could be disturbed by floodplain management activities or erosion from floodwaters), and provide guidance to Incident Control Centre decision making.

***REGIONAL PRIORITY 6 – Incorporate Traditional Owner knowledge into floodplain management activities***

***As an initial action, Traditional Owners will be invited to contribute to Municipal Flood Emergency Committees. It is anticipated that the relationship between Traditional Owners and floodplain management agencies will mature and evolve over time. This first action will ensure consistent conversations and be a starting point for longer-term involvement in the other identified initiatives.***

### 2.4.6 Access

The disruption to major transport routes was a recurring theme in the risk identification process. In large floods, major highways (such as the Calder, Pyrenees and Midland) can become inundated and close, and railways can be damaged and become unstable. In the upper catchment, where flooding occurs more rapidly, the impact can be felt not only through roads being closed, but also the lengthy process of repairing roads afterwards. In the lower catchments, roads can remain closed for months as a result of inundation from slow-moving and expansive floodwaters. Both situations are exacerbated by the need to access funding to repair the infrastructure, which can often take months to secure.

In some instances, this can place additional pressure on alternative routes. For example, when the Calder Highway is flooded and closed, drivers detour via local roads, which have not been built to withstand heavy-access or over-dimension vehicles.

In larger floods, the closure of arterial roads can severely disrupt community connectivity and compromise the response by emergency and support services. For example, previous large floods have compromised regular transport routes to Kerang, so providing critical supplies has become an emergency response priority. Charlton experiences similar issues as large floods can cut access to the town from the north, east and south so that the only road access is from the west. As food supplies to Charlton normally come from Bendigo, resupply efforts are significantly disrupted due to the extra travel distance and time to safely access the town from the west.

The loss of major transport routes has implications for new developments within the large floodplains of the northern part of our region. Demonstrable safe access is a requirement of all development applications. Typically, the North Central CMA has deemed 'safe access' to be to the nearest major road. In the lower catchment, however, the major road itself may be closed, and so the criteria for 'safe access' may need to be reconsidered. If arterial transport routes are not made more resilient, development permits in areas with already low levels of development or population decline could be turned down, which may be undesirable.

**The Murray Valley Highway closed at Patchell Bridge, Kerang.** ***Photograph: Adrian Martins, North Central CMA***

If the criteria consider the potential isolation of townships, this adds another level of complexity. Kerang, for example, could be considered a 'safe' area due to its well-maintained township levee, but it becomes isolated for long periods, placing pressure on emergency services to either further evacuate populations or maintain supplies to them. Several townships within the North Central CMA region become isolated during flood events, including Dunolly, Charlton and Boort.

***REGIONAL PRIORITY 7 – Create a flood-resilient transport network***

***It is important to maintain major access linkages between towns and regions during major flood events. An initial region-wide project will identify key transport linkages across the region and determine priorities for upgrades to ensure reliable access during floods.***

### 2.4.7 Local government capacity

Of the 14 LGAs within the North Central CMA region, population varies from 8,000 to 110,000 and geographical size varies from 6,000 square kilometres to 110,500 square kilometres. The resulting population densities range from less than one person per square kilometre to more than 130, which presents a diversity of challenges in providing even the basic services expected by our communities. The size and population of LGAs heavily underpins their ability to raise revenue and this is exacerbated by the recent introduction of legislation that limits annual increases to property rates.

This Strategy acknowledges the challenges of the North Central CMA region's LGAs and recognises their limited ability to raise revenue to invest in new flood studies, new flood mitigation infrastructure and/or new community services. It cannot necessarily be expected that all high-priority actions be addressed in the first three years of implementation, if the cumulative cost is outside the lead agency's means. With that in mind, the Strategy has been developed in partnership with LGAs to realistically account for their capacity to address flood risk within their administrative boundaries. This is reflected in the priority, cost and timeframe of each identified action in the work plan.

Collaborative and innovative approaches in thinking, and delivery of projects will reduce pressure on individual LGAs and improve outcomes across the region. As an example, planning scheme amendments have been identified as an action for most LGAs. The North Central CMA will lead a regional action to identify and use any potential economies of scale in pursuing these actions in a collaborative way. Similar opportunities exist within the work plan and the North Central CMA, as coordinator of this Strategy, will actively work with LGAs and agencies to achieve any regional efficiencies.

**Flooded roads at Pyramid Hill in 2011. Loddon Shire constructed a temporary levee around Pyramid Hill (upper part of the photograph).** ***Photograph: Adrian Martins, North Central CMA***

# PART 3 – REGIONAL WORK PLAN

The Regional Work Plan identifies priority actions that meet the objectives of the Strategy. The intention is to match regional management priorities with regional flood risks. The work plan provides information on the implementation of these priority management tasks, identifying accountabilities, costs and timeframes. In this way, the ambiguity of accountabilities that have hindered effective floodplain management in the past will not be continued.

It is acknowledged that floodplain management issues are rarely contained, and hence this Strategy and its actions will be applied using a 'no-borders' approach, to ensure the most appropriate actions are considered across LGA, CMA and state (in the case of the Murray River) borders and across public and private land borders.

***Figure 4: Regional priorities***

1. ***Update planning controls to reflect the best available information (page 23)***
2. ***Construct new flood mitigation infrastructure, resolving ownership and maintenance accountabilities, and improving floodplain function (page 26)***
3. ***Address gaps in flood knowledge through flood mapping projects (page 28)***
4. ***Improve preparedness for flood emergencies (page 29)***
5. ***Educate agencies and individuals on the roles and responsibilities in floodplain management (page 31)***
6. ***Incorporate Traditional Owner knowledge into floodplain management activities (page 32)***
7. ***Create a flood-resilient transport network (page 33)***

## 3.1 Regional priorities and actions

### 3.1.1 Determining regional priorities

Regional priorities (see Figure 4) have been identified through the discussion in Part 2 of this document.

These regional priorities have been paired against each area's flood risk. Local actions have been designated as contributing to the achievement of single or multiple regional priorities and therefore contributing to the overall reduction of flood risk across the region. Actions included within the work program are those that:

- address a significant risk identified through the risk assessment process
- address a risk where existing treatments are inadequate
- are financially, socially and environmentally feasible
- have commitment from the relevant authorities.

The actions have been documented in the Regional Work Plan and grouped to align with the most relevant regional priority. All suggested actions are subject to feasibility, which may require further detailed investigation, and the availability of funding.
The proposed actions have been prioritised over the local government scale, and may not address some specific localised issues including stormwater flooding, which are more appropriately dealt with through other processes.

### 3.1.2 Regional Work Plan

The Regional Work Plan provides detail of regional priority actions for the life of this strategy (nominally 10 years). It is a rolling three-year work plan, which will be reviewed annually. It has been developed assuming 'typical years', however, if events such as extreme floods occur during the life of the Strategy, agencies may be required to adapt delivery of specific actions within the work plan in light of changed conditions and/or risk, in a seasonally adaptive approach.

The regional priorities identified in this document encapsulate the work plan actions, and have been identified in the Work Plan. It is important to acknowledge the interrelation between actions and how they deliver the priority outcomes. For example, a flood study has been assigned under the regional priority of 'addressing gaps in flood knowledge through flood mapping projects', however the study outcomes will enable follow-on actions of updating the planning scheme, raising flood awareness, and possibly construction of flood mitigation infrastructure to reduce the existing risk.

## 3.2 Monitoring, Evaluation, Review and Improvement Plan

An adaptive approach to review and implementation of this strategy will be required. This involves flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood.

To support this approach, a detailed Monitoring, Evaluation, Review and Improvement (MERI) Plan will be developed to accompany this Strategy from planning to completion.

The MERI Plan will incorporate the following guiding principles:

> regularly convening a steering committee to oversee strategy implementation (annually at a minimum)

> development of key evaluation questions and key evaluation criteria to assess Strategy implementation performance

> review of progress of the work plan

> monitoring, evaluation and review of work plan actions in terms of appropriateness, effectiveness, efficiency, impact and legacy

> monitoring, evaluation and review of the Strategy implementation to alignment with other regional strategies

> reporting at a regional and state level.

| REGIONAL PRIORITY 1: Update planning controls to reflect the best available information | | | |
|---|---|---|---|
| **Aligns with objective:**<br>**3. Avoid future risk – through effective strategic and statutory land use planning and building controls**<br>**Who is involved in delivering on this priority: LGAs, North Central CMA, DELWP, communities** | | | |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** |
| R.101 | North Central CMA | LGAs, DELWP | Identify and coordinate a region-wide collaborative approach to updating planning |
| CoB.101 | City of Ballarat | North Central CMA | Extend the Environmental Significance Overlay to all waterways within the North C |
| CGB.101 | City of Greater Bendigo | North Central CMA | Update planning controls for Heathcote. |
| CGB.102 | City of Greater Bendigo | North Central CMA | Update planning controls for Marong. |
| CGB.103 | City of Greater Bendigo | North Central CMA | Update planning controls from rural flood studies (e.g. Axe Creek, Campaspe Rive |
| CGB.104 | City of Greater Bendigo | North Central CMA | Update planning controls after flood mitigation works have been implemented. |
| B.101 | Buloke Shire | North Central CMA | Update planning controls for Charlton. |
| B.102 | Buloke Shire | North Central CMA | Update planning controls for Donald. |
| B.103 | Buloke Shire | North Central CMA | Update planning controls if flood mitigation works have been implemented. |
| B.104 | Buloke Shire | North Central CMA | Update planning controls for Lower Loddon and Avoca floodplains, based on regio |
| B.105 | Buloke Shire | North Central CMA | Update planning controls from rural flood studies (e.g. Gowar Creek, Yeungroon C |
| C.101 | Campaspe Shire | North Central CMA | Update planning controls for Rochester. |
| C.102 | Campaspe Shire | North Central CMA | Review controls of Rural Activity Zone in Campaspe Shire. |
| C.103 | Campaspe Shire | North Central CMA | Review and update existing planning controls and schedules for Campaspe Shire. |
| C.104 | Campaspe Shire | North Central CMA | Update planning controls for Echuca. |
| C.105 | Campaspe Shire | North Central CMA | Update planning controls from rural flood studies (e.g. Torrumbarry, Mount Hope |
| CG.101 | Central Goldfields Shire | North Central CMA | Update planning controls for Maryborough. |
| CG.102 | Central Goldfields Shire | North Central CMA | Update planning controls for Carisbrook. |
| CG.103 | Central Goldfields Shire | North Central CMA | Update planning controls for Dunolly. |
| CG.104 | Central Goldfields Shire | North Central CMA | Update planning controls from rural flood studies (e.g. Bealiba, Timor-Bowenvale). |
| G.101 | Gannawarra Shire | North Central CMA | Update planning controls for Quambatook. |
| G.102 | Gannawarra Shire | North Central CMA | Update planning controls for Lower Loddon and Avoca floodplains, based on regio |
| G.103 | Gannawarra Shire | North Central CMA | Develop local floodplain development plans for priority areas. |
| G.104 | Gannawarra Shire | North Central CMA | Update planning controls for Koondrook. |
| H.101 | Hepburn Shire | North Central CMA | Update planning controls for Creswick and Clunes. |
| H.102 | Hepburn Shire | North Central CMA | Update planning controls for Trentham. |
| L.101 | Loddon Shire | North Central CMA | Update planning controls for Lower Loddon and Avoca floodplains, based on regio |
| L.102 | Loddon Shire | North Central CMA | Update planning controls for Bridgewater. |
| L.103 | Loddon Shire | North Central CMA | Update planning controls for Wedderburn. |
| L.104 | Loddon Shire | North Central CMA | Update planning controls for Inglewood. |
| L.105 | Loddon Shire | North Central CMA | Update planning controls for Borung Hills and Hope Creek catchments. |
| MR.101 | Macedon Ranges Shire | North Central CMA | Update planning controls for Woodend. |
| MAS.101 | Mount Alexander Shire | North Central CMA | Update planning controls for Newstead. |

| | Low: ≤$50,000<br>Medium: $50,000-$300,000<br>High: ≥ $300,000 | | |
|---|---|---|---|
| | Cost | Priority | Expected Completion |
| g schemes. | Low | High | 1-3 years |
| Central CMA boundaries of the City of Ballarat. | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| r, Bullock Creek). | Low | Low | 6+ years |
| | Low | Low | 6+ years |
| | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| | Low | High | 4-6 years |
| onal flood mapping. | Medium | High | 4-6 years |
| reek, Tyrell Creek, Lalbert Creek, Marmal Creek, Mosquito Creek, Cooroopajerup Creek). | Low | Low | 6+ years |
| | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| | Low | High | 4-6 years |
| Creek, Campaspe River, Mount Pleasant Creek). | Low | Low | 6+ years |
| | Low | High | 4-6 years |
| | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| | Low | Medium | 4-6 years |
| | Low | High | 1-3 years |
| onal flood mapping. | Medium | High | 4-6 years |
| | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| | Low | Low | 6+ years |
| onal flood mapping. | Low | High | 4-6 years |
| | Low | High | 1-3 years |
| | Low | Medium | 4-6 years |
| | Low | Medium | 4-6 years |
| | Low | Low | 6+ years |
| | Low | High | 4-6 years |
| | Low | Medium | 4-6 years |

| REGIONAL PRIORITY 1: Update planning controls to reflect the best available information (continued) | | | |
|---|---|---|---|
| **Aligns with objective:**<br>**3. Avoid future risk – through effective strategic and statutory land use planning and building controls**<br>**Who is involved in delivering on this priority: LGAs, North Central CMA, DELWP, communities** | | | |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** |
| MAS.102 | Mount Alexander Shire | North Central CMA | Update planning controls for Harcourt. |
| MAS.103 | Mount Alexander Shire | North Central CMA | Update planning controls from rural flood studies (e.g. Campbells Creek [rural] an |
| MAS.104 | Mount Alexander Shire | North Central CMA | Update planning controls for Maldon. |
| MAS.105 | Mount Alexander Shire | North Central CMA | Update planning controls for Castlemaine, Campbells Creek and Chewton. |
| NG.101 | Northern Grampians Shire | North Central CMA | Update planning controls for St Arnaud. |
| NG.102 | Northern Grampians Shire | North Central CMA | Update planning controls for Richardson River and Avon River catchments. |
| NG.103 | Northern Grampians Shire | North Central CMA | Update planning controls for the Avoca River. |
| P.101 | Pyrenees Shire | North Central CMA | Update planning controls for Avoca, Amphitheatre and Natte Yallock. |
| P.102 | Pyrenees Shire | North Central CMA | Update planning controls for Lexton. |
| P.103 | Pyrenees Shire | North Central CMA | Update planning controls for Waubra. |
| SH.101 | Swan Hill Rural City | North Central CMA | Update planning controls for Tyntynder Flats, Swan Hill, Pental Island and Woori |
| SH.102 | Swan Hill Rural City | North Central CMA | Update planning controls for Lower Loddon and Avoca floodplains, based on regio |

**New developments setback from Eaglehawk Creek, Eaglehawk.** ***Photograph: Adrian Martins, North Central CMA***

| | Low: ≤$50,000<br>Medium: $50,000-$300,000<br>High: ≥ $300,000 | | |
|---|---|---|---|
| | **Cost** | **Priority** | **Expected Completion** |
| | Low | Medium | 4-6 years |
| d Muckleford Creek). | Low | Medium | 4-6 years |
| | Low | Low | 6+ years |
| | Low | High | 1-3 years |
| | Low | High | 4-6 years |
| | Low | Low | 6+ years |
| | Low | Medium | 6+ years |
| | Low | High | 4-6 years |
| | Low | Low | 6+ years |
| | Low | Low | 6+ years |
| inen. | Low | High | 4-6 years |
| onal flood mapping. | Low | High | 4-6 years |

| REGIONAL PRIORITY 2: Construct new flood mitigation infrastructure, resolving ownership and maintenance accountabilities, a | | | |
|---|---|---|---|
| **Aligns with objective:**<br>**2. Reduce existing flood risk – by implementing and maintain flood mitigation infrastructure**<br>**Who is involved in delivering on this priority: LGAs, North Central CMA, DELWP, water corporations, communities** | | | |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** |
| R.201 | North Central CMA | LGAs | In conjunction with LGAs, undertake a review of existing flood mitigation infrastructure ac |
| R.202 | North Central CMA | Water corps, LGAs | Develop guiding principles for flood flow distributions that consider social and environmer the strategy). |
| R.203 | North Central CMA | LGAs | Investigate the current situation and potential future options for improved floodplain funct<br>• the lakes system from Kerang to the Little Murray River outfall (including investigation<br>• actions listed within the Swan Hill Regional Flood Strategy 1999<br>• Lake Meran and surrounds, including outlet structure and floodway<br>• Tragowel Swamp<br>• the Avoca River downstream of Quambatook, particularly Hogan's Weir and Farley's We Kerang-Quambatook Road<br>• the passage of flood flows beneath the Boort-Kerang Road west of the Wandella floodv<br>• the floodways in the area bounded by Prairie-Rochester Road, the Northern Highway, E<br>• additional sites identified in consultation with the community. |
| CGB.201 | City of Greater Bendigo | North Central CMA, DELWP, Parks Vic | Formalise management arrangements for Epsom-Huntly levees. |
| CGB.202 | City of Greater Bendigo | North Central CMA, DELWP, Parks Vic | Formalise management arrangements for the constructed (lined) section of Bendigo Cree |
| B.201 | Buloke Shire | North Central CMA | Determine community support and financial viability for constructing Charlton flood mitiga ensure the integrity of the levees). |
| B.202 | Buloke Shire | North Central CMA | Construction of Donald flood mitigation levees 1 and 4 and associated works. |
| C.201 | North Central CMA | Campaspe Shire, Gannawarra Shire | Investigate the future of the Torrumbarry levees and define permitted works and ongoing |
| C.202 | Campaspe Shire | North Central CMA | Undertake feasibility assessment for identified flood mitigation works at Rochester as per |
| C.203 | Campaspe Shire | | Invest in mobile pumps for flood water management. |
| C.204 | Campaspe Shire | | Upgrade flood valves around Echuca and Rochester to an automated system. |
| CG.201 | Central Goldfields Shire | Central Highlands Water | Investigate feasibility of reinstating Carisbrook Reservoir. |
| CG.202 | Central Goldfields Shire | | Undertake ongoing management of drains through Carisbrook. |
| CG.203 | Central Goldfields Shire | North Central CMA, DELWP | Develop an agreed waterway management plan for the urban area of Carisbrook |
| CG.204 | Central Goldfields Shire | | Complete implementation of flood mitigation works at Carisbrook. This includes: (1) weste Williams road to divert additional overland flow into McCallums Creek, and (3) a non-retu |
| CG.205 | Central Goldfields Shire | | Design and construct priority flood mitigation works as outlined in the Dunolly Flood Inves |
| G.201 | Gannawarra Shire | | Design and construct priority flood mitigation works as outlined in the Quambatook Flood |
| G.202 | Gannawarra Shire | North Central CMA | Investigate community's desire and willingness for ongoing management of Taverner Roa |
| G.203 | North Central CMA | Gannawarra Shire | Investigate community's desire and willingness for ongoing management of levees along arrangements. |
| H.201 | Hepburn Shire | | Undertake further investigations into the local drainage issues and potential stormwater r |
| H.202 | Hepburn Shire | | Undertake a detailed investigation into drainage issues in Creswick. |
| H.203 | Hepburn Shire | | Undertake ongoing management of drains through Creswick and Clunes. |
| H.204 | Hepburn Shire | North Central CMA | Review of Clunes Flood Mitigation and Urban Drainage Plan. Further investigate and prov |
| H.205 | Hepburn Shire | | Develop a levee management system (maintenance plan) for the Creswick levees and as |

| nd improving floodplain function | | | |
|---|---|---|---|
| | Low: ≤$50,000<br>Medium: $50,000-$300,000<br>High: ≥ $300,000 | | |
| | Cost | Priority | Expected Completion |
| ross the region to determine existing service levels and future management arrangements. | Medium | High | 1-3 years |
| ntal impacts to inform the management of floodwaters during a flood emergency (refer to section 2.3 of | Low | High | 1-3 years |
| tion in identified areas, including but not limited to:<br>of 6/7 Channel, the Washpen Creek and levees and the Sheepwash creek and levees)<br><br>eir, diverting flows to Sandhill Lake, Lake Lookout and the Back Creek, and issues with flooding over<br><br>way<br>chuca-Mitiamo Road and Bamawm Road | Medium | High | 1-3 years |
| | Low | High | 1-3 years |
| ek. | Low | High | 1-3 years |
| ation levee treatments and associated works (this may include improvements to town drainage to | High | High | 1-3 years |
| | High | High | 1-3 years |
| management arrangements. | Low | High | 1-3 Years |
| Rochester Flood Management Plan 2013 | Low | High | 1-3 years |
| | Medium | High | 1-3 years |
| | Medium | High | 1-3 years |
| | Low | Medium | 1-3 years |
| | Low | High | ongoing – as required |
| | Low | High | 1-3 years |
| ern floodway and levee to divert overland flows to the west of the township, (2) a smaller levee near rn valve on culverts under Landrigan Rd near Camp St. | High | High | 1-3 years |
| stigation 2014. | Medium | High | 1-3 years |
| l Management Plan 2013. | High | High | 1-3 years |
| d Levee. Implement ongoing management arrangements. | Low | Medium | 4-6 years |
| the Murray River, Pyramid Creek, Gunbower Forest and Loddon River. Implement ongoing management | Low | Medium | 4-6 years |
| mitigation works for Clunes. | Low | Medium | 4-6 years |
| | Medium | Medium | 4-6 years |
| | Low | High | Ongoing – as required |
| ide opportunity for the community to comment on levee options | Low | High | 1-3 years |
| sociated drainage infrastructure | Low | High | 1-3 years |

| REGIONAL PRIORITY 2: Construct new flood mitigation infrastructure, resolving ownership and maintenance accountabilities, a | | | |
|---|---|---|---|
| **Aligns with objective:**<br>**2. Reduce existing flood risk – by implementing and maintain flood mitigation infrastructure**<br>**Who is involved in delivering on this priority: LGAs, North Central CMA, DELWP, water corporations, communities** | | | |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** |
| L.201 | North Central CMA | Loddon Shire, VicRoads | Review Serpentine to Boort floodplain management plan, including an extension of the p changes to the Flume Creek bridge on Boort-Pyramid Road (near Durham Ox). |
| L.202 | Loddon Shire | | Investigate protection of old Inglewood Reservoir. |
| L.203 | Loddon Shire | | Construct mitigation works at Pyramid Hill. |
| L.204 | Loddon Shire | | Construct mitigation works at Serpentine. |
| L.205 | Loddon Shire | | Construct mitigation works at Boort. |
| MR.201 | Macedon Ranges Shire | North Central CMA | Develop a levee management system (maintenance plan) for the Woodend levees. |
| MR.202 | Macedon Ranges Shire | | Complete construction of Woodend Detention dam. |
| MAS.201 | Mount Alexander Shire | | Implement recommend mitigation options of Castlemaine, Campbells Creek and Chewto |
| MAS.202 | Mount Alexander Shire | | Upgrade and resolve ownership and maintenance arrangements for Newstead levee. |
| NG.201 | Northern Grampians Shire | | Re-construct retention dam upstream of St Arnaud. |
| NG.202 | Northern Grampians Shire | North Central CMA | Investigate operating controls for structures in Avon River upstream of Rich-Avon Weir. |
| NG.203 | Northern Grampians Shire | North Central CMA | Investigate use of Lake Batyo Catyo for flood storage. |
| SH.201 | North Central CMA | Swan Hill Rural City | Investigate community's desire and willingness for ongoing management of Pental Island |
| SH.202 | North Central CMA | Swan Hill Rural City, GMW | Investigate community's desire and willingness for ongoing management of Little Murray management arrangements. |

**Flood levees protect Kerang in January 2011.** ***Photograph: Adrian Martins, North Central CMA)***

| nd improving floodplain function (continued) | | | |
|---|---|---|---|
| | Low: ≤$50,000<br>Medium: $50,000-$300,000<br>High: ≥ $300,000 | | |
| | Cost | Priority | Expected Completion |
| lan to include floodways and road crossings in the Yando area, and to include a review of the impacts of | Low | High | 1-3 years |
| | Medium | High | 1-3 years |
| | High | Medium | 1-3 years |
| | High | Low | 4-6 years |
| | High | High | 1-3 years |
| | Low | High | 1-3 years |
| | High | High | 1-3 years |
| n flood management plan (levees and minor creek improvement works). | High | High | 1-3 years |
| | High | High | 1-3 years |
| | High | High | 4-6 years |
| | Low | Low | 6+ years |
| | Low | High | 1-3 years |
| levees and Pental Island floodway. Implement ongoing management arrangements. | Low | High | 1-3 years |
| River levees, Tyntynder Flats levees, Avoca Floodway and Avoca Outfall. Implement ongoing | Low | High | 1-3 years |

| REGIONAL PRIORITY 3: Address gaps in flood knowledge through flood mapping projects | | | |
|---|---|---|---|
| **Aligns with objective:**<br>**1. Build resilient communities – through collating and sharing flood risk information**<br>**Who is involved in delivering on this priority: LGAs, NCCMA, DELWP, water corporations, VICSES, communities** | | | |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** |
| R.301 | DELWP | North Central CMA | Complete regional flood mapping for Lower Loddon and Lower Avoca. |
| R.302 | DELWP | North Central CMA, Swan Hill Rural City | Complete the Swan Hill Regional Flood Study (includes Swan Hill, Tyntynder Flats |
| CGB.301 | City of Greater Bendigo | North Central CMA | Undertake a flood mitigation study for the Bendigo urban area. |
| CGB.302 | City of Greater Bendigo | North Central CMA | Undertake high-level gap analysis of rural flood mapping in City of Greater Bendi |
| CGB.303 | City of Greater Bendigo | North Central CMA | Undertake a rapid flood risk assessment for Redesdale. |
| CGB.304 | City of Greater Bendigo | North Central CMA | Undertake flood study for Axe Creek and tributaries. |
| CGB.305 | City of Greater Bendigo | North Central CMA | Undertake a flood mitigation study for the Kangaroo Flat/Golden Square area, c guidance. The study will take into account best practice advocated by Australian estimates of climate change impacts. |
| CGB.306 | City of Greater Bendigo | North Central CMA | Future review of the Bendigo Urban Flood Study to consider climate change scer account best practice advocated by Australian Rainfall and Runoff, and any upda |
| CGB.307 | City of Greater Bendigo | North Central CMA | Undertake a flood study for Marong. |
| B.301 | Buloke Shire | North Central CMA | Undertake a flood study to cover gaps in Charlton flood mapping for Gowar and |
| B.302 | Buloke Shire | North Central CMA | Undertake a flood study, including irrigation channel and informal levees, for Gov |
| B.303 | Buloke Shire | North Central CMA | Undertake a flood study, including irrigation channel and informal levees, for Yeu |
| B.304 | Buloke Shire | North Central CMA | Undertake a flood study, including irrigation channel and informal levees, for Tyr |
| B.305 | Buloke Shire | North Central CMA | Undertake a flood study, including irrigation channel and informal levees, for Lall |
| B.306 | Buloke Shire | North Central CMA | Undertake a flood study, including irrigation channel and informal levees, for Ma |
| B.307 | Buloke Shire | North Central CMA | Undertake a flood study, including irrigation channel and informal levees, for Mo |
| B.308 | Buloke Shire | North Central CMA | Undertake a flood study, including irrigation channel and informal levees, for Wo |
| C.301 | Campaspe Shire | North Central CMA | Undertake a flood study for Echuca. |
| C.302 | Campaspe Shire | North Central CMA | Undertake a flood study for Torrumbarry. |
| C.303 | Campaspe Shire | North Central CMA | Undertake a rapid flood risk assessment for the area between the Campaspe Ri |
| C.304 | Campaspe Shire | North Central CMA, City of Greater Bendigo | Undertake a flood study for Axe Creek and the Campaspe River downstream of |
| C.305 | Campaspe Shire | North Central CMA | Undertake a flood study for the Campaspe River downstream of Rochester throu |
| CG.301 | Central Goldfields Shire | North Central CMA | Undertake flood study for Maryborough. |
| CG.302 | Central Goldfields Shire | North Central CMA | Undertake a rapid flood risk assessment across whole of Central Goldfields Shir |
| GC.303 | Central Goldfields Shire | North Central CMA | Undertake a flood study for Bealiba. |
| CG.304 | Central Goldfields Shire | North Central CMA | Undertake a rapid flood risk assessment for Timor-Bowenvale. |
| G.301 | Gannawarra Shire | North Central CMA | Undertake a study on protection provided by Koondrook township levee. |
| G.302 | Gannawarra Shire | North Central CMA | Investigate opportunity to produce Murray Flood Plan in partnership with NSW O |
| G.303 | Gannawarra Shire | North Central CMA | Review flood information for Murrabit. |
| H.301 | Hepburn Shire | North Central CMA | Undertake flood study for Coomoora. |
| H.302 | Hepburn Shire | North Central CMA | Undertake a rapid flood risk assessment for Daylesford/Hepburn Springs. |

| | Low: ≤$50,000<br>Medium: $50,000-$300,000<br>High: ≥ $300,000 | | |
|---|---|---|---|
| | Cost | Priority | Expected Completion |
| | Medium | High | 1-3 years |
| s and Pental Island). | Medium | High | 1-3 years |
| | Medium | Medium | 4-6 years |
| go region. | Low | Low | 6+ years |
| | Low | Medium | 4-6 years |
| | Medium | Low | 6+ years |
| onsidering climate change scenarios (when available) and revised Australian Rainfall and Runoff Rainfall and Runoff, and any updated information from CSIRO or other agencies to improve regional | Medium | High | 1-3 years |
| narios (when available) and revised Australian Rainfall and Runoff guidance. The review will take into ated information from CSIRO or other agencies to improve regional estimates of climate change impacts. | Medium | Medium | 4-6 years |
| | Low | High | 1-3 years |
| Yeungroon Creeks via railway line to Avoca River. | Medium | Medium | 4-6 years |
| war Creek. | Medium | Medium | 4-6 years |
| ungroon Creek. | Medium | Medium | 4-6 years |
| ell Creek. | Medium | Medium | 4-6 years |
| bert Creek. | Medium | Medium | 4-6 years |
| rmal Creek. | Medium | Medium | 4-6 years |
| squito Creek/North-East floodplains stream. | Medium | Medium | 4-6 years |
| oroonook Lakes, Cooroopajerup Creek and Wycheproof. | Medium | Medium | 4-6 years |
| | Medium | High | 1-3 years |
| | Medium | High | 1-3 years |
| iver and Mt Hope Creek north of Rochester to the Murray River. | Medium | Medium | 4-6 years |
| Lake Eppalock to Rochester, and including Mt Pleasant Creek and the townships of Axedale and Elmore. | Medium | High | 1-3 years |
| ugh to Echuca | Medium | High | 1-3 years |
| | Medium | High | 1-3 years |
| e to determine priorities for new mapping projects. | Low | High | 1-3 years |
| | Medium | Medium | 4-6 years |
| | Low | Medium | 4-6 years |
| | Medium | High | 1-3 years |
| ffice of Environment and Heritage and Murray River Council. | Medium | High | 1-3 years |
| | Low | High | 1-3 years |
| | Low | Medium | 4-6 years |
| | Low | Medium | 4-6 years |

| REGIONAL PRIORITY 3: Address gaps in flood knowledge through flood mapping projects (continued) | | | |
|---|---|---|---|
| **Aligns with objective:**<br>**1. Build resilient communities – through collating and sharing flood risk information**<br>**Who is involved in delivering on this priority: LGAs, NCCMA, DELWP, water corporations, VICSES, communities** | | | |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** |
| H.303 | Hepburn Shire | North Central CMA | Undertake a rapid flood risk assessment for Newlyn North and Smeaton. |
| H.304 | Hepburn Shire | North Central CMA | Undertake a flood and drainage study for Trentham. |
| L.301 | Loddon Shire | North Central CMA | Undertake a flood study for Wedderburn. |
| L.302 | Loddon Shire | North Central CMA | Undertake a flood study for Inglewood. |
| L.303 | Loddon Shire | North Central CMA | Undertake a rapid flood risk assessment for Korong Vale. |
| L.304 | Loddon Shire | North Central CMA | Undertake a flood study for the Borung Hills and Hope Creek floodplains. |
| L.305 | Loddon Shire | North Central CMA | Undertake a rapid flood risk assessment for Tarnagulla. |
| MR.301 | Macedon Ranges Shire | North Central CMA | Undertake a flood study for Kyneton. |
| MR.302 | Macedon Ranges Shire | North Central CMA | Consider rapid flood risk assessments for areas with little information to determi |
| MR.303 | Macedon Ranges Shire | North Central CMA | Undertake a flood study for urban waterways in Woodend and investigate if a flo |
| M.301 | Mitchell Shire | North Central CMA | Undertake rapid flood risk assessment of the North Central CMA region to deter |
| MAS.301 | Mount Alexander Shire | North Central CMA | Undertake a flood study for Newstead. |
| MAS.302 | Mount Alexander Shire | North Central CMA | Undertake a flood study for Harcourt. |
| MAS.303 | Mount Alexander Shire | North Central CMA | Undertake a flood study for Muckleford Creek. |
| MAS.304 | Mount Alexander Shire | North Central CMA | Undertake a flood study for Campbells Creek (rural). |
| MAS.305 | Mount Alexander Shire | North Central CMA | Undertake a rapid flood risk assessment for Sutton Grange. |
| MAS.306 | Mount Alexander Shire | North Central CMA | Undertake a rapid flood risk assessment for Baringhup. |
| MAS.307 | Mount Alexander Shire | North Central CMA | Undertake a flood and drainage study for Maldon. |
| MAS.308 | Mount Alexander Shire | North Central CMA | Undertake a rapid flood risk assessment for Guildford. |
| MAS.309 | Mount Alexander Shire | North Central CMA | Undertake a rapid flood risk assessment for Taradale. |
| MAS.310 | Mount Alexander Shire | North Central CMA | Undertake a rapid flood risk assessment for Metcalfe |
| NG.301 | Northern Grampians Shire | North Central CMA | Undertake a flood study for Marnoo. |
| NG.302 | Northern Grampians Shire | North Central CMA | Undertake a flood study for St Arnaud. |
| NG.303 | Northern Grampians Shire | North Central CMA | Undertake a flood study for the Richardson River and Avon River upstream of Do |
| NG.304 | Northern Grampians Shire | North Central CMA | Undertake a flood study for the Avoca River |
| P.301 | Pyrenees Shire | North Central CMA | Undertake a rapid flood risk assessment of Lexton. |
| P.302 | Pyrenees Shire | North Central CMA | Undertake a flood management plan for Lexton. |
| P.303 | Pyrenees Shire | North Central CMA | Undertake a flood study of the Upper Avoca River to inform flood intelligence and and potential flood mitigation for the Avoca Recreation Reserve. |
| P.304 | Pyrenees Shire | NCCMA | Undertake a flood study for Waubra. |
| SH.301 | Swan Hill Rural City | North Central CMA/ Mallee CMA | Review flood mapping in Woorinen area. |

| | Low: ≤$50,000<br>Medium: $50,000-$300,000<br>High: ≥ $300,000 | | |
|---|---|---|---|
| | Cost | Priority | Expected Completion |
| | Low | Medium | 4-6 years |
| | Medium | Low | 6+ years |
| | Medium | Medium | 4-6 years |
| | Medium | Medium | 4-6 years |
| | Low | Low | 4-6 years |
| | Low | Low | 6+ years |
| | Low | Low | 6+ years |
| | Low | High | 1-3 years |
| ne areas of risk. | Low | Medium | 4-6 years |
| od warning system is warranted. | Medium | High | 1-3 years |
| mine flood risk. | Low | Medium | 4-6 years |
| | Medium | High | 1-3 years |
| | Medium | High | 1-3 years |
| | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| | Low | Low | 6+ years |
| | Low | Low | 6+ years |
| | Low | Low | 6+ years |
| | Low | Low | 6+ years |
| | Low | High | 1-3 years |
| | Low | Low | 6+ years |
| | Medium | Low | 6+ years |
| | Medium | High | 1-3 years |
| onald. | Medium | Medium | 4-6 years |
| | Medium | Low | 6+ years |
| | Low | High | 1-3 years |
| | Medium | Medium | 4-6 years |
| d planning scheme maps for Amphitheatre, Avoca and Nattee Yallock and the rural areas in between, | Medium | High | 1-3 years |
| | Medium | High | 1-3 years |
| | Low | Medium | 4-6 years |

| REGIONAL PRIORITY 4: Improve preparedness for flood emergencies | | | |
|---|---|---|---|
| **Aligns with objectives:**<br>**1. Build resilient communities – through collating and sharing flood risk information**<br>**4. Manage residual risk – by improving and coordinating flood warning and response arrangements**<br>**Who is involved in delivering on this priority: LGAs, North Central CMA, DELWP, water corporations, VICSES, communities** | | | |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** |
| R.401 | VICSES | DELWP, North Central CMA | Investigate options to improve community access to website flood risk informati |
| R.402 | VICSES | LGAs, DELWP, North Central CMA, CFA | Using a risk-based approach to prioritise, undertake operational readiness train Centres) |
| R.403 | North Central CMA | VICSES, LGAs | Investigate flash flood warning systems tailored for relevant towns/communities |
| R.404 | VICSES | North Central CMA, LGAs | Using a risk-based approach to prioritise, pre-develop community messaging tai |
| R.405 | VICSES | City of Greater Bendigo, North Central CMA | Develop a strategy for sustainable community engagement programs (for flood area. |
| R.406 | VICSES | North Central CMA, LGAs | Develop community engagement activities and or awareness products, relating boards or community-led response plans. |
| R.407 | VICSES | LGAs, North Central CMA | Incorporate updated flood mapping, flood intelligence and local knowledge into required, etc. |
| R.408 | VICSES | LGAs, North Central CMA | Develop a 10-year regional strategy for sustainable community engagement pro |
| R.409 | VICSES | LGAs, North Central CMA | Develop catchment plans to summarise main points out of Municipal Flood Em |
| R.410 | LGAs | North Central CMA, VICSES, VicRoads | Install road signage at priority locations with known flood risk that enable more |
| R.411 | DELWP (Regional Water Monitoring Partnership) | North Central CMA, LGAs | Undertake discussions with neighbouring LGAs for cost-sharing arrangements fo |
| CGB.401 | North Central CMA | VICSES, City of Greater Bendigo | Investigate a local flash flood warning system for Bendigo Creek. |
| CGB.402 | North Central CMA | VICSES, City of Greater Bendigo | Investigate a local flash flood warning system for McIvor Creek upstream Eppalo |
| CGB.403 | North Central CMA | VICSES, City of Greater Bendigo, BoM | Review flood class levels for Redesdale |
| B.401 | Buloke Shire | VICSES | Install gauge board within Donald township (e.g. at Bullocks head or Sunraysia |
| B.402 | Buloke Shire | BoM, DELWP, North Central CMA, VICSES | Update flood warning prediction services for Charlton and Donald, Coonooer Bri |
| B.403 | North Central CMA | BoM, DELWP, VICSES, Buloke Shire | Investigate improvements to flood warning for Coonooer Bridge and Culgoa. |
| C.401 | North Central CMA | VICSES, Campaspe Shire | Investigate improvements to flood warning for Mt Pleasant Creek. |
| C.402 | North Central CMA | Campaspe Shire, VICSES, | Staged implementation of a flood warning system for Rochester. |
| C.403 | North Central CMA | BoM | Review flood class levels for the Campaspe River at Echuca. |
| C.404 | North Central CMA | BoM, DELWP, VICSES, Campaspe Shire | Investigate the possibility of a flood warning prediction service for the Campasp |
| C.405 | BoM | VICSES, DELWP, North Central CMA, Campaspe Shire | Update flood forecasting service for Echuca upon completion of the Echuca Flo |

**Low: ≤$50,000**
**Medium: $50,000-$300,000**
**High: ≥ $300,000**

| | Cost | Priority | Expected Completion |
|---|---|---|---|
| on to allow people to better plan, prepare and respond to flooding. | Medium | High | 1-3 years |
| ing/exercising for all priority areas that incorporate MFEP in operational response (in Incident Control | Medium | High | 1-3 years |
| s | Low | High | 1-3 years |
| ilored for relevant towns/communities with known impacts for various AEPS. | Low | High | 1-3 years |
| risk); including community education, engagement and community led planning for the Bendigo urban | Low | Various | ongoing - as required |
| to high flood risk townships and communities. This may include: Installing community signs, gauge | Low | Various | ongoing - as required |
| MFEP for all flood affected communities, incorporating new flood studies, townships, levees, survey | Low | High | ongoing - as required |
| ograms (for flood risk), including community education, engagement and community led planning. | Low | High | 1-3 years |
| ergency Plans. | Low | High | 1-3 years |
| efficient closure (and reopening) of arterial roads and major local roads. | Medium | Medium | 4-6 years |
| or flood warning infrastructure. | Low | High | ongoing - as required |
| | Low | High | 1-3 years |
| ock (to inform Heathcote). | Low | High | 1-3 years |
| | Low | Medium | 1-3 years |
| Highway). | Low | Medium | 1-3 years |
| idge and Culgoa. | Low | High | 1-3 years |
| | Low | Medium | 4-6 years |
| | Low | Medium | 4-6 years |
| | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| e River at Echuca | Low | High | 1-3 years |
| od Study | Low | High | 4-6 years |

| REGIONAL PRIORITY 4: Improve preparedness for flood emergencies (continued) | | | |
|---|---|---|---|
| **Aligns with objectives:**<br>**1. Build resilient communities – through collating and sharing flood risk information**<br>**4. Manage residual risk – by improving and coordinating flood warning and response arrangements**<br>**Who is involved in delivering on this priority: LGAs, North Central CMA, DELWP, water corporations, VICSES, communities** | | | |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** |
| CG.401 | North Central CMA | Central Goldfields Shire, VICSES, BoM, DELWP | Investigate the possibility of providing a flood warning prediction service for Cari |
| CG.402 | North Central CMA | Central Goldfields Shire VICSES | Investigate the possibility of a flash flood warning system for Dunolly. |
| CG.403 | Central Goldfields Shire | VICSES, North Central CMA | Installation of a flood gauge board within Dunolly Township. |
| G.401 | North Central CMA | Loddon Shire, Gannawarra Shire | Investigate the benefits of a streamflow gauge at Durham Ox. |
| G.402 | VICSES | Gannawarra Shire | Flood intelligence from Quambatook flood study to be incorporated into MFEP. |
| G.403 | North Central CMA | Gannawarra Shire, VICSES | Update flood warning services for Quambatook. |
| G.404 | VICSES | Gannawarra Shire | Incorporate intelligence from Lower Loddon and Avoca regional flood studies int |
| G.405 | North Central CMA | Gannawarra Shire, DELWP, BoM | Investigate options to enable a flood warning prediction service for Gannawarra |
| G.406 | North Central CMA | Gannawarra Shire, VICSES, GMW | Investigate options for the management of flood flows through the Kerang Lake |
| H.401 | Hepburn Shire | North Central CMA | Installation of gauge board upstream of the Water Street bridge to assist in futu |
| L.401 | VICSES | Loddon Shire, North Central CMA | Develop Municipal Flood Emergency Plan for Loddon Shire (including flood intel Lyndger). |
| L402 | North Central CMA | Loddon Shire, VICSES | Investigate the development of a flood warning system for Bridgewater. |
| MR.401 | Melbourne Water | Macedon Ranges Shire, NCCMA | Review and update the Flood Management Plan for Macedon Ranges, Melbour |
| MAS.401 | North Central CMA | Mount Alexander Shire, VICSES | Investigate the possibility of a flash flood warning system for Chewton, Campbel |
| NG.401 | North Central CMA | Northern Grampians Shire, VICSES | Investigate the possibility of a flash flood warning system for St Arnaud. |
| P.401 | North Central CMA | Pyrenees Shire, VICSES | Investigate best options for improving TFWS data collection network. Potential o to the existing telemetered gauge at Avoca River at Amphitheatre. |

**Low: ≤$50,000**
**Medium: $50,000-$300,000**
**High: ≥ $300,000**

| | Cost | Priority | Expected Completion |
|---|---|---|---|
| isbrook. | Low | High | 1-3 years |
| | Low | Medium | 4-6 years |
| | Low | High | 1-3 years |
| | Low | Medium | 6+ years |
| | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| to MFEP. | Low | High | 4-6 years |
| Shire. | Low | High | 1-3 years |
| s to inform management actions during flood events. | Low | High | 1-3 years |
| ure flood warning for Creswick. | Low | High | 1-3 years |
| lligence from Bridgewater Flood Management Plan and the operational rules for Lake Boort and Lake | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| rne Water and North Central CMA (June 2013). | Low | High | 1-3 years |
| lls Creek and Castlemaine. | Low | High | 1-3 years |
| | Low | High | 1-3 years |
| ptions are: (a) add telemetry to Forrest Creek at Amphitheatre Reservoir head gauge; (b) add rain gauge | Low | High | 1-3 years |

| REGIONAL PRIORITY 5: Educate agencies and individuals on the roles and responsibilities in floodplain management | | | |
|---|---|---|---|
| **Aligns with objective:**<br>**2. Reduce existing flood risk – by implementing and maintaining flood mitigation infrastructure**<br>**Who is involved in delivering on this priority: LGAs, North Central CMA, DELWP, water corporations, communities** | | | |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** |
| R.501 | North Central CMA | LGAs, VICSES, Water corps | Develop communication plan and promotional material for the education of LGA actions. |

| REGIONAL PRIORITY 6: Incorporate Traditional Owner knowledge into floodplain management | | | |
|---|---|---|---|
| **Aligns with objectives:**<br>**1. Build resilient communities – through collating and sharing flood risk information**<br>**4. Manage residual risk – by improving and coordinating flood warning and response arrangements**<br>**Who is involved in delivering on this priority: LGAs, North Central CMA, DELWP, VICSES, Traditional Owners** | | | |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** |
| R.601 | VICSES | LGAs, CMA | Incorporate Traditional Owner knowledge into Municipal Flood Emergency Mana |
| R.602 | North Central CMA | | Develop regional guidelines for how to include Traditional Owner interests and k |

| REGIONAL PRIORITY 7: Create a flood-resilient transport network | | | |
|---|---|---|---|
| **Aligns with objectives:**<br>**1. Build resilient communities – through collating and sharing flood risk information**<br>**2. Reduce existing risk – by implementing and maintaining flood mitigation infrastructure**<br>**Who is involved in delivering on this priority: LGAs, North Central CMA, VicRoads, VicTrack** | | | |
| **ID** | **Lead Agency** | **Supporting Agency** | **Action** |
| R.701 | VicRoads | LGAs | Identify key transport routes between townships to determine priorities for upgra |
| B.701 | VicRoads | Buloke Shire | Construct major culvert at Calder Highway floodway over Yeungroon Creek. |
| CG.701 | Central Goldfields Shire | VicRoads | Upgrade London Bridge in Talbot. |
| CG.702 | Central Goldfields Shire | | Upgrade Vinecombes Ford. |
| CG.703 | Central Goldfields Shire | VicRoads | Consider elevating bridges to provide access during a major flood event for any |
| CG.704 | Central Goldfields Shire | VicRoads | Replace highway bridge with a clear-span structure when bridge is due for repla |
| MAS.701 | Mount Alexander Shire | VicRoads | Investigate options for Pyrenees and Midland Highway floodways (multiple sites) |
| MAS.702 | Mount Alexander Shire | | Investigate broader project to assess economic impacts of road closures across |

**Low: ≤$50,000**
**Medium: $50,000-$300,000**
**High: ≥ $300,000**

| | Cost | Priority | Expected Completion |
|---|---|---|---|
| As, authorities and individuals on floodplain and waterway management policies, accountabilities and | Low | High | 1-3 years |

**Low: ≤$50,000**
**Medium: $50,000-$300,000**
**High: ≥ $300,000**

| | Cost | Priority | Expected Completion |
|---|---|---|---|
| agement Plans. | Low | High | 1-3 years |
| knowledge into flood emergency and planning response. | Low | High | 1-3 years |

**Low: ≤$50,000**
**Medium: $50,000-$300,000**
**High: ≥ $300,000**

| | Cost | Priority | Expected Completion |
|---|---|---|---|
| ades. | Low | High | 1-3 years |
| | High | Medium | 4-6 years |
| | High | Low | 6+ years |
| | High | Low | 6+ years |
| future bridge upgrades in Dunolly. | High | Low | 6+ years |
| acement (or when funding becomes available) for Carisbrook. | High | Low | 6+ years |
| ). | Medium | Medium | 4-6 years |
| s the shire. | Low | Medium | 4-6 years |

# GLOSSARY

**Annual Exceedance Probability (AEP)**
The likelihood of the occurrence of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood flow of 500 $m^3/s$ has an AEP of 5%, it means that there is a 5% (one-in-20) chance of a flow of 500 $m^3/s$ or larger occurring in any one year (see also Average Recurrence Interval, flood risk, likelihood of occurrence, probability).

**Average Recurrence Interval (ARI)**
A statistical estimate of the average number of years between floods of a given size or larger than a selected event. For example, floods with a flow as great as or greater than the 20-year ARI (5% AEP) flood event will occur, on average, once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event (see also Annual Exceedance Probability).

**Catchment**
The area of land draining to a particular site. It is related to a specific location and includes the catchment of the main waterway as well as any tributary streams.

**Consequence**
The outcome of an event or situation affecting objectives, expressed qualitatively or quantitatively. Consequences can be adverse (e.g. death or injury to people, damage to property and disruption of the community) or beneficial.

**Development**
Development may be defined in jurisdictional legislation or regulation. It may include erecting a building or carrying out work, including the placement of fill; the use of land, or a building or work; or the subdivision of land.

New development is intensification of use with development of a completely different nature to that associated with the former land use or zoning (e.g. the urban subdivision of an area previously used for rural purposes). New developments generally involve rezoning, and associated consents and approvals. Major extensions of existing urban services, such as roads, water supply, sewerage and electric power may also be required.

Infill development refers to the development of vacant blocks of land within an existing subdivision that are generally surrounded by developed properties and is permissible under the current zoning of the land.

Redevelopment refers to rebuilding in an existing developed area. For example, as urban areas age, it may become necessary to demolish and reconstruct buildings on a relatively large scale. Redevelopment generally does not require either rezoning or major extensions to urban services.

Greenfield development refers to building in a currently undeveloped area or development that is unrestrained by prior work.

**Flash flooding**
Flooding that is sudden and unexpected, often caused by sudden local or nearby heavy rainfall. It is generally not possible to issue detailed flood warnings for flash flooding. However, generalised warnings may be possible. It is often defined as flooding that peaks within six hours of the causative rain.

**Flood**
A natural phenomenon that occurs when water covers land that is normally dry. It may result from coastal or catchment flooding, or a combination of both.

**Flood awareness**
An appreciation of the likely effects of flooding, and knowledge of the relevant flood warning, response and evacuation procedures. In communities with a high degree of flood awareness, the response to flood warnings is prompt and effective. In communities with a low degree of flood awareness, flood warnings are likely to be ignored or misunderstood, and residents are often confused about what they should do, when to evacuate, what to take with them and where it should be taken.

**Flood class levels**
The terms minor, moderate and major flooding are used in flood warnings to give a general indication of the types of problems expected with a flood

Minor flooding: Causes inconvenience. Low-lying areas next to watercourses are inundated. Minor roads may be closed and low-level bridges submerged. In urban areas, inundation may affect some backyards and buildings below the floor level as well as bicycle and pedestrian paths. In rural areas, removal of stock and equipment may be required.

Moderate flooding: In addition to the above, the area of inundation is more substantial. Main traffic routes may be affected. Some buildings may be affected above the floor level. Evacuation of flood-affected areas may be required. In rural areas removal of stock is required.

Major flooding: In addition to the above, extensive rural areas and/or urban areas are inundated. Many buildings may be affected above the floor level. Properties and towns are likely to be isolated and major rail and traffic routes closed. Evacuation of flood-affected areas may be required. Utility services may be impacted.

**Flood damage**
The tangible (direct and indirect) and intangible costs (financial, opportunity costs, clean-up) of flooding. Tangible costs are quantified in monetary terms (e.g. damage to goods and possessions, loss of income or services in the flood aftermath). Intangible damages are difficult to quantify in monetary terms and include the increased levels of physical, emotional and psychological health problems suffered by flood-affected people.

**Flood education**
Education that raises awareness of the flood problem to help individuals understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.

**Flood emergency management**
Emergency management is a range of measures to manage risks to communities and the environment. In the flood context, it may include measures to prevent, prepare for, respond to and recover from flooding.

**Flood hazard**
Potential loss of life, injury and economic loss caused by future flood events. The degree of hazard varies with the severity of flooding and is affected by flood behaviour (extent, depth, velocity, isolation, rate of rise of floodwaters, duration), topography and emergency management.

**Flood-prone land**
Land susceptible to flooding by the largest probable flood event. Flood-prone land is synonymous with the floodplain. Floodplain management plans should encompass all flood-prone land rather than being restricted to areas affected by defined flood events.

**Flood readiness**
An ability to react within the effective warning time (see also flood awareness and flood education).

**Flood risk**
The potential risk of flooding to people, their social setting, and their built and natural environment. The degree of risk varies with circumstances across the full range of floods. Flood risk is divided into three types – existing, future and residual.

Existing flood risk refers to the risk a community is exposed to as a result of its location on the floodplain.

Future flood risk refers to the risk that new development within a community is exposed to as a result of developing on the floodplain.

Residual flood risk refers to the risk a community is exposed to after treatment measures have been implemented. For example: in a town protected by a levee, the residual flood risk is the consequences of the levee being overtopped by floods larger than the design flood event.

**Flood severity**
A qualitative indication of the 'size' of a flood and its hazard potential. Severity varies inversely with likelihood of occurrence (i.e. the greater the likelihood of occurrence, the more frequently an event will occur, but the less severe it will be). Reference is often made to major, moderate and minor flooding (see also flood class levels).

**Flood study**
A comprehensive technical assessment of flood behaviour. It defines the nature of flood hazard across the floodplain by providing information on the extent, depth and velocity of floodwaters, and on the distribution of flood flows. The flood study forms the basis for subsequent management studies and needs to take into account a full range of flood events up to and including the largest probable flood. Flood studies should provide new flood mapping for planning scheme inclusion, data and mapping for Municipal Flood Emergency Plan (MFEPs0, and a preliminary assessment of possible structural and non-structural flood mitigation measures.

**Flood warning**
A Total Flood Warning System (TFWS) encompasses all the elements necessary to maximise the effectiveness of the response to floods. These are data collection and prediction, interpretation, message construction, communication and response. Effective warning time refers to the time available to a flood-prone community between the communication of an official warning to prepare for imminent flooding and the loss of evacuation routes due to flooding. The effective warning time is typically used for people to move farm equipment, move stock, raise furniture, transport their possessions and self-evacuate.

**Floodplain**
An area of land that is subject to inundation by floods up to, and including, the largest probable flood event.

**Floodplain management**
The prevention activities of flood management together with related environmental activities (see also floodplain).

**Flow**
The rate of flow of water measured in volume per unit time, for example, megalitres per day (ML/day) or cubic metres per second (m3/sec). Flow is different from the speed or velocity of flow, which is a measure of how fast the water is moving, for example, metres per second (m/s).

**Frequency**
The measure of likelihood expressed as the number of occurrences of a specified event in a given time. For example, the frequency of occurrence of a 20% Annual Exceedance Probability or five-year average recurrence interval flood event is once every five years on average (see also Annual Exceedance Probability, Average Recurrence Interval, likelihood and probability).

**Likelihood**
A qualitative description of probability and frequency (see also frequency and probability).

**Likelihood of occurrence**
The likelihood that a specified event will occur (see also Annual Exceedance Probability and average recurrence interval).

**Local overland flooding**
Inundation by local runoff on its way to a waterway, rather than overbank flow from a stream, river, estuary, lake or dam. Can be considered synonymous with stormwater flooding.

**Mitigation**
Permanent or temporary measures (structural and non-structural) taken in advance of a flood aimed at reducing its impacts.

**Municipal Flood Emergency Plan**
A sub-plan of a flood-prone municipality's Municipal Emergency Management Plan. It is a step-by-step sequence of previously agreed roles, responsibilities, functions, actions and management arrangements for the conduct of a single or series of connected emergency operations. The objective is to ensure a coordinated response by all agencies having responsibilities and functions in emergencies.

**Planning scheme zones and overlays**
Planning schemes set out the planning rules – the state and local policies, zones, overlays and provisions about specific land uses that inform planning decisions. Land use zones specify what type of use and development is allowed in an area (e.g. urban (residential, commercial, industrial), rural, environmental protection). Overlays specify extra conditions for developments that are allowed in a zone. For example, flooding overlays specify that developments must not affect flood flow and storage capacity of a site, must adhere to freeboard requirements, and not compromise site safety and access.

**Rainfall intensity**
The rate at which rain falls, typically measured in millimetres per hour (mm/h). Rainfall intensity varies throughout a storm in accordance with the temporal pattern of the storm.

**Riverine flooding**
Inundation of normally dry land when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam. Riverine flooding generally excludes watercourses constructed with pipes or artificial channels considered as stormwater channels.

**River Regulation**
The act of controlling river water level or the variability of river flows to meet human demands (e.g. for domestic supply, irrigation, navigation, etc)

**Runoff**
The amount of rainfall that drains into the surface drainage network to become stream flow; also known as rainfall excess.

**Service Level**
The performance of a system. For example, a levee which has a 1% AEP service level will be of sufficient height and quality to provide protection in a 1% AEP flood event.

**Stormwater flooding**
The inundation by local runoff caused by heavier than usual rainfall. It can be caused by local runoff exceeding the capacity of an urban stormwater drainage systems, flow overland on the way to waterways or by the backwater effects of mainstream flooding causing urban stormwater drainage systems to overflow (see also local overland flooding).

# ACRONYMS

| | |
|---|---|
| AEP | Annual Exceedance Probability |
| ARI | Average Recurrence Interval |
| BoM | Bureau of Meteorology |
| CMA | Catchment Management Authority |
| DELWP | Department of Environment, Land, Water and Planning |
| ESO | Environmental Significance Overlay |
| FO | Floodway Overlay |
| LGA | Local Government Authority |
| LSIO | Land Subject to Inundation Overlay |
| MFEP | Municipal Flood Emergency Plan |
| NCCMA | North Central Catchment Management Authority |
| NCRCS | North Central Regional Catchment Strategy |
| NCWS | North Central Waterway Strategy |
| NDRRA | Natural Disaster Relief and Recovery Arrangements |
| NDRGS | Natural Disaster Resilience Grants Scheme |
| SBO | Special Building Overlay |
| TFWS | Total Flood Warning System |
| UFZ | Urban Floodway Zone |
| VFMS | Victorian Floodplain Management Strategy |
| VICSES | Victoria State Emergency Services |

**Avoca River flooding north of Charlton in 2010.**
***Photograph: Adrian Martins, North Central CMA***

# Regional Floodplain Management Strategy

Everyone has a role to play in preparing for floods