GOULBURN BROKEN
CATCHMENT MANAGEMENT AUTHORITY

Goulburn Broken Regional Floodplain Management Strategy 2018-2028

Published by:

Goulburn Broken Catchment Management Authority

PO Box 1752, Shepparton 3632

Please cite this document as: Goulburn Broken CMA (2018) Goulburn Broken Regional Floodplain Management Strategy 2018-2028, Goulburn Broken Catchment Management Authority, Shepparton.

ISBN: 978-1-876600-11-2

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The Goulburn Broken CMA would like to thank those who contributed to the development of this strategy, in particular the Steering Committee and Working Groups comprising local government representatives from Benalla Rural City, Campaspe, Greater Shepparton, Mansfield, Mitchell, Moira, Murrindindi and Strathbogie as well as representatives from VICSES, EMV, GVW, G-MW, RDV, DELWP, TCAC, YYNAC, Parks Victoria and NSW Office of Environment and Heritage.

We would also like to thank members of the community who attended forums, made submissions and provided support and advice.

The Strategy

The Goulburn Broken Regional Floodplain Management Strategy (the Strategy), together with related national, state and regional documents and a range of related sub-strategies, underpin the Regional Catchment Strategy (RCS). This Strategy presents an integrated catchment planning framework for floodplain management in the Goulburn Broken region and is the primary guide for improving community flood resilience.

The strategy is intended to be adaptable and able to respond to new information or because new opportunities or priorities change.

International framework

The Australian Government has ratified several international human rights instruments that recognise and maintain Indigenous peoples' special connection to land and waters and provide for the right to practice, revitalise, teach and develop culture, customs and spiritual practices. The Strategy recognises the significant contribution that can be made by indigenous peoples towards implementing the Strategy and the legal requirements to consult.

The Vision

Through partnerships, improve the flood resilience of the catchment's people, infrastructure, land and water resources.

Implementing the Strategy

The implementation of this Strategy will be influenced by available funding and resources. Investment proposals to support actions within the strategy will be developed as investment opportunities arise. This is expected to be influenced by new information, community support and the impacts of extreme climatic events within the region, such as bushfire, drought and floods. The Strategy will be implemented within an "adaptive framework", with continued reviews incorporated into an annual planning cycle.

Guiding Principles

The Goulburn Broken Regional Floodplain Management Strategy 2018-2028, like the Goulburn Broken Regional Catchment Strategy 2013-2019, is underpinned by a resilience approach to catchment management.

Foreword

Floodplains in the Goulburn Broken Catchment are crucially important to our agriculture, food processing, forestry and tourism industries: the industries that underpin our regional economy. However, major floods can destroy crops and livestock, cause significant social and economic hardship for individuals and businesses, disrupt communities, damage property and, in some cases, lead to loss of life.

The Goulburn Broken Catchment Management Authority has partnered with our community and all tiers of government to guide future floodplain management through the Goulburn Broken Regional Floodplain Management Strategy 2018–2028. The Strategy focuses on improving community resilience and managing the environmental values of floodplains. It recognises the importance of Traditional Owners' intrinsic connection with waterways and floodplains.

This Strategy has been largely guided by the 2016 Victorian Floodplain Management Strategy and incorporates requirements of the *Climate Change Act 2017*. As Chair, I commend the Strategy's resilience approach, which aligns with the Goulburn Broken Regional Catchment Strategy 2013-19 and builds the capacity of communities to make well-informed decisions that minimise or avoid the impact of major floods.

Community access to reliable information is the best way to help stakeholders prepare for living in a floodplain area. This is why sharing reliable information is a priority action within all four of the Strategy's program themes: Flood Mitigation, Total Flood Warning Systems, Land-use Planning and Municipal Flood Emergency Plans.

This Strategy will be implemented within an adaptive management framework. This means future management approaches will be flexible enough to embrace opportunities such as new technologies, or to cope with emerging pressures such as urban growth.

By combining clear accountabilities, strong community engagement, partnerships and technical rigour to improve flood resilience, floodplain management actions will continue to be guided by their feasibility, the needs of the community and the availability of resources.

Importantly, the Strategy's Action–Investment Plan forms the business case for investment by all tiers of government to implement floodplain management actions. The success of implementing the Strategy will rely on funding initiatives such as the Natural Disaster Resilience Grants Scheme and through the monitoring, review, reporting and improvement plan process.

I am proud to share the vision for this Strategy with our partners, who have signed below.

Annie Volkering
Chair, Goulburn Broken CMA

We the undersigned…

commend the consultative process that was undertaken by the Goulburn Broken Catchment Management Authority to develop the Goulburn Broken Regional Floodplain Management Strategy and look forward to working in partnership with other stakeholders to deliver the Strategy outcomes.

CEO Benalla Rural City	CEO Campaspe Shire Council	CEO City of Greater Shepparton
CEO Mansfield Shire Council	CEO Mitchell Shire Council	CEO Moira Shire Council
CEO Murrindindi Shire Council	CEO Strathbogie Shire Council	Victoria SES (North East)
CEO Goulburn Valley Water	CEO Goulburn-Murray Water	CEO Taungurung Clans Aboriginal Corporation
CEO Yorta Yorta Nation Aboriginal Corporation	Regional Development Victoria	Regional Manager Parks Victoria

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Part A: The Strategy

Chapter 1: Strategic context

1.1 Background

State-wide, each Catchment Management Authority and Melbourne Water were tasked by Government to coordinate the development of regional floodplain management strategies for their respective regions.

The Goulburn Broken Regional Floodplain Management Strategy (the Strategy) is a shared document for all regional communities and agencies (collectively known as stakeholders) to guide continuous improvement for effective flood resilience.

This Strategy follows the release of the Victorian Floodplain Management Strategy (Department of Environment, Land, Water and Planning, 2016) (VFMS), which included the government's position in response to two investigations:

Investigation	Government response
Review of the Flood Warnings in Victoria (Comrie, 2011)	Victorian Floods Review (Victorian Government, 2012)
Parliamentary Inquiry into Flood Mitigation Infrastructure (Parliament of Victoria, 2012)	Flood Mitigation Infrastructure Review (Victorian Government, 2013)

The Victorian Floodplain Management Strategy (VFMS) included significant stakeholder consultation and sets the direction for floodplain management in Victoria, particularly around policies, actions and accountabilities (institutional arrangements). The VFMS builds on the technical basis of the Victoria Flood Management Strategy 1998 (State Flood Policy Committee, 1998). Regional floodplain management strategies interpret and apply the policies, actions and accountabilities in the VFMS at the regional and local levels.

This regional strategy focuses on floodplain management, which is a subset of flood management. The relationship is described in **Appendix A**: Flood and Floodplain Management.

This Strategy will continue to enhance flood resilience through the implementation of the ten-year Action-Investment plan, taking into account agreed priorities. However, it is important that the Action-Investment plan is adaptable and responsive to new information, technologies and opportunities and changing priorities – this is known as adaptive management.

This Strategy is presented in three parts, the Strategy, the Action-Investment Plan and supporting documents (Appendices). The Appendices largely comprise the investigation and consultation phase of the preparation of the Strategy and should be read in conjunction with the regional Strategy and Action-Investment plan for completeness.

The Strategy is presented in five chapters, namely:

Part A

- Chapter 1 – Strategic Context
- Chapter 2 – Review of previous regional Strategies and current Service Levels
- Chapter 3 – Priority setting
- Chapter 4 – Strategy implementation

Part B

- Chapter 5 – Action-Investment Plan

Part C

- Supporting documents (Appendices)

1.2 Introduction

Floodplains are the commercial, cultural, social and environmental arteries of the Goulburn Broken region. Associated with waterways, they are generally highly fertile areas, and support major agricultural, food processing, forestry and tourism industries of vital significance to the region and to the State of Victoria.

Regular flooding enhances agricultural productivity by increasing soil moisture, recharging groundwater and depositing fertile silt across the floodplain. However, widespread flooding impacts on large-scale rural agricultural areas and many major urban centres within the Goulburn Broken region. Whether floods are caused by high rainfall from upstream catchments, or direct localised severe storms, they can severely disrupt communities and regional economies by causing injury, property and environmental damage, personal suffering, productivity loss and, in some cases, loss of life.

On the other hand, small floods play a vital role on the ecosystems. This has been evident over the past two decades, with increasing recognition given to the interdependence of the health of rivers and their floodplains. Environmental watering programs to improve waterway and floodplain health have received significant commitment from all tiers of government.

The economic, social, environmental and cultural values from living and using floodplains need to be balanced against the inherent disadvantages associated with flood hazard and risks. This requires a good understanding of flood behaviour, something that was not necessarily appreciated by those settling on the floodplains.

Early floodplain management focused on addressing legacy flood problems as many towns were settled on low-lying floodplain areas because of ease of access to water supply and transport links via waterways. Land-use planning to manage the escalation of flood risk (and damage) was developed over the mid-1970s through to the 1990s culminating in the Victoria Planning Provisions, which allowed land use planning to be undertaken consistently across Victoria. More recently, reforms around emergency management and the development of Emergency Management Victoria have greatly assisted flood resilience through consistent and standardised Municipal Flood Emergency Management Plans (MFEPs) across the state.

1.3 The three flood problems

The management of “flood problems” can be broadly categorised as follows:

Management of the existing (legacy) flood problems

- This can involve a range of structural mitigation measures such as floodways, levees, diversion channels, retardation basins, and total flood warning systems.

Management of the future flood problems

- This is achieved by land-use planning policy and guidelines in municipal planning schemes to ensure future decisions around land-use and development do not unduly add to existing legacy flood problems. More recently, taking a strategic policy approach to planning schemes, such as master planning for new areas within the local planning policy framework, is now becoming commonplace in the Goulburn Broken region.

Management of the residual flood problem

- Where the management of above two problems cannot be effectively realised then the residual flood problem must shift to emergency management arrangements at state, regional and local levels, in particular through the Municipal Flood Emergency Plans (MFEPs).

1.4 Developing the Strategy for stakeholders

Sound partnerships and joint ownership of the Strategy are essential for effective implementation of the actions identified in the Action-Investment Plan. It is important that the Strategy belongs to all stakeholders.

The vision and objectives for this Strategy were developed in consultation with community, Steering and Working Group Committees. This recognises that sound partnerships and joint ownership of the Strategy is essential for effective implementation. As such, it is important that the Strategy belongs to all stakeholders who can then advance flood resilience by implementing floodplain management actions over the next decade (outlined in the in the Action-Investment plan – see Part B, Chapter 5:).

Fifteen public forums were held to capture local and regional issues. There were also opportunities to provide written submissions. Development of the Strategy and opportunities to get involved where promoted via local media, social media and the Goulburn Broken CMA and local government websites.

Robust discussions and meetings were conducted with the Steering and Working Group Committees, which were made up of representatives from local government, Traditional Owners, and other government agencies. Input from the committees, public submissions and issues were recorded and guided preparation of the Strategy. The Department of Environment, Land, Water and Planning (DELWP) provided support to ensure a consistent approach was taken by all Catchment Management Authorities and Melbourne Water developing regional Strategies, largely through their coordination of the Victorian Floodplain Managers' Forum and Strategy Writers' Group meetings.

The Strategy, together with a Summary, was released in October 2017 for further stakeholder input.

More information on the early development of the Strategy is presented in **Appendix B**: Consultation Material to Promote Stakeholder Discussions and Input.

1.5 Purpose, vision and objectives of the Strategy

The purpose of the Strategy is to provide pathways to foster and enhance flood resilience (see **Section 1.7**) across the region. This is reflected by the stakeholders' shared vision:

> ***Through partnerships, improve the flood resilience of the catchment's people, infrastructure, land, water and biodiversity.***

This Strategy has four objectives to achieve the long-term outcomes, namely:

- **Build community resilience** – by encouraging communities to act responsibly to manage their own risks (a part of the Total Flood Warning System program) by improving dissemination and communication, education and awareness through the sharing of flood information, etc;
- **Reduce legacy flood risk** to minimise exposure to flood hazard and their consequences (part of all four programs – Flood Mitigation Works, Total Flood Warning Systems, Land-use planning, and Municipal Flood Emergency Plans); and
- **Avoid future flood risk** by not making things worse (part of the Land-use Planning program); and
- **Manage residual flood risk** by with emergency services by integrated sharing of flood intelligence, interpretation at incident control (part of the MFEP and TFWS programs), flood insurance (part of the Total Flood Warning System program).

1.6 Scope

There are four programs that form the basis for the four-year rolling Action-Investment Plan in **Chapter 5:**

- Flood mitigation works
- Total flood warning systems
- Land use planning
- Municipal flood emergency management plans.

The program elements were reviewed against local needs. The process entailed undertaking a stocktake of past floodplain management activities to identify what had been achieved, the determination of service levels in consultation with stakeholders and the identification and prioritisation of actions to address any gaps.

The four-year rolling Action-Investment Plan will be reviewed periodically, as it requires the support of the stakeholders and is subject to the availability of funding.

The scope is illustrated in the program logic shown in Figure 1. The program logic for each of the four programs overlap and are further described in **Appendix C:** Program logic for program delivery.

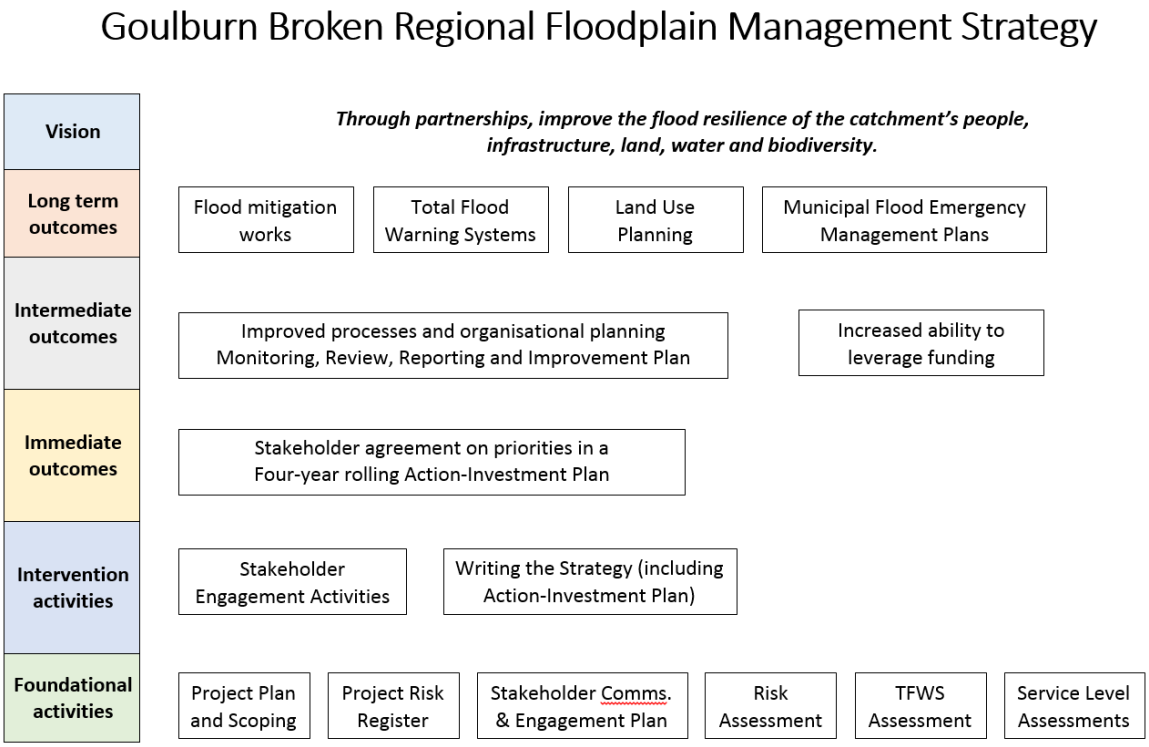


Figure 1: Regional Floodplain Management Strategy Program logic

1.7 Resilience: alignment with the National, Victorian and Regional approaches

Resilience thinking is a multidisciplinary approach for understanding and managing dynamic systems. A resilience-based approach underpins development of this Strategy.

Resilience[1] is defined as a system's capacity to absorb disturbance and continue to function in a desired way. Depending on the scale, a system might be a region, catchment or part of a catchment.

Flood behaviour can be described in terms of the likelihood and consequences of flooding, and the flood hazard, which is often expressed as the extent, depth and velocity of flooding. Understanding

[1] This is discussed in detail in the Goulburn Broken Regional Catchment Strategy (2013-2019)

flood behaviour enables communities to become more flood resilient, provided such information can be made readily accessible. Understanding flood behaviour also enables agencies and communities to assess the benefits of potential flood mitigation measures, flood warning and emergency management arrangements, and land-use planning for managing or minimising flood hazard and risk.

Figure 2 illustrates conceptually how systems can be evaluated. There are three system states: pre-European settlement, desirable and needed (as defined in 2017), and undesirable. However, achieving the pre-European state is not realistically achievable.

Each system (in this case towns are used) can be evaluated in terms of where it is now and where it should be, noting that improving the system state will take resources.

The regional Strategy implementation is building flood resilience to achieve desirable and needed system states. Overall flood impacts have increased significantly since European settlement (and will continue to do so) because of increased (and increasing) infrastructure and assets on the floodplain, but improved management has significantly reduced what the annual average damages would have been.

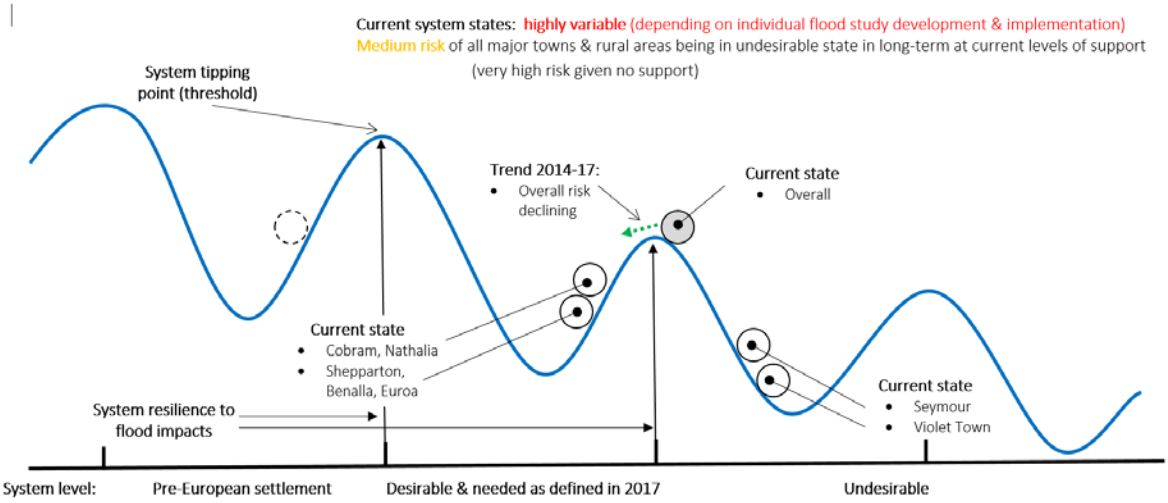


Figure 2: Conceptualisation of building flood impact resilience in example towns

The resilience model helps to narrow the high-level choices in the face of unforeseen and shifting circumstances: restore, prevent, maintain, drive transformation, or accept change and adapt.

National Approach

The National Strategy for Disaster Resilience (CoAG, 2011) makes specific reference to the application of a resilience-based approach not solely for agencies but rather a shared responsibility between government agencies, communities, businesses and individuals. Furthermore, the CoAG document defined a disaster resilient community as one that works together to understand and manage the risks that it confronts.

The National Strategy initiated a national review of land-use planning and building codes to consider ways to enhance disaster resilience in the built environment.

Victorian Approach

The resilience approach is articulated with the Victorian Floodplain Management Strategy (Department of Environment, Land, Water and Planning, 2016), and was purposely aligned with the National approach (Section 5 of the VFMS). In particular, the passage of the *Emergency*

Management Act 2013 paved the way for reforms including the introduction of the State Crisis and Resilience Council, Emergency Management Victoria and the Inspector General for Emergency Management. The alignment of flood warning arrangements and land-use planning is also articulated, which forms part of resilience.

The four objectives of this Strategy are similar to the VFMS's four objectives, namely:

- Encouraging communities to act responsibly to manage their own risks;
- Reducing legacy issues to minimise exposure to future flood risk and consequence;
- Not making things worse; and
- Providing support to emergency services by focusing on prevention activities.

Shared responsibility was also highlighted in the Victorian Bushfires Commission Final Report (2010) and again shows consistency with the National approach.

Linkages to regional strategies and plans

The Goulburn Broken Regional Catchment Strategy (Goulburn Broken Catchment Management Authority, 2013) was purposely developed using a resilience approach. The RCS vision reads *Healthy, resilient and increasingly productive landscapes supporting vibrant communities*.

The RCS's strategic objectives relate to floodplain management in the following ways:

- To embed the resilience approach with strategic priorities;
- To update and develop strategies, and with the management measure to review and update sub strategies and create new ones (such as this regional floodplain Strategy) according to need;
- To provide adaptive management and leadership, and with the management measures to build community and agency capacity to respond together to drivers of change.
- To adapt to climate variability with the strategic priority to adapt to climate variability risks, and with the management measure to factor risks of climate variability and identify adaption strategies in the Goulburn Broken CMA and partner plan;
- To adopt land-use change with strategic priority to plan for and manage floods, and with the following management measures:
    - To understand more about the nature of flooding to manage its impacts on the natural and built environments. More specifically, minimise the impact of flooding on the built environments, including infrastructure, and maximise benefits of flooding on natural assets, and
    - To provide floodplain decisions and advice in land-use planning.

Hume Regional Growth Plan (2014) and Municipal Planning Schemes

The Hume Regional Growth Plan (Department of Transport, Planning and Local Infrastructure, 2014) provides a regional approach to land-use planning in the Hume Region, which approximately aligns with the areas within the Goulburn Broken and North East CMAs.

The Growth Plan recognises adaption to climate change and the need to manage exposure to natural hazards. The Growth Plan has selected locations for development based on available infrastructure, access to employment, protection of environmental assets and avoidance of natural hazards. It also recognises that:

- Land-use planning should consider the best available information relating to the potential impacts of, adaptation to and opportunities from climate change.

- Design settlements to maximise resilience to natural hazards and climate change and take advantage of the opportunities from climate change
- The risks of flood must be considered in land-use planning decisions. These decisions should be based on the best quality information on flood hazards to minimise risk to life, property, community infrastructure and environmental assets

All eight municipal planning schemes within the Goulburn Broken region have flood zone and overlay controls, five of which have flood risk assessment guidance as an incorporated document within planning schemes, which are known as *local floodplain development plans*. This fits with the Strategy objective of "not making things worse."

Goulburn Broken Waterway Strategy (2014 – 2022)

In terms of floodplain management, the Goulburn Broken Waterway Strategy (Goulburn Broken Catchment Management Authority, 2014) recognises the resilience approach, land-use planning, and emergency management plans. It also recognises the importance of healthy waterways and their connection to floodplain and wetlands, the link between floodplain management and environmental watering, and opportunities to investigate connecting floodplains to their waterways.

The strategy also describes Traditional Owners' cultural connection to waterways and floodplains (refer to **Section 1.12**).

1.8 Climate change to be part of all future studies

The new Victorian *Climate Change Act, 2017* sets out policy objectives and guiding principles (sections 23 to 28 of the Act) requiring that the impacts due to climate change shall be considered in decision making.

This is consistent with the *Rainfall and Runoff, A Guide to Flood Estimation* (Ball J, 2016), where it advises the wide acceptance that human activities are contributing to climate change, and this change has the potential to alter extreme rainfall and flood behaviour. In all, there are four aspects of flood behaviour that are likely to be impacted by climate change in the region (Ball J, 2016):

- Rainfall Intensity Frequency Duration (IFD) relationships;
- Rainfall temporal patterns;
- Sequences of rain events; and
- Antecedent conditions and base-flow.

Unfortunately, the magnitude of the impact on any of the above aspects has not been studied comprehensively either nationally or internationally (Ball J, 2016).

The VFMS and the *Climate Change Act 2017* recognise that climate change will increase flood risks. It clarifies the roles and responsibilities of Government agencies and authorities for managing floods, and commits to improving flood warnings and the sharing of flood information for communities.

The *Victorian Climate Change Adaption Plan 2017-2020* (Department of Environment, Land, Water and Planning, 2017) states that ongoing flood studies will help flood-prone communities understand their risk, and new flood studies will more explicitly consider the implications of climate change. Floodplain management in the areas of emergency management and land-use planning shall address climate change and increased exposure to vulnerabilities.

Whilst the policy framework is in place to manage flood risk for the impact of climate change, there is substantial uncertainty about such risks posed.

Australia Rainfall & Runoff (ARR) (Ball J, 2016) focuses the potential change in rainfall intensity caused by climate change, but not rainfall temporal patterns, sequences of rain events, antecedent

conditions or base flow. Further research will be required to fill in the gaps. In the interim, a risk based approach is advocated, looking at a planning horizon for the decision and the consequences of failure. This is more aligned for asset considerations. In terms of zone and flood overlay controls for planning schemes, the planning horizon for climate change to 2050 must be considered.

To assess the climate change induced changes in relation to flood risk, ARR has used the projections of Global Climate Models. These models are coarse for application at a regional scale.

More recently, the Victorian government has commissioned CSIRO to develop downscaled climate projections across Victoria that will give a better representation of the influence of local factors such as topography on the change in rainfall intensity. Such data will greatly assist in future flood studies with a more informed focus relating to climate change and its associated impacts.

Bushfire impact

It is expected that the impact from climate change will see an increase in the number of bush fires across the region. Bushfire-impacted areas will lead to increases in rainfall runoff because of the effect of heat on the soil and removal of vegetation. Such impact will be dramatic in terms of increased magnitudes of runoff, which could see a 5% AEP (20-year ARI) rainfall storms result in a 1% (100-year ARI) type flood.

Following bush fires, the increase in flood risk will last around six months for grassland areas and 18 months for forested areas.

1.9 Description of the region

The Goulburn Broken CMA region, covers some 2.4 million hectares, and includes part of the Murray Riverina Basin, the Goulburn and Broken River Basins. Some 1.3 million hectares have dry land agriculture and irrigated agriculture covers 300,000 hectares (Montecillo, 2013). The population in 2011 was 204,000, an increase of almost 9% from 2001.

Seven municipalities are located mostly or entirely within the region (Benalla Rural City, Greater Shepparton City, Mitchell, Mansfield, Murrindindi, Moira and Strathbogie). About half of Campaspe Shire is also located within the CMA boundary, along with small portions of Greater Bendigo City and Rural City of Wangaratta. Municipal and catchment boundaries are in **Figure 3**.

Figure 4 provides an overview of the regional land-use classifications. Generally, the upper parts of the catchment are forested, while the lower parts have been developed for agriculture. Population trends from 2006, 2011 and 2016 census data indicate that most local government areas show relatively low population growth. Greater Shepparton and Mansfield local government areas show higher population growth than the region average. A breakdown of rural and urban population is presented in **Appendix L**: Goulburn Broken regional population statistics.

In recent years, Mitchell Shire has seen significant population growth due its proximity to Melbourne. Since 2001, a 30% growth has occurred.

Plan Melbourne (Chapter 6 – State of Cities) identifies Broadford, Kilmore and Seymour as peri-urban towns with potential to attract housing and population growth out of Melbourne. It is likely that demand for housing in these centres would be accelerated in the future with the imposition of a permanent growth boundary around Melbourne. Consideration around floodplain management priorities has been recognised in preparing the Action-Investment plan.

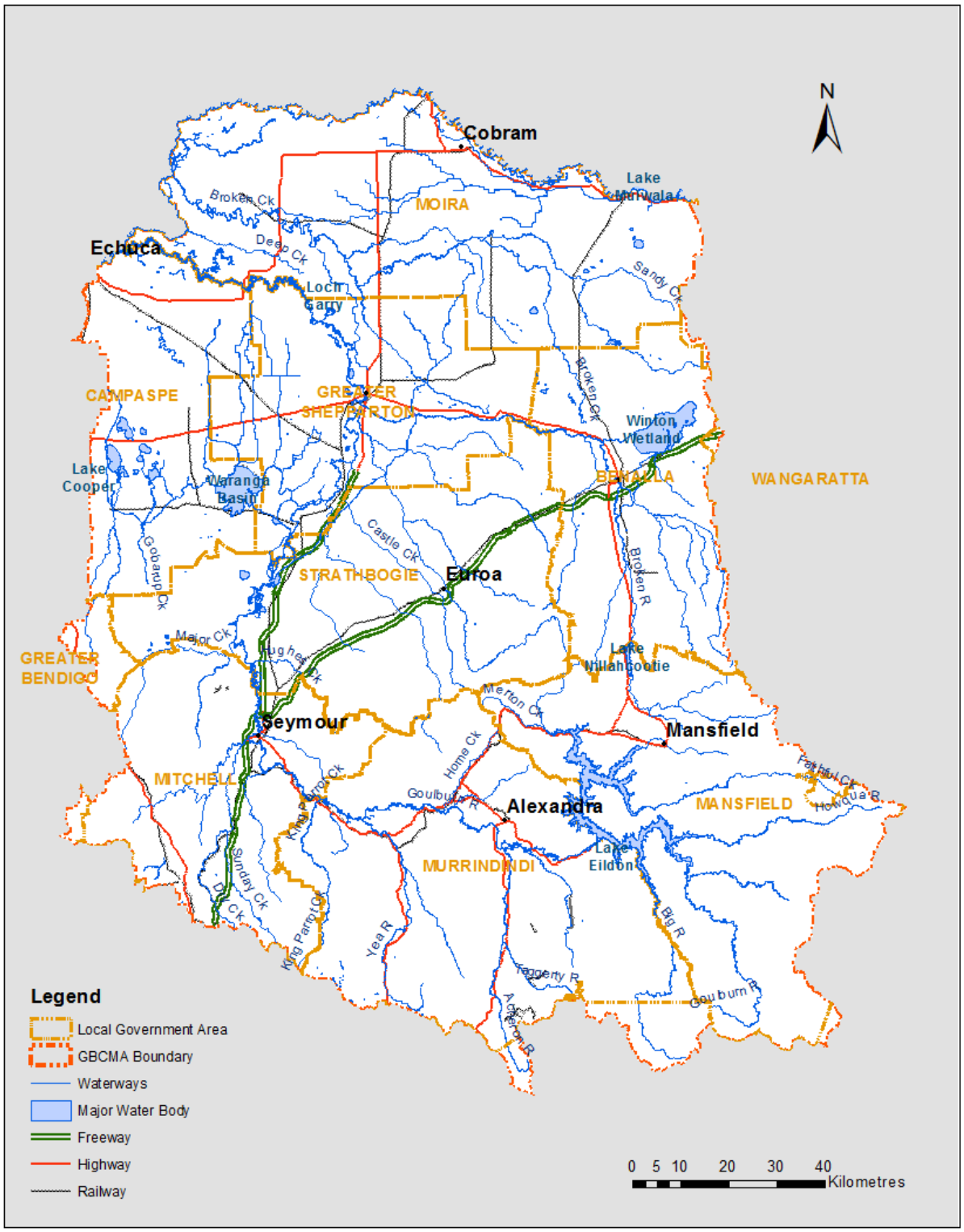


Figure 3: Goulburn Broken Catchment Management Authority Locality Plan

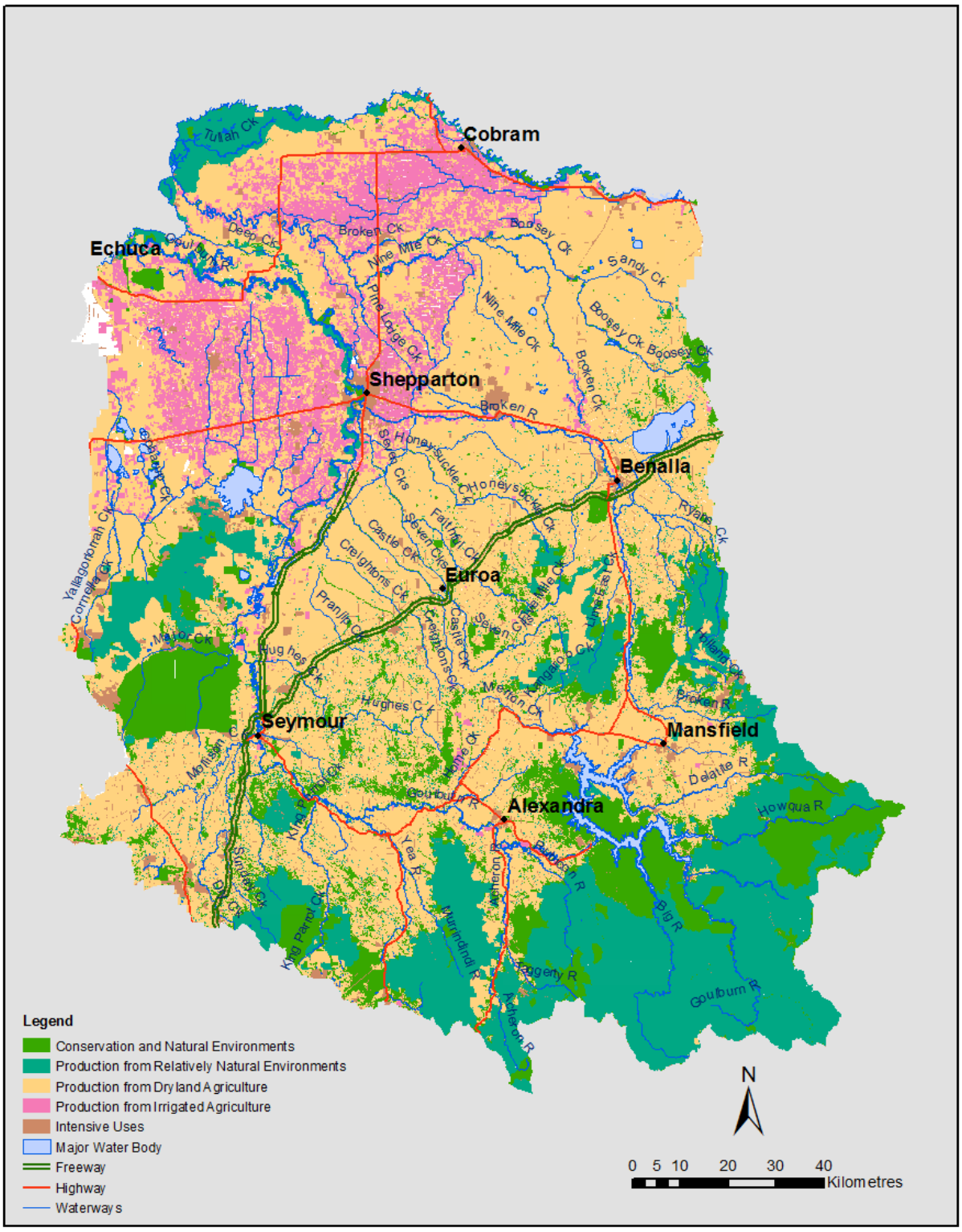


Figure 4: Land Use

Industry and Agriculture

The opening up of the area to agriculture (which commenced in the 1840s) heralded the development of a significant number of agricultural, commercial and public assets (Sinclair Knight Merz, 2002), including:

- Significant irrigation areas in the lower floodplains of the lower Goulburn and Broken Rivers;
- Arterial irrigation and drainage infrastructure such as East Goulburn Main Channel and a number of diversion weirs in Broken River and Broken Creek);
- Water storage reservoirs along many of the major water courses;
- Railways and road systems throughout the region; and
- Private and public softwood and hardwood plantations in the upper Goulburn Broken catchment.

Agriculture is the dominant land-use in the region and a substantial portion of the region's agricultural business is centred on its floodplains. Over 60% of the Goulburn, Broken and Murray River catchments and over 90% of the Broken Creek catchment have been cleared. This has led to increased pressure on waterways. Waterways have been substantially modified in many areas to permit access for stock and people to waterway frontages, to convey water for irrigation purposes during the summer months, to drain excess water and to protect properties from flooding.

The Gross Regional Product in 2008-09 was $7.08 billion and the Output was $15.2 billion of the eight local government areas in the region (Socio-Economic Profile of the Goulburn Broken Catchment, 2013). The services sector is the biggest contributor to the economic activity. Employment in 2011 was 90,000 and manufacturing was the biggest employer (11,000 people), followed by the Health Care and Social Assistance services and Retail sectors.

The gross value of agricultural production was $1.77 billion in 2011 almost the same as the pre-drought level in 2001. Irrigation continues to drive the agricultural sector - contributing two-thirds of this value, although its share declined from 67% in 2005-06 to 62% in 2011.

The results of the natural resources management survey conducted for the financial years 2007-08 and 2009-10 shows farm businesses in the Goulburn Broken region outperformed the State. The Goulburn Broken region provides unique opportunities to value add agricultural produce and provide competitive output. The enhancement of environmental and sustainability values is being achieved with new opportunities to value-add waste products by converting them to an input for another industry, whether it be milk by-products, horticultural processing waste, piggery waste, timber by-products or aquaculture waste.

There is a strong competition between the existing irrigation areas and the dryland for the investment dollars for high value horticulture development, whether it be for fruit, wine-grapes, olives, nuts or any other enterprise. In this regard, the irrigation area already is well served. It has the water, the irrigation infrastructure and many of the supporting services to enable new development to occur.

1.10 Floodplains within the Goulburn Broken region

The current flood zone and overlay information, which has been incorporated into planning schemes across the region, broadly identifies the flood prone areas as illustrated in **Figure 5**. Note there is other information not yet incorporated into planning schemes, which forms part of the Action-Investment plan of this Strategy (see Part B, Chapter 5). In order to gain an understanding of environmental factors and the exposure to flood hazard and risk in the Goulburn Broken region, floodplain areas have been split into their catchments as discussed further below.

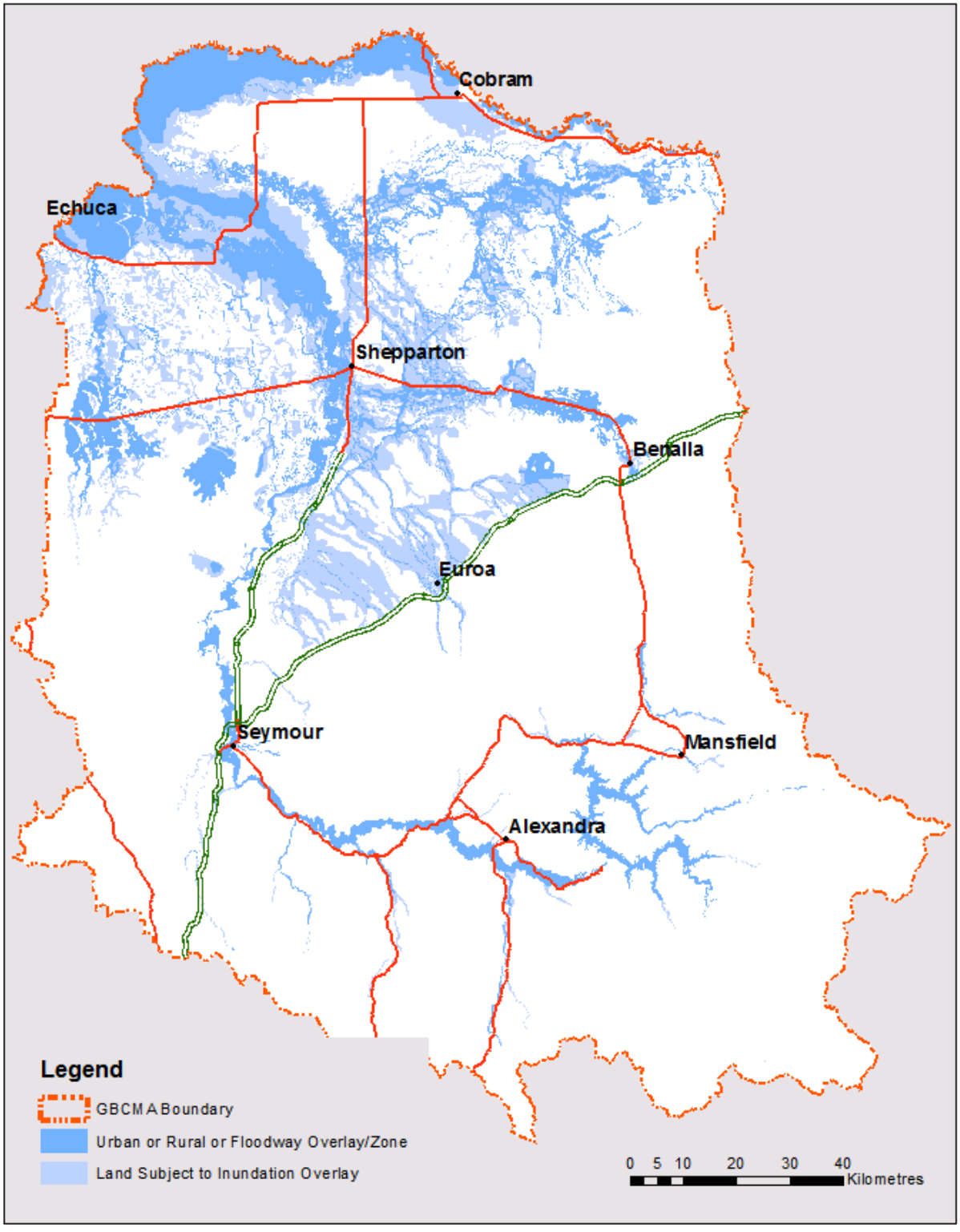


Figure 5: Gazetted planning scheme flood zone and overlay controls

More detailed flood maps are presented in **Appendix B**: Consultation Material to Promote Stakeholder Discussions and Input based on LGA areas together with some of the significant features as described below.

For convenience, floodplains in the Goulburn Broken region have been split into the following areas:

Murray Riverina:

- Lake Mulwala to Tocumwal; and
- Tocumwal to Goulburn River confluence (near Echuca).

Goulburn Basin:

- Upstream of Lake Eildon;
- Lake Eildon to Seymour;
- Seymour to Murchison; and
- Murchison to Murray confluence.

Broken River Catchment

Broken Creek Catchment

1.10.1 Environmental factors linkages

Flooding is a natural phenomenon upon which a number of environmental benefits depend. Floodplains, waterways and their associated wetlands, have a fundamental role in supporting flora and fauna habitats. Floods replenish wetlands, transport food supplies and trigger stages in the life cycles of many plants and animals.

Substantial areas of natural wetlands have been lost since European settlement, particularly in the Goulburn River and Broken Creek catchments.

If the environmental and cultural values of floodplains are to be managed effectively, reliable inventories of their assets and an understanding of potential impact are necessary inputs to the implementation of flood mitigation preparation of future floodplain management plans. Significant environmental features were originally listed in the Goulburn Broken Regional Floodplain Management Strategy (Sinclair Knight Merz, 2002).

Opportunities may arise to purchase freehold land (or use freehold land by agreement) suitable for restoration of natural functioning of floodplain. Government funding opportunities could be pursued if significant community benefits can be identified, such as specific significant environmental values, nutrient reduction and recreational values, for instance.

Other opportunities for enhancing environmental values include nutrient reduction plans, and implementing the standards as outlined in the Infrastructure Design Manual (Local Government Infrastructure Design Association , 2017), in particularly relating to water urban sensitive design that all LGAs are associated across the region.

In addition to these measures, landholders could be encouraged to undertake measures to improve environmental values on their properties. For instance, fencing incentive programs for the protection of riparian areas along waterways, and native re-vegetation programs.

1.10.2 Murray Riverina

The Murray Riverina basin extends from Lake Hume to the confluence of the Wakool River, north of Swan Hill. The portion within the Goulburn Broken region lies between the lower reaches of Lake Mulwala and the confluence of the Goulburn River. Its catchment area is not clearly defined, but is approximately 1,100 square kilometres.

Lake Mulwala to Tocumwal

Flooding for this reach originates from the headwaters of the Murray River, and/or its tributaries (the main ones being the Ovens, Kiewa and Mitta Mitta Rivers). Flooding can arise from rainfall across a number of catchments or from flooding for specific catchments (the Ovens catchment, for instance).

Lake Mulwala is located at the eastern boundary of the CMA. Two other storage reservoirs - Lake Hume and Lake Dartmouth – are located outside the Goulburn Broken region, but have an effect on flood flows and flood frequency along the Murray, particularly for frequent type floods. Further reading can be found in the Murray River Flood Plain Management Study (Gutteridge Haskins & Davey Pty Ltd, 1986).

The floodplain is naturally confined until about five kilometres upstream of Cobram, where sand hills give way to flatter terrain and the floodplain consequently becomes much broader. Two small levees – Dick's Levee (spillway)[2] and Cavagnas Levee – are located between gaps in sand hills immediately upstream of Cobram. Further downstream, a system of levees (with varying integrity) extending from Cobram to Barmah, largely protected rural areas from flooding, as experienced in 2016, which is estimated to be less than a 5% AEP (20-year ARI) type flood.

The construction of these levees has strongly influenced flooding for this reach, as has the development of irrigation, road and railway infrastructure.

Townships at risk from flooding from the Murray River include Cobram, Koonoomoo, Strathmerton, Yarroweyah and parts of Yarrawonga.

Tocumwal to Goulburn River Confluence (near Echuca)

Downstream of Tocumwal, floodwaters leave the Murray through a number of effluent flow paths passing northwards into the NSW's Edward River system. These flow paths are partially obstructed by levees and raised roads on the north side of the river.

On the Victorian side of the Murray, the natural floodplain downstream of Tocumwal is 20 kilometres wide. However, the reach between Cobram and Tocumwal, embankments associated with irrigation and drainage infrastructure[3] confine floodwaters to a width of about 11 kilometres.

Below Tocumwal, a ridge of land between Deniliquin and Echuca, known as the Cadell Fault, has diverted the western-flowing Murray southwards into a former course of the Goulburn River. As a result, flood flows in the Murray River, downstream of the Barmah Forest area, are limited to around 35,000 ML/d. In times of major floods, about 90% of the flood flows leave the Murray into New South Wales, through the Edward/Wakool system. A consequence of this behaviour is that flood levels remain similar for a wide range of floods.

Another interesting effect for this area is the occasional reversal of flows at the western end of the Cadell Fault. This is caused by floodwaters from Goulburn River effluents backing up behind the Bama Sand Hills and flowing northwards into the Edward/Wakool River system.

Barmah is the only significant town at risk of flooding for this reach. However, low-density development areas at Bearii, Lower Picola and Echuca Village are flood prone.

A history of large floods recorded since European settlement, within the Murray Riverina are presented in **Table 1**.

[2] Dick's levee is designed to spill for flood magnitudes around the 2% AEP and is part of an approved Water Management Scheme under the Water Act 1989. Hence the levee is also known as a spillway to alleviate pressures of flooding for Cobram.

[3] Such infrastructure has a primary purpose of supporting agriculture and not flood protection

Table 1: History of large known floods within the Murray Riverina

Date	Waterway Name	Town Affected	Approx. ARI (years) AEP (%)	Comments
1870	Murray River	Yarrawonga & downstream	150 (0.67%)	Largest known flood in the Murray catchment, record flood heights in Echuca & Mildura
1916	Murray River	Echuca	100 (1%)	Largest in the 20th Century
1917	Murray River	Yarrawonga & downstream	100 (1%)	
	Murray River	Cobram	100 (1%)	Levees breach at Cobram.
1956	Murray River	Cobram	<20 (5%)	Long duration flood
1975	Murray River	Yarrawonga to Barmah	35 (0.28%)	Several rural levees breached
1993	Murray River	Yarrawonga & downstream	<20 (5%)	
2012		Yarrawonga	>100 (1%)	Overland flooding largely from direct rainfall
2016	Murray River	Yarrawonga & downstream	<20 (5%)	

Significant identified environmental features within the Murray Riverina

In summary, the following environmental values are recognised:

- Billabongs and forests in the floodplain between Yarrawonga and Cobram;
- Forested areas and wetlands on public land between the levees and the river from Cobram to Barmah Forest;
- Barmah Forest, now a National Park, is one of the top ten Victorian wetland areas classified by the RAMSAR convention as being of international significance for its wildlife and vegetation; and
- A State reserve at Ulupna Island near Tocumwal.

1.10.3 Goulburn River

With a catchment area of around 16,900 km^2, the Goulburn River is the largest river system within Victoria. In the lower reaches of the catchment its floodplains are extensive. Significant floodplains also exist for part of its upstream reaches and for many of its tributaries.

Goulburn River Upstream of Lake Eildon.

Located within Mansfield Shire, the Big, Upper Goulburn, Jamieson, Howqua and Delatite Rivers, and Ford and Merton Creeks all flow into Lake Eildon, which has a catchment area of 3,910 km^2. With the exception of agricultural land along the lower reaches of the Howqua River and the Delatite River, the land is forested. The floodplains of these rivers and creeks are relatively well confined. Towns with known flood problems include Mansfield (flooded from Fords Creek) and Jamieson (flooded from Jamieson and Upper Goulburn Rivers).

Lake Eildon

Because of its size (current capacity 3,390 GL), Lake Eildon has a substantial effect on mitigating flood flows downstream of Eildon dam. This diminishes downstream of the dam, because of the contributions from downstream tributaries. However, the effect can still be substantial. In October 1993, the peak inflow to Eildon was 170,000 ML/d and the maximum rate of release was 48,000 ML/d. This compares with a peak flow of 160,000 ML/d at Shepparton, downstream of Broken River, where despite flows along Broken River reaching record levels, the flood magnitude was substantially less than other historic floods. Lake Eildon was also effective in attenuating floods in 1958 and 1975. Without the attenuation of Lake Eildon, flood flows at Seymour and Shepparton would have been substantially higher.

Goulburn River - Lake Eildon to Seymour

Downstream of Eildon the floodplain is well defined. Within the Shire of Murrindindi, its width generally varies from 1.2 to 3.0 kilometres. Further downstream towards Seymour, its width generally varies from 0.5 to 2.4 kilometres.

A number of significant tributaries flow into this reach of the Goulburn River, including: Snobs Creek; Rubicon River; Acheron River; Home Creek; Yea River (and its tributary, the Murrindindi River); King Parrot Creek (and its tributary, Strath Creek); and Dabyminga Creek.

The floodplains for these tributaries are also well defined.

The floodplains for these rivers and creeks have been mostly cleared. Generally, land-use is consistent with the flood risk, although an urban area in Yea, and low-density developments along Yea River, King Parrot Creek and Strath Creek encroach onto the floodplains. Four townships have areas liable to flooding: Buxton (flooded from Steavenson and Little Steavenson Rivers), Molesworth (flooded from the Goulburn River), Thornton (located at the junction of Goulburn and Rubicon Rivers and almost entirely flood prone) and Tallarook (flooded from Dabyminga Creek).

Over the past two decades, a number of floodplain quarries have been identified, many of which pose intolerable flood risk to infrastructure and the environment.

Seymour to Murchison

The township of Seymour has a history of flooding dating back to 1844, one year after it was founded. Pressure for urban expansion and a desire for flood mitigation for existing development resulted in a number of flood studies being undertaken in the 1980s, and again from 2000 to current day, where Mitchell Shire are coordinating detailed design for a proposed levee protection scheme.

The township is liable to flooding from Goulburn River, Whiteheads and Sunday creeks. The floodplains for the tributaries are well-defined and have steep flood gradients resulting in fast flowing floodwaters.

Sunday and Dry creeks also pass through the township of Broadford and a number of smaller towns including Wandong, Kilmore East, and Waterford Park. Some low-density residential development, to the west of Broadford encroach onto the floodplain areas. Generally, urban developments do not encroach into the floodplain.

Between Seymour and Murchison, the Goulburn River floodplain is well defined but variable, with widths ranging from up to 3.6 kilometres at Lake Nagambie to 200 metres in confined areas and averaging about 1.8 kilometres. Flooding in this reach of the Goulburn River can be the result of flooding from individual or a number of tributaries, combined with flows passing downstream of Seymour.

Nagambie Lake Leisure Park, located on the western side of Lake Nagambie is exposed to significant flood hazard, but the flood risk has been reduced due to a reconfiguration in the mid-2000s, when

the park was transformed from the then Chinaman's Caravan Park to the Nagambie Lake Leisure Park with significant government incentives for infrastructure upgrades. During a 1% AEP (100-year ARI) flood, inundation depths through the Park will range from 0.75 m to in excess of 2 m. The Caravan Park can be exposed to flooding from a combination of flood flows, not just directly from the Goulburn River, but also from its tributaries, Hughes Creek and Major Creek. While flood travel times from the Goulburn River upstream of Seymour are around eight hours or more, and flood warning arrangements along the Goulburn River are satisfactory, flood travel times for tributaries downstream of Seymour are less, and flood warning arrangements are not as reliable.

Between Seymour and Goulburn Weir, Hughes Creek, Major Creek and a number of lesser tributaries flow into the Goulburn River. Generally, floodplains to the west of the Goulburn are not well mapped as there is currently insufficient flood information to define the flood extent. An exception is the Hughes Creek floodplain, which a part of a current investigation refers to known as the Regional Granite Creek Flood Mapping Project.

Apart from Seymour and Broadford, only four towns have known flood problems – Avenel, Nagambie, Murchison and Kilmore. Parts of Avenel are liable to flooding from Hughes Creek and a number of small creeks that run through the northern portion of the town. At Nagambie, some urban lots back onto the Lake and parts of the town can flood from the Tabilk Depression catchment.

A large portion of Murchison, including its retail shop strip and residential areas, are located within a low-lying land-locked area that experienced flooding in 1916. A levee was constructed after then to prevent overflows from the Goulburn River entering this area. Some areas to the south are still exposed to flooding as detailed in the Murchison Flood Study (Water Technology, 2014).

In 1992, parts of Kilmore flooded, flooding at least six shops. This has been attributed to local drainage inadequacies rather than mainstream flooding.

Murchison to Murray River

Between Murchison and Shepparton, the Goulburn River floodplain varies in width from 1.2 km at Murchison to 3.7 km at Shepparton. Significant tributaries for the east side of the river include Pranjip Creek (catchment area about 800 km^2), Castle Creek (catchment area about 200 km^2), Seven Creeks (catchment area about 1,500 km^2) and Broken River (catchment area about 2,500 km^2). These tributaries have substantial floodplains.

There are also a number of flow paths to the west of the Goulburn River in the Toolamba area which convey local drainage to the Goulburn, but which can also function as effluent flow paths for extreme floods.

Towns and cities at risk from flooding from the Goulburn River include Kialla West, Mooroopna and Shepparton. West of the Goulburn River, parts of the townships of Tatura and Merrigum can be flooded from Mosquito Depression and its tributaries. On the east side of the catchment, the townships of Euroa and Violet Town are subject to flooding from Seven Creeks and Castle and Honeysuckle creeks respectively. The township of Baddaginnie is subject to flooding from Folly Creek (in the Goulburn River catchment) and Baddaginnie Creek (in the Broken River catchment). West of the Goulburn River, the townships of Tongala and Kyabram were subject to flooding from local runoff, but this is now substantially managed through retardation and pumping schemes.

Downstream of Shepparton, an almost continuous system of levees has been constructed along the Goulburn River. For convenience, these are described as the northern floodplain (the "Shepparton side") and the southern floodplain (the "Mooroopna side"). The levees have been instrumental in allowing a substantial portion of the Goulburn River floodplain to be developed on both sides of the river, including intensive irrigation and dryland agriculture. The level of protection for the levees

diminishes the further downstream one goes. Even in moderate floods flow will be distributed away from the river and onto the adjoining floodplains.

The northern floodplain downstream of Shepparton starts at Loch Garry, where effluent flows pass through the Deep Creek system, which end in the Murray near Barmah. Significant effluent flow paths include Bunbartha Creek, Deep Creek, Skeleton Creek, Sheepwash Creek, Wakiti Creek and Hancocks Creek.

The southern floodplain includes the small tributary catchment of Wells Creek. Flows from the creek are supplemented by drainage flows from Rodney Main Drain, which provides irrigation drainage. The drain outfalls to Wells Creek just upstream of its confluence with the Goulburn River.

Further downstream, also on the southern floodplain, Wyuna Main Drain and Tongala Main Drain outfall to the Kanyapella Basin, which in turn outfalls through Warrigal Creek to the Goulburn River immediately upstream of the Murray River.

At the westernmost part of the Goulburn catchment lies Cornella and Wanalta Creeks. These collect local runoff into a number of lakes and swamps. In exceptionally wet years, these lakes and swamps overflow into Wanalta Depression, which splits into three directions north of the "Bay of Biscay" on the Murray Valley Highway. One branch – the Southern Cross Depression – runs north-west to the Murray River at Echuca. Another runs north east into the Kanyapella Basin and the third - Beattie's Depression – runs north to the Murray.

Large floods within the Goulburn basin, recorded since European settlement, are presented in **Table 2.**

Table 2 History of large flood in the Goulburn Basin

Date	Waterway Name	Town Affected	ARI (years) AEP (%)	Comments
1870	Goulburn River	Shepparton	>100 (1%)	600 mm higher than 1916 flood
	Campaspe River [i]	Rochester to Echuca	?	
1916	Goulburn River	Generally, Molesworth to the Murray	~100 (1%)	>100-year at Eildon
	Seven Creeks	Euroa	100 (1%)	
	Honeysuckle Creek	Violet Town	~100 (1%)	
1917	Goulburn River	Eildon	>100 (1%)	
1934	Yea River	Yea	100 (1%)	
	Goulburn River	Eildon to Molesworth	100 (1%)	
1939	Goulburn River	Shepparton	~50 (2%)	
1958	Goulburn River	Shepparton	20 (5%)	
1973	Whiteheads Creek	Seymour	>100 (1%)	One drowning. Severe storm from Yea to Seymour
	Overland flooding	Yea	>100 (1%)	
1974	Sunday Creek	Seymour	30 (3.3%)	
	Goulburn River	Shepparton	70 (1.4%)	
	Campaspe River	Rochester to Echuca		
1975	Delatite River		~100 (1%)	
	UT Creek	Alexandra	~100 (1%)	
	Ford Creek	Mansfield	~100 (1%)	

Date	Waterway Name	Town Affected	ARI (years) AEP (%)	Comments
	Corop Lakes		~100 (1%)	
1983	Campaspe River	Rochester to Echuca		
1987	Sunday Creek	Broadford	20 (5%)	
1989	King Parrot Creek	Flowerdale	~50 (2%)	Largest
1989	Yea River	Yea	30 (3.3%)	
1993	Broken Creek	Nathalia	40 (2.5%)	
	Seven Creeks	Euroa	40 (2.5%)	
	Honeysuckle Creek	Violet Town	~100 (1%)	
1998	Jamieson River	Jamieson	40 (2.5%)	
	Acheron River	Buxton to Taggerty	~30 (3.3%)	
2005	King Parrot Creek	Flowerdale	~20 (5%)	
2010	Seven Creeks	Euroa	20 (5%)	
	Delatite River		>50 (2%)	Second largest on record
	Goulburn River	Jamieson	~100 (1%)	
	Acheron River	Buxton to Taggerty	40 (2.5%)	Largest flood on record
2011	Campaspe River	Rochester to Echuca	>100 (1%)	January 2011 is the largest flood on record
2013	Overland Flooding	Shepparton East	>100 (1%)	
2016	Whiteheads Creek	Seymour	~20 (5%)	One drowning.
2016	Long Gully Creek	Violet Town	~100 (1%)	

i. The Goulburn Broken CMA has a small proportion of the Campaspe Basin in its region south of Echuca, which is rural. The Towns are within the region of the North Central CMA.

Significant identified environmental features within the Goulburn Basin

The following significant environmental values are recognised:

- Riverine floodplain wetlands in the active floodplains of the Goulburn River, including Loch Garry, Gemmills and Reedy Swamps;
- Forested areas in the active floodplains of the Goulburn River, including a continuous strip from Shepparton to the Murray River confluence, and remnant forested areas along the Deep Creek system to the Murray River, parts of which are within a Nation Park;
- Forests in Kanyapella Basin and Yambuna, parts of which are within a National park;
- Remnants of ancient salt lakes, with characteristic sand dunes or lunettes on the eastern fringe, such as the Corop Lakes system and Lake Kanyapella Basin;
- Wetlands associated with prior stream systems, such as Mosquito Depression (refer to soil maps for a useful indication of where these areas are located);
- Wetlands associated with ovoid depressions, 100 to 200 metres across and with a slightly raised sand, silt or clay rim (the remains of salt scalds resulting from salinity events that occurred thousands of years ago; they are common in the Shepparton Irrigation Region);
- Recent stream systems, particularly in the northern floodplain of the Lower Goulburn River (e.g. Yambuna Creek); and
- Large water storage reservoirs such as Lake Nagambie, Lake Eildon and Waranga Basin.

1.10.4 Broken River Catchment

This basin has a catchment area of about 5,800 km^2 comprising the catchments of Broken River (2,500 km^2), and the Broken/ Boosey Creeks (3,300 km^2).

Broken River Catchment

The Broken River and its upper tributaries, Holland Creek and Ryans Creek, rise in the hills at Mount Samaria, south of Benalla. The floodplains of these upper tributaries, and Broken River upstream of Benalla, are narrow and steep and they exhibit rapid flood responses. Just upstream of Benalla the floodplain becomes wider. About 35 km south of Benalla lies Lake Nillahcootie, a 39,950 ML storage located on Broken River.

About 15 km downstream of Benalla, Five Mile Creek (or Baddaginnie Creek) joins the Broken River.

Flow from the Winton wetlands catchment (338 km^2) drains into the Broken River via Stockyard Creek some 10 km north-west of Benalla. Formerly, the Winton wetlands were known as Lake Mokoan, which acted as a water storage supply for irrigation and was decommissioned in the late 2000s. A ten-metre section of the storage's dam embankment has been removed as part of the return to wetland program (part of decommissioning process). Today, in time of major floods, floodwater is significantly attenuated (retarded) by the modified dam embankment.

In October 1993, substantial parts of the Broken River catchment were inundated by floodwater, causing major flood damage to Benalla township. Areas affected included Holland Creek, land downstream of Lake Mokoan, substantial parts of the Broken River floodplain from Benalla to Shepparton, Honeysuckle Creek and Seven Creeks at Kialla West.

Downstream of Benalla, the Broken River floodplain becomes less defined. During major floods (as occurred in October 1993) substantial flood flows can leave northwards from Broken River, through a number of breakaways, including Broken Creek, O'Keefe Creek, Pine Lodge Creek, Daintons Creek and Congupna Creek.

Large floods within the Broken River catchment, recorded since European settlement are presented in **Table 3**.

Table 3 History of flooding in the Broken River Catchment

Date	Waterway Name	Town Affected	ARI (years) AEP (%)	Comments
1916	Broken River	Benalla	~100 (1%)	Pre-Benalla Lake
1958	Broken River	Benalla	~20 (5%)	Pre-Benalla Lake
1993	Broken River	Benalla and downstream	100 (1%)	Some 1,100 homes and business experience over floor flooding
2010	Broken River	Benalla	20 (5%)	4.46 (1958) check 2010

Significant identified environmental features within the Broken River Catchment

The following significant environmental values are recognised as follows:

- Riverine wetlands in the active floodplain of Broken River and its tributaries;
- Gum Swamp, located adjacent to Stockyard Creek near Casey Weir;
- Lake Nillahcootie and Winton Wetlands (once part of Lake Mokoan irrigation supply);
- Lake Benalla in Benalla and Kialla Lakes in Shepparton; and
- Lightly timbered areas in the Dookie Hills near Nalinga.

1.10.5 Broken Creek Catchment

Ground slopes for this catchment are generally quite flat and the catchment boundary is indistinct for the northern and western boundary. The eastern boundary is defined by the Warby Ranges and the southern boundary is defined by the lower Dookie Hills.

Floods are generated from local runoff from the Major Plains area east of Dookie, from the Dookie Hills and from Broken River break-outs. For the smaller events, floodwaters are confined to the numerous drainage lines and depressions which traverse the area such as the Muckatah Depression. For the larger events (as occurred in 1974 and 1993) floodwaters from within the catchment are supplemented with effluent flows from Broken River. Towns with known flood problems include Katamatite, Nathalia, Numurkah, Tungamah and Wunghnu. Many other smaller townships along the upper Broken and Boosey creeks are known to experience some degree of flooding including: Devenish, Lake Rowan, St James, Thoona, and Wilby.

The development of an extensive irrigation and drainage system in the western half of the catchment, together with the construction of roads and railways, channels and levees, has led to considerable changes in flood behaviour. This is discussed in some detail in the Broken Creek Waterway Management Strategy (Sinclair Knight Merz, 1998).

Large floods within the Broken Creek catchment, recorded since European settlement are presented in **Table 4**.

Table 4 History of flooding in the Broken Creek Catchment

Date	Waterway Name	Town Affected	Approx. ARI (years) AEP (%)	Comments
1916	Broken Creek	Katamatite to Nathalia	Unknown	Likely to be a 100-year type flood with contributions from the Murray River (largely before infrastructure development across floodplain areas)
1939	Broken Creek		20 (5%)	
1974	Boosey Creek	Tungamah	50 (2%)	
1993	Broken Creek	Nathalia	40 (2.5%)	
2012	Broken Creek	Katamatite, Numurkah, Nathalia to the Murray	~100 (1%)	Ranked 1 flood of record at both stream flow gauges at Nathalia and Katamatite
2012	Boosey Creek	Tungamah	~50 (2%)	Ranked 1 flood of record at the Tungamah Gauge

Significant identified environmental features within the Broken Creek Catchment

The following significant environmental values are recognised as follows:

- Remnant riparian vegetation and linear wetlands along many of the water courses in the catchment;
- Tungamah Swamps east of Tungamah;
- Dowdle Swamp south east of Yarrawonga (State Game Reserve);
- Rowans Swamp on Boosey Creek;
- Ornamental lake at Numurkah and Tungamah;
- Moodies Swamp just west of Broken Creek (about 10 km south west of Tungamah);
- Kinnairds Swamp near Numurkah;
- Black Swamp, about 3 km upstream of Wunghnu; and
- Wunghnu Common.

1.11 Role of vegetation and woody habitat

There is a great deal of information and understanding about the management of rivers and waterways for ecological health. There is also a high level of understanding around management actions and their impacts on ecology, water quality, flows, stream stability, etc. It is well understood that a mostly continuous and broad swathe of native riparian vegetation is a key component of the ecological health of a river or waterway.

Native vegetation

The benefits of riparian and instream native vegetation including retention, replanting, recruitment and management include:

- **Continual leaf fall.** This plays a critical role in the functioning of freshwater aquatic ecosystems. The composition of native leaves, including eucalypts, is known to be a key component of this.
- **Improved water quality/buffer.** The clearing of catchments for agricultural land, soil disturbance during forestry operations or urban development, and bare areas such as gravel roads and stock tracks, have led to substantial increases in the amounts of sediment (gravel, sand, silt and clay) entering ours streams and rivers. This sediment and its associated nutrients and chemicals can contaminate human and stock water supplies, smother breeding sites for fish and other in-stream animals and, by filling up stream pools, deprive these animals of the deeper waters that are a vital refuge in dry seasons and prolonged droughts. Vegetation within a riparian zone can slow the overland movement of water, and cause sediment and attached nutrients to be deposited on the land before they can reach the stream channel. Riparian vegetation can also take up and remove some of the nutrients being transported (Price & Lovett, 2002).
- **Control of light and temperature.** Riparian vegetation shades streams, decreasing the amount of direct and diffuse sunlight reaching the water surface and reducing daily and seasonal extremes of water temperature. Shading controls primary productivity within the stream to a greater extent than nutrient levels, as the growth of most aquatic plants is regulated by light availability. At sites with elevated nutrient levels, shading can therefore control the effect of nutrient enrichment. In cleared streams, water temperature can exceed the lethal limits for aquatic fauna, directly influencing local biodiversity and, at lower temperature levels, the growth and development of aquatic plants and animals. The temperature tolerance of Australian aquatic macroinvertebrate fauna is similar to that measured elsewhere in the world.

In temperate systems, a target of 21°C is recommended, and in northern systems, 29°C for stream water temperatures (Davies, Bunn, Mosisch, Cook, & Walsh, 2007).

Woody habitat

Woody habitat is the branches, trunks and whole trees found lodged in waterways. They form structures in the river and create scour pools (deep holes) in the river bed. Woody habitat usually occurs naturally from trees on the river bank either falling in or dropping their branches. This can occur because of flooding, bank erosion, wind or limb shed.

Woody habitat is the inland equivalent of coastal reefs and provide habitat for native fish and other animals such as tortoises and native water rats. Native fish use them to shelter from fast currents and sunlight and take refuge from predation. Native fish also use woody habitat as feeding and spawning sites, and as nursery areas for juvenile fish.

Removal of wood debris from Victorian streams is listed as potentially threatening processes in accordance with Section 10 of the Victorian *Flora and Fauna Guarantee Act, 1988.*

Large Woody Debris (LWD) is often thought to contribute to flooding. There is, however, little evidence that LWD increases flood frequency or reduces the capacity of a river to carry floodwaters. The removal of LWD has been shown to increase the rates of erosion affecting stream bed and bank stability, and potential loss of valuable agricultural land.

Electrofishing studies carried out over a seven year period in the Goulburn River near Shepparton found almost twice as many fish at sites with a high density of woody habitat compared to sites with a low density of woody habitat. Other fish surveys have found that 80% of Murray Cod are found within one-metre of a snag.

Past river management practices have led to the widespread and systematic removal of logs and branches, yet wood in streams performs many different roles and is a vital component of riverine ecosystems (Land & Water Australia, 2003).

Removal of this material has a large affect on the ecology of stream systems:

- Provides secure roosting and preening sites for birds as well as excellent feeding vantage points;
- Fishes are more abundant and diverse in rivers with complex LWD; and
- Affecting energy sources, essential to the food web.

Until recently, logs were thought to be significant contributors to bank erosion and flooding. However, logs can enhance stream stability — their presence can exert significant control on channel complexity in bedrock rivers and channel geomorphology in alluvial rivers (Land & Water Australia, 2003).

With the exception of large wood accumulations, there is little evidence that logs and branches have a dramatic effect on flooding. Rivers will flood irrespective of the presence of wood (Land & Water Australia, 2003). Vegetation can reduce flow velocities and can influence water depth in stream systems. However, as the vast majority of the flood flow is carried on the floodplain and not in the river, localised instream and riparian vegetation will only have a minor to negligible influence on the depth and extent of major flood events (Alluvium, 2011). Further, research by river geomorphologist, Dr Chris Gippel, found that large wood that does not exceed 10% of the river channel cross-section area and does not have a significant impact on flood levels (Gippel, 1999).

Logs and branches from Australian riparian zones are relatively immobile. Our streams tend to have a low average stream power, the wood has a high density and many riparian trees have a complex branching structure that ensures they are easily anchored in position after falling into the stream (Land & Water Australia, 2003).

There is a recognition of the need for management of woody debris in situations where flood levels are impacted and towns and infrastructure are put at risk, i.e. localised flooding from large accumulation of wood or need for realignment of wood to reduce impact on flow deviation near assets.

Management policy and guidelines

Following the 2012 ENRC Review, the policy and actions contained in Section 18 of the Victorian Floodplain Management Strategy (2016) were established to include vegetation clearing, namely:

Policy 18b: Large-scale flood mitigation activities or works on waterways must be demonstrated, through a flood study, to be cost effective, i.e. have demonstrable benefits in terms of reduced average annual damage (AAD) that are greater than any costs to waterway health.

Action 18a, The Department has developed guidelines on how to apply to a CMA for authorisation to carry out works on waterways (refer to "Guidelines for Catchment Management Authorities: Assessing applications to manage vegetation and large wood in waterways and riparian zones, 2015").

1.12 Cross border issues

The Goulburn Broken catchment borders the Murray River, and as such needs to liaise with New South Wales agencies on any proposed plans including flood studies or works. Except for emergency management services, there are no formal consultation arrangements, and progress relies on good will between agencies to coordinate activities. For NSW and Victoria State Emergency Services, emergency management arrangements have been put in place to respond to the impact from major floods.

During the development of this regional Strategy, information flow to the NSWs Department has been provided that allowed for feedback in the finalisation of the Strategy.

An example of cross border cooperation was the development of the Regional Murray Flood Study where it was purposely expanded to include both the NSW Berrigan Shire and by the then NSW Department of Environment and Climate Change. Flood intelligence, was ultimately provided in both NSWSES and VICSES emergency plans (in Victoria using the Municipal Flood Emergency Plan for Moira Shire).

Similarly, the sharing and the coordination of flood information work across borders includes the capture of aerial flood photography, coordinated by the Murray Darling Basin Authority.

Cross border issues can also occur where Victorian municipalities are located within two or more catchment management authorities. As Campaspe Shire is located within both the Goulburn Broken and North Central catchments, the two catchment management authorities have worked collaboratively to provide a single point of reference in setting collective priorities for the Shire.

Another example of a partnership approach is the regional floodplain study of the Campaspe River from Rochester to Echuca, which was supported by both North Central and Goulburn Broken CMAs.

VICSES regional service boundaries do not always align with the Goulburn Broken CMA catchment boundaries. The Shire of Campaspe and the Shire of Mitchell are within the Western VICSES region, while the remaining Shires are located in the North East VICSES region. As part of the development of this Strategy both regional VICSES regions have been engaged.

1.13 Aboriginal connection to Country – waterways and floodplains

Approximately 6,000 Indigenous Australians reside within the Goulburn Broken region, many of whom identify as Traditional Owners.

Traditional Owners in the north of the region are represented by Yorta Yorta Nation (see **Figure 6**), which includes the northern plains of the Goulburn and Murray rivers, and comprising nine clans: the Kaitheban, Wollithiga, Moira, Ulupna, Bangerang, Kwat Kwat, Yalaba Yalaba and Ngurai-illiam-wurrung.

The south of the region forms part of the traditional lands of Taungurung Clans, which includes the mountains and rivers to the Great Divide as illustrated in **Figure 6**. Taungurung Clans are defined by nine clans: Buthera Balug; Look William; Moomoom Gundidj; Nattarak Balug; Nira Balug; Warring-Illum Balug; Yarran-Illam; Yeeren-Illam-Balug and Yowung - llam Balug.

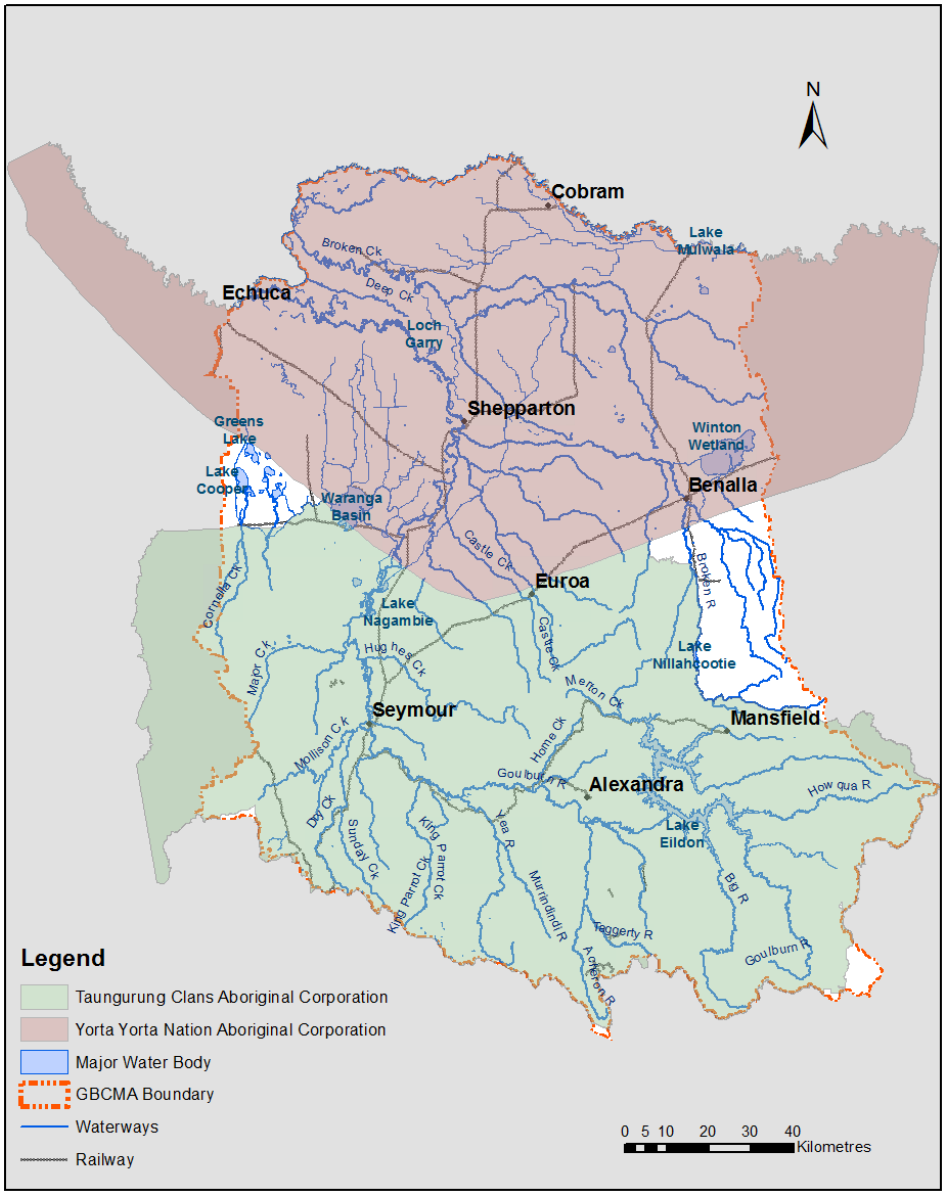
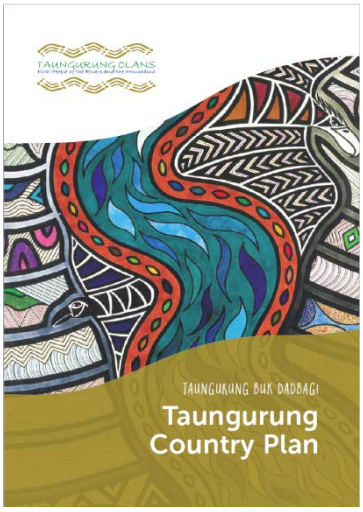


Figure 6: Registered Aboriginal Party boundaries across the Goulburn Broken region

The two following Sections contain extracts from the Country Plan prepared by each of the Registered Aboriginal Parties to highlight significant connection to waterways and their floodplains.

1.13.1 Taungurung Clans Aboriginal Corporation

As the Traditional Owners of a large part of the Goulburn Broken and North Central catchment areas, we as Taungurung People have a crucial role in managing and caring for the waterways that nourish this catchment.

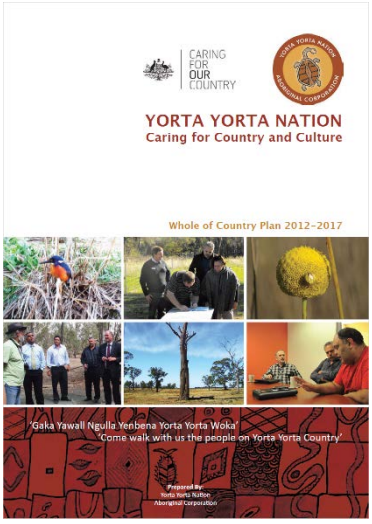


Water is the lifeblood of our Country. It keeps Country alive by nurturing and sustaining plants, animals, soils and ecosystems. As Traditional Owners, we have responsibilities handed to us by our Ancestors to continue to look after Country. As water is the source of life for our Country, we have had and will continue to have significant responsibilities relating to how water is managed now and into the future. Taungurung people have always and will always continue to look after Country.

The degradation of our waterways since European settlement is a source of great concern to the Taungurung people. Issues that we believe undermine the health of the waterways within the Goulburn Broken catchment and which need to be addressed include, amongst other things, change to the links between waterways with their floodplains.

1.13.2 Yorta Yorta Nation Aboriginal Corporation

The movement of our people within Country enabled us to use our vast resources without overuse or damage. Our Ancestors had an intimate knowledge of their environment and were able to sustain the ecology of each region. They used food and other resources to lead healthy and productive lives, without exploiting any resource.



Traditional Owners' knowledge of land and water resources and cultural heritage in the landscape is rich and unique.

The very essence of water itself - being flow - is of high spiritual importance to Indigenous peoples and represents*, The physical health of country is also directly connected to the physical, emotional and spiritual health of the Yorta Yorta People. Land, water and natural resources are not only necessary for survival, but are sacred and require protection and sustainable management under Yorta Yorta. The impact that watering regimes have on culturally significant fauna species is also one of importance. Lack of water, or lack of water to specific wetland areas, can be debilitating for species such as the Broad Shelled Turtle, the totem of the Yorta Yorta people.*

Both Country Plans features an Action Plan, which includes target areas and strategies for on-ground application.

1.13.3 Consultation requirements and partnerships

Traditional Owners have unique rights and interests under the *Aboriginal Heritage Act 2006* that differentiate them from the broader community. Accordingly, direct engagement is required when contemplating activities and works on floodplains including the preparation this Strategy.

The Yorta Yorta Nation Aboriginal Corporation (YYNAC) and Taungurung Clans Aboriginal Corporation (TCAC) are both Registered Aboriginal Parties (RAPs), under the Victoria *Aboriginal Heritage Act 2006* (the Act). The Act recognises Aboriginal people as the primary guardians, keepers and knowledge holders of Aboriginal cultural heritage. At regional and local levels, RAPs are the voice of Aboriginal people in the management and protection of Aboriginal cultural heritage.

RAPs have responsibilities relating to the management of Aboriginal cultural heritage under the Act. These include evaluating Cultural Heritage Management Plans, providing advice on applications for Cultural Heritage Permits, decisions about Cultural Heritage Agreements and advice or application for interim or ongoing Protection Declarations.

"…floodplains, rivers, wetlands, estuaries and aquifers are all part of an interconnected system that needs to be managed holistically. It is also important to note that the vast majority (95% of the 30,000 recorded significant Aboriginal places and heritage sites) are located on or near Victorian waterways". (Federation of Victorian Traditional Owner Corporations, 2014)

Waterways and their associated floodplains are a vital importance for Traditional Owners' livelihood and well-being including: cultural and spiritual connections, sustainable ecological sources for traditional foods and fibre, traditional medicines, and water resources.

The ecological and cultural values are particularly threatened by changed flow regimes, particularly in regulated water supply systems that support both potable and irrigation water supplies.

Opportunities to manage the absence of freshes and floods have been subject to environmental waterway initiatives at all levels of government. The strategic use of floodwaters, such as that originally proposed by the lower Goulburn Constraints Strategy (2016) sought to engage the wetting of the riparian ecosystems which are not only important to the flora's health but recognised as important to Aboriginal peoples.

A full range of values, rather than focusing on asset protection for urban towns for instance, is recognised as part of the decision-making process in floodplain management initiatives. Tools to undertake assessments and determine priorities need to include engaging with Traditional Owners and seek alignment with strategic documents such as: Country Plans, Regional Growth Plans, State Policy and Planning Framework.

Traditional Owners are required to be engaged in any floodplain management activities and/or works. This includes any emergency management arrangements through the Incident Control Centre during major floods.

The Goulburn Broken CMA and its partners are conscious of meaningful engagement with Traditional Owners as set out in Aboriginal Participation Guideline (Department of Environment, Land, Water and Planning, 2016) and its associated document Implementation Plan – Pathways to Participation (Department of Environment, Land, Water and Planning, 2016).

To assist in meeting these participation guidelines, a combined working committee comprising RAPs, CMAs and other guests meet three times annually to discuss issues of the day, including this regional Strategy. Also, the Goulburn Broken CMA employs two staff members representing the Traditional Owners general interest including the cultural flow initiative. The Goulburn Broken CMA coordinates the Woka Walla (land and water) program that include on-grounds work program including Traditional Owners.

The Regional Waterway Management Strategy (2014) recognises integrated management including the best available scientific information and aspiration of knowledge of Traditional Owners.

1.14 Flooding versus drainage

The boundary between drainage issues and flood issues is sometimes blurred. However, there are some noticeable differences.

Rural and urban drainage do not form part of this regional Strategy

Flooding

Flooding is a natural phenomenon that occurs when water covers land that is normally dry. Adverse flood impacts are mostly associated with flood damages and trauma from infrequent floods (generally greater than the 20% AEP or 5-year ARI event). Where appropriate, flood mitigation infrastructure is constructed to protect communities from flooding. Other non-structural options, such as land use planning and development controls, are applied to reduce the frequency and severity of flooding.

Flooding from riverine catchments has historically been a major focus in floodplain management. In recent years, the Goulburn Broken CMA has recognised the importance of overland flooding from localised severe intense thunderstorm episodes. This occurs in areas such as Kilmore, Shepparton East and Alexandra. Such overland flooding investigations have been commonplace in the Melbourne Water area of responsibility, and have been documented as having a similar flood damage profile as riverine flooding.

Overland flooding identification is particularly important within peri-urban centres close to Melbourne as there are pressures to intensify development with greenfield areas. This largely applies to Mitchell Shire and to a lesser extent to Murrindindi Shire.

Rural drainage

Rural drainage is focused on constructing infrastructure to remove water off the land to improve agricultural productivity. Without the drains, the land is frequently waterlogged. Drainage capacity is usually focussed on the more frequent (50% AEP or 2-year ARI) rainfall events. Non-structural solutions don't apply.

Irrigation drainage is managed through the Goulburn-Murray Irrigation District Drainage Program through in partnership between Goulburn-Murray Water (lead agency) and Goulburn Broken CMA. There are no existing dryland drainage schemes that were historically present under either the Drainage Areas Act 1958 or and the Drainage of Land Act 1975. These acts have been repealed and superseded by the Local Government Act 1989.

The draft Victorian Dryland Drainage Strategy is currently being developed by DELWP, and is expected to be released by the late 2017 for comment.

Urban drainage

Urban drainage is managed by LGAs and generally was historically concerned with managing localised rainfall episodes equivalents to a 20% AEP (5-year ARI) standard. Contemporary standards seek to be guided by a common document known as the Design Infrastructure Manual, which most Victoria Councils use employing a 1% AEP standard through the use of localised retardation basins, particularly for greenfield areas.

1.15 Integrated catchment management – identifying threats and opportunities

Integrated catchment management (ICM) recognises the intrinsic linkages between land-use and subsequent impacts on land, water, cultural heritage and biodiversity and seeks a holistic approach to their management.

Actions within a catchment (such as residential/commercial development, agriculture and forestry) can have significant impacts on the functions and uses of floodplains. For example, development of 'greenfield' sites on floodplains can impact a number of floodplain functions, including: habitat maintenance; cultural heritage, wetland connectivity, flood storage and conveyance; and groundwater recharge. Also refer to Section 1.10.1.

Similarly, floodplain mitigation works (such as levees) can also impact floodplain functions by constricting the floodplain area causing adverse impacts to surrounding areas, as well as effectively disconnecting the floodplain from the waterway, reducing the retention of water in wetlands, decreasing habitat diversity, and destroying riparian vegetation.

ICM opportunities for floodplain management

Opportunities for integrated outcomes will make floodplain management stronger and more resilient. They may arise from changes in government policy, community perceptions to floodplain function, emerging technology, improved stakeholder engagement and other forces relevant to floodplain management.

More tangible opportunities exist through collaboration and cooperation within CMAs, particularly waterway management. Examples include:

- Environmental watering, particularly where it includes inundation of the floodplain to mimic natural flow regimes to improve environmental and cultural values[4].
- Vegetation management e.g. willow replacement programs. Willows can choke waterways leading to in-channel constrictions and the backing up floodwaters.
- Protection of waterway assets for their environmental values e.g. Gunbower forest. When we preserve floodplains for their environmental values and the ecosystem services they offer, we are also maintaining their capacity to store and convey floodwaters.

[4] Provided that environmental watering does not impact of private land without landowner agreement

Chapter 2: Service level and previous strategy assessments

2.1 Overview

This Chapter provides commentary and documentation on the achievements in the delivery of the first regional floodplain management strategy released in 2002[5] and provides a summary of service levels for the four programs that form the basis for the four-year rolling Action-Investment Plan in **Chapter 5:**

- Flood mitigation works
- Total flood warning systems
- Land use planning
- Municipal flood emergency management plans.

The first three programs form part of the program logic, which is discussed in **Section 1.6**. The fourth program, Municipal Flood Emergency Plans, is a combination of the first three programs above and including identified regional community infrastructure and vulnerable communities.

Service levels are defined as a list of attributes or a score that enable the quality or performance of a program element to be evaluated.

2.2 Regional Floodplain Management Strategy 2002

The 2002 regional Strategy comprised nine programs. Their alignment against the four programs in **Section 1.6** is illustrated in **Table 5.**

Table 5: Alignment of programs between the 2002 and 2018 Strategy

2018 Programs	2002 Strategic Programs
Flood Mitigation	Asset Management (levees) Floodplain Management Plans
Total Flood Warning Systems	Education, Promotion and Communication. Floodplain Management Plans
Land Use Planning	Statutory Land Use Planning Development Assessment Guidelines Control of Works and Activities on Floodplain Information Management Systems Flood Studies and Floodplain Management Plans
Municipal Flood Emergency Plan	Emergency Response Planning Flood Monitoring Actions Flood Studies and Floodplain Management Plans

In the 2002 strategy, flood studies and floodplain management plans were identified as a distinct program. This is not the case for the current strategy, but they are still of vital importance. Flood studies and floodplain management plans are a means to an end that provide the necessary products to deliver on the activities identified in the Action-Investment Plan

[5] Note an Interim Goulburn Broken Regional Floodplain Management Strategy (2014-2016) was prepared where nine of the ten listed actions are either completed or underway. This Interim Strategy is available on the Goulburn Broken CMA website.

A review into all studies completed since 1997 was undertaken as part of this regional Strategy stocktake. Detailed listings are presented in **Appendix D**: Summary of Flood Studies, Plans, Work Plans and their numbers are summarised in **Table 6**.

Studies prior to 1997 (i.e. the year the Goulburn Broken CMA was established) have not been listed. They were however considered when providing information to stakeholders. Most are referenced in the stocktake in **Appendix B**: Consultation Material to Promote Stakeholder Discussions and Input.

There have been ten studies completed pre-Strategy (1997-2001). During the period of the 2002 regional Strategy (2002-2013) another 28 flood studies were completed, and another ten studies post Strategy – refer to **Table 6**: Summary of number of studies, plans and action since CMA formation (1997).

There are some 19 actions in terms of flood mitigation implementation, which are largely carried out by local government (there are numerous other supporting documents prepared by local government that are not listed).

It is important to note that information from the 48 studies completed (and another 7 underway) are utilised to action land-use planning, emergency management (MFEPs), and education and awareness initiatives (i.e. Local Flood Guides, web access to property-specific information, and the Flood Victoria website), which are numerous.

Table 6: Summary of number of studies, plans and action since CMA formation (1997)

Study Type	No of Studies and Plans
1997-2001 (Pre-2002 regional Strategy)	
Flood Scoping Studies	1
Flood Studies	4
Floodplain Management Plans	5
Flood (Mitigation) Implementation Actions	3
2002 – 2013 (2002 Regional Strategy Phase)	
Flood Scoping Studies	3
Flood Studies	17
Floodplain Management Plans	8
Flood (Mitigation) Implementation Actions	12
2013 -2017 Interim Strategy (2013-2016)	
Flood Scoping Studies	0
Flood Studies	8 [i]
Floodplain Management Plans	2
Flood (Mitigation) Implementation Actions	3

i. Plus an additional 7 studies underway.

The carrying out flood studies, floodplain management plans, mitigation schemes, emergency management plans and land-use planning controls would have not been possible without the collaboration of all stakeholders, and particularly the strong support for Local, State and Commonwealth funding over the past two decades

Appendix E: 2002 Regional Strategy Program Review provides a commentary to what extent each of the nine programs presented in the 2002 regional Strategy have been implemented.

2.3 Service levels for structural mitigation works

It is important to document information about existing structural flood mitigation works (mostly levees). The information can be documented in terms of:

- Management arrangements;
- General characteristics, such as location and height;
- Service levels (where known), such as condition, freeboard, the level of protection and management arrangements;
- The source of the information;
- A description of the infrastructure and the beneficiaries; and
- Any proposed improvements., as well as identify whether the current service levels are appropriate or should be improved. The documentation includes governance arrangements, freeboard, and assets protected.

There also needs to be consideration of whether there are *prima facie* cases for new flood mitigation infrastructure, or a need to modify existing infrastructure, or a need to bring such infrastructure under ongoing management (operation and maintenance) arrangements, preferably under a Water Management Scheme as outlined in the *Water Act 1989*.

A review has been carried out for each LGA (urban management units) and for the regional areas (rural management units) and is presented Appendix F: Service levels – structural flood mitigation works**.**

Most flood mitigation infrastructure in Victoria is not being formally managed. If no current formal management arrangements are in place, it will be assumed that the infrastructure will be privately managed or not managed at all. A likely consequence of this is that the flood mitigation infrastructure will continue to deteriorate. This will impact on emergency management planning and on land-use planning.

Where existing flood mitigation infrastructure does exist, a description is provided (usually about a levee), including the service level, the main beneficiaries and the management arrangements.

Where new flood mitigation infrastructure is desirable or whether there is a plausible case for modifying or expanding the existing flood mitigation infrastructure, the regional Strategy highlights a need for investigations for flood mitigation infrastructure options.

There are three phases of work:

- The planning phase, where information on existing or proposed flood mitigation infrastructure is reviewed;
- The decision-making phase, where LGAs, the CMA and other relevant stakeholders convene to determine what further actions should be addressed in the regional Strategy; and
- The documentation phase where findings are recorded.

2.3.1 Management arrangements for rural levees

Victorian Floodplain Management Strategy policy on Flood Mitigation Infrastructure.

Section 17 of the Victorian Floodplain Management Strategy (VFMS) sets out a policy framework for the consideration for either building and/or managing floodplain infrastructure.

Most flood mitigation infrastructure in Victoria is not being formally managed. If no current formal management arrangements are in place, it will be assumed that the infrastructure will be privately managed or not managed at all. A likely consequence of this is that the flood mitigation

infrastructure will continue to deteriorate. This will impact on emergency management planning and on land-use planning.

A separate process exists for individuals (or group of individuals) wishing to carry out levee maintenance works on Crown land. Note that levee maintenance on private land is subject to planning scheme processes (in some cases, if considered "routine maintenance" under the planning scheme provisions then no planning permit is required).

Generally new levees are unlikely to be supported outside an approved process (i.e. *Water Act 1989* or *Local Government Act 1990*).

The Victorian Government prefers flood mitigation infrastructure that is to be formally managed to become Water Management Schemes. The process is outlined in the *Water Act 1989*.

The VFMS acknowledges that the processes surrounding Water Management Schemes are not perfect. An Action in the VFMS is for DELWP to prepare, for government consideration, a proposal to amend the Water Act to clarify and simplify the liability and assurance arrangements for LGAs when they construct or maintain flood mitigation infrastructure through the implementation of Water Management Schemes.

Management of rural levees by Local Government

The VFMS sets out the policy that LGAs are best placed in its role in supporting communities to manage levees (if there is the resolve to do so). Many LGAs however, articulated strong resistance to this policy during the development of the VFMS.

Section 17.2.1 of the VFMS sets out the investment criteria including, amongst other things, how community and private benefits are considered. As such LGAs are unlikely to play a role in the management of rural levees in the region.

Whilst in can be argued that there will always be some "community benefit" around "rural" levee management (i.e. major access routes being maintained, large businesses remaining operational), it is considered relatively small compared with the "private" benefits. Therefore, the beneficiary principle for rural levees, such as the lower Goulburn and the Public Works Levee[6] would remain with the rural landowners.

Cost sharing principles (both rural and urban)

The VFMS focusses on the beneficiary pays principle. The three tiers of government (Australian/State/LGA) would only invest in existing mitigation infrastructure if this met the "investment criteria" contained in Section 17.2 of VFMS. These include, amongst other things, cost effectiveness, and (specific) community criteria that needs to be met if the three tiers of government are going to invest financially. The VFMS suggest that it is unlikely that rural levee will managed into the future due to such investment criteria.

Economic prima-facie case

The VFMS requires that a *prima facie* case for economic effective be carried out for rural levees as part of the development of regional catchment management strategies. In this regard, the Goulburn Broken CMA commissioned Jacobs to carry out a rapid appraisal assessment, which found the benefits of managing the current lower Goulburn and Public Works levees are not economically viable.

Conclusion

Having regard to the above, and the workshop with DELWP, Greater Shepparton, Campaspe, Moira Councils and Goulburn Broken CMA, the conclusion reached was not only was there strong

[6] The Murray River levees extending from Cobram to Piree Creek (near Picola).

reluctance by LGAs to be part of any rural levee management largely due to legal liability and lack of resources, but the required work to bring rural levees up to a reasonable standard failed to align with the Victoria investment criteria.

Individuals (or groups of individuals) under the new Goulburn Broken CMA permitting process may be granted permission only for levee maintenance works on Crown land. This is now available on the Goulburn Broken CMA website.

2.3.2 Irrigation Infrastructure acting as levees

Goulburn-Murray Water under its Connections Project for modernising aging infrastructure, has determined many "non-backbone" irrigation channels that could be decommissioned and handed over to the landowner (i.e. irrigation channels determined as surplus for future delivery of irrigation water supply).

Goulburn-Murray Water commissioned the Goulburn Broken and the North Central CMAs to carry out an impact assessment or a traffic-light assessment (Red: channels to remain, Yellow: channels can be removed with landowner consent, Green: channels may be removed). Issues may occur where channels provide a degree of urban flood protection, which then requires a process to maintain such channels (or equivalent infrastructure) into the future. The consequences of "unmanaged private channels" once decommissioned, could be significant.

The body of work performed for GMW was reassessed with a focus of urban flood protection from "non-backbone" channels decommissioning.

If a levee (or a channel that may perform the function of a levee) is considered important, then an LGA needs to consider bringing the asset into a Water Management Scheme (or similar).

A summary of where abandoned irrigation channels could have significant flood impacts is included in **Appendix E**: 2002 Regional Strategy Program Review (Table F-32).

2.4 Service levels for total flood warning systems

DELWP commissioned Michael Cawood and Associates to develop a state-wide Total Flood Warning Assessment Tool to provide consistency across CMAs in determining existing service levels.

The results delivered by the Tool provide guidance on the service level being achieved by each element of the TFWS, as well as the TFWS as a whole, for each location or river reach analysed relative to the assessed flood risk for that location or reach. The Tool allows for the examination of potential actions to improve the TFWS to be explored.

The elements that the Tool considers are shown in **Table 7**, where the factors are broken down (sub-factors) and scored in accordance to with the Total Flood Warning System Assessment Tool – User Manual for Version A.

Table 7: TFWS Elements and Tool Factors

TFWS Elements	Tool factors
Data Collection and Collation	Factor A – Data Collection Network
Flood Forecasting (i.e. detection and prediction)	Factor B – Forecasting
Interpretation	Factor E – Interpretation
Message construction	Factor C – Dissemination/Communication
Message dissemination	
Response Planning and Response	Factor F – Response Planning
Education and Awareness	Factor D – Flood Awareness and Education
	Factor G – Social and Economic Assessment

The service levels are compared with Factor G (see **Table 7**), which is based on the work prepared by Aither through the state-wide application of the DELWP methodology for rapid appraisal of flood risk, which is the same body of work used to initiate the risk assessment and priority setting in **Chapter 3:**. However, Factor G did consider impact to key infrastructure and the loss of major access-ways that affect evacuation and other response activities during a 1% AEP type flood (refer to **Chapter 3:**).

This Tool then allows for the examination of potential actions to improve TFWS service level scores to at least match the flood risk level scores. (i.e. improve education and awareness via Local Flood Guides, improve interpretation of flood intelligence, etc.)

The assessment and action identified are presented in **Appendix H**: Service levels – Total Flood Warning System (TFWS).

2.4.1 Managing the rain and stream flow gauge network across the region

DELWP coordinates the Regional Water Monitoring Partnerships' program. The partnership approach allows data to be collected to a well-defined standard once, but used for multiple business needs, such as allocation management, compliance monitoring, flood warning, water resource assessment and river health management.

It provides a coordinated and efficient approach to the statewide collection of the information required for delivering a continuous program of water resource assessment for Victoria, as required under the *Water Act 1989*.

Any new gauge network should be managed under the regional partnership's program.

2.4.2 Maximising flood resilience within the TFWS program

Building on the resilience theme, outlined in **Section 1.7** and **Section 2.4,** most of the activities identified as TFWS improvements are aimed at assessing and collating information about flood risk and its associated consequence, and making it more widely available to at-risk communities rather than at collecting data and improving the forecast for times of major floods.

Discussions with Michael Cawood[7] and with the state-wide and regional working groups, confirmed that the reason for making access to fit-for-purpose flood risk information as a priority is threefold, as follows:

- The TFWS is a great deal more than installing gauges, collecting data and making flood forecasts. More data does not by itself imply better results in terms of the overall goal of warning systems (i.e. improved safety for those at-risk and reduced human suffering and flood damages).
- Consistent with Federal and State initiatives, there is a need to increase community resilience to flood. Key to that increase is authoritative and credible information about flood risk and local access to that information and real-time data in the lead up to and during floods. Together, that enables the at-risk community to assess individual and collective risk information, and make decisions about what to do to avoid or reduce that risk.
- There are many communities for which the Bureau of Meteorology does not provide a flood warning service, and unlikely to see change in the short term. A request for new services has to be justified on the basis of risk and benefit. Development, operation and maintenance costs also have to be met from outside the Bureau of Meteorology.

There is currently better value to be had from investing in other elements of the TFWS than in the data collection network (Cawood, 2005). There is need to think about and act on:

[7] Michael Cawood developed the TFWS Tool and earlier assessments for VFFCC.

- How to make existing data and information / flood intelligence easily accessible to at-risk communities;
- Assisting at-risk communities in how they use that data and intelligence (the "what does it mean for my home or my business");
- Developing / providing tools that add value to or drag value from available data and intelligence;
- On a location by location basis, developing a means of providing an indication of likely flooding with some lead time for the many communities that BoM does not provide a flood warning service for and is very unlikely to any time soon or even in the medium to longer term;
- Linking flood study outputs and mapping back to a local or reference gauge so that it becomes more useful to the local community;
- Focussing the existing flood warning prediction service on what is required in order to achieve a reduction in damages rather than on delivery of a technically accurate forecast (i.e. recasting so that the focus is on lead-time and a degree of accuracy rather than on precision); and
- Providing the data, information and tools to enable at-risk communities to build resilience.

In conclusion, the regional Strategy actions that are best aimed to improve the TFWS are generally focussed on:

- Identifying and mapping flood risk as part of a flood or related study;
- Identifying consequence (i.e. extracting intelligence from flood study activities and outputs);
- Sharing mapping and information about consequence through LFGs, the MFEP and other means;
- Assisting provision to at-risk communities of real-time access to all available rain, river and other relevant data;
- Developing indicative flood likelihood and severity tools for local application; and
- Refocussing forecasting attention on lead time and exceedance of critical levels rather than on the precision of the forecast peak height and time.

2.4.3 Stakeholder engagement and access to flood data to improve flood preparedness

Flood risk information that provides the pathway to improved flood preparedness and resilience not only applies to home and business owners, but to private companies and government agencies that manage assets and business operations, such a bridges, recreational activities, sand and gravel mines and caravan parks.

During the development of this regional Strategy, the recognition by stakeholders around access to data to build flood resilience is not only paramount but is the one single effective way of minimising human suffering and flood damage to the built and natural environment.

An engagement plan should consider historical flood events and improve on engagement materials and programs, communities have been exposed to in the past. An enabling way to gain interest and find out what the community wants is by identifying the already existing and successful community groups and meetings and utilising these to gain information about the community, and then understand the best ways to increase flood risk awareness.

Identifying community needs to shape type of engagement

The following are sample questions that could be used to understand the current level of community awareness and engagement for what and how flood risk information is shared.

- What is the demographic, land-use and vulnerable communities and high-risk areas of the landscape as identified by the community?

- Which specific community groups have been targeted?
- What methods would the community like to see used to address the identified gaps?
- What information has been provided and in what manner (e.g. verbal at meetings, hand-out documents, downloads from a website)?
- What actions or activities have been undertaken?
- Has there been a noticeable maintenance or increase in understanding of flood risk management due to the above?

Groups are often a support network for communities and provide ongoing contact that will be utilised in an emergency event. When there are multiple community pressures during an event, vulnerable people can be forgotten and are most at risk, which highlights the importance of maintaining a Vulnerable Persons Register.

Community values and desires

Identifying community stakeholders, their values and what they want will enable development of fit–for–purpose engagement programs and materials. A major goal of the regional Strategy is to ensure that those living and/or working in flood prone areas are aware of their flood risk and of the measures they may adopt to manage or mitigate this risk.

Communicate level of influence

Collectively agencies will document how communities are:

- Provided with information and opportunities to increase their awareness of flood risk and improve their skills at being able to assess their own level of risk;
- Empowered to share flood risk management information and skills with their community; and
- Empowered to make appropriate (fit-for-purpose) plans or decisions that benefit themselves, their family, and other community members.

Service levels for information, education and empowerment

Agencies need to support communities about the relevance of taking action before, during and after flood events. It is good engagement practice (to not only apply information found out about the community to inform management practices), but to educate and collaborate with the community to empower community resilience. Some suggested service levels include:

Information and awareness	*Education and training*	*Empowerment*

• Community profile understood and stakeholders mapped
• Community values and aspirations identified
• Websites and portals link to partner agency sites, not duplicate
• Agencies aware who is leading each specific aspect of flood management, response and recovery
• Development of community materials and tools gives opportunity to partnering with relevant agencies
• Integration of local knowledge into flood planning
	• Community are able to access and interpret information before, during and after emergencies
	• Community understand the multi-faceted nature of floodplain management, including the environmental benefits of flooding and the risks encountered by altering natural regimes, not just the risks to human life, property and economy.
	• Community understand the role of floodplain management in an integrated water management system
	• Community aware of local groups and services and are willing to be involved in emergency response actions to help others
		• Community meetings incorporating with popular outreach services
		• Communities are enabled to understand their own personal risk of flooding where they live or work
		• Community know their local members and how to put forward their opinion and values
		• Individuals aware of opportunities to mitigate flood risk by
		  • identifying vulnerable neighbours in the community who they can assist
		  • understanding the benefits and limitations of available flood warning systems
		  • taking out appropriate insurance cover

2.5 Service levels for land-use planning

Land-use planning is considered paramount to ensure that land-use and development do not unduly add to legacy flood problems, and to ensure the functions of floodplains to convey and store floodwater are not adversely compromised.

The formation of the Victoria Planning Provisions in the late 1990s provided a range of standard tools, namely:

1. Zone and Overlays that provide triggers for assessment for land-use and development proposals (Urban Floodway Zone, Floodway Overlay, Land Subject to Inundation Overlay and Special Building Overlay);
2. State Planning Policy Framework (this provides high level objectives which are determined at the State level and cannot be changed);
3. Local Planning Policy Framework (enables the LGS to provide local context about floodplain management);
4. Schedules to the flood overlay controls to remove the need for unnecessary planning permits (known as exemptions); and
5. Floodplain Development Plans (provide performance-based criteria for assessment of routine permit applications).

All of the above tools have been utilised in major planning scheme amendment for six of the eight local government authorities, namely:

- Campaspe Shire Council;
- Greater Shepparton City Council;
- Mansfield Shire Council;
- Mitchell Shire Council;
- Murrindindi Shire Council; and
- Strathbogie Shire Council.

Although Benalla Rural City Council planning scheme has zone and overlay controls, they are in urgent need of updating across the entire municipality.

The DELWP has provided a state-wide assessment tool to determine desirable service levels with the following matters to be considered:

- The quality of the flood data that presently exist (if any) in planning schemes, which is fit for purpose, i.e. rural regional areas versus growing large urban centres.
- The demand for land-use and development. This is important in terms of priority setting, particularly as the planning scheme amendment process is lengthy and resource intensive.
- Whether there is benefit in updating existing zone and overlays.

The desirable service levels were broken into five tiers as follows: 0 (Low), 1 (Low-medium), 2 (Medium), 3 (Medium-high), and 4 (High). These desirable service levels were compared against the current planning scheme information relating to floodplain management. For example, for large urban centres experiencing growth should have a desirable service level of either 3 or 4 (high service

level), whereas a rural area along a reach of floodplain may only desire a service level of 0 or 1 (low service level).

The desirable service levels and the existing floodplain management planning scheme comparisons are detailed in **Appendix G**: Service levels – Land-use planning**.**

2.6 Municipal Flood Emergency Plans

The primary purpose of the Municipal Flood Emergency Plan (MFEP) is to detail the agreed arrangements and responsibilities of agencies and communities with regard to flood. A well-informed MFEP should drive proactive flood response operations and build community resilience by enhancing the capacity of communities to effectively withstand, respond and recover from a flood emergency.

VICSES has now introduced a MFEP standard template that can be populated with relevant flood intelligence, etc. Adopting the standard template not only ensures consistency across the state, it allows for ease of use during flood emergencies.

Under the *Emergency Management Act 2013* municipal councils are required to prepare Municipal Emergency Management Plan (MEMP). A municipal council must appoint a Municipal Emergency Planning Committee constituted by persons appointed by the municipal council being members and employees of the municipal council, response and recovery agencies and local community groups involved in emergency management issues. The function of a committee is to prepare a draft municipal emergency management plan for consideration by the municipal council. Therefore, by endorsing the MEMP, the council agrees to all processes and arrangements detailed in the MEMP.

Sub plans to the MEMP, including the MFEP, do not have formal endorsement arrangements, but are prepared under the guidance material prepared by VICSES, namely: Municipal Flood Emergency Plan (VICSES, 2012) and Municipal Flood Emergency Plan Fact Sheet (VICSES).

Service levels were not identified for MFEPs across the region as the goal is always to have the best available flood information in them. They are required to be updated:

1. Following the completion of flood studies or floodplain management plans;
2. After major floods where new flood intelligence has been captured; and
3. On a three-year cycle if the above has not occurred.

Chapter 3: Priority setting

3.1 Overview

This Chapter pulls together a range of information to determine the final priority rankings for the regional Strategy, namely:

- Stakeholder feedback including community information sessions (refer to **Section 1.4**)
- Risk assessment (refer to **Section 3.2**)
- Major vulnerable communities and infrastructure (refer to **Appendix M**: Vulnerability and Infrastructure assessment)
- Review of the past Regional Floodplain Management Strategy (refer to **Section 2.2**)
- Review Service Levels for existing flood mitigation infrastructure (refer to **Section 2.3**)
- Review Service Levels for land-use planning for floodplain management (refer to **Section 2.5**)
- Review Service Levels for Total Flood Warning Systems (refer to **Section 2.4**)

The stakeholder feedback, including the information sessions, written submission and returned feedback forms together a response is presented in **Appendix I**: Comments, Issues and Feedback Received at Public Information Sessions. The final priority rankings, together with the risk assessment scores are provided in **Appendix N**: Final priority and risk assessment scores.

3.2 Risk assessment

The assessment of flood risk is an important input into the prioritisation of floodplain management activities included in the regional strategies. These activities include the delivery and operation of total flood warning services, statutory land-use planning, the construction and management of flood mitigation structures and emergency management arrangements.

Developing an evidence-based approach for effective risk assessment, and fostering consistent baseline information on flood risk will enable flood risks (and hazards) to be managed equitably across both state-wide and regional levels. Furthermore, the risk assessment will provide guidance for priority setting for investment. This is consistent with state and national emergency management reform agendas, and is aligned with the requirements of the Victorian Floodplain Management Strategy.

DELWP's rapid appraisal of flood risk methodology has been developed with the intention of providing a simplified appraisal tool that can be used to rapidly gain an understanding of flood risk with an appropriate level of reliability.

The methodology assesses flood risk associated with agriculture, property, buildings, and emergency services, where by flood risk is represented using a 1 to 5 score of relativity for the following three metrics:

- Density of damages (measured as the ADD[8] divided by the 1% AEP flood event)
- Population affected (measured as the AAPA[9] divided by the population of the town)

[8] Average Annual Damage divided by the area of inundation for the 1% AEP

[9] Equivalent to the number of houses inundated divided by the total number of houses inundated, but is expressed as population given the number of residents per house hold as provided by the ABS Census (2011)

- Absolute risk (the absolute size of the AAD[10] from the cost-probability curve)

The relative flood risk score of 1 to 5 relates 1 representing lowest risk, and 5 the highest risk. This comparative basis can be used to set flood risk management rankings. The methodology is not designed to be an absolute assessment of flood risk for the justification of flood risk mitigation expenditure at the local level, but is one tool designed to assist with priority setting for input into the Action-Investment plan (refer **Chapter 4:**).

Aither (economic consultancy) was commissioned by DELWP to assist with developing the methodology and to carry out the risk assessment for the Goulburn Broken region. Further methodology can be found in **Appendix J**: DELWP's Rapid Appraisal Methodology.

The risk assessment scores are presented in **Appendix N**: Final priority and risk assessment scores**.**

3.3 Major vulnerable communities and infrastructure

As part of the risk assessment, some consideration of community vulnerability and infrastructure was explored as part of the TFWS assessment by Michael Cawood and Associates using data sourced from: flood study reports, media reports, MFEPs, Planning Scheme Maps, the VicRoads Directory, and local knowledge and experience.

Appendix M: Vulnerability and Infrastructure assessment, which provides a summary of the number identified.

Vulnerable communities:

Vulnerable groups include schools, kindergartens, childcare and aged care facilities, hospitals and medical facilities as well as VICSES and other emergency services. The social impacts on vulnerable groups are expected to be higher than general community impacts.

Both under and over-floor flooding are considered because evacuation and danger are not confined to over-floor flooding scenarios.

Infrastructure:

This looks at key infrastructure and essential services likely to be affected by flooding in the at-risk locations.

Key infrastructure is considered to include 'A' rated highways, railways, shopping centres, sewerage treatment and water supply facilities.

It should be noted that while a major road may be affected by flooding at a number of different at-risk locations, it needs to be counted for each of those locations.

The data for this assessment was obtained from flood study reports, media reports, MFEPs, Planning Scheme maps and the VicRoads Directory combined with individual experience / knowledge.

3.4 Other factors in priority setting

This Strategy acknowledges the significant challenges of addressing flood risk across the catchment and recognises the limited ability of stakeholders to raise revenue to invest in new projects. It cannot necessarily be expected that all high priority actions be addressed in the first few years of implementation, if the cumulative cost is outside the lead agency's means.

[10] Average Annual Damage

Chapter 4: Strategy Implementation

4.1 Overview

An Action-Investment plan is presented as a stand-alone document in **Part B**. This is the culmination from the investigations and engagement presented in previous chapters and the Appendices of this Strategy. From this a four-year rolling Action Plan will be prepared, under the oversight of an Implementation Committee of relevant stakeholders.

A detailed Monitoring, Evaluation, Reporting and Improvement (MERI) Plan will be developed to accompany this strategy from the planning stages to its completion. The MERI Plan will incorporate the following principles:

- convening of the Implementation Steering Committee regularly (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 in achieving the objectives of the strategy
- monitoring, evaluation and review of the strategy implementation to alignment with other regional strategies
- reporting at a regional and state level.

This strategy supports using the best available information, science and approaches and identifies a number of good practice principles to achieve this. the Supporting Documents of this Strategy.

Community engagement processes are required for most activities in the Action-Investment Plan. Lead agencies are identified below, along with partners and other stakeholders.

Sharing flood information with the community, insurance industry and agencies required to manage flood risk, is crucial, so that decisions are made using the best available information. The Strategy is seeking to establish a regional web portal for sharing flood intelligence to supplement actions by DELWP to sharing information with the insurance industry and to manage its FloodZoom flood intelligence platform.

Local flood disputes can arise if planning permit conditions are not complied with. The Goulburn Broken CMA will continue to work with LGAs to assess and provide guidance on non-compliance issues. Processes in the Water Act enable land owners to seek rectification for works constructed before planning controls were in place.

4.2 Monitoring, evaluation, reporting, and improvement (MERI) Plan

Programs and investments that embed robust MERI processes are more resilient to change, more often return maximum value on every dollar spent, and allow for more effective demonstration of this value. Effective MERI enhances the performance of program activities themselves, but is also critical to ensuring the availability of data on outputs or outcomes that can help answer a range of critical questions for decision-makers such as:

- Did the management actions, plan or policy make a difference?
- How can things be done better, more efficiently, or more effectively?
- What should we continue doing, what should we stop doing?
- Is the overall target still achievable and appropriate?

The more embedded the MERI approach and the stronger and more immediate the feedback loops, the more value that can be delivered through the ability to adaptively manage the program over its duration. This is fundamentally important for the Goulburn Broken region because better managed programs are ultimately more effective at achieving the outcomes desired from the investment and are more cost effective.

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.

Evaluation of the success of the regional Strategy will target the five areas, namely:

1. **Appropriateness** – the extent to which the investment's objectives align with the driving priorities, values and needs of stakeholders
2. **Effectiveness** – the extent to which outputs achieve desired outcomes or objectives
3. **Efficiency** – the extent to which the investments are minimised for a given level of outputs, or to which outputs are maximised for a given level of inputs
4. **Impact** – the relationship between the programs outputs and outcomes
5. **Legacy** – the likelihood that the program's impacts will continue over time, including after the program ceases

The detailed MERI Plan will be developed in 2018.

4.3 Good practice implementation of the Action-Investment implementation

In carrying out activities in the Action-Investment plan, the following principles are to be incorporated, to the extent that they are relevant:

- Communities must be consulted and given opportunities for input.
- Traditional Owners must be consulted prior to any proposed activities in accordance with the *Aboriginal Heritage Act 2006* (see Section 1.12).
- Responsibility for community engagement vests in the lead agency.
- A flood risk management approach must be followed (see Figures 4.2 and 4.3 of the 1998 Victoria Flood Management Strategy, or Figure 1.1 of Australian Disaster Resilience Handbook 7 Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia).
- Flood studies shall follow best practice, including allowance for climate change, the impacts of bush fire on catchment runoff and technical advice and information provided in Australian Rainfall & Runoff (Ball J, 2016).
- An Integrated Catchment Management approach must be followed (See Section 1.15 and Section 1.10.1), particularly protecting, and where possible enhancing, environmental values (see Section 1.11).
- Implementing the standards as outlined in the Infrastructure Design Manual (Local Government Infrastructure Design Association , 2017), in particularly relating to water urban sensitive design.
- The scope and priorities of activities in the Action-Investment Plan must be reviewed and updated, taking into account opportunities, constraints and changed circumstances.

4.4 Community engagement and responsibilities

Implementation responsibilities for the actions are summarised in the table below:

Table 8: Implementation responsibilities for the actions

Action	Flood Mitigation	TFWS	Land-use planning	MFEP [v]
Lead agency [i]	Local Government [ii]	VICSES / Local Government [iii]	Local Government [iv]	VICSES
Partners	Community, Traditional Owners, GB CMA	Community, VICSES, GB CMA	VICSES, GB CMA, DELWP [vi]	Local Government, TOs, GB CMA
Sharing data	Community, VICSES, EMV, DELWP, AAV, PV	Community, VICSES, EMV, DELWP, PV	DELWP	EMV, DELWP, AAV, PV

i. Although, the Goulburn Broken CMA does not generally have a leading role in any of the four programs above, it is committed to coordinate the implementation of the Strategy through leading the monitoring, evaluation, reporting and improvement (MERI) Plan, which includes a rolling four-year Investment-Action Plan.
ii. Local Government's role is generally related to urban flood mitigation. See 2.4.1 Management arrangements for rural levees (on page 34).
iii. There are a number of elements to this program where VICSES will take the lead around education and awareness, communications and dissemination and Local Government will take the lead in sharing operation and maintenance costs of the relevant gauge network components under the Northern Regional Water Monitoring Partnership.
iv. Goulburn Broken CMA is the lead agency for preparation of mapping for planning scheme amendments and may become the lead agency for rural studies and become the planning authority where studies cross multiple Local Government Areas.
v. Note that MFEPs need to be reviewed following the completion of a flood study, a major flood or part on the three-yearly review cycle.
vi. DELWP, at a regional level provides planning guidance around the preparation on proposed planning scheme amendments.

Note: DELWP, at the State level generally provides support and guidance across all programs including financial assistance. Other agencies may be a partner such as BoM, G-MW, GVW, VicRoads, and VicTrack depending on the nature of the investigation.

It is most important to engage with communities, particularly for any new flood study and particularly for the preparation of floodplain management plans. Communities have first-hand knowledge and experience that needs to be taken into on board with any new investigation.

The IAP2 International Federation has developed the IAP2 Public Participation Spectrum (2014) that sets out how groups define public's role in any participation process ranging from informing to empowering communities. The Spectrum is designed to assist with the selection of the level of participation that defines the public's role in any community engagement program. The Spectrum show that differing levels of participation are legitimate depending on the goals, time frames, resources and levels of concern in the decision to be made (International Association for Public Participation Australasia, website).

4.4.1 Community-based committees under the *Water Act 1989*

Floodplain management plans may include mitigation options that require community input. The Water Management Scheme process under the *Water Act 1989* includes appointing a community-based committee to carry out investigations. This approach may ultimately lead to a Ministerially Approved Scheme, and should be utilised for new investigations that are likely to include mitigation measures.

4.5 Sharing information

Individuals and communities at risk of future flooding need to be aware of the risks. Access to insurance provides one form of reducing their potential flood damages. Other mitigation strategies include flood mitigation works and total flood warning system improvements.

Having the best available flood information on flood risk and flood behaviour, and sharing this information, with all stakeholders is of paramount importance. People, with access to shared flood information, should be able to choose where they live in an informed way, where the relative size of flood insurance premiums in different locations provide an important signal of exposure to flood risk. Through gathering flood intelligence from future flood studies information should be accessible to able insurers to price flood insurance premiums.

As part of the whole of region Action-Investment plan, the Strategy is seeking to establish regional web portal for sharing flood intelligence, which is part of the Total Flood Warning program.

DELWP will also work with the insurance industry to facilitate exchange of mapping and other flood risk information in order to ensure fair pricing of insurance.

Recently work by DELWP on its flood intelligence platform, known as FloodZoom will be the one source of truth for all flood information across the State. Approved access to the one source of truth will be utilised for regional web flood portal to facilitate the sharing of flood information publicly.

4.6 Activities and works controls (compliance) – region wide

Currently, across all LGAs within Victoria, there is a reliance on sound planning controls to manage flood risk. This relies on developers complying with their conditions of permit. Experience has shown that local flood issues (often associated with poor drainage) drive most complaints. Land owners often seek government assistance to resolve the issue.

Compliance activities under planning schemes and VCAT are complex, cumbersome, and expensive, but remain the best available tool to manage breaches to the planning scheme.

The Goulburn Broken CMA has and will continue to provide significant resources and support to LGAs in providing assessment and guidance to resolve breaches to the planning scheme.

In many cases local flood issues occur as a result of works that were constructed before effective planning controls were in place.

Free flow principle – liability under the Water Act 1989

Aggrieved individuals, under Section 16 of the Act, can exercise their right through VCAT to have matters resolved associated with works that create an unreasonable flood of water or interferes with a reasonable flow of water whereby nuisance or damage has or may result in the future (through an interlocutory order). Section 20 of the Act list those matters that VCAT should consider.

Glossary

Above floor flooding
Where floodwater rises and enters a building above the floor height of a building.

Adaptive management
Policy and programs are part of a broader framework of adaptive management, supported by effective monitoring, reporting, evaluation and research, to ensure continuous improvement.

Climate Adaptation
Adjustment in response to actual or expected climate change or its effects, which moderates harm or exploits beneficial opportunities.}

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 m3/s has an AEP of 5%, it means that there is a 5% (one-in-20) chance of a flow of 500 m3/s or larger occurring in any one year (see also average recurrence interval, flood risk, likelihood of occurrence, probability).

Average annual damage (AAD)
Depending on its size (or severity) of a flood and the amount of assets exposed, each flood will cause a different amount of flood damage to a flood-prone area. AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time. If the damage associated with various annual events is plotted against their probability of occurrence, the AAD is equal to the area under the consequence–probability curve. AAD provides a basis for comparing the economic effectiveness of different management measures (i.e. their ability to reduce the AAD).

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).

Australian Rainfall and Runoff (ARR)
ARR (Ball J, 2016) is a national guideline for the estimation of design flood characteristics in Australia published by Geoscience Australia and is available through its website. ARR aims to provide reliable (robust) estimates of flood risk to ensure that development does not occur in high risk areas and that infrastructure is appropriately designed. There are associated research projects, which have been designed to fill knowledge gaps that have arisen since the 1987 edition was published.

Avulsion
The rapid abandonment of a river channel and the formation of a new river channel. Avulsions occur as a result of channel slopes that are much lower than the slope that the river could travel if it took a new course. Avulsions typically occur during large floods that carry the power necessary to rapidly change the landscape.

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.

Curtilage
The land occupied by a dwelling and its yard, outbuildings, etc., actually enclosed or considered as enclosed.

Design flood event (DFE)
In order to identify the areas that the planning and building systems should protect new development from the risk of flood, it is necessary to decide which level of flood risk should be used. This risk is known as the design flood event.

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. VICSES has EMCOP warnings in place to deliver warnings where observations of actual flash flooding exist.

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 (see also catchment flooding and coastal flooding).

Flood awareness
An appreciation of the likely effects of flooding, and a 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 liable 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 that are attributed to a flooding episode.

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 peaks
The maximum flow occurring during a flood event past a given point in the river system (see also flow and hydrograph). The term may also refer to storm-induced flood peaks and peak ocean or peak estuarine conditions.

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 proofing of buildings
A combination of measures incorporated in the design, construction and alteration of individual buildings or structures that are subject to flooding, to reduce structural damage and potentially, in some cases, reduce contents damage.

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: 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; for an area where flood risk is managed by land-use planning controls, the residual flood risk is the risk associated with the consequences of floods larger than the DFE on the community.

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 MEMPs, and a preliminary assessment into 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/d) or cubic metres per second (m3/s). 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).

Freeboard
The height above the design flood level or design flood used, in consideration of local and design factors, to provide reasonable certainty that the risk exposure selected in deciding on a particular design flood is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest heights and so on. Freeboard compensates for a range of factors, including wave action, localised hydraulic behaviour and levee settlement, all of which increase water levels or reduce the level of protection provided by levees. Freeboard should not be relied upon to provide protection for flood events larger than the relevant design flood event.

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).

Hazard
A source of potential harm or a situation with a potential to cause loss.

Hydraulics
The study of water flow in waterways; in particular, the evaluation of flow parameters such as water level, extent and velocity.

Hydrology
The study of the rainfall and runoff process, including the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.

Intolerable risk
A risk that, following understanding of the likelihood and consequences of flooding, is so high that it requires consideration of implementation of treatments or actions to improve understanding of, avoid, transfer or reduce the risk.

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.

Local Flood Guide
A guide for a local community summarising flood information (usually historical floods linked to known streamflow gauge) and their consequences. The plan also provides Information to help individuals plan for floods and provides a list of resources and contact details. Existing guide can be found on VICSES's website.

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 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.

Probable Maximum Flood
The largest flood that could conceivably occur at a particular location. Generally, it is not physically or financially possible to provide general protection against this event. This flood defines the maximum extent of land liable to flooding. The extent, nature and potential consequences of flooding associated with the PMF event should be assessed in a Flood Study. The PMF event may form the basis of evacuation planning and the identification of refuge areas. Considerations should be given to adopting the PMF event as the design flood event for emergency services planning and for determining the location and floor levels of facilities such as telephone exchanges, police stations and hospitals. The PMF event may also be used to develop land-use development guidelines in the floodplain management plan

Probability
A statistical measure of the expected chance of flooding. It is the likelihood of a specific outcome, as measured by the ratio of specific outcomes to the total number of possible outcomes. Probability is expressed as a number between zero and unity, zero indicating an impossible outcome and unity an outcome that is certain. Probabilities are commonly expressed in terms of percentage. For example, the probability of 'throwing a six on a single roll of a dice is one in six, or 0.167 or 16.7% (see also Annual Exceedance Probability).

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 (see also temporal pattern).

Regional Coastal Boards
Members of Victoria's three coastal boards have been appointed by the Minister for Environment and Climate Change because of their experience and expertise in areas such as local government, coastal planning and management, tourism and recreational use of the coast. The functions of the Western, Central and Gippsland Coastal Boards, set out under the Coastal Management Act 1995, include developing regional coastal plans and providing advice to the Minister on regional coastal development issues.

Risk analysis
Risk is usually expressed in terms of a combination of the consequences of an event and the associated likelihood of its occurrence. Flood risk is based upon the consideration of the consequences of the full range of flood events on communities and their social settings, and the natural and built environment. Risk analysis in term of flooding is a combination of defining what threat exists (see flood risk) and what steps are taken (see risk management) (see also likelihood and consequence).

Risk management
The systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, treating and monitoring flood risk.

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.

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

Storm surge
The increases in coastal water levels above the predicted tide level resulting from a range of location dependent factors such as wind and waves, together with any other factors that increase tidal water level.

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).

Vulnerability
The degree of susceptibility and resilience of a community, its social setting, and the natural and built environments to flood hazards. Vulnerability is assessed in terms of ability of the community and environment to anticipate, cope and recover from flood events. Flood awareness is an important indicator of vulnerability (see also flood awareness).

Water Management Scheme
The formal process set out in the *Water Act 1989* that can be applied to a flood mitigation infrastructure development and its ongoing management. It can be based on and carried out in parallel with a floodplain management study under a ministerially appointed community-based committee.

Acronyms

AAD Average Annual Damage

AEP Annual Exceedance Probability

ARI Average Recurrence Interval

ARR Australian Rainfall and Runoff

BCA Building Code of Australia

BoM Bureau of Meteorology

CMA Catchment Management Authority

DELWP Department of Environment, Land, Water and Planning

DFE design flood event

EMCOP Emergency Management Common Operating Picture (Web-based platform)

LGA Local Government Authority

LFS Local Flood Guide

LPPF Local Planning Policy Framework

MFEP Municipal Flood Emergency Plan

PMF Probable Maximum Flood

SPPF State Planning Policy Framework

TFWS Total Flood Warning System

TOs Traditional Owners

VCS Victorian Coastal Strategy

VFD Victorian Flood Database

VFMS Victorian Floodplain Management Strategy

VICSES Victoria State Emergency Service

VPP Victoria Planning Provisions

WMS Water Management Scheme

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Part B: The Action-Investment Plan

Chapter 5: Action-Investment Plan

The Action-Investment Plan forms the business case for investment by all tiers of government to implement floodplain management actions. Implementation of the Strategy will firstly, be reliant on funding initiatives such as the Natural Disaster Resilience Grants Scheme, and secondly, through the monitoring, review, reporting and improvement plan process. Implementation is dependent on the availability of funding.

The rolling Action-Investment plan will be prepared and annually reviewed by an Implementation Committee under the monitoring, evaluation, review and improvement process to ensure it remains adaptive and flexible.

Reading the following tables.

Five sets of tables are presented:

1. Implementation responsibilities for actions
2. Investment summary – all Local Government Areas
3. Individual Local Government Investment Summaries
4. Individual Local Government Action-Investment Plans
5. Whole of region actions.

Implementation responsibilities for the actions

Action	Flood Mitigation	TFWS	Land-use planning	MFEP [v]
Lead agency [i]	Local Government [ii]	VICSES / Local Government [iii]	Local Government [iv]	VICSES
Partners	Community, Traditional Owners, GB CMA	Community, VICSES, GB CMA	VICSES, GB CMA, DELWP [vi]	Local Government, TOs, GB CMA
Sharing data	Community, VICSES, EMV, DELWP, AAV, PV	Community, VICSES, EMV, DELWP, PV	DELWP	EMV, DELWP, AAV, PV

i. Although, the Goulburn Broken CMA does not generally have a leading role in any of the four programs above, it is committed to coordinate the implementation of the Strategy through leading the monitoring, evaluation, reporting and improvement (MERI) Plan, which includes a rolling four-year Investment-Action Plan.
ii. Local Government's role is generally related to urban flood mitigation. See 2.4.1 Management arrangements for rural levees (on page 34).
iii. There are a number of elements to this program where VICSES will take the lead around education and awareness, communications and dissemination and Local Government will take the lead in sharing operation and maintenance costs of the relevant gauge network components under the Northern Regional Water Monitoring Partnership.
iv. Goulburn Broken CMA is the lead agency for preparation of mapping for planning scheme amendments and may become the lead agency for rural studies and become the planning authority where studies cross multiple Local Government Areas.
v. Note that MFEPs need to be reviewed following the completion of a flood study, a major flood or part on the three-yearly review cycle.
vi. DELWP, at a regional level provides planning guidance around the preparation on proposed planning scheme amendments.

Note: DELWP, at the State level generally provides support and guidance across all programs including financial assistance. Other agencies may be a partner such as BoM, G-MW, GVW, VicRoads, and VicTrack depending on the nature of the investigation.

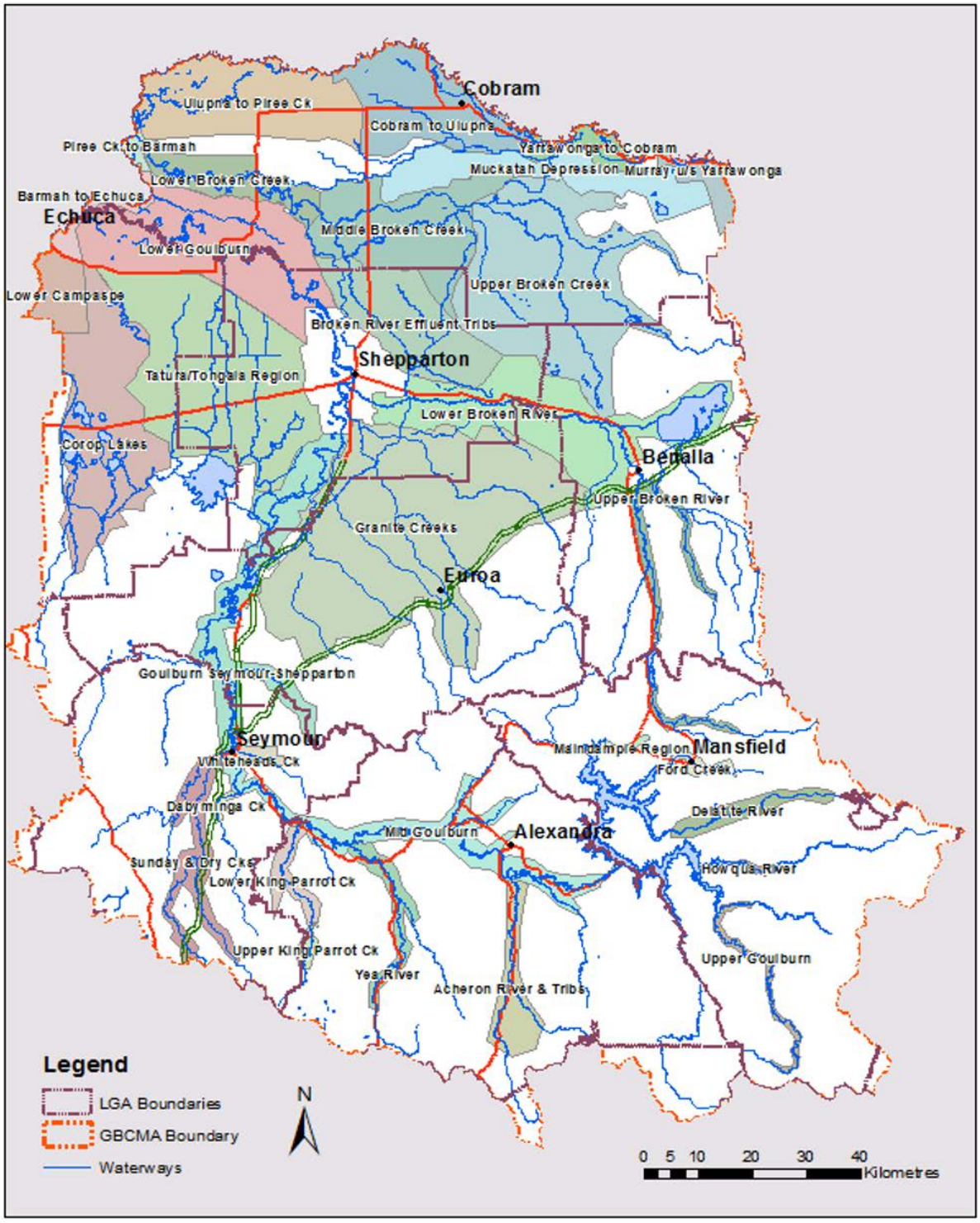
Investment Summary – all Local Government Areas by Action type and Priority

	High	Medium	Low	Very low	Total
Mitigation	$18,880,000	$820,000	$5,195,000	$-	$24,895,000
TFWS	$642.500	$690,000	$107,500	$-	$1,440,000
Land-use Planning	$595,000	$240,000	$1,425,000	$50,000	$2,310,000
MFEP	$160,000	$120,000	$165,000	$15,000	$460,000
	$20,277,500	**$1,870,000**	**$6,892,500**	**$65,000**	**$29,105,000**

Approximately $22.5 million of the total investment figure is due to three large proposed Mitigation projects: two for Moira Shire, Numurkah (High priority) $16 million and Barmah (Low priority) $5 million and one for Strathbogie Shire, Violet Town (High priority) $1.5 million. It excludes funding for implementing works to provide flood protection in Seymour.

Separate investment summaries for each local government area are shown with the Action-Investment Plans on the following pages.

Where a town locality is named in the following Tables, it represents the urban centre, and generally does not include the surrounding areas. The coverage for the regional (rural) areas is shown below.



5.1 Benalla Rural City

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$-	$15,000	$15,000
TFWS	$25,000	$300,000	$22,500	$347,500
Land-use Planning	$100,000	$120,000	$-	$220,000
MFEP	$5,000	$25,000	$-	$30,000
	$130,000	**$445,000**	**$37,500**	**$612,500**

Table 9: Benalla Rural City Action-Investment Plan

Terminology: **-** = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Baddaginnie	**Actions**	nil	Deliver a Local Flood Guide following the completion of the Granite Creeks Regional Flood Mapping Study.	Introduce flood overlay controls following completion of the Granite Creeks Regional Flood Mapping Study (part of the LGA-wide planning scheme amendment).	Update MFEP using intelligence from Granite Creeks Regional Flood Mapping Study	
	Cost	-	$7,500	$40,000 [i]	$5,000	$52,500
	Priority	-	Low	High	High	
Benalla	**Actions**	Maintain the Benalla Water Management Scheme. Review decommissioned Mokoan Inlet embankments if they need to be maintained for Benalla flood protection.	Improve dissemination and communication, awareness and education (Local Flood Guide). Share site-specific property information using web portal.	As part of LGA-wide amendment, prepare UFZ, FO and LSIO mapping based on the reference 1993 flood together with Cardno's modelling work of 2009.	Review as part of the three-year cycle or following a major flood.	
	Cost	$15,000	$25,000	-	-	$40,000
	Priority	Low	High	High	High	
Devenish	**Actions**	nil	nil	As part of LGA-wide amendment, prepare rudimentary mapping. In the longer term, utilise mapping if and when the Upper Broken Creek Regional Flood Study becomes available.	Utilise flood intelligence from the proposed Upper Broken Creek Regional Flood Study.	
	Cost	-	-	See Upper Broken Creek	$10,000 [ii]	$10,000
	Priority	-	-	High	Medium [ii]	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Granite Creeks	**Actions**	nil	Deliver Fact Sheet for the Granite Creeks, following the completion of the Granite Creeks Regional Flood Study.	Revise flood overlay controls from the completed Granite Creeks Regional Flood Study, which include numerous towns	Incorporate flood intelligence from Regional Flood Study.	
	Cost	-	$10,000	$40,000	$15,000	$65,000
	Priority	-	Low	Medium	Medium	
Lower Broken River	**Actions**	nil	Part of new Goulburn and Broken River Regional Flood Study.	Introduce and revised flood overlay control from Goulburn and Broken Rivers Flood Study.	Incorporate flood intelligence from Regional Flood Study.	
	Cost	-	Funded	$60,000 [iii]	-	$60,000
	Priority	-	Low	High	High	
Tatong	**Actions**	nil	nil	As part of LGA-wide amendment adopt the FDTP flood mapping, and seek any new information.	Subject to identification any flood risk, update MFEP.	
	Cost	-	-	In-house by GB CMA	-	-
	Priority	-	-	Medium	Low	
Thoona	**Actions**	nil	nil	Prepare rudimentary mapping. In the longer term, utilise mapping if and when the Upper Broken Creek Regional Flood Study becomes available.	Subject to identification of any flood risk, update MFEP.	
	Cost	-	-	In-house by GB CMA	In-house	-
	Priority	-	-	Medium	Low	
Upper Broken Creek	**Actions**	nil	Undertake a Regional Flood Study covering numerous Towns	Introduce and revised flood overlay controls from Regional Study	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	$300,000	$40,000 [ii]	See TFWS	$340,000
	Priority	-	Medium	Medium	Medium	
Upper Broken River	**Actions**	nil	Part of new Goulburn and Broken River Regional Flood Study	Introduce and revised flood overlay control from Goulburn and Broken Rivers Flood Study	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	Funded	See [iii]	-	See [iii]
	Priority	-	Medium	High	Medium	
Winton	**Actions**	nil	Prepare a Local Flood Guide	A scoping flood is required to inform rudimentary mapping.	nil	
	Cost	-	$5,000	$40,000	-	$45,000
	Priority	-	-	Medium	-	

[i] Cost for a LGA-wide planning scheme amendment

[ii] Upper Broken Creek Regional Flood Study includes Moira Shire Council (longer term action). Cost is for planning scheme amendment.

[iii] Coordinated by the Goulburn Broken CMA across five LGAs. Cost of $60,000 is to implement a planning scheme amendment coordinated by the CMA as the proposed planning authority.

5.2 Campaspe Shire

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$-	$-	$-
TFWS	$-	$-	$-	$-
Land-use Planning	$120,000	$-	$40,000	$160,000
MFEP	$-	$-	$30,000	$30,000
	$120,000	**$-**	**$70,000**	**$190,000**

Table 10: Campaspe Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Colbinabbin	**Actions**	nil	Goulburn-Murray Water continue to host information about Waranga Western Channel operations.	nil	Link G-MW material to MFEP.	
	Cost	-	In-house by G-MW	-	In-house by VICSES	-
	Priority	-	Medium	-	Medium	
Kyabram	**Actions**	See land-use planning.	nil	Carry out a new flood study to review the current mitigation scheme and to improve flood intelligence and mapping.	See land-use planning.	
	Cost	-	-	$120,000	-	$120,000
	Priority	Low	-	High	Medium	
Lower Goulburn	**Actions**	1. Re-evaluate options on an opportunistic basis 2. Investigate impact on Cultural Heritage Values [i]	nil	Revise flood overlay controls from the completed Lower Goulburn Floodplain Rehabilitation Scheme Study.	Incorporate flood intelligence from Scheme Study.	
	Cost	-	-	$40,000 [ii]	$30,000	$70,000
	Priority	-	-	Low	Low	

[i] Cultural Heritage Impact assessment – $50,000 shared cost with Greater Shepparton and Moira Shire

[ii] Indicative costs associated with planning scheme amendment process

5.3 Greater Shepparton City

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$520,000	$-	$520,000
TFWS	$10,000	$-	$47,500	$57,500
Land-use Planning	$100,000	$-	$40,000	$140,000
MFEP	$-	$-	$45,000	$45,000
	$110,000	**$520,000**	**$132,500**	**$762,500**

Table 11: Greater Shepparton Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Broken Creek Tribs [i]	**Actions**	nil	Improve education and awareness, interpretation, dissemination and communication	nil	Incorporate any flood intelligence from TWFS	
	Cost	-	$20,000	-	$15,000	$35,000
	Priority	-	Low	-	Low	
Bunbartha		nil	nil	See Lower Goulburn Regional Flood Study	nil	
Katandra West	**Actions**	nil	(Local Flood Guide prepared and delivered)	Carry out rudimentary flood mapping	nil	
	Cost	-	-	$25,000	-	$25,000
	Priority	-	-	High	-	
Goulburn Seymour to Shepparton	**Actions**	nil	Prepare a Fact Sheet for the Goulburn and Broken Rivers, following the completion of the Goulburn and Broken Rivers Flood Study.	Revised flood overlay controls from Goulburn and Broken Rivers Flood Study	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	Funded	See [ii]	Funded	-
	Priority	-	High	Medium	Medium	
Lower Broken River	**Actions**	nil	Part of new Goulburn and Broken River Regional Flood Study	Revised flood overlay controls from Goulburn and Broken Rivers Flood Study.	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	Funded	See [ii]	-	-
	Priority	-	Low	High	High	

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Lower Goulburn	**Actions**	1. Re-evaluate options on an opportunistic basis 2. Investigate impact on Cultural Heritage Values [iv]	nil	Revise flood overlay controls from the completed Lower Goulburn Floodplain Rehabilitation Scheme Study.	Incorporate flood intelligence from Scheme Study.	
	Cost	$50,000	-	$40,000 [iii]	$30,000	$120,000
	Priority	Medium	-	Low	Low	
Merrigum	**Actions**	nil	Proposed education and awareness material such a Local Flood Guide	nil	Review MFEP	
	Cost	-	$10,000	-	Funded	$10,000
	Priority	-	Low	-	Low	
Murchison	**Actions**	Investigate bringing existing levees under maintenance arrangements. Refer to **Appendix F**: Service levels – structural flood mitigation works	Update Local Flood Guide using Murchison Flood Study	Update planning scheme with new flood mapping from the Murchison Flood Study. Do as part of Goulburn and Broken Rivers Flood Study.	MFEP has been updated	
	Cost	$50,000	$10,000	$20,000	-	$80,000
	Priority	Medium	Low	High	-	
Shepparton East	**Actions**	nil	Prepare a Local Flood Guide for Area	Update planning scheme with new flood mapping from the Shepparton East Overland Flood Study. Do this together with Shepparton/ Mooroopna.	Update intelligence from Shepparton East Overland Flood Study	
	Cost	-	$10,000	See Shepparton/ Mooroopna	Funded	$10,000
	Priority	-	High	High	High	
Shepparton & Mooroopna	**Actions**	Investigate bringing existing levees under maintenance arrangements. Refer to **Appendix F**: Service levels – structural flood mitigation works	Improve education and awareness, access to shared flood intelligence (property specific data), and improve communication and dissemination.	Update planning scheme with new flood mapping from the Shepparton Mooroopna Flood Intelligence and Mapping Study.	Update MFEP with intelligence from the Shepparton Mooroopna Flood Intelligence and Mapping study.	
	Cost	$150,000	funded	$40,000	Funded	$190,000
	Priority	Medium	High	High	High	
Surplus Irrigation Channels	**Actions**	Investigate bringing existing levees under maintenance arrangements. Refer to **Appendix F**: Service levels – structural flood mitigation works	nil	nil	nil	
	Cost	$150,000	-	-	-	$150,000
	Priority	Medium	-	-	-	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Tallygaroopna	**Actions**	Carry out a flood study to determine viable flood mitigation solutions.	(Local Flood Guide prepared and delivered)	Update following completion of a Flood Study. In the short term carry out broad brush mapping.	nil	
	Cost	$120,000	-	$15,000	-	$135,000
	Priority	Medium	-	High	-	
Tatura	**Actions**	nil	Propose education and awareness material such a Local Flood Guide	nil	nil	
	Cost	-	$7,500	-	-	$7,500
	Priority	-	Low	-	-	
Toolamba	**Actions**	nil	nil	Revised flood overlays following completion of the Goulburn and Broken Rivers Flood Regional Flood Study	Update flood intelligence following completion of the Goulburn and Broken Rivers Flood Study	
	Cost	-	-	funded	funded	-
	Priority	-	Low	Medium	Medium	

[i] Includes: Pine Lodge, Daintons, Congupna Guilfus & O'Keefe Creeks

[ii] Coordinated by the Goulburn Broken CMA across five LGAs. Cost of $60,000 is to implement a planning scheme amendment coordinated by the CMA as the proposed planning authority.

[iii] Includes Shire of Campaspe and Moira Shire

[iv] Cultural Heritage Impact assessment – $50,000 shared cost with Campaspe and Moira Shires

5.4 Mansfield Shire

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$-	$-	$-
TFWS	$-	$-	$-	$-
Land-use Planning	$-	$-	$410,000	$410,000
MFEP	$-	$20,000	$45,000	$65,000
	$-	**$20,000**	**$455,000**	**$475,000**

Table 12: Mansfield Shire Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning [i]	MFEP	Total Cost
Delatite River	**Actions**	nil	nil	Hydrology completed. Carry out a Regional Flood Mapping Study.	Incorporate flood intelligence from Regional Flood mapping Study.	
	Cost	-	-	$50,000		$50,000
	Priority	-	-	Low	Low	
Ford Creek	**Actions**	nil	nil	Carry out regional flood study (include Mansfield)	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	-	$80,000	$15,000	$95,000
	Priority	-	-	Low	Low	
Howqua River	**Actions**	nil	nil	Hydrology completed. Carry out a Regional Flood Mapping Study.	Incorporate flood intelligence from Regional Flood mapping Study	
	Cost	-	-	$60,000	$15,000	$75,000
	Priority	-	-	Low	Low	
Jamieson	**Actions**	nil	(Local Flood prepared and delivered). Update following Upper Goulburn and Jamieson Rivers Flood Mapping Study	Introduce and revise flood overlay controls following the completion of the Upper Goulburn River Flood Mapping Project.	Provide intelligence following completion of Upper Goulburn River Flood Mapping Project.	
	Cost	-	See Upper Goulburn	See Upper Goulburn	See Upper Goulburn	-
	Priority	-	Low	Low	Low	
Mansfield	**Actions**	nil	nil	Carry out an overland flood study. Seek LiDAR Capture.	Update flood intelligence from Mansfield Flood Mapping and Overlay Studies. Include targeted floor level survey.	
	Cost	-	-	$150,000	$20,000	$170,000
	Priority	-	-	Low	Medium	

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning [i]	MFEP	Total Cost
Upper Goulburn	**Actions**	nil	nil	Hydrology completed. Carry out a Regional Flood Mapping Study – include Jamieson.	Incorporate flood intelligence from Regional Flood mapping Study	
	Cost	-	-	$70,000	$15,000	$85,000
	Priority	-	-	Low	Low	

[i] Complete regional mapping programs before introducing planning scheme amendments

5.5 Mitchell Shire

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$-	$-	$-
TFWS	$57,500	$7,500	$17,500	$82,500
Land-use Planning	$40,000	$-	$100,000	$140,000
MFEP	$70,000	$20,000	$-	$90,000
	$167,500	**$27,500**	**$117,500**	**$312,500**

Table 13: Mitchell Shire Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning [i]	MFEP	Total Cost
Broadford	**Actions**	nil	Improve interpretation of data based on completion of the Sunday and Dry Creeks Regional Flood Intelligence and Mapping Study. Prepare Local Flood Guide.	Revise flood overlay controls following the completion of the Sunday and Dry Creeks Regional Flood Intelligence and Mapping Study.	Update flood intelligence following completion of the Sunday and Dry Creeks Regional Flood Intelligence and Mapping Study.	
	Cost	-	$7,500	Funded	Funded	$7,500
	Priority	-	Medium	High	High	
Dabyminga Creek	**Actions**	nil	nil	Carry out a Regional Flood Study covering three Towns (Reedy Creek, Tallarook, and Tyaak).	Incorporate flood intelligence from Regional Flood Study.	
	Cost	-	-	$100,000	-	$100,000
	Priority	-	-	Low	Low	
Goulburn Seymour to Shepparton	**Actions**	nil	Prepare a Fact Sheet, following the completion of the Goulburn and Broken Rivers Flood Study.	Revised flood overlay controls from Goulburn and Broken Rivers Flood Study.	Incorporate flood intelligence from Regional Flood Study.	
	Cost	-	$10,000	Funded [ii]	Funded	$10,000
	Priority	-	Low	Medium	Medium	
Kilmore	**Actions**	Utilise Flood modelling (Kilmore Flood Study) to determine overland mitigation options (e.g. retardation basins)	Prepare a Local Flood Guide.	Introduce flood overlay controls following the completion of the Kilmore Creek Flood Intelligence and Mapping Study.	Update flood intelligence following completion of the Kilmore Creek Flood Intelligence and Mapping Study.	
	Cost	Underway	$7,500	Funded	Funded	$7,500
	Priority	Low	Low	High	High	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning [i]	MFEP	Total Cost
Kilmore East		nil	nil	See Sunday and Dry Creeks Regional Study	See Sunday and Dry Creeks Regional Study	
Mid Goulburn	**Actions**	nil	Prepare a Fact Sheet, following the completion of the Goulburn and Broken Rivers Flood Study.	Use data from Regional Goulburn and Broken Rivers Regional Flood Study	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	-	Funded [ii]	Funded	
	Priority	-	Low	Medium	Medium	
Pyalong		nil	nil	See Sunday and Dry Creeks Regional Study	See Sunday and Dry Creeks Regional Study	
Reedy Creek		nil	nil	See Dabyminga Creek Regional Flood Study.	See Dabyminga Creek Regional Flood Study	
Seymour	**Actions**	Implementation of Town levee - ongoing	Revise flood intelligence with levee in place – see MFEP. Prepare a new Local Flood Guide.	See MFEP. From post levee flood modelling revise zone & overlay controls.	Revise flood intelligence with levee in place. Require post levee flood modelling.	
	Cost	Funded	$7,500	Part of MFEP	$70,000	$77,500
	Priority	High	High	High	High	
Sunday & Dry Creeks	**Actions**	nil	Complete Regional Study.	Complete Regional Study.	Complete Regional Study.	
	Cost	-	Funded	Funded	Funded	
	Priority	-	Medium	Medium	Medium	
Tallarook	**Actions**	nil	nil	Revise flood overlay controls from the completed Tallarook Flood Mapping Investigation unless Dabyminga Creek Regional Flood Study is completed.	Identify vulnerable buildings in the MFEP.	
	Cost	-	-	-	$20,000	$20,000
	Priority	-	-	Medium	Medium	
Tyaak		nil	nil	See Dabyminga Creek Regional Flood Study.	See Dabyminga Creek Regional Flood Study.	
Whiteheads Creek	**Actions**	nil	Improve education and awareness (e.g. Local Flood Guide). Look at warning systems for low culvert crossing.	Revise flood zones and overlay controls following the completion of the Whiteheads Creek Flood Intelligence and Mapping Study.	Update flood intelligence following completion of the Whiteheads Creek Flood Intelligence and Mapping Study, including threats to Seymour Town Levee.	
	Cost	-	$50,000	$40,000	Funded	$90,000
	Priority	-	High	High	High	

[i] Package flood mapping from flood studies into a single planning scheme amendment.

[ii] Coordinated by the Goulburn Broken CMA across five LGAs. Cost of $60,000 is to implement a planning scheme amendment coordinated by the CMA as the proposed planning authority.

5.6 Moira Shire

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$16,575,000	$150,000	$5,000,000	$21,725,000
TFWS	$145,000	$340,000	$20,000	$505,000
Land-use Planning	$90,000	$40,000	$530,000	$660,000
MFEP	$15,000	$10,000	$45,000	$70,000
	$16,825,000	**$540,000**	**$5,595,000**	**$22,960,000**

Table 14: Moira Shire Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Barmah	**Actions**	Implement Barmah Township Flood Mitigation Functional Design (levees)	Prepare Local Flood Guide.	nil	Review MFEP following 2016 Murray River flood.	
	Cost	$5 million	$7,500	-	$10,000	$5.01M
	Priority	Low	Medium	-	Medium	
Broken Creek Tribs [i]	**Actions**	nil	Improve education and awareness, interpretation, dissemination and communication.	nil	Incorporate any flood intelligence from TFWS.	
	Cost	-	$20,000	-	$15,000	$35,000
	Priority	-	Low	-	Low	
Cobram	**Actions**	Carry out flood mitigation design and implement works to prevent flooding from the east. Functional design (Funded).	Improve education and awareness, dissemination and communication. Prepare Local Flood Guide (NSWSES & VICSES).	See Murray Regional Study.	See Murray Regional Study.	
	Cost	$500,000	$25,000	-	-	$525,000
	Priority	High	Medium	-	-	
Katamatite	**Actions**	nil	(Local Flood Guide prepared and delivered)	Revise overlay controls when Upper Broken Creek Regional Flood Study becomes available.	Part of Upper Broken Creek Regional Flood Study when available.	
	Cost	-	-	See Regional Areas.	See Regional Areas.	
	Priority	-	-	Low	Medium	
Koonoomoo		nil	nil	See Murray River Regional Flood Study Cobram to Ulupna.	nil	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Lake Rowan		nil	nil	See Regional Upper Broken Creek Flood Study.	nil	
Lower Broken Creek	**Actions**	nil	nil	Revise flood overlay controls with data from the completed Nathalia and Numurkah Floodplain Management Plans.	Finalise flood intelligence from the completed Flood Studies.	
	Cost	-	-	$40,000	-	$40,000
	Priority	-	-	Low	Low	
Lower Goulburn	**Actions**	1. Re-evaluate options on an opportunistic basis 2. Investigate impact on Cultural Heritage Values [ii]	nil	Revise flood overlay controls from the completed Lower Goulburn Floodplain Rehabilitation Scheme Study.	Incorporate flood intelligence from Scheme Study.	
	Cost	-	-	$40,000	$30,000	$70,000
	Priority	-	-	Low	Low	
Mid Broken Creek	**Actions**	nil	nil	Revise flood overlay controls with data from the completed Numurkah Floodplain Management Plan.	Finalise flood intelligence from the completed Flood Study.	
	Cost	-	-	See Numurkah	See Numurkah	
	Priority	-	-	Low	Low	
Muckatah Depression	**Actions**	nil	nil	Carry out a regional flood study.	Part of regional flood study.	
	Cost	-	-	$200,000	-	$200,000
	Priority	-	-	Low	Low	
Murray Barmah to Echuca		nil	nil	See Lower Goulburn.	See Lower Goulburn.	
Murray Cobram to Ulupna	**Actions**	See Cobram	See Cobram	Revise flood overlay controls from the completed Murray River Regional Flood Study – Cobram to Ulupna.	Incorporate flood intelligence from Regional Study – drafted.	
	Cost	-	-	$30,000	-	$30,000
	Priority	-	-	High	Medium	
Murray Ulupna to Barmah	**Actions**	nil	nil	Carry out a regional flood study.	Incorporate flood intelligence from Regional Study.	
	Cost	-	-	$250,000	-	$250,000
	Priority	-	-	Low	Medium	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Murray Yarrawonga to Cobram East	**Actions**	nil	nil	Use amended minor anomalies for LGA-wide shire for revised flood overlay controls	Part of three-year review cycle	
	Cost	-	-	In-house	-	
	Priority	-	-	Low	Low	
Nathalia	**Actions**	Maintain and renewal of town levees	Revise Flood Class Level at Walshs Bridge and Nathalia	nil	nil	
	Cost	Funded	In-house	-	-	
	Priority	High	High	-	-	
Numurkah	**Actions**	Finalise Stage 1 flood mitigation functional design (Funded), Implement works ($1M), and then Stage 2 design and works ($15M).	Implement new flood prediction service with Flood Class levels and augment rain and stream gauge network. Prepare a revised Local Flood Guide.	Revise zones and flood overlay controls following the completion of the Numurkah Floodplain Management Plan.	Update flood intelligence following completion of the Numurkah Floodplain Management Plan.	
	Cost	$16 M	$145,000	40,000	Drafted	$16.18 M
	Priority	High	High	High	High	
Strathmerton		nil	nil	See Murray River Regional Flood Study Cobram to Ulupna.	nil	
Tungamah	**Actions**	Undertake a new floodplain management study as part of Upper Broken Creek Flood Study				
	Cost	See Regional Upper Broken Creek Flood Study				
	Priority	High	High	High	High	
Upper Broken Creek	**Actions**	nil	Undertake a Regional Flood Study covering numerous Towns.	Introduce and revised flood overlay controls from Regional Study.	Incorporate flood intelligence from Regional Flood Study.	
	Cost	-	$300,000	$40,000	See TFWS	$340,000
	Priority	-	Medium	Medium	Medium	
Waaia	**Actions**	nil	nil	Introduce significant drainage line data as a FO as part of LGA-wide amendment	nil	
	Cost	-	-	-	-	
	Priority	-	-	Low	-	
Wilby		nil	nil	See Regional Upper Broken Creek Flood Study.	nil	
Wunghnu	**Actions**	Carry out a new flood study.	Prepare a Local Flood Guide.	Part of new flood study.	Update MFEP from study	
	Cost	$150,000	$7,500	-	-	$157,500
	Priority	Medium	Medium	Medium	Medium	

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Yarrawonga	**Actions**	LGA to determine mitigation options.	nil	Introduce flood overlay controls from the completed Yarrawonga Drainage Study.	Update flood intelligence following completion of the Study.	
	Cost	$75,000	-	$20,000	$15,000	$110,000
	Priority	High	-	High	High	
Yarroweyah		nil	nil	See Murray River Regional Flood Study Cobram to Ulupna.	nil	

[i] Includes: Pine Lodge, Daintons, Congupna Guilfus & O'Keefe Creeks, and include Greater Shepparton City Council

[ii] Cultural Heritage Impact assessment – $50,000 shared cost with Greater Shepparton and Campaspe Shire

5.7 Murrindindi Shire

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$-	$180,000	$180,000
TFWS	$5,000	$35,000	$-	$40,000
Land-use Planning	$40,000	$40,000	$230,000	$310,000
MFEP	$25,000	$30,000	$-	$55,000
	$70,000	**$105,000**	**$410,000**	**$585,000**

Table 15: Murrindindi Shire Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Acheron River	**Actions**	nil	See Buxton	Complete hydrology and carry out flood mapping along the Acheron & Steavenson valleys.	Incorporate flood intelligence from flood mapping study.	
	Cost	-	-	$20,000	-	$20,000
	Priority	-	Low	High	Low	
Alexandra	**Actions**	Undertake a combined overland and riverine flood management study. Require LiDAR and Survey.	Prepare a Local Flood Guide.	Part of new study – see mitigation.	Part of new study – see mitigation.	
	Cost	$180,000	$7,500	-	-	$187,500
	Priority	Low	Medium	High	High	
Buxton	**Actions**	Part of Buxton Flood Study	Improve flood intelligence, education and awareness, communication and dissemination (Local Flood Guide).	Revise flood overlay controls when Buxton, Marysville and Taggerty Flood Studies are completed.	Import flood intelligence into MFEP when Buxton Flood Study is completed.	
	Cost	Funded	$20,000	$20,000 [i]	$15,000	$55,000
	Priority	Medium	Medium	High	High	
Flowerdale		nil	nil	See Upper King Parrot Creek Regional Study.	nil	
Lower King Parrot Creek	**Actions**	nil	nil	Carry out a Regional Flood Study.	Incorporate flood intelligence from Scheme Study.	
	Cost	-	-	$80,000	-	$80,000
	Priority	-	-	Low	Low	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TFWS	Land-use Planning	MFEP	Total Cost
Marysville	**Actions**	nil	nil	Revise flood overlay controls when Buxton, Marysville & Taggerty Flood Studies are completed.	Import flood intelligence into MFEP when Marysville Flood Study is completed.	
	Cost	-	-	$20,000	$15,000	$35,000
	Priority	-	-	Medium	Medium	
Mid Goulburn	**Actions**	nil	Prepare a fact sheet similar to Local Flood Guide	Revised flood overlay controls from Goulburn and Broken Rivers Flood Study.	Incorporate flood intelligence from Flood Study.	
	Cost	-	$5,000	Funded	Funded	$5,000
	Priority	-	High	Medium	Medium	
Strath Creek		nil	nil	See Lower King Parrot Creek Regional Flood Study.	nil	
Taggerty	**Actions**	nil	nil	Revise flood overlay controls when Taggerty, Buxton Marysville Flood Studies are completed.	Import flood intelligence into MFEP when Taggerty Flood Study is completed.	
	Cost	-	-	$20,000	$15,000	$35,000
	Priority	-	-	Medium	Medium	
Thornton		nil	Part of new Goulburn and Broken River Regional Flood Study [ii]	Introduce and revised flood overlay control from Goulburn and Broken Rivers Flood Study [ii]	nil	
Upper King Parrot Creek	**Actions**	nil	nil	Update flood overlay control from completed Flowerdale Study Intelligence and Mapping Study.	Update MFEP	
	Cost	-	-	Part of LGA-wide	-	
	Priority	-	-	High	High	
Yea	**Actions**	nil	A revised Local Flood Guide to be prepared consistent with new gauge. Review Flood Class Levels	nil	Update MFEP with addendum Yea Flood Study.	
	Cost	-	$7,500	-	$10,000	$17,500
	Priority	-	Medium	-	High	
Yea River	**Actions**	nil	Review Flood Class Levels at Devlins Bridge.	Carry out a regional Flood Mapping Study.	Incorporate flood intelligence from Regional Study.	
	Cost	-	-	$150,000	-	$150,000
	Priority	-	Low	Low	Low	

[i] allow $60,000 for planning scheme amendment process for Buxton, Marysville and Taggerty.

[ii] Coordinated by Goulburn Broken CMA across five LGAs.

5.8 Strathbogie Shire

Investment summary by Action type and Priority

	High	Medium	Low	Very low	Total
Mitigation	$2,305,000	$150,000	$-	$-	$2,455,000
TFWS	$65,000	$7,500	$-	$-	$72,500
Land-use Planning	$105,000	$40,000	$75,000	$50,000	$270,000
MFEP	$45,000	$15,000	$-	$15,000	$75,000
	$2,520,000	**$212,500**	**$75,000**	**$65,000**	**$2,872,500**

Table 16: Strathbogie Shire Action-Investment Plan

Terminology: - = No further action

FO = Floodway Overlay, **LSIO** = Land Subject to Inundation Overlay, **UFZ** = Urban Floodway Zone

MFEP = Municipal Flood Emergency Plan, **TFWS** = Total Flood Warning System

		Proposed Actions, Priorities and Indicative Costs (subject to funding)				
		Mitigation	TWFS	Land-use Planning	MFEP	
Avenel	**Actions**	Floodplain Management Plan required to determine flood mitigation options, flood intelligence and mapping.	See Mitigation	See Mitigation	See Mitigation	
	Cost	$150,000	-	-	-	$150,000
	Priority	Medium	Medium	High	Medium	
Euroa	**Actions**	Augment Castle Creek levee in accordance with Euroa Flood Intelligence and Mapping Study and Urban Levee Audit. Continue maintenance of the Levee Scheme.	Improve dissemination and communication, and education awareness (e.g. Local Flood Guide and property specific data on web based portal).	Revise zones and flood overlay controls with data from the completed Euroa Flood Intelligence and Mapping Study.	Incorporate flood intelligence from the completed Euroa Flood Intelligence and Mapping Study.	
	Cost	$180,000	$40,000	$40,000 [i]	$15,000	$275,000
	Priority	High	High	High	High	
Goulburn Seymour to Shepparton	**Actions**	nil	nil	Revised flood overlay controls from Goulburn and Broken Rivers Flood Study.	Incorporate flood intelligence from Flood Study.	
	Cost	-	-	Funded [ii]	Funded	
	Priority	-	-	Medium	Medium	
Granite Creeks	**Actions**	nil	Deliver Fact Sheet, following completion of the Granite Creeks Regional Flood Study	Revise flood overlay controls from the completed Granite Creeks Regional Flood Study, which include numerous towns.	Incorporate flood intelligence from Regional Flood Study	
	Cost	-	-	$40,000	15,000	$55,000
	Priority	-	Low	Medium	Medium	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TWFS	Land-use Planning	MFEP	
Graytown	**Actions**	nil	nil	Undertake a scoping study. May require survey.	Consider intelligence data from scoping study.	
	Cost	-	-	$50,000	$15,000	$65,000
	Priority	-	-	Very Low	Very Low	
Locksley		nil	nil	See Granite Creeks Regional Area.	nil	
Longwood		nil	nil	See Granite Creeks Regional Area.	nil	
Mangalore	**Actions**	nil	nil	Undertake a scoping study. May require survey.	Consider intelligence data from scoping study.	
	Cost	-	-	$50,000		$50,000
	Priority	-	-	Low	Low	
Nagambie	**Actions**	1. Provision of permanent electric pumps and rising main from Industrial Estate basin to former borrow pit ($555,000) 2. Removal of informal levee and redundant bridge approach ramp at Western end of the Old Chinamans Bridge, and provide abutment protection ($50,000).	Improve education awareness, prepare a Local Flood Guide.	Revise zones and Introduce flood overlay controls with data from the completed Nagambie Flood Intelligence and Mapping Study.	Incorporate flood intelligence from the completed Nagambie Flood Intelligence and Mapping Study.	
	Cost	$605,000	$7,500	$40,000	$15,000	$667,500
	Priority	High	Medium	High	High	
Old Longwood		nil	nil	See Granite Creeks Regional Area.	nil	
Strathbogie	**Actions**	nil	nil	Undertake a scoping study.	Consider intelligence data from scoping study.	
	Cost	-	-	$25,000	-	$25,000
	Priority	-	-	Low	Low	

Proposed Actions, Priorities and Indicative Costs (subject to funding)						
		Mitigation	TWFS	Land-use Planning	MFEP	
Violet Town	**Actions**	1. Finalise the Violet Town Water Management Scheme $160,000) and construct the proposed levee ($1,260,000) 2. Upgrade the Murray Street rural drain and provide localised bunding or floor raising of houses ($100,000)	Improve dissemination and communication, and education awareness (e.g. Local Flood Guide and property specific data on web based portal.	Revise zones and flood overlay controls with data from the completed Violet Town Flood Study.	Incorporate flood intelligence from the completed Violet Town Flood Study.	
	Cost	$1,520,000	$25,000	$25,000	$15,000	$1.585 M
	Priority	High	High	High	High	

[i] Package flood mapping from flood studies into a single planning scheme amendment.

[ii] Coordinated by the Goulburn Broken CMA across five LGAs. Cost of $60,000 is to implement a planning scheme amendment coordinated by the CMA as the proposed planning authority.

5.9 Whole of region

Investment summary by Action type and Priority

	High	Medium	Low	Total
Mitigation	$-	$-	$-	$-
TFWS	$135,000	$-	$-	$135,000
Land-use Planning	$-	$-	$-	$-
MFEP	$-	$-	$-	$-
	$135,000	**$-**	**$-**	**$135,000**

Table 17 Whole of region Action-Investment Plan

Proposed Actions, Priorities and Indicative Costs (subject to funding)					
Actions	Lead	Partners	Priority	Objective	Cost
Update **Goulburn Broken CMA flood information online** to assist with decision making process for land-use planning proposals.	GB CMA		High	Land-use planning	GB CMA
Prepare regional Development Floodplain Management Principles and Assessment Practices for Land-use and Development.	GB CMA	All LGAs, DELWP	Medium	Land-use planning	GB CMA
Investigate options to improve community access to **website flood risk information** to allow communities (and business) to better plan, prepare and respond to major floods.	GB CMA	VICSES, all LGAs	High	TFWS	$200,000
Update and maintain **flood intelligence** in line with State-wide protocols.	GB CMA	DELWP	High	TFWS	GB CMA
Investigation options to improve flood intelligence gathering during and after major floods.	GB CMA	VICSES, all LGA	Medium	All	GB CMA
Develop community flood education and awareness products/programs relating to flood risk for high priority areas, to build and maintain community resilience. Examples may include individual flood awareness property charts, pre-recorded flood education videos, interactive interpretational products such as animations of flood behaviour, community signs, gauge boards and local flood guides or other initiatives as identified.	VICSES	VICSES, all LGAs, DELWP	High	TFWS	$65,000
State Community Observers Network Website enabling the community to provide local knowledge during a flood event using smartphones to collect flood data via an app. Photos can be instantly uploaded to the web page, viewed and shared between agencies and the community. A source of valuable information where there are gaps in telemetered stream data.	VICSES	DELWP, all CMAs	High	TFWS	$70,000
Update MFEPs to incorporate school bus runs impacted by flooding where flood mapping is available. Determine approaches to manage changes to school bus routes.	VICSES	Dept. of Education, GB CMA, all LGAs	Medium	MFEP	VICSES
Undertake exercising of **MFEPs**	VICSES	CMA, all LGAs	High	MFEP	VICSES
Investigate methods to recognise Aboriginal values before any new proposed floodplain management works, and flood activities, which may include but is not limited to risks to cultural assets after floods, and notification of flood events to relevant Traditional Owner corporations (e.g. **MFEPs** could include information regarding these risks, including notifying the relevant RAP).	VICSES	All LGAs, GB CMA	Medium	MFEP	VICSES