



ADAPTING TO CHANGE

REGIONAL CLIMATE ADAPTATION PLAN

This Plan outlines opportunities for councils in the Southern Loddon Mallee and the Shire of Buloke to work together to respond to the very real challenges and opportunities posed by a rapidly changing climate.

Southern Loddon Mallee Region



ADAPTING TO CHANGE

REGIONAL CLIMATE ADAPTATION PLAN

Participants

The Southern Loddon Mallee Region includes the municipalities of Central Goldfields, Greater Bendigo, Loddon, Macedon Ranges and Mount Alexander. While the Shire of Buloke falls outside the Southern Loddon Mallee, it has been included in this project. This Plan refers to the Region as the spatial area that includes all participant local government areas.

This Plan is also of relevance to other municipalities in the Loddon Mallee Region where similar characteristics and priorities have been identified, such as Gannawarra Shire. In this way, the Plan enables a collaborative, cost-effective response, to shared regional issues.

Introduction

The Region stretches from the southern end of the Great Dividing Range to the open cropping country of the north.

A rich cultural history is present, and this Plan acknowledges that Aboriginal Traditional Owners of Victoria maintain their connection to their ancestral lands and waters.

The economy of the Region is as diverse as the natural landscape. Food manufacturing and service industries dominate the south, while agriculture remains the economic foundation of the north.

As one of the overall warmer and drier climates in Victoria, the Region is very exposed to present and projected climate change impacts.

Climate change can best be understood as a gradual warming of our climate due to human activities such as the burning of fossil fuels, agriculture and land clearing. The extra heat in the climate system affects atmospheric and ocean circulation patterns that then influence rainfall and wind patterns. Scientists largely agree that the worst effects of climate change may be avoided if the issue is addressed decisively. However, there is a level of impact that is now unavoidable.

Councils in the Region have a role in managing climate risk as it relates to their assets and services, and in supporting their communities to make informed decisions. Businesses need to consider climate change as a business risk.

Regional Vulnerabilities

Vulnerability describes the extent to which systems (such as the economy, infrastructure or community) are susceptible to or unable to cope with the effects of climate change. It is comprised of not only the risk of impact to systems, but also the capacity of the systems to deal with climate events.

For example, a small town on a riverbank may be exposed to a flood risk. Adaptive capacity refers to the degree to which the community is prepared for the flood. The combination of flood risk and preparedness gives the small town a vulnerability rating with respect to floods.

In this Plan, the vulnerabilities for each municipality were carefully assessed, collated, prioritised and regionally themed according to the process outlined in The Plan Approach.

Figure 1:
Vulnerability definition





The Plan Approach

Responding strategically at both a regional and municipal level is important in building resilience to the challenges posed to our community and economy by a changing climate.

Developing a collaborative multi-council approach allows for increased knowledge sharing, the strengthening of relationships and the creation of efficiencies that benefit each council and the region as a whole.

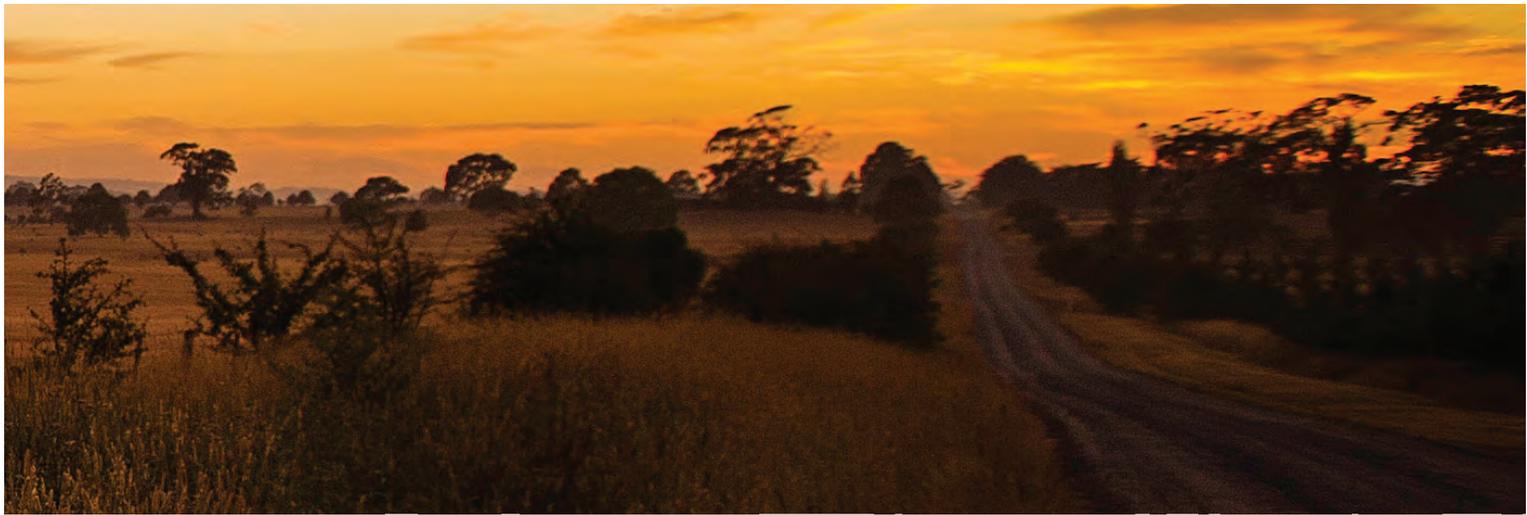
This Plan was developed using a 'building block' methodology whereby vulnerability information, projections and data were assembled at a municipal level and then through a series of extensive workshops, feedback mechanisms and collaborative theming, collated to build a set of priority areas relevant to all councils, as shown in Figure 2:

Figure 2:
Overview of the Adapting to
Change project approach



- 1 A summary of the economic, social and environmental character of each municipality was prepared to guide the formulation of the vulnerability priorities
- 2 Relevant staff from each municipality completed a climate change vulnerability assessment specific to their operations
- 3 A detailed vulnerability report was prepared for each municipality based upon agreed priorities
- 4 The vulnerabilities of highest concern to several municipalities were then identified and grouped together according to the six themes of Community health and individual wellbeing; Energy, water and other utility infrastructure; Emergency management; Water resources; Rural commercial activities; and Buildings and development
- 5 This two year process resulted in an extensive report that details the key themed Regional Adaptation Action opportunities. These are summarised in this Plan.

The Regional Adaptation Actions represent the well-considered priorities that respond to the Region's extreme and high climate related vulnerabilities expected for 2030.



Regional Adaptation Actions

Opportunities for a Regional approach

The following themed list of actions acts as a guide to best direct future shared approaches, enabling the region to work together effectively to achieve mutually beneficial outcomes:



Community health and individual wellbeing

- S** Review heat wave management plans, alter systems and develop programs to assist vulnerable community groups during heat waves



Water resources

- I** Maximise community awareness and encourage participation in flood preparedness activities



Energy, water and other utility infrastructure

- A** Develop a regional Infrastructure Protection Plan
- L** Broaden existing community based programs to empower the region to become self-sufficient
- A** Integrate improved standards for infrastructure and building design
- A** Collaborate with the energy sector to develop local and distributed energy in the region from diverse energy sources
- I** Enhance communication about essential services pre, during and post extreme weather events



Rural commercial activities

- I** Collaborate with financial institutions to refer existing rural support programs to the agricultural community
- L** Develop regional business cases to inform how agricultural practices can adjust to new issues and opportunities presented by climate change



Emergency management

- L** Develop regional local government guidelines for state and federal funding bodies
- I** Enhance recruitment drive for more volunteers to assist with emergency events
- C** Build capacity of existing council staff and volunteers with the appropriate training and knowledge to respond to extreme weather events



Buildings and development

- L** Review bushfire and flood inundation overlays to inform development in bushfire or flood hazard areas
- L** Provide commercial incentives for retrofit of developments in a manner that reduces climate change risks to new and existing infrastructure and property
- I** Work with businesses in the multiplicities to integrate climate adaptation planning and resilience into business continuity plans
- A** Conduct more frequent structural inspections of properties in advance of extreme events and adapt properties accordingly
- L** Continue to encourage the uptake of commercial insurance in the region to mitigate costs of building damage



Discussion of Actions

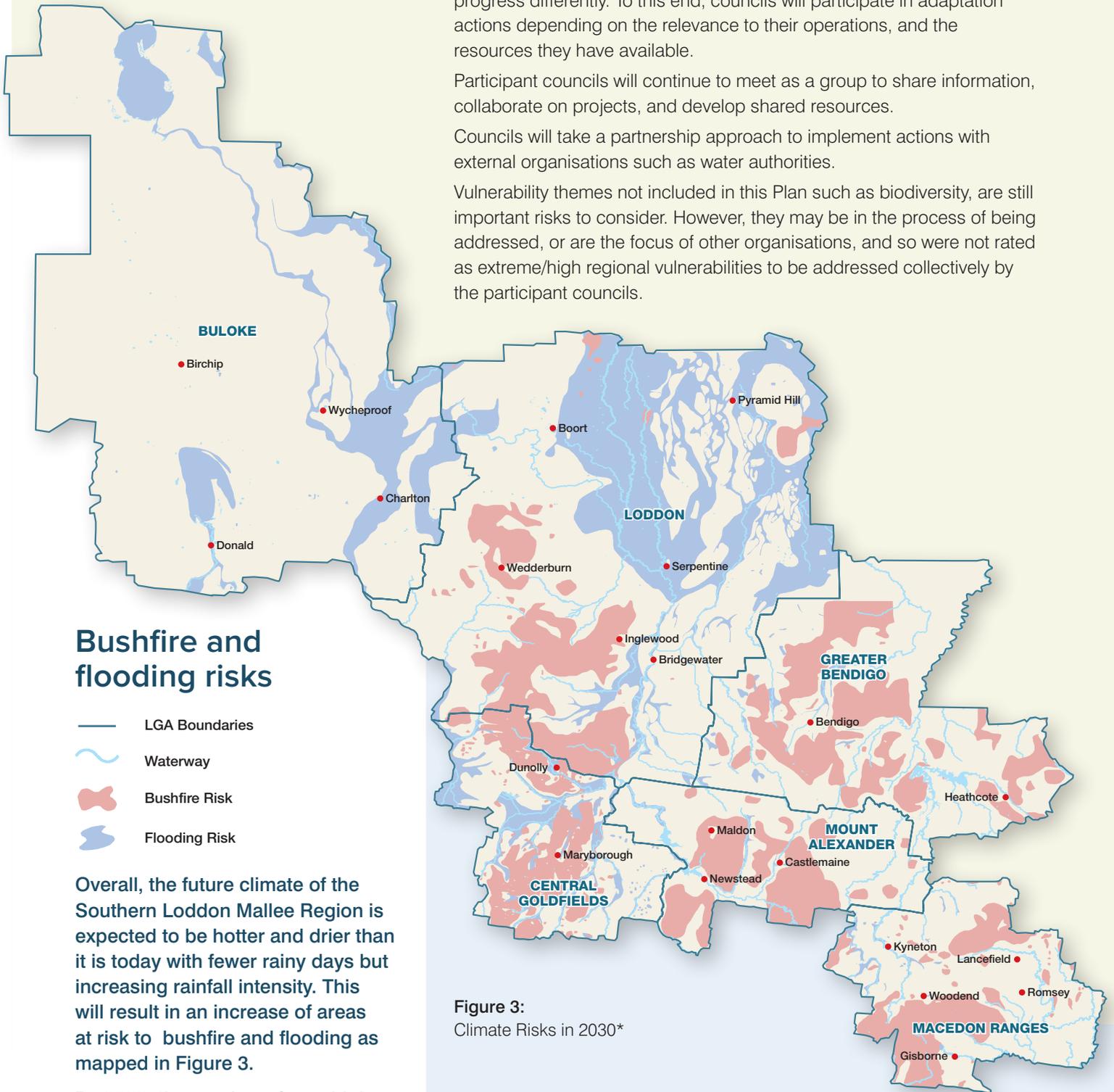
As this is the first Plan for the Region, many of the proposed actions focus on improving our understanding of climate risks and vulnerabilities, and integrating climate change thinking into existing activities.

Each council is at a different stage in its adaptation response, and will progress differently. To this end, councils will participate in adaptation actions depending on the relevance to their operations, and the resources they have available.

Participant councils will continue to meet as a group to share information, collaborate on projects, and develop shared resources.

Councils will take a partnership approach to implement actions with external organisations such as water authorities.

Vulnerability themes not included in this Plan such as biodiversity, are still important risks to consider. However, they may be in the process of being addressed, or are the focus of other organisations, and so were not rated as extreme/high regional vulnerabilities to be addressed collectively by the participant councils.



Bushfire and flooding risks

- LGA Boundaries
- ~ Waterway
- Bushfire Risk
- Flooding Risk

Overall, the future climate of the Southern Loddon Mallee Region is expected to be hotter and drier than it is today with fewer rainy days but increasing rainfall intensity. This will result in an increase of areas at risk to bushfire and flooding as mapped in Figure 3.

By 2030, the number of very high or extreme fire risk days across the region is projected to increase from a maximum of approximately 14 days per year to 19 days per year.

* Projections to 2030 are based on a medium emissions growth scenario with a global increase of 2.8 degrees Celsius likely by 2100 (Department of Sustainability and Environment, 2008, Future Climate (Port Phillip & Westernport, Wimmera, Mallee, North Central and Goulburn Broken)).

Figure 3: Climate Risks in 2030*

The number of extreme temperature days in Donald is projected to increase from approximately 15 days per year to between 18 and 19 days per year.

Donald's temperatures and annual rainfall would resemble those of present day Balranald in New South Wales.

Bendigo's temperatures would resemble those of present day Ouyen, while annual rainfall would be similar to Charlton.

The number of extreme temperature days in Bendigo is projected to increase from approximately 11 days per year to between 13 and 17 days per year.



Further reading

Contact a participant council for further information.

Buloke Shire Council

03 5478 0100
buloke@buloke.vic.gov.au

Central Goldfields Shire Council

03 5461 0610
mail@cgoldshire.vic.gov.au

City of Greater Bendigo

03 5434 6000
enquiries@bendigo.vic.gov.au

Loddon Shire Council

03 5494 1200
loddon@loddon.vic.gov.au

Macedon Ranges Shire Council

03 5422 0333
mrsc@mrsc.vic.gov.au

Mount Alexander Shire Council

03 5471 1700
info@mountalexander.vic.gov.au

Partnerships and Collaboration

This Plan was funded through a grant from the Victorian Government and participant councils recognise the significance of this support.

This Plan acknowledges that the community and all levels of government will need to cooperate in building the Region's resilience to climate change.

Councils in the Region are beginning to build their capability and capacity to provide community leadership on climate change adaptation. At the same time, the expertise and skills needed to enable adaptation reside in the community.

Reducing greenhouse gas pollution remains a critical task for society as a whole.

Review Process

This Plan is a living document and will be reviewed periodically to take into account new information regarding climate change risks and vulnerabilities, and associated actions and opportunities. Updating the Plan will ensure that the Region's adaptation responses and approaches remain valid and effective.

Southern Loddon Mallee Region





ADAPTING TO CHANGE

REGIONAL CLIMATE ADAPTATION REPORT

Southern Loddon
Mallee Region

This report details the shared regional risks and vulnerabilities applicable to the Southern Loddon Mallee and the Shire of Buloke's economy and community as a result of a changing climate. Adaptation options are evaluated, prioritised and themed to produce a set of priority action options relevant to the entire region.

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Introduction

The Adapting to Change project has sought to clearly present the current and potential future climate-related vulnerability for the Southern Loddon Mallee Region. The project has informed the actions documented in this Regional Climate Adaptation Plan (the Plan) to improve the region's resilience to a changing climate.

The Southern Loddon Mallee region covers six municipalities including Greater Bendigo, Central Goldfields Shire, Loddon Shire, Macedon Ranges Shire, Mount Alexander Shire and Buloke Shire. While the local government area of Buloke falls outside of the Southern Loddon Mallee Region, it has been included in this project.

This Plan presents actions for the region as a whole, rather than the individual local government organisations. It is acknowledged that local governments, community, and other stakeholders will need to collaborate to build the region's resilience to climate change impacts.

The Adapting to Change project has been funded through the Victorian Adaptation and Sustainability Partnership, administered by the Department of Environment and Primary Industries, and is identified in the State Government's Victorian Climate Change Adaptation Plan. The key project stages for the Adapting to Change project are presented in Figure 1.



Figure 1 Overview of the Adapting to Change project approach.

Regional actions

Priority adaptation actions for the Southern Loddon Mallee region have been identified based on the common regional risks and vulnerabilities identified throughout the Adapting to Change project. The priority actions are intended to respond to the region's extreme and high climate related vulnerabilities for 2030.

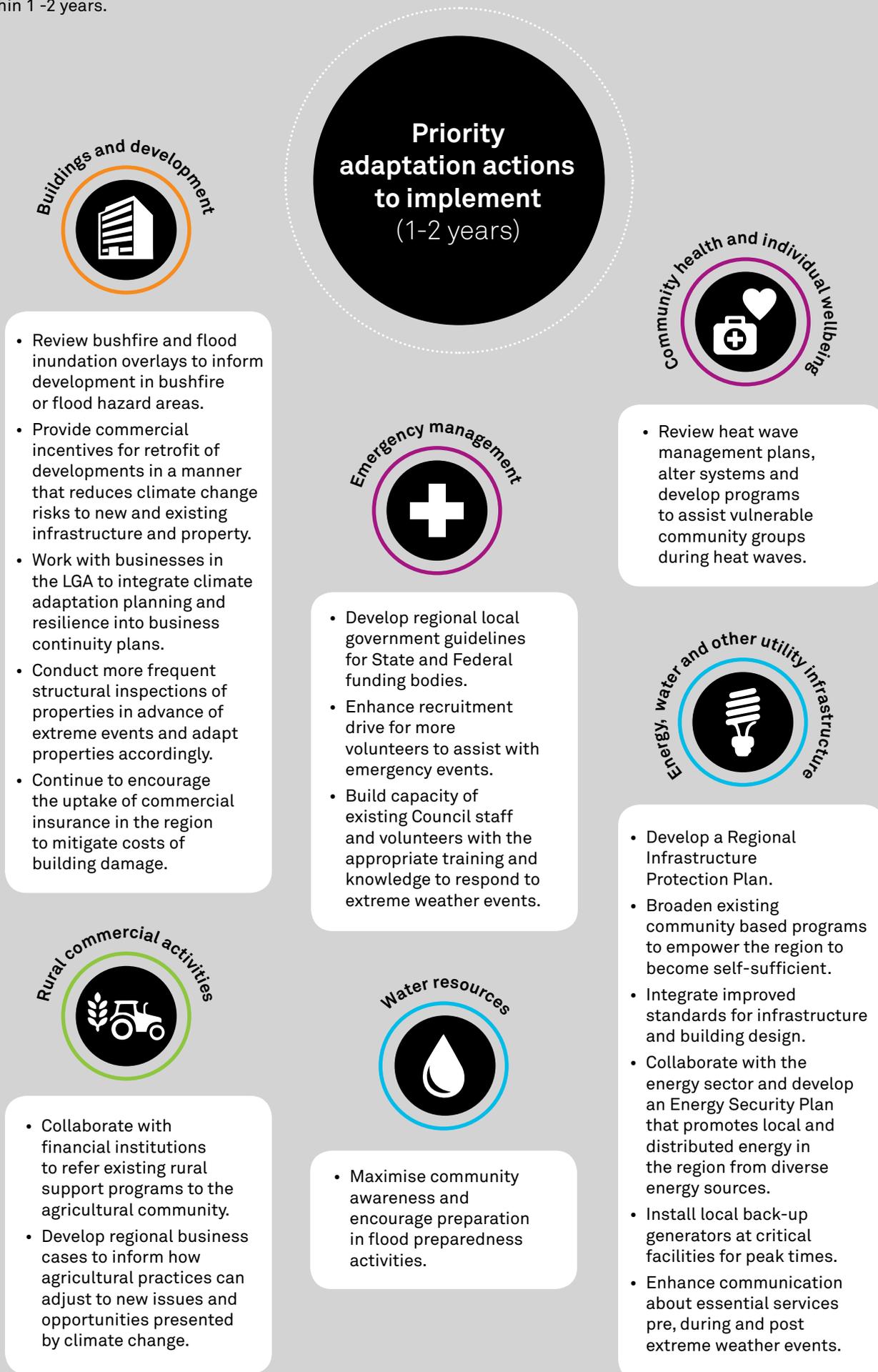
Shared regional vulnerabilities have been identified under the following themes:

- Community health and individual wellbeing
- Energy, water and other utility infrastructure
- Emergency management
- Water resources
- Buildings and development
- Rural commercial activities

This Plan identifies actions for the region to address the identified climate vulnerabilities. Further detail setting out how each of these areas will be impacted by climate change in the Southern Loddon Mallee region is included in Appendix B.

The prioritised adaptation actions, best progressed in the next 1 to 2 years, are presented in Figure 2. Each prioritised adaptation option is then explained further noting the level of authority required to implement the action and the role Council can play to advance the actions for the Southern Loddon Mallee region as a whole. The full list of identified and evaluated adaptation options, for the region, including their timeframe for implementation, is presented in Appendix C.

Figure 2. Priority adaptation options identified for implementation in the Southern Loddon Mallee region within 1 -2 years.



Action	Description	Level of responsibility for implementation	Role for Council
Buildings and development			
Review bushfire and flood inundation overlays to inform development in bushfire or flood hazard areas.	This adaptation option predominantly focuses on building resilience in future development for the region. Council can advocate for the review of planning overlays and design standards to ensure adequate climate change tolerances have been considered. A review of overlays or producing guidelines for development applications in flood or bushfire hazard areas for developers may also be alternative measures of integrating adaptation measures into future development.	Federal and State e.g. DTPLI	Lead - climate adaptation can be considered when Council undertake their planning scheme reviews and/or develop new policies that form part of the Local Planning Policy Framework in individual planning schemes. Advocate federal and state government authorities for reviews of broader planning policies to guide direction for adaptation measures.
Provide commercial incentives for retrofit of developments in a manner that reduces climate change risks to new and existing infrastructure and property.	<p>In 2009, Victorian building regulations prescribed that all new homes must be designed, construction and located with improved bushfire protection. While these regulations do not include mandatory retrofitting, organisations in the region may incentivise building and asset owners to implement measures that improve resilience.</p> <p>This adaptation option can be tested at one of the regional LGAs. Financial institutions such as banks may also be involved to facilitate this option by financing retrofit works that will improve resilience in existing and new buildings located in the Southern Loddon Mallee region. Examples of retrofitting measures may include:</p> <ul style="list-style-type: none"> - Construction of private or community bushfire shelters - Installing a sprinkler system - Replacing parts of the building with non-combustible or bushfire materials - Relocating or raising property out of floodplain areas to higher group - Construction of flood walls or levees around properties to hold back flood water <p>Further guidance can be provided by the CFA in their 'A guide to retrofit your home for better protection from a bushfire'. Grant funding may aid in the implementation of this option.</p>	Local governments and commercial developers	Lead – through policy development in the planning scheme and/or implementation of measures in community areas.
Work with businesses in the LGA to integrate climate adaptation planning and resilience into business continuity plans.	Climate change is likely to impact businesses and organisations in the Southern Loddon Mallee region and all businesses have an interest in managing potential risks. Business planning should include measures to mitigate or avoid impacts to business from extreme weather events. Examples of this may include:	Local government area and the private business sector	Influence and encourage forward planning in the private sector so businesses and dominant industry sectors are prepared for disaster events and can continue business while the

Action	Description	Level of responsibility for implementation	Role for Council
	<ul style="list-style-type: none"> - Developing disaster management plan e.g. for flood or bushfire events - Moving critical operations/equipment/facilities in advance of flood warnings - During extreme heat, reducing the use of heat generating equipment and energy demand - Taking out appropriate insurance policies that cover for physical damage, income loss etc. - Establishing procedures for workforce, customer or supply chain impacted by extreme weather events e.g. health/welfare and transport. - Protective measures for building/operations <p>An engaging way to involve businesses may be to hold regional forums and invite small township leaders together to network and share successes, challenges, approaches, case studies and provide training and coaching.</p>		region recovers.
Conduct more frequent structural inspections of properties in advance of extreme events and adapt properties accordingly.	Regular maintenance and structural inspections of building stock can identify weaknesses in assets in advance of extreme weather events. Homeowners can maintain residential properties proactively and government and commercial property owners can integrate additional inspections in maintenance procedures. Existing building practices and maintenance regimes should be reviewed to ensure that climate change adaptation is considered.	State e.g. DEPI	Advocate state government authorities to manage assets strategically and play an education role in encouraging households to inspect their own properties.
Continue to encourage the uptake of commercial insurance in the region to mitigate costs of building damage.	Damage to buildings and development is an insurable risk. Given the climate hazards in the Southern Loddon Mallee region, encouragement of commercial insurance should continue. This may be in the form of an education or communication campaign.	State e.g. Chamber of Commerce and the private business sector	Lead – through development of a communication program to assist commercial sectors to take up insurance in the region.

Action	Description	Level of responsibility for implementation	Role for Council
Energy, water and other utility infrastructure			
Develop a Regional Infrastructure Protection Plan.	<p>Road and rail networks, telecommunication, drainage, water and power assets in the region is particularly vulnerable to extreme weather events, such as flash flooding and bush fires. The quality of the infrastructure varies across the region, with some infrastructure being quite poor and others relatively new due to recent repair and recovery works or project upgrades. The thresholds of key infrastructure such as drainage in flood hazard areas, needs to be reviewed and upgraded to withstand the more frequent and intense rainfall events that are already experienced and projected for the region.</p> <p>It should be noted that the 'Critical Infrastructure Resilience Interim Strategy' (December 2013) currently sets out new management arrangements for critical infrastructure resilience in Victoria. This strategy encourages local governments to identify their local critical infrastructure and then develop necessary plans to protect and build resilience for these identified assets. A regional approach may be ideal given the interdependencies and vulnerabilities identified for the Southern Loddon Mallee region. This would also identify further adaptation solutions for implementation.</p>	State e.g. DTPLI	Advocate for strategic planning and management of infrastructure assets at state level.
Broaden existing community based programs to empower the region to become self-sufficient.	<p>The focus of this adaptation option is for the region to be less dependent on the state for food and essential services (such as energy and water) and to shorten supply chains for food and power. DEPI is currently supporting Moira Shire, through the VASP funding program as well, in identifying self-sufficiency initiatives for the LGA. Examples of community based programs that may address this include:</p> <ul style="list-style-type: none"> - The concept of a virtual renewable power station that is hosted by regional community owned assets is being investigated to drive adaptation to and investment in decentralised electricity generation and distribution infrastructure. Experiences from this initiative can be shared throughout the Southern Loddon Mallee LGAs to build resilience. - Providing useful local and regional context information sheets and case studies to small townships to inform community planning processes. - Tools, training and capacity building for community leaders, community planning groups (or LGA staff supporting these groups). <p>Tools/checklists that allow community planning groups to check if their plans are supporting adaptation and how they can strengthen adaptation in their community plans (including case studies).</p>	Local government area	Lead – through program development of community based programs and events.

Action	Description	Level of responsibility for implementation	Role for Council
Integrate improved standards for infrastructure and building design.	<p>This adaptation option relates to integrating resilience during the design phase for a range of infrastructure and building types. However, it is important to address all aspects of the asset life cycle. There are already developments in policy that will progress this adaptation option for the state. The Victorian Critical Infrastructure Resilience Interim Strategy' (December 2013) will drive this adaptation and resilience initiatives. Industry will be developing (voluntarily) best practice standards for vital and critical infrastructure. This may cover critical infrastructure for the Southern Loddon Mallee region. Other resilience measures that may influence asset design include:</p> <ul style="list-style-type: none"> - Elevating assets above defined flood levels - Providing access to and incorporating resilience for generator connection at key facilities to temporarily provide power supply - Using bushfire or flood resistant materials <p>Integrating protective measures such as expandable or portable design fittings</p>	State e.g. DPC	Advocate for strategic planning and management of infrastructure assets at state level.
Collaborate with the energy sector and develop an Energy Security Plan that promotes local and distributed energy in the region from diverse energy sources.	<p>The adaptive capacity of the region can be enhanced by decreasing stress on the centralized power generation system. Councils in the region can collaborate with power suppliers and industry associations (e.g. clean energy council, energy efficiency council) to develop a business model for local and distributed energy generation. Working with power suppliers can help understand barriers and challenges for the region. The feasibility and practicality of this option can be trailed at one LGA and once evaluated for their effectiveness, be rolled out to the rest of LGAs in the region.</p>	Private – power sector	Advocate the energy sector to develop an Energy Security Plan. Council may play more a management/coordinator role once any distributed energy generation initiatives are piloted.
Install local back-up generators at critical facilities for peak times.	<p>A first pass assessment of this option may include undertaking an energy needs analysis to help understand the energy demand and critical locations across the region. Securing power supply to critical services and facilities e.g. hospitals and town halls can alleviate the community's impact when power supply is disrupted from extreme weather events. Knowing where the critical points are can prioritise installation and size of secondary power sources, which may also address emergency management risks.</p>	Private – power sector	Lead strategic actions such as the energy needs analysis for the region. This adaptation option would also require LGAs to collaborate with the power sector to arrange back up power supplies in areas that do not yet have them.

Action	Description	Level of responsibility for implementation	Role for Council
<p>Enhance communication about essential services pre, during and post extreme weather events.</p>	<p>The regional community is most vulnerable in the event of a natural disaster and with limited or no essential services. The region needs to be informed about the length of service disruptions such as power blackouts, road closures, and disconnected telecommunication. This adaptation involves enhancing communications about such events and engaging key stakeholders. Examples may include:</p> <ul style="list-style-type: none"> - Developing an agreed communication process with stakeholders such as VicRoads, Telstra, Powercor etc and the community during the natural disaster events. - Continuing to conduct debriefs and post-event reviews following events to improve management of essential services during extreme weather events. The reviews should consider the following: <ul style="list-style-type: none"> - Identification of lessons learned - Communication of lessons across the council organisation, and more widely amongst local and regional stakeholders. <p>Identification of requirements for procedures/systems to be updated.</p>	<p>Private – utility sector and emergency management organisations.</p>	<p>Influence utility suppliers to improve communication during extreme weather events</p>
Rural commercial activities			
<p>Collaborate with financial institutions to refer existing rural support programs to the agricultural community.</p>	<p>This adaptation option involves developing a rural support program for the agricultural community that relies on financial institutions such as banks referring community members that may be at risk or likely to benefit from the program. This program can be piloted by Bendigo Bank in one of the LGAs.</p> <p>Collaboration with LGAs on support programs would also build resilience in the region. For example, Macedon Ranges has shared resources such as psychologists to support affected farming individuals and communities.</p>	<p>State e.g. DEPI and private e.g. Bendigo Bank</p>	<p>Influence – through development of a program targeted at the agricultural sector and in collaboration with financial institutions that cross promotes rural support programs and services across the region.</p>

Action	Description	Level of responsibility for implementation	Role for Council
<p>Develop regional business cases to inform how agricultural practices can adjust to new issues and opportunities presented by climate change.</p>	<p>Rural production is a significant contributor to the regional economy, although the nature of agriculture is changing. The region's agricultural sector is continually adapting to the changing climate in the Southern Loddon Mallee. Climate change may impact on the agricultural sector, potentially changing the mix of agricultural enterprises in the region. There is a need for broader sector wide response to maintain the region's economic viability.</p> <p>Developing regional business cases focused on the agricultural sector's risks and vulnerabilities, protection and constraints to growth such as flood, bushfire hazard, native vegetation, and strategically important agricultural land may further enhance the region's adaptive capacity and resilience. The regional business cases may explore:</p> <ul style="list-style-type: none"> - Policy development - Regional practices to adjusting sowing and harvesting practices/dates - Changing regional crop patterns and locations - Collaboration with stakeholders e.g. continuing to engage and collaborate with regional farmers, research and development (R&D), and government organisations, such as CSIRO and DEPI. - Promoting the uptake of insurance for farmers and businesses in the region - Knowledge transfer e.g. continuing to support and communicate R&D into adaptation and new crop and pasture varieties that withstand changing climate conditions. <p>Identifying new land use opportunities for the region in response to a changing climate.</p>	<p>State e.g. DEPI and private e.g. farmers</p>	<p>Lead – through the development of a various policies, programs and initiatives that builds adaptation capacity in the agricultural sector.</p>
<h3>Emergency management</h3>			
<p>Develop regional local government guidelines for State and Federal funding bodies.</p>	<p>Regional LGAs face unique challenges when applying for State and Federal funding, particularly for repair funding to assist with disaster recovery works. Developing guidelines unique for the Southern Loddon Mallee region would support activities around funding design, collaboration, and provide tips on leveraging off other funds and make it easier for regional local government agencies to secure and effectively use State and Federal funding that is available. These guidelines would need to be reviewed and updated regularly to keep them relevant and current for the region.</p>	<p>Federal and state funding departments</p>	<p>Lead – the development of guidelines for LGAs in the region.</p>

Action	Description	Level of responsibility for implementation	Role for Council
Enhance recruitment drive for more volunteers to assist with emergency events.	<p>This adaptation option focuses on increasing volunteer resources in the region for emergency events. Examples of this may include:</p> <ul style="list-style-type: none"> - Assessing constraints and opportunities for recruiting and maintaining volunteers for the region - Developing a recruitment campaign using a range of communications e.g. social media and networks e.g. universities. This was done successfully following the Christchurch earthquakes in 2010 and 2011. - Collaborating with stakeholders e.g. SES and CFA and existing volunteer programs e.g. Blazeaid and building partnerships with other regions to support volunteers. - Providing incentives for new CFA/SES volunteer members/response groups e.g. business recognition, tax breaks, superannuation benefits. <p>A potential funding source for this adaptation solution is the state fire service levy.</p>	State e.g. CFA, SES	Influence and support relevant authorities recruit volunteers and raise awareness.
Build capacity of existing Council staff and volunteers with the appropriate training and knowledge to respond to extreme weather events.	<p>The region's close and connected communities form a key part of the region's ability to adapt, respond and recover from emergency and extreme weather events. Building emergency response capacity for Council staff and volunteers and extending it beyond the community will help improve the region's resilience.</p> <p>Five of the six LGAs are signatories of the voluntary Municipal Emergency Management Enhancement Group (MEMEG), which is an agreement between council's to provide resources to other LGAs to assist with response and recovery tasks during and after emergencies. The region should continue to draw on this network to build capacity and resilience</p> <p>Another example of driving this change in Council is incorporating emergency management responsibilities into Position Descriptions/KPIs.</p>	Local government area and MAV	Collaborate with MAV in using the MEMEG to build capacity.

Action	Description	Level of responsibility for implementation	Role for Council
Community health and individual wellbeing			
Review heat wave management plans, alter systems and develop programs to assist vulnerable community groups during heat waves.	<p>All LGAs have a heat wave management plan to manage heat stress / illness and vulnerable population groups during heat wave events. This adaptation solution focuses on reviewing barriers, challenges and opportunities from the experiences so far. Some examples of gaps and areas for improvement include:</p> <ul style="list-style-type: none"> - Enhanced communication and education for vulnerable groups - Developing a heat stress reduction program for businesses/industries working outdoors - Consideration of social media and/or other communication methods to communicate use of public facilities (e.g. library, cinemas, churches or Community Houses) as refuge/relief during heatwaves. <p>Developing a 'Good Neighbour' program in townships across the region to encourage the community to check on vulnerable neighbours during heatwaves.</p>	State e.g. Department of Health	Support DoH in reviewing the relevant heat wave plans in the region. The regional Councils can lead development and communication of programs that reduce heat stress on vulnerable groups.
Water resources			
Maximise community awareness and encourage preparation in flood preparedness activities.	<p>Enhancing the ability for region's and community's to prepare for flood events in the region is essential for effective risk communication and awareness as emergency services may not be able to respond in time. Building community capacity and helping them make informed decisions about responding to extreme weather events can improve the region's resilience and ability to recover. Examples of guidance include:</p> <ul style="list-style-type: none"> - Review of current processes and identify gaps for improvement. - Advising residents on how they can provide their own flood protection e.g. having their own sand bags and evacuation plan. <p>Printed materials e.g. guidance pamphlet on how to be prepared and protect properties in flood events.</p>	State e.g. CFA, SES	Influence by collaborating with emergency management organisations.

Implementation

An important action to ensure implementing of this Regional Adaptation Plan for the Southern Loddon Mallee region relates to the governance and endorsement of this Plan. There will be a need to collaborate to deliver on the key actions and to monitor progress and update the plan over time.

Partnerships and Collaboration

LGAs in the Southern Loddon Mallee region are already engaging the community and building their capacity for community leadership on climate change adaptation. This Plan acknowledges that the community, and other levels of government, will need to continue being engaged in building the Southern Loddon Mallee region's resilience to climate change impacts. For example, the Community Resilience Mentoring Initiative (CRMI) initiated by the Central Goldfields Shire is a flood recovery initiative that leveraged the experience and capacity of towns to support disaster-affected communities and prioritise efforts. Framing climate change adaptation as being about building resilience is important for engaging members of the community in recovery rather than the issue of climate change. Another example in the City of Greater Bendigo is how the Community Houses received a grant to undertake emergency preparedness projects in the community.

A key recommendation of implementing this plan is to assign responsibility for this Plan and further driving adaptation throughout the region. Endorsing this Plan can be incorporated into an existing committee's role such as the Adapting to Change Project Control Group (PCG). Alternatively, a new committee could be established that includes representatives from government agencies. The role of this group could be to evaluate and manage climate change risks and vulnerabilities and to develop approaches that are compatible with the agencies and reinforce climate change adaptation. The committee would also have a strong role in communication and building partnerships in the region. Examples of this can include:

- Developing partnerships with industry, investment, and insurance networks to understand their potential role in climate change risk mitigation and in enhancing the region's economic viability.
- Enhancing communication strategies to engage stakeholders.
- Disseminating critical information to stakeholders, promoting resilience and building awareness of climate risk.

Monitoring and Review

This plan is a living document and will continue to be revised as climate change risks and associated opportunities change over time. As this is the first adaptation plan for the Southern Loddon Mallee Region, many of the proposed actions focus on improving our understanding of climate risks and integrating climate change into existing activities.

To ensure that the region's adaptation responses and approaches remain valid and relevant to local priorities and climatic conditions, a possible recommendation could be to review and update the Plan every five years and/or review the risks identified in this plan annually, as per standard risk management practices.

These reviews may re-assess each LGA's risk profile in consideration of changes to climate change information, policy, assets and activities. Consideration should also be given to the potential opportunities and benefits that may arise as a result of the changing climate and policy environment (e.g. new funding sources, opportunities for the development of renewable energy or green business precincts). Reviews may also cover monitoring on the progress of adaptation actions.

Regular and ongoing reporting of the region's climate change adaptation performance is critical to inform decision making and motivate changes in behaviour. Consideration in annual budgets, internal reporting and communication to the general public is recommended to ensure that decision-makers, staff and the community are aware of progress in implementing the adaptation actions outlined in this Plan.

Regional Profile and Climate Projections

The Southern Loddon Mallee Region is located in the geographic centre of Victoria. The region is 50km away from the centre of Melbourne at its closest point. The participating municipalities for the project are Greater Bendigo, Central Goldfields Shire, Loddon Shire, Macedon Ranges Shire, Mount Alexander Shire and Buloke Shire. Additional information about each LGA has been collated and presented in the Municipality Overviews and Regional Theming Report.

Community and agricultural activities in the Southern Loddon Mallee region that dominate the local economy have historically faced many challenges from extreme weather events including drought and flooding. With climate change, the region is expected to be warmer and drier in the future, facing increasingly variable weather, particularly with regards to rainfall. The changing climate will act as a 'threat multiplier' making existing issues worse (e.g. more frequent or intense flood events).

Figure 4 presents the current and future climate conditions in the Southern Loddon Mallee Region for the following climate hazards: average temperature, extreme temperature, average rainfall, extreme rainfall and storms and wildfires. All of the current climate variables are based on data covering 1961 – 1990, except for very high or extreme fire risk days, which is based on a 1973 – 2006 period. The future climate projections are based on the catchment management authority (CMA) areas in the Southern Loddon Mallee region. Projections are based on a medium emissions growth scenario with a global temperature increase of 2.8°C (+1.7 to +4.4°C) likely by 2100.

Climate projections and impacts that each climate hazard may contribute has been collated and presented in the Risk and Vulnerability Reports for each LGA.

Figure 4
Current (1961 – 1990) climate conditions for representative townships in the Southern Loddon Mallee Region and climate change projections for 2030 for the Southern Loddon Mallee Region (relative to 1990) for the A1B emission scenario - median figure (and 80% confidence range unless otherwise noted) (Sources: DSE 2008).

Average temperature		Average rainfall		Frosts* (Days where minimum temperature falls below 2°C or less)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
16.3°C	+0.6 to +1.2°C (+0.9°C)	331mm	-10 to +2% (-4%)	18 days	-5 to +10 days (-8 days)
NOW	2030	NOW	2030	NOW	2030
Extreme temperature*		Rainfall intensity (99th percentile)		No. of rainy days (11mm ²)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
31 days	+4 to +9 days (+6 days)		-9.6% to +15.6% (-0.3%)	61 days	-21% to no change (-6%)
NOW	2030	NOW	2030	NOW	2030
Change in runoff		Relative humidity (%)		Potential evaporation (%)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
	Up to -20% for Lower Murray River		-1.5% to -0.1% (-0.7%)		No change to +5% (+2 to +3%)
NOW	2030	NOW	2030	NOW	2030
Very high or extreme fire risk days**					
(Annual) Current (1973-2006)	Projected changes 2030				
13 – 14 days	18 – 19 days				
NOW	2030				

* These projections relate to Ouyen, the closest specific town within the Catchment Management Authority area for which projections are available.
 ** Projections are for Bendigo in 2020 and are sourced from The Bushfire Trends in Southeast Australia: Recent Trends and Projected Climate Change Impacts report (Lucas et al, 2007).

Average temperature		Average rainfall		Frosts* (Days where minimum temperature falls below 2°C or less)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
14.8°C	+0.6 to +1.2°C (+0.9°C)	491mm	-5% (-9 to +1%)	26 days (D); 35 days (B)	-7 days (-5 to -13 days)
NOW	2030	NOW	2030	NOW	2030
Extreme temperature*		Rainfall intensity (99th percentile)		No. of rainy days (11mm ²)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
15 days (D); 11 days (B)	+3 to +4 days (+2 to +6 days)		-7.2% to +15.9% (+1.1%)	82 days	-18 to -1% (-6%)
NOW	2030	NOW	2030	NOW	2030
Change in runoff		Relative humidity (%)		Potential evaporation (%)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
	-3 to -40% (Avoca River)		-0.7% (-1.5 to -0.1%)		+2% (no change to +5%)
NOW	2030	NOW	2030	NOW	2030
Very high or extreme fire risk days**					
(Annual) Current (1973-2006)	Projected changes 2030				
13 – 14 days	18 – 19 days				
NOW	2030				

* These projections relate to Donald (D) and Bendigo (B), the closest specific towns within the Catchment Management Authority area for which projections are available.
 ** Projections are for Bendigo in 2020 and are sourced from The Bushfire Trends in Southeast Australia: Recent Trends and Projected Climate Change Impacts report (Lucas et al, 2007).

Average temperature		Average rainfall		Frosts* (Days where minimum temperature falls below 2°C or less)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
13.9°C	+0.6 to +1.2°C (+0.9°C)	774mm	-9 to +1% (-3%)	39 days	-8 to -15 days (-11 days)
NOW	2030	NOW	2030	NOW	2030
Extreme temperature*		Rainfall intensity (99th percentile)		No. of rainy days (11mm ²)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
13 days	+2 to +6 days (+4 days)		-7.1% to +15.1% (+1.2%)	112 days	-17% to -1% (-5%)
NOW	2030	NOW	2030	NOW	2030
Change in runoff		Relative humidity (%)		Potential evaporation (%)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
	Up to -35% for Goulburn and Broken Rivers		-1.5% to -0.1% (-0.7%)		+1 to +5% (+3%)
NOW	2030	NOW	2030	NOW	2030
Very high or extreme fire risk days**					
(Annual) Current (1973-2006)	Projected changes 2030				
13 – 14 days	18 – 19 days				
NOW	2030				

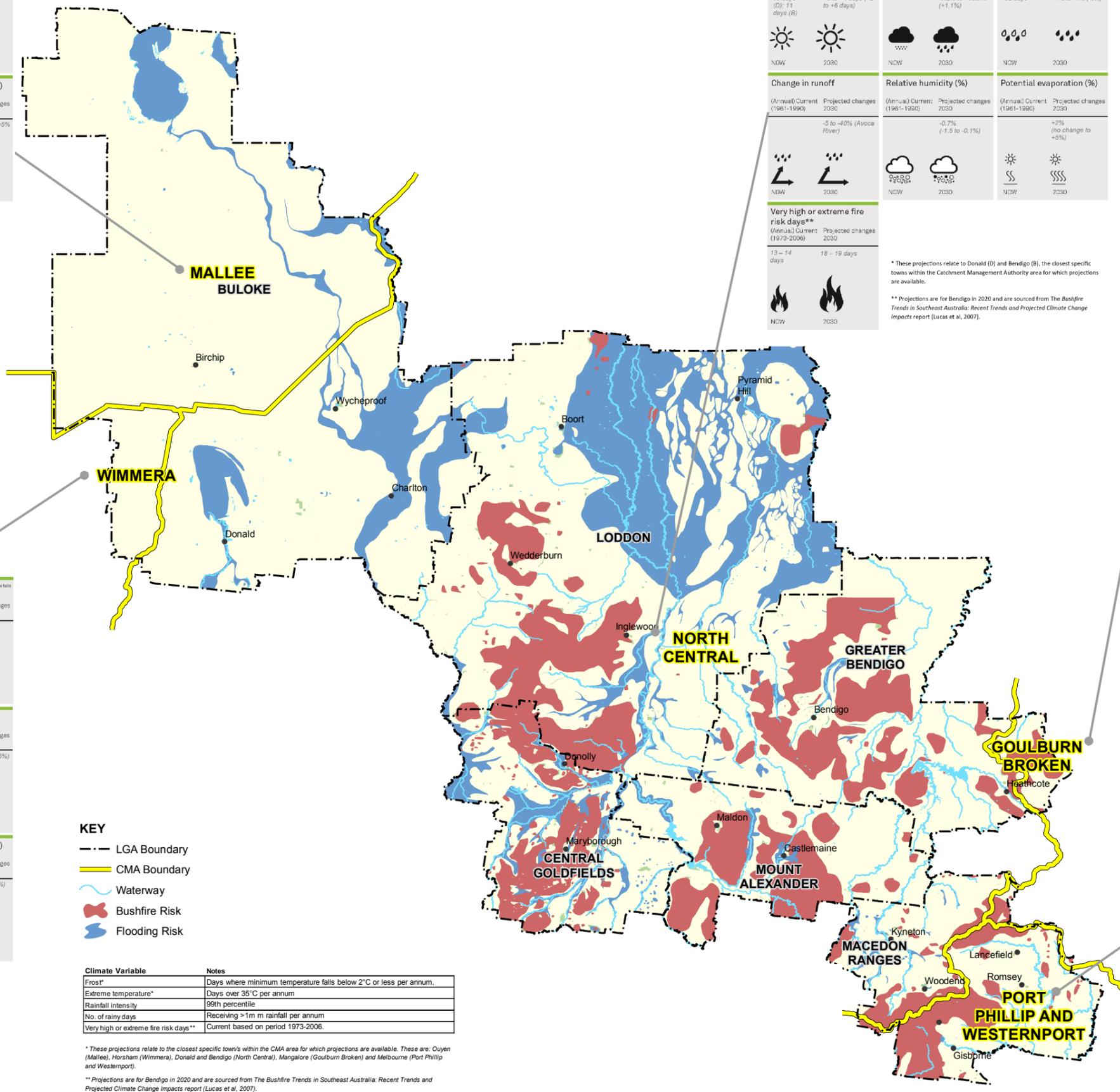
* These projections relate to Mangalore, the closest specific town within the Catchment Management Authority area for which projections are available.
 ** Projections are for Bendigo in 2020 and are sourced from The Bushfire Trends in Southeast Australia: Recent Trends and Projected Climate Change Impacts report (Lucas et al, 2007).

Average temperature		Average rainfall		Frosts* (Days where minimum temperature falls below 2°C or less)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
14.6°C	+0.6 to +1.1°C (+0.8°C)	490mm	-9 to +1% (-4%)	35 days	-8 to -15 days (-12 days)
NOW	2030	NOW	2030	NOW	2030
Extreme temperature*		Rainfall intensity (99th percentile)		No. of rainy days (11mm ²)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
17 days	+2 to +6 days (+4 days)		-8.8% to +14.8% (-0.6%)	88 days	-19% to -1% (-6%)
NOW	2030	NOW	2030	NOW	2030
Change in runoff		Relative humidity (%)		Potential evaporation (%)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
	Up to -20% for Wimmera-Avon River		-1.4% to -0.1% (-0.7%)		+1 to +5% (+2%)
NOW	2030	NOW	2030	NOW	2030
Very high or extreme fire risk days**					
(Annual) Current (1973-2006)	Projected changes 2030				
13 – 14 days	18 – 19 days				
NOW	2030				

* These projections relate to Horsham, the closest specific town within the Catchment Management Authority area for which projections are available.
 ** Projections are for Bendigo in 2020 and are sourced from The Bushfire Trends in Southeast Australia: Recent Trends and Projected Climate Change Impacts report (Lucas et al, 2007).

Average temperature		Average rainfall		Frosts* (Days where minimum temperature falls below 2°C or less)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
13.5°C	+0.6 to +1.1°C (+0.8°C)	864mm	-8 to no change (-4%)	3 days	-1 to -2 days (-1 day)
NOW	2030	NOW	2030	NOW	2030
Extreme temperature*		Rainfall intensity (99th percentile)		No. of rainy days (11mm ²)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
9 days	+1 to +4 days (+2 days)		-7.7% to +15.2% (+0.9%)	125 days	-17% to -1% (-6%)
NOW	2030	NOW	2030	NOW	2030
Change in runoff		Relative humidity (%)		Potential evaporation (%)	
(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030	(Annual) Current (1961-1990)	Projected changes 2030
	Between -5 to -30% for Maryborough, Werrbee and Bunyip Rivers		-1.5% to -0.2% (-1%)		+1 to +5% (+3%)
NOW	2030	NOW	2030	NOW	2030
Very high or extreme fire risk days**					
(Annual) Current (1973-2006)	Projected changes 2030				
13 – 14 days	18 – 19 days				
NOW	2030				

* These projections relate to Melbourne, the closest specific town within the Catchment Management Authority area for which projections are available.
 ** Projections are for Bendigo in 2020 and are sourced from The Bushfire Trends in Southeast Australia: Recent Trends and Projected Climate Change Impacts report (Lucas et al, 2007).



KEY
 - - - LGA Boundary
 — CMA Boundary
 — Waterway
 Bushfire Risk
 Flooding Risk

Climate Variable	Notes
Frost*	Days where minimum temperature falls below 2°C or less per annum.
Extreme temperature*	Days over 35°C per annum
Rainfall intensity	99th percentile
No. of rainy days	Receiving >1m rainfall per annum
Very high or extreme fire risk days**	Current based on period 1973-2006.

* These projections relate to the closest specific towns within the CMA area for which projections are available. These are: Ouyen (Mallee), Horsham (Wimmera), Donald and Bendigo (North Central), Mangalore (Goulburn Broken) and Melbourne (Port Phillip and Westernport).
 ** Projections are for Bendigo in 2020 and are sourced from The Bushfire Trends in Southeast Australia: Recent Trends and Projected Climate Change Impacts report (Lucas et al, 2007).

Acronyms

CCAP	Climate change adaptation plan
CFA	Country Fire Authority
CGSC	Central Goldfields Shire Council
CMA	Catchment Management Authorities
CRMI	Community Resilience Mentoring Initiative
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVGA	Central Victorian Greenhouse Alliance
DEPI	Victorian Department of Environment and Primary Industries
DoH	Victorian Department of Health
DPC	Victorian Department of Premier and Cabinet
DTPLI	Victorian Department of Transport Planning and Local Infrastructure
KPI	Key performance indicator
LGA	Local government area
MAV	Municipal Association of Victoria
MEMEG	Municipal Emergency Management Enhancement Group
NVIRP	Northern Victorian Irrigation Renewal Project
PCG	Project Control Group
R&D	Research and development
RDV	Regional Development Victoria
SES	Victoria State Emergency Service
VASP	Victorian Adaptation and Sustainability Partnership

References

Buloke Shire Council, 2013, *Annual Budget 2013-14*

Central Goldfields Shire Council, 2013, *Annual Budget 2013-14*

City of Greater Bendigo, 2013, *Annual Budget 2013-14*

City of Greater Bendigo, 2013, *A shared journey: local government service delivery in changing climate. Evaluation Summary*

Department of Sustainability and Environment, 2008, *Future Climate (Port Philip & Westernport, Wimmera, Mallee, North Central and Goulburn Broken)*, viewed 8 November 2013, <<http://www.climatechange.vic.gov.au/regional-projections>>

Department of Health (DoH), 2012, *Loddon Mallee Region Health Status Profile 2011*

Department of Health (DoH), 2012b, *Municipal public health and wellbeing planning – Having regard to climate change*

Department of Planning and Community Development (DPCD), 2011, *Change and disadvantage in the Loddon Mallee Region, Victoria*

Department of Planning and Community Development (DPCD), 2012, *Top twenty data sources for describing community wellbeing in Victoria*

Department of Planning and Community Development (DPCD), 2013, *Draft Regional Growth Plan Background Report (Parts 1 and 2)*

Department of Premier and Cabinet (DPC), 2013, *Critical Infrastructure Resilience Interim Strategy*, Victorian Government Melbourne

Loddon Shire Council, 2013, *Annual Budget 2013-14*

Macedon Ranges Shire Council, 2013, *Annual Budget 2013-14*

Mount Alexander Shire Council, 2013, *Annual Budget 2013-14*

Regional Development Victoria (RDV), 2010, 'Loddon Mallee Regional Strategic Plan Southern Region', viewed 28 October 2013, <http://www.rdv.vic.gov.au/_data/assets/pdf_file/0008/188153/1762-SM-Loddon-Mallee-Regional-Strategy-Plan-40pp-SOUTHERN-FINAL-PROOF10.pdf>

Regional Development Victoria (RDV), 2011, *Loddon Mallee Regional Strategic Plan Southern Region Progress Report 2010-11*

Regional Development Victoria (RDV), 2011b, *Loddon Mallee Regional Strategic Plan Southern Region Progress Report 2011-12 (no. 2)*

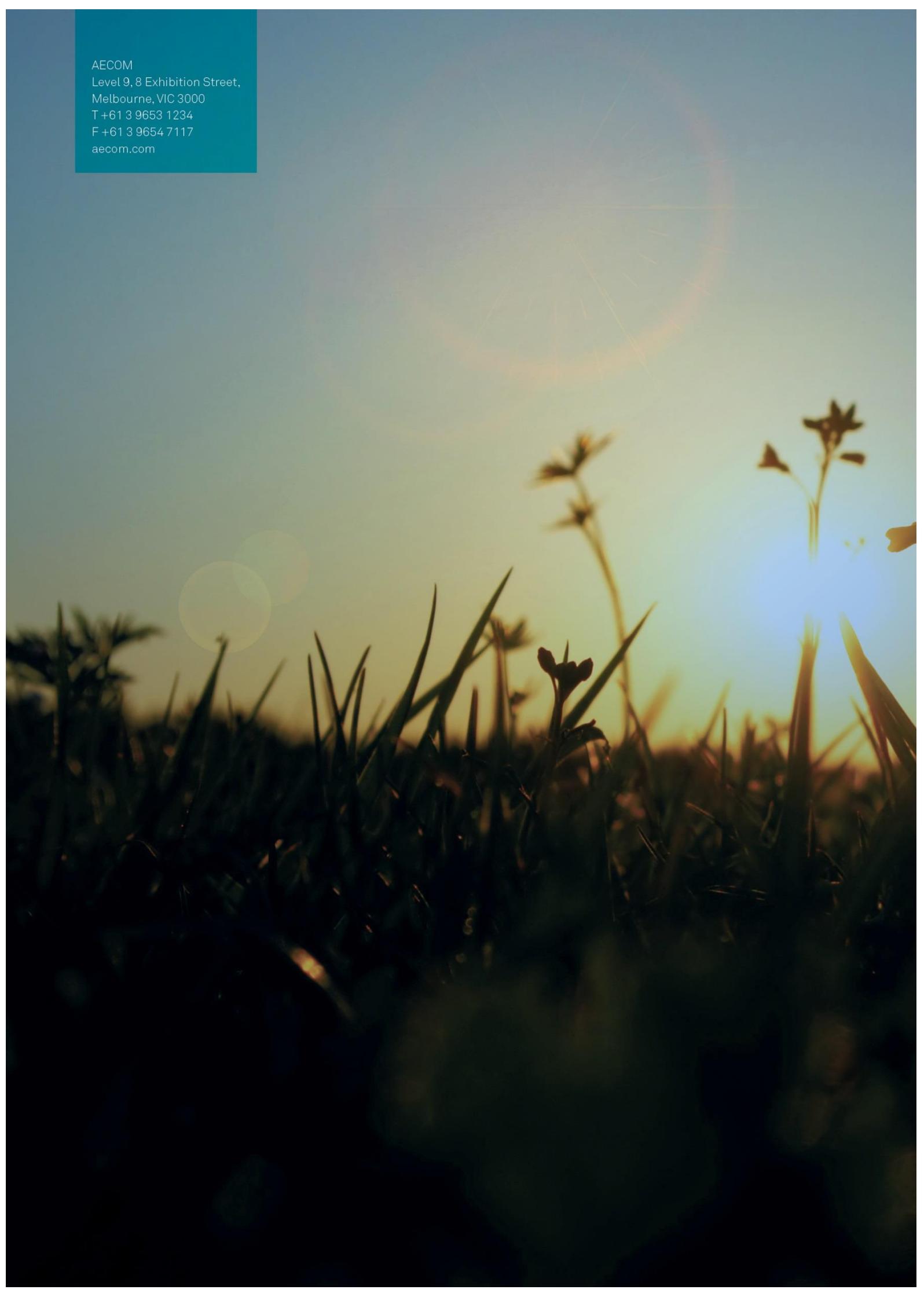
Regional Development Victoria (RDV), 2012, *Economic Snapshot for individual municipalities*, <www.rdv.vic.gov.au>

Smit, B. and Pilifosova, O., *Working Group II: Impacts, Adaptation and Vulnerability*, 'Chapter 18 Adaptation to Climate Change in the Context of Sustainable Development and Equity', viewed 11 February 2014, <<https://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=641>>

Stanley, J., (2010), *Promoting Social Inclusion in Adaptation to Climate Change: Discussion Paper*, Monash Sustainability Institute, commissioned by Victorian Department of Sustainability and Environment, Melbourne.

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ADAPTING TO CHANGE

REGIONAL CLIMATE ADAPTATION REPORT

Southern Loddon
Mallee Region

This report details the shared regional risks and vulnerabilities applicable to the Southern Loddon Mallee and the Shire of Buloke's economy and community as a result of a changing climate. Adaptation options are evaluated, prioritised and themed to produce a set of priority action options relevant to the entire region.

Appendix A

Assessment Approach

Appendix A Assessment Approach

Risk assessment approach

AECOM used the same approach to assess the climate risks and vulnerabilities for all local government areas in the region. The approach considers the risks that result from the interaction of climate hazards with a set of sectors (and themes) and the adaptive capacity of the assets, communities and environments.

The approach was informed by *AS5334-2013 Climate change adaptation for settlements and infrastructure – A risk based approach*. The information was captured in a consistent spreadsheet for all local government areas (LGAs) to assist in the filtering of the risks and vulnerabilities. Local context and stakeholder consultation feedback was considered in determining the risk, adaptive capacity and vulnerability ratings. A summary of the approach is detailed below and further articulated in Figure 2.

The six step approach to determining and scoring risks and vulnerabilities for each LGA is as follows:

- **Step one: Confirm sectors, themes and climate projections to be assessed.** A set of sectors and themes were identified to provide a thorough coverage of the potential risks to the municipality. The Victorian Government and CSIRO (2008) projections for 2030 for the North Central, Mallee, Wimmera and Port Phillip and Western Port regions were used.
- **Step two: Risk identification.** For each theme, a list of risks were identified that identify the impact (e.g. loss of productivity from agriculture) and the influencing climate hazards (e.g. as a result of reductions in average rainfall or increases in average temperatures).
- **Step three: Risk rating.** Each risk was rated using a likelihood and consequence approach consistent with the *AS5334-2013 Climate Adaptation for Settlements and Infrastructure*.
- **Step four: Considering adaptive capacity.** Adaptive capacity refers to the region's ability to respond to the identified risks. For each risk, a qualitative statement was made identifying the relative ability of the council area to respond to the risk. This was supported by a High, Medium or Low ranking.
- **Step five: Vulnerability scoring.** The risk rating and adaptive capacity scores were combined to determine an indicative vulnerability score for each risk. The purpose of the vulnerability score is to help inform the adaptation discussion by enabling Councils to understand the areas of greatest risk as well as greatest vulnerability. Responses can then be targeted at a combination of reducing the likelihood or consequence of an event, or focussing efforts on building the adaptive capacity of the community, infrastructure or assets that are at risk.

The vulnerability rating was determined by the risk rating and considering the existing adaptive capacity, as shown in Figure 1.

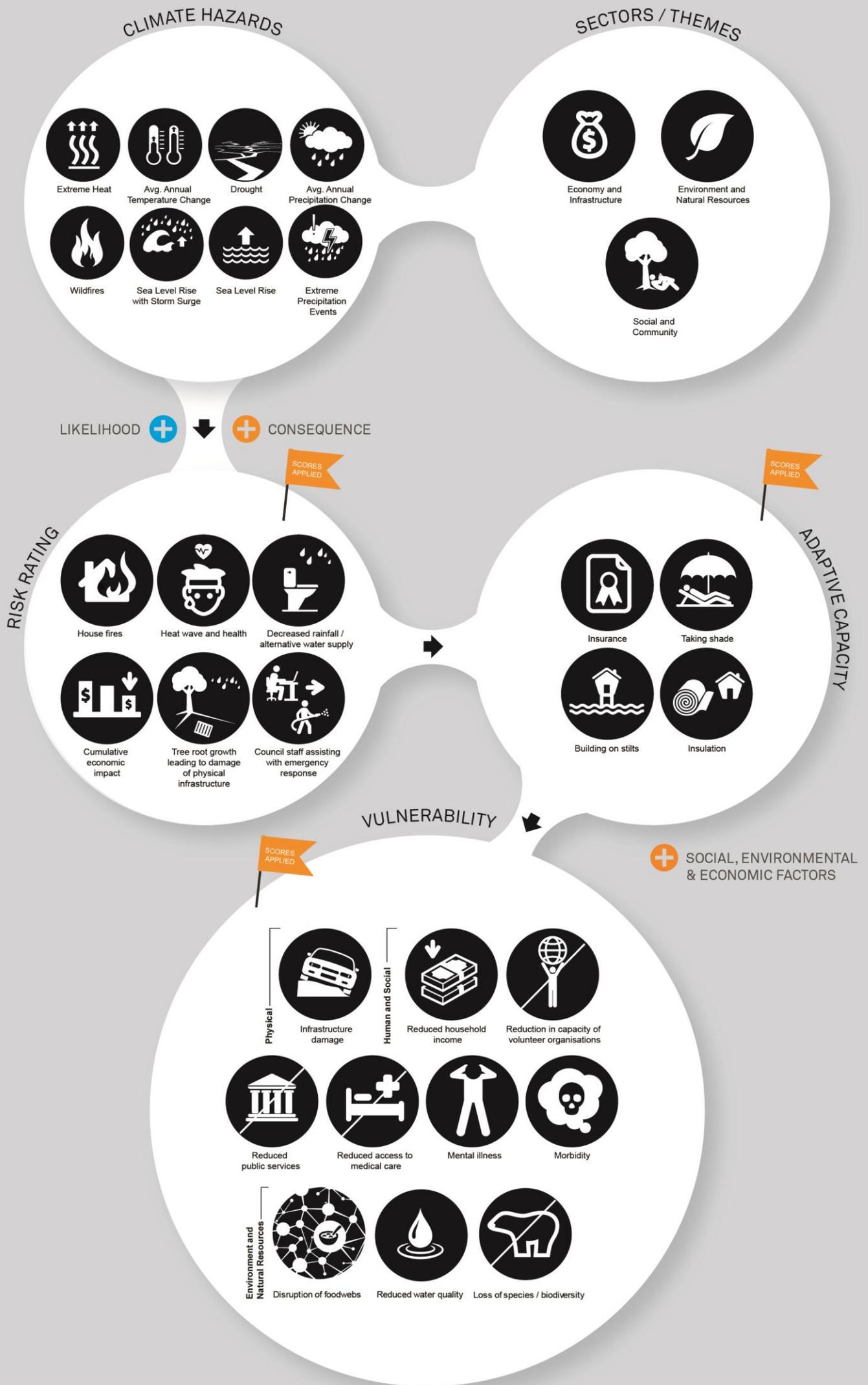


Figure 1 Process used to determine each LGA's vulnerability to climate-related risks.

Selection of regional risks and vulnerabilities

AECOM collated all the vulnerability ratings for each climate risk. Each risk that received two or more extreme or high vulnerability ratings were selected as the priority risk and vulnerabilities for the Southern Loddon Mallee region. The full list of vulnerability ratings for each municipality is presented in Appendix B.

Figure 2: An illustration of the risk and vulnerability assessment process



Assessing adaptation options

Once adaptation options were identified for the region, each option was evaluated and prioritised. This was based on costs, benefits, efficiency/timeliness and practicality. The criteria below formed the basis of which adaptation actions were evaluated for the Adapting to Change project.

- **Cost:** The estimated cost to implement an adaptation solution, including whether funding options are available.
- **Effectiveness:** The likely level of success that an adaptation solution may have in mitigating a climate change induced risk.
- **Timeliness:** How soon an adaptation action can be implemented.
- **Environmental, economic & social impacts:** The scale and type of impacts an adaptation solution may have to the surrounding environment, communities and the regional economy. This criterion also considers benefits such as efficiency, safety, community acceptance and environmental improvement that an adaptation solution may provide.

The influence of each criterion on an adaptation option was evaluated using scores between 1 (highly unfavourable) to 4 (highly favourable). Table 1 presents the criterion that was used to assess the adaptation options for the Southern Loddon Mallee region. The score for cost and effectiveness has a double weighting (i.e. multiplied by 2) due to their significance in affecting the likely implementation of an option. The scores for each option are then summed into a total score and then ranked in order of priority. This approach allowed the adaptation solutions to be prioritised. This approach was used in the Regional Adaptation Workshop.

Table 1 Multi criteria assessment used to evaluate adaptation solutions for the Southern Loddon Mallee Region

Criteria	Highly Unfavourable (1)	Unfavourable (2)	Moderately Favourable (3)	Highly Favourable (4)
Cost (AUD\$)	100,000,000+ Major costs	10,000,000- 100,000,000 High costs	1,000,000- 10,000,000 Medium costs	<1,000,000 Low costs
Effectiveness	Potential to reduce vulnerability is uncertain	Potential to reduce vulnerability is low	Moderate potential to reduce vulnerability in 1 or 2 Councils	High potential to reduce vulnerability in greater than 2 Councils
Timeliness	Implementation best delayed for at least 10 years	Initial implementation likely to be greater than 5 years	Initial implementation possible between 2-5 years	Initial implementation possible within 2 years
Environmental, financial and social impacts	Highly negative	Moderately negative	Moderately positive	Highly positive

The adaptation options with a ranking of 21 points or more are best progressed in the next 1 to 2 years and are listed in Table 5 (Appendix C) in green. The adaptation options with a ranking of less than 21 points are best progressed in the next 2 to 5 years (coloured orange). The remaining adaptation options are best delayed in the interim and reviewed for implementation in the next 5 to 10 years (coloured red). Options with the same score based on the assessment criteria have the same ranking.

Appendix B

Regional Risk and Vulnerability Ratings

Appendix B Regional Risks and Vulnerability Ratings

This chapter explains the process undertaken to identify the risks and vulnerabilities for the LGAs and presents the priority climate risks and vulnerabilities for the Southern Loddon Mallee region.

Overview

A total of 63 risks were identified and rated for each participating local government area (LGA) in the Southern Loddon Mallee region.

Of those risks identified, 28 risks were common across all LGAs (i.e. rated either extreme or high by more than two LGAs). 16 risks were identified in the economy and infrastructure sector, with 5 relating to climate change impacting energy, water and other utility infrastructure and services. 8 risks were identified for the social and community sector, with three risks identified each for the community health and individual wellbeing and emergency management themes. The most common risk identified for the environment and natural resources sector across the Southern Loddon Mallee region related to water availability and quality.

Considering the **existing adaptive capacity has the potential to reduce the overall vulnerability rating**, which for the Southern Loddon Mallee region **reduces the total 28 extreme and high risks down to 12 extreme and high vulnerabilities**. Table 2 presents the number of extreme and high vulnerabilities across the region by sector and theme.

The common vulnerabilities identified for the region relate to funding limitations for infrastructure repairs and increases in clean-up costs for Council following floods or bushfires. Flood damage to road infrastructure, disruption to transport access and increased heat stress in the community during heat waves were also significant vulnerabilities. Climate change may also reduce water availability, impacting the region's agricultural sector.

Table 2 Summary of extreme and high vulnerability ratings by sector and theme for the Southern Loddon Mallee region

Sector	Theme	Number of vulnerability ratings across region
 Economy and Infrastructure	Buildings and development	2
	Energy, water and other utility infrastructure	3
	Rural commercial activities	2
 Social and Community	Emergency management	2
	Community health and individual wellbeing	1
 Environment and Natural Resources	Water resources	2

A complete summary of the vulnerability ratings for each LGA is presented in Table 3.

Table 4 summarises the regional climate vulnerabilities identified for each sector: economy and infrastructure, social and community, and environment and natural resources.

Table 3 Summary of regional climate related vulnerability ratings for the LGAs participating in the Adapting to Change project

Risk #	Sector	Theme	Risk Description	Local government areas					
				Buloke	Bendigo	Central Goldfields	Loddon	Mount Alexander	Macedon Ranges
1	Economy and Infrastructure	Buildings and development	Damage to buildings and development from increased intensity and frequency of extreme rainfall and bushfire events.	Medium	High	Medium	Medium	High	Medium
3	Economy and Infrastructure	Buildings and Development	Increased residential, community and commercial property damage due to extreme events.	High	Medium	Medium	High	Medium	Medium
14	Economy and Infrastructure	Energy, water and other utility infrastructure	Disruption of essential services including telecommunications, power and water due to more frequent extreme weather events.	Extreme	Medium	Medium	High	Medium	Medium
16	Economy and Infrastructure	Energy, water and other utility infrastructure	Increased maintenance costs and service disruptions due to accelerated degradation and increased failure of infrastructure (water, traffic signals, power etc.) from extreme rainfall, heat, increase in average temperature and reduced rainfall.	High	Low	Low	High	Medium	Medium
18	Economy and Infrastructure	Energy, water and other utility infrastructure	More frequent power blackouts caused by peak electricity demand exceeding available supply during heatwaves.	High	Medium	Medium	High	Medium	Medium
21	Social and Community	Emergency management	Limitations to available State and Federal funding for infrastructure repairs due to more frequent extreme weather events, requiring Council to self fund.	High	High	Medium	Medium	High	Medium
22	Economy and Infrastructure	Rural commercial activities	Reduced productivity (e.g. work disruption, loss of livestock/crops and transport distribution impacts) due to reduction in average rainfall and increase in average temperatures and long term drought.	High	Medium	Low	Extreme	Medium	Low

Risk #	Sector	Theme	Risk Description	Local government areas					
				Buloke	Bendigo	Central Goldfields	Loddon	Mount Alexander	Macedon Ranges
34	Environment and Natural Resources	Water resources	Increased flooding from overflowing riverbanks or failure of levees as a result of extreme rainfall.	Extreme	Medium	Medium	High	Medium	Medium
42	Environment and Natural Resources	Water resources	Reduction in availability of water resources due to reduced average rainfall, increased average temperature, increased evaporation and fires in water catchments.	High	High	High	Medium	Medium	Medium
46	Social and Community	Community health and individual wellbeing	Increase in heat stress illness and death of vulnerable population groups (i.e. elderly, sick, young and poor) due to increase in average temperature and extreme heatwaves.	Extreme	High	Medium	High	Medium	High
58	Social and Community	Emergency management	Increase in clean-up costs for council and businesses to recover from extreme events.	High	Medium	Medium	Medium	High	Medium
61	Economy and Infrastructure	Rural commercial activities	Reduced agricultural yields resulting in unemployment and income losses due to increased extreme weather events, average temperature and reduced rainfall.	High	Medium	Medium	High	Medium	Medium

Table 4 Summary of significant vulnerability ratings by sector and theme for the Southern Loddon Mallee region

Sector	Theme	Climate variables	Potential regional climate risks	Potential regional vulnerabilities
 Economy and Infrastructure	Energy, water and other utility infrastructure	<ul style="list-style-type: none"> - More frequent and extreme weather events. - Increasing extreme rainfall events. - More frequent heatwave events. - Increasing temperature. - Decreasing rainfall. 	<ul style="list-style-type: none"> - Disruption of essential services including telecommunications, power and water. - More frequent power brownouts and blackouts due to increased peak electricity demand or during bush fires. - Reduction in power supply to region. - Accelerated degradation and failure of infrastructure assets. - Higher infrastructure maintenance costs. 	<ul style="list-style-type: none"> - Power outages are already experienced by all LGAs during heatwaves due to use of air conditioning (from increased/peak demand) and telecommunications networks are interrupted during peak use. The LGAs affected by the January 2011 floods experienced power outages for days and damaged water mains, requiring potable water to be trucked in in some areas. - Generally, the larger and rural LGAs already experience unreliable power supply as a result of poor infrastructure to the municipality and a low population. Some areas in the region have had circumstances of power being cut for 2 ½ days. Anecdotal evidence suggests that priority for reconnection in low population areas occurs due to the large local area, resource availability and competing demands across the region. These parts of the region may be more vulnerable to increased power, telecommunication and water disruptions due to climate change. - Critical infrastructure is vulnerable to accelerated degradation and/or failure. The power substation in Charlton (Buloke LGA) was inundated by the January 2011 floods and this disrupted power supply for 48 hours.
	Buildings and development	<ul style="list-style-type: none"> - Increasing intensity and frequency of extreme rainfall and bushfire events. 	<ul style="list-style-type: none"> - Damage to buildings and development. - Residential, community and commercial property damage. 	<ul style="list-style-type: none"> - Some townships are already located within an existing flood or bushfire hazard area, making them particularly vulnerable to bushfires, extreme rainfall and flooding events in the future. - The more urban LGAs such as Greater Bendigo have a higher amount of building stock. As such there are more buildings at risk and vulnerable to flood and bushfire events. Development is also significantly higher in Greater Bendigo compared to the rest of the LGAs. - The 2011 floods caused \$30 million damage in the Loddon LGA to Council managed infrastructure alone with more than 20 community buildings were damaged or destroyed. In Buloke, approximately 500 properties were damaged by the

Sector	Theme	Climate variables	Potential regional climate risks	Potential regional vulnerabilities
				same flood event.
	Rural commercial activities	<ul style="list-style-type: none"> - Decreasing rainfall. - Increasing temperatures and evaporative losses. 	<ul style="list-style-type: none"> - Reduced productivity in rural commercial sector (e.g. work disruption, loss of livestock/crops and transport distribution impacts). - Reduced agricultural yields resulting in regional unemployment and income losses. 	<ul style="list-style-type: none"> - The LGAs in north with strong agricultural sectors are particularly vulnerable to climate change. - For the LGAs located in the south of the region, this is less of a risk and vulnerability, due to the higher economic focus on manufacturing.
 <p>Social and Community</p>	Community health and individual wellbeing	<ul style="list-style-type: none"> - Increasing temperatures - More frequent heatwave events. 	<ul style="list-style-type: none"> - Increase in heat stress illness and death. - Commercial activities may also be affected reducing productivity or causing businesses losses. 	<ul style="list-style-type: none"> - The portions of the regional population that are elderly, require assistance or of low socio-economic status is forecast to grow in the future making more people vulnerable to heatwave events.
	Emergency Management	<ul style="list-style-type: none"> - More frequent and extreme weather events. 	<ul style="list-style-type: none"> - Limitations to available State and Federal funding for regional infrastructure repairs. - Greater emphasis for Councils to self-fund emergency management. - Higher clean-up costs for Council and community. 	<ul style="list-style-type: none"> - Funding limitations would delay infrastructure repairs and service restorations following extreme weather events. This would have flow on impacts to community and businesses in the region.
 <p>Environment and Natural Resources</p>	Water resources	<ul style="list-style-type: none"> - Increasing extreme rainfall events. - Decreasing rainfall. - Increasing temperature and evaporative losses. - More frequent heatwave events. - Increasing intensity and frequency of bushfire events. - Reduced runoff 	<ul style="list-style-type: none"> - Increased flooding from overflowing riverbanks. - Failure of levees causing inundation of local areas. - Reduction in water availability, impacting agricultural sector. 	<ul style="list-style-type: none"> - Water supply in the region is vulnerable to climate change. During previous droughts and flood events, water has been trucked to some areas. - Some townships are located in flood hazard areas and vulnerable to riverbanks overflowing. Little can be done to adapt riverbanks from overflowing.

Appendix C

Adaptation Options Table

Appendix C Adaptation Options Table

The adaptation options with a ranking of 21 points or more are best progressed in the next 1 to 2 years and are listed in Table 5 in green. The adaptation options with a ranking of less than 21 points are best progressed in the next 2 to 5 years (coloured orange). The remaining adaptation options are best delayed in the interim and reviewed for implementation in the next 5 to 10 years (coloured red). Options with the same score based on the assessment criteria have the same ranking.

Table 5 Multi criteria assessment and ranking summary of adaptation options identified for the Southern Loddon Mallee region.

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
34	Environment and Natural Resources	Water resources	Increased flooding from overflowing riverbanks or failure of levees as a result of extreme rainfall.	Maximise community awareness and encourage preparation in flood preparedness activities.	Residents need to provide their own flood protection, have their own sand bags and evacuation plan. Emergency services may not be able to respond in time. Raise community awareness of risks - help them make informed decisions about responding to extreme weather events. Provide guidance pamphlets and communication material about preparing for extreme events, and how to protect properties.	8	8	4	4	24	1
61	Economy and Infrastructure	Rural commercial activities	Reduced agricultural yields resulting in unemployment and income losses due to increased extreme weather events, average temperature and reduced rainfall.	Collaborate with financial institutions to refer existing rural support programs to the agricultural community.	Develop early warning systems or programs to identify those at risk. This may be centred on mental health management programs. Financial institutes could participate in registering at risk or those likely to benefit from support. Informal referral of those defaulting on their loans. Program may better prepare farmers with adaptive responses to climate, encourage regional networks.	8	8	4	4	24	1

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank	
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score		
					<p>Collate support programs using loan conditions as an indicator/or voluntary. Develop case studies who have used services. Have conversations with banks; providing direction. This could support package service could be provided as a referral from financial institutions. Pilot with Bendigo Bank.</p> <p>Develop new crop varieties specific to the region that can withstand changing climate conditions.</p>							
14	Economy and Infrastructure	Energy, water and other utility infrastructure	Disruption of essential services including telecommunications, power and water due to more frequent extreme weather events.	Develop a Regional Infrastructure Protection Plan	<p>Document a framework that supports government and private sector decision-making to help protect critical infrastructure and improve resilience. This could include a risk management framework, methods for prioritising critical infrastructure and metrics for demonstrating progress in managing risks.</p> <p>Plan could cover a review of current infrastructure capabilities/thresholds to current climate. Prioritise the review of existing drainage practices. Once capabilities are identified, specific adaptation solutions can be implemented.</p> <p>Identify practical measures for key infrastructure assets to improve their resilience.</p> <p>Consider using a safety margin in guidelines and standards for climate</p>	8	8	4	4	24	1	

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank	
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score		
					<p>change factors based on studies already undertaken in the region, standards authorities and other tiers of government.</p> <p>Conduct a critical infrastructure resilience/vulnerability assessment of infrastructure assets in the region to identify practical measures e.g.:</p> <ul style="list-style-type: none"> - constructing a levee around substations - Improving design standards for specific components of the smart grid and protective measures for lightning, wildfires, wind, flooding, and other extreme events. <p>Involve emergency management response agencies in the design and construction of infrastructure in the review process for replacing or repairing damaged infrastructure</p>							
1	Economy and Infrastructure	Buildings and development	Damage to buildings and development from increased intensity and frequency of extreme rainfall and bushfire events.	Continue to encourage the uptake of commercial insurance in the region to mitigate costs of building damage.	Commercial building insurance in an insurable risk, given the climate hazards in the area, flooding and bushfire events are projected to increase.	8	8	4	3	23	2	

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
3	Economy and Infrastructure	Buildings and Development	Increased residential, community and commercial property damage due to extreme events.	Conduct more frequent structural inspections of properties in advance of extreme events and adapt properties accordingly.	Integrate into existing inspection processes across the region. Review work practices and maintenance regimes to ensure that climate change is considered.	8	8	4	3	23	2
0	General	Governance	Stakeholder engagement	Assign responsibility or establish a Regional Climate Change Adaptation Committee to implement the CCAP.	<p>Assign responsibility to existing regional group e.g. CVGA.</p> <p>If new committee, include representatives from government agencies to evaluate and manage climate change risks and vulnerabilities and to develop approaches through which the policies and practices of the agencies could be made compatible with and reinforce climate change adaptation.</p> <p>Advocate for the need to endorse a regional or shared approach to climate change adaptation with other local government areas and relevant stakeholders. A consistent regional approach is desirable and will make better use of existing resource and expertise.</p> <p>Group can also develop partnerships with investment, financial, and insurance networks to understand their potential role in climate change risk mitigation, including through the use of financial instruments like insurance.</p>	8	8	3	4	23	2

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
					<p>Group can provide enhanced communication strategies to engage stakeholders, disseminate critical information, build awareness of climate risk, promote the widespread endorsement of resilient technologies and practices, and evaluate societal responses to perceived risk in the region.</p> <p>Develop principles for adaptation to foster action and facilitate adaptation for the region.</p>						
61	Economy and Infrastructure	Rural commercial activities	Reduced agricultural yields resulting in unemployment and income losses due to increased extreme weather events, average temperature and reduced rainfall.	Develop regional business cases to inform how agricultural practices can adjust to new issues and opportunities presented by climate change.	<p>Selection of resistant crops for region. Adjust business practices to new opportunities presented by climate change.</p> <p>Develop a business case to invest in new agricultural opportunities.</p> <p>Identify/adjust to new land use opportunities for the region in response to a changing climate. Highlight the top 5 opportunities across the region and indication for the potential for the region and develop a business case. Business cases can focus on how production can be affected/grow.</p>	8	8	4	3	23	2
1	Economy and Infrastructure	Buildings and development	Damage to buildings and development from increased intensity and frequency of	Review government planning and building regulations and integrate climate adaptation.	Ensure they address climate risk at all stages and government levels. Develop standards to address climate adaptation – the state government is already leading resilience for critical infrastructure that may inform/drive this.	8	8	4	2	22	3

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
			extreme rainfall and bushfire events.		Advocate for a review of planning and design standards to ensure adequate climate change tolerances have been considered. Alternatively develop guidance notes for Councils in the region.						
3	Economy and Infrastructure	Buildings and Development	Increased residential, community and commercial property damage due to extreme events.	Review bushfire and flood inundation overlays to inform development in bushfire or flood hazard areas.	Discourage development in high risk areas. This adaptation only addresses future development.	8	8	3	3	22	3
3	Economy and Infrastructure	Buildings and Development	Increased residential, community and commercial property damage due to extreme events.	Work with businesses in the LGA to integrate climate adaptation planning and resilience into business continuity plans.	Ensure businesses integrate climate change risks into future plans, particularly those more likely to be affected by climate change e.g. agricultural industry, transport logistic operators, tourism etc.	8	6	4	4	22	3
21	Social and Community	Emergency management	Limitations to available State and Federal funding for infrastructure repairs due to more frequent extreme weather events, requiring Council to self-fund.	Develop regional local government guidelines for state and federal funding bodies.	Guidelines would include design, collaboration, and leveraging off other funds. Allocate a larger amount of funding for the design phase when applying for repair funding for infrastructure works.	8	6	4	4	22	3

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
14	Economy and Infrastructure	Energy, water and other utility infrastructure	Disruption of essential services including telecommunications, power and water due to more frequent extreme weather events.	Broaden existing community based programs to empower the region to become self-sufficient.	<p>Intent for region to be less reliance on state.</p> <p>Program should attract further uptake and provide regional incentives for self-sufficiency behaviours/adoption of self-sufficiency actions e.g. installation of rainwater tanks, solar panels, etc.</p> <p>Establish short and local supply chains for food and power supply.</p>	8	6	4	4	22	3
14	Economy and Infrastructure	Energy, water and other utility infrastructure	Disruption of essential services including telecommunications, power and water due to more frequent extreme weather events.	Enhance communication about essential services pre, during and post extreme weather events.	<p>Community needs to be informed about length of power blackouts, road closures, and telecommunication services during natural disaster events.</p> <p>Developing a communication plan may help formalise the communication process with utility stakeholders and the community (e.g. engage with VicRoads, Telstra, Powercor).</p> <p>Continue to conduct debriefs and post-event reviews following extreme weather events to improve management of essential services during extreme weather events. The reviews should consider the following:</p> <ul style="list-style-type: none"> - Identification of lessons learned - Communication of lessons across the organisation - Identification of requirements for systems to be updated. 	8	8	3	3	22	3

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
					Capacity building of LGA emergency response officers and extend emergency response knowledge and responsibility to all Council staff. Incorporate responsibility into Position Descriptions/KPIs.						
18	Economy and Infrastructure	Energy, water and other utility infrastructure	More frequent power blackouts caused by peak electricity demand exceeding available supply during heatwaves.	Develop and implement a community energy and water efficiency program specific to buildings.	Physical measures may include: plant more trees, install sun shades, green/white roofs, and retrofit high energy using buildings. Tap into existing community engagement already occurring throughout region.	8	8	2	4	22	3
46	Social and Community	Community health and individual wellbeing	Increase in heat stress illness and death of vulnerable population groups (i.e. elderly, sick, young and poor) due to increase in average temperature and extreme heatwaves.	Review heat wave management plans and alter systems and develop programs to assist vulnerable community groups during heat waves	Review barriers, challenges and opportunities from implementing heat wave plans experience so far. Examples: develop a heat stress reduction program for business/industries working outdoors (currently the plan omits outdoor workers). Ensure revised plan accommodates for more frequent heatwave and has a strong focus on communication/education.	8	6	4	4	22	3
42	Environment and Natural Resources	Water resources	Reduction in availability of water resources due to reduced average rainfall, increased average temperature,	Promote water conservation measures and engagement of users.	Develop community programs and education campaigns, E.g. permanent water saving schemes, water rebates, and product incentives.	8	6	4	4	22	3

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
			increased evaporation and fires in water catchments.								
3	Economy and Infrastructure	Buildings and Development	Increased residential, community and commercial property damage due to extreme events.	Provide commercial incentives for retrofit of developments in a manner that reduces climate change risks to new and existing infrastructure and property.	Some members of the community are low income/elderly. Incentives would need to address this and not exclude their affordability. Incentives to promote one example such as raising floor levels can be piloted at one Council first.	8	8	3	3	22	3
58	Social and Community	Emergency management	Increase in clean-up costs for council and businesses to recover from extreme events.	Build capacity of existing Council staff and volunteers with the appropriate training and knowledge to respond to extreme weather events.	Review existing emergency response systems and service delivery models in relation to climate change impacts, especially extreme weather events with more of a local government focus. Effective coordination and enhanced communication are important aspects of this adaptation option.	8	8	4	3	23	4
58	Social and Community	Emergency management	Increase in clean-up costs for council and businesses to recover from extreme events.	Enhance recruitment drive for more volunteers to assist with emergency events	Existing stakeholders and programs are SES, CFA, Blazeaid. Assess constraints and opportunities for recruiting and maintaining volunteers for the region. E.g. universities have large volumes of resources that may assist. . - Student Army Region can run a campaign to and build partnerships with other regions to support volunteers. Explore opportunities to use social media and academic networks. Provide incentives for new CFA/SES	8	6	4	3	21	4

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
					volunteer members/response groups e.g. business recognition, tax breaks, superannuation benefits. This would also attract more volunteers. The fire service levy could fund this.						
16	Economy and Infrastructure	Energy, water and other utility infrastructure	Increased maintenance costs and service disruptions due to accelerated degradation and increased failure of infrastructure (water, traffic signals, power etc.) from extreme rainfall, heat, increase in average temperature and reduced rainfall.	Integrate improved standards for infrastructure and building design.	Review existing Council design and construction standards to identify whether climate change is adequately considered and/or whether Council should advocate for or consider amending its standards. Change building regulations to increase energy efficiency in LGA.	8	6	4	3	21	4
18	Economy and Infrastructure	Energy, water and other utility infrastructure	More frequent power blackouts caused by peak electricity demand exceeding available supply during heatwaves.	Collaborate with the energy sector and develop an Energy Security Plan that promotes local and distributed energy in the region from diverse energy	Work with energy sector and devise a model that addresses the barriers and challenges for the region around decentralized power generation. This would decrease stress on the centralized power generation system.	8	6	4	3	21	4

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
				sources.							
61	Economy and Infrastructure	Rural commercial activities	Reduced agricultural yields resulting in unemployment and income losses due to increased extreme weather events, average temperature and reduced rainfall.	Work with producers to promote the value of the region's agricultural industry and find ways to enhance employment opportunities.	Identify and promote local value add activities e.g. paddock to plate programs to extend local industry and employment opportunities. Engage with stakeholders to create an appreciation of agriculture's value to the region to grow local supply chains. This is a long term campaign requiring strategic engagement and messaging to influence communities and businesses.	6	8	2.5	4	20.5	5
1	Economy and Infrastructure	Buildings and development	Damage to buildings and development from increased intensity and frequency of extreme rainfall and bushfire events.	Establish relevant partnerships with insurers to review cover and affordability for extreme rainfall and bushfire events.	The problem is some industries not covered, it is unaffordable, policies are hard to read, too many conditions. Community needs better interactions with insurers. A regional workshop/forum facilitated by the LGAs may help promote insurance.	8	8	2	2	20	6
46	Social and Community	Community health and individual wellbeing	Increase in heat stress illness and death of vulnerable population groups (i.e. elderly, sick, young and poor) due to increase in	Identify project options for enhancing availability of cool/safe spaces for community during heat waves	Review of heat wave management plans may drive this initiative.	8	8	2	2	20	6

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
			average temperature and extreme heatwaves.								
46	Social and Community	Community health and individual wellbeing	Increase in heat stress illness and death of vulnerable population groups (i.e. elderly, sick, young and poor) due to increase in average temperature and extreme heatwaves.	Implement a selection cool/safe spaces for community during heat waves across region.	Review of heat wave management plans may drive this initiative.	8	8	2	2	20	6
21	Social and Community	Emergency management	Limitations to available State and Federal funding for infrastructure repairs due to more frequent extreme weather events, requiring Council to self fund.	Establish a central facilitation body (funded by State or Federal government) that uses existing channels to improve collaborate between funders and fundees.	Body would be similar to Office of Living Victoria. Encourage the region to take a 'futures thinking perspective' to effectively direct infrastructure funds to create preferred outcomes for the region.	6	6	4	4	20	6
18	Economy and Infrastructure	Energy, water and other utility infrastructure	More frequent power blackouts caused by peak electricity demand exceeding available supply during heatwaves.	Provide commercial incentives in the region for new developments that incorporate micro/on site energy generation.	Examples include rebates, planning conditions/allowances.	6	8	3	3	20	6

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
58	Social and Community	Emergency management	Increase in clean-up costs for council and businesses to recover from extreme events.	Improve coordination of goods and recovery support from volunteers during emergency events.	This adaptation option covers post-event recovery.	8	4	4	3	19	7
46	Social and Community	Community health and individual wellbeing	Increase in heat stress illness and death of vulnerable population groups (i.e. elderly, sick, young and poor) due to increase in average temperature and extreme heatwaves.	Implement environmental measures that improve shading/cooling in outdoor spaces.	Environmental measures may include planting more trees and installing sun shades. There would need to be a process to prioritise outdoor areas in the community.	8	4	4	3	19	7
18	Economy and Infrastructure	Energy, water and other utility infrastructure	More frequent power blackouts caused by peak electricity demand exceeding available supply during heatwaves.	Collaborate with energy utilities to manage regional energy demand through piloting three pilot projects for large energy drawers to reduce energy.	Explore practical models and tools for integrating renewable resources, demand side management, and alternative energy storage technologies into power assets in the region. Continue current community and Council energy and water efficiency programs to encourage measures that reduce climate change risks related to energy and water consumption.	8	4	4	3	19	7
34	Environment and Natural Resources	Water resources	Increased flooding from overflowing riverbanks or failure of levees as a result of extreme rainfall.	Assess effectiveness and cost of implementing advance warning systems via stream and reservoir level	The systems/flood monitoring station should be automatic and located at stations upstream/along creeks/reservoirs. The recent flood studies completed for the region may advise of appropriate thresholds.	6	6	3	4	19	7

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
				gauging.							
34	Environment and Natural Resources	Water resources	Increased flooding from overflowing riverbanks or failure of levees as a result of extreme rainfall.	Investigate feasibility of land buy back scheme for flooding areas in the region.	The Bush Fire Royal Commission's has recommended to buy back properties that were at significant fire risk. A similar approach can be applied for flood affected property where it is impractical to property from flooding or cost exceeds value of property being protected (CGSC, submission, 2012). Flood buy back is already happening in Benjeroop in the Gannawarra LGA.	8	6	2	3	19	7
22	Economy and Infrastructure	Rural commercial activities	Reduced productivity (e.g. work disruption, loss of livestock/crops and transport distribution impacts) due to reduction in average rainfall and increase in average temperatures and long term drought.	Develop a program to support transition of farming practices to better suit changing climate conditions.	This would involve collaboration with CSIRO, farming community and industry.	4	8	3	3	18	8
21	Social and Community	Emergency management	Increase in clean-up costs for council and businesses to recover from extreme events.	Integrate emergency management for homes in school curriculum and assignments for all	This is a long term initiative to drive through the school system. However, this would be a good mechanism for increasing proportion of resilient home strategies and enhancing awareness of responsibilities and actions by	4	8	3	3	18	

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
				schools in region.	community.						
18	Economy and Infrastructure	Energy, water and other utility infrastructure	More frequent power blackouts caused by peak electricity demand exceeding available supply during heatwaves.	Install local back-up generators at critical facilities for peak times.	A framework would need to be developed to prioritise certain areas. Solutions should consider precinct/town level, not individual buildings. Generation connections need to be properly considered. This solution also addresses emergency management risks.	4	8	3	3	18	8
3	Economy and Infrastructure	Buildings and Development	Increased residential, community and commercial property damage due to extreme events.	Monitor level of damage against type and scale of extreme weather events to determine progress.	This could involve review of the level of damage to property in the region.	6	6	3	3	18	8
18	Economy and Infrastructure	Energy, water and other utility infrastructure	More frequent power blackouts caused by peak electricity demand exceeding available supply during heatwaves.	Investigate the feasibility of regional cogeneration precincts in the region.	Multi purpose community facilities e.g. bushfire shelter.	6	6	3	3	18	8
34	Environment and Natural Resources	Water resources	Increased flooding from overflowing riverbanks or failure of levees as a result of extreme rainfall.	Complete flood plans/studies for region and implement recommendations.	Most studies are underway; will be completed soon. CMAs to lead further mapping studies in region. Councils will need to fund recommendations. Recommendations cover updating planning scheme, levies, drainage & community awareness.	4	8	2	4	18	8

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
34	Environment and Natural Resources	Water resources	Increased flooding from overflowing riverbanks or failure of levees as a result of extreme rainfall.	Investigate opportunities for retarding or redirecting runoff from storms to reduce the risk of localised flooding.	This could include retarding basins, increases in permeable surfaces or wetlands, intercept tanks or storages.	8	4	3	3	18	8
16	Economy and Infrastructure	Energy, water and other utility infrastructure	Increased maintenance costs and service disruptions due to accelerated degradation and increased failure of infrastructure (water, traffic signals, power etc.) from extreme rainfall, heat, increase in average temperature and reduced rainfall.	Place critical local electricity, water, transport infrastructure in locations that are not anticipated to be affected by inundation.	Critical assets would need to be prioritised. May be costly for region to replace infrastructure.	4	8	2	3	17	10
42	Environment and Natural Resources	Water resources	Reduction in availability of water resources due to reduced average rainfall, increased average temperature, increased evaporation and fires in water catchments.	Diversify and decentralise water resources in the region.	This would take pressure off centralised system and enable region to be self-sufficient.	4	8	1	2.5	15.5	11

#	Sector	Theme	Risk & Vulnerability	Adaptation Solution	Adaptation Description	Multi criteria assessment					Rank
						Cost	Effectiveness	Timeliness	Env, Econ & Soc Impacts	Total Score	
42	Environment and Natural Resources	Water resources	Reduction in availability of water resources due to reduced average rainfall, increased average temperature, increased evaporation and fires in water catchments.	Minimise water evaporation of water storage facilities and leakage through improved design.	This is primarily focused at agricultural sector. NVIRP project would address this as well.	4	8	1	2.5	15.5	11
34	Environment and Natural Resources	Water resources	Increased flooding from overflowing riverbanks or failure of levees as a result of extreme rainfall.	Raise bridges/roads near riverbanks to prevent isolation of towns in region after flood events.	Critical assets would need to be prioritised. May be costly for region to replace infrastructure.	4	6	2	3	15	12
14	Economy and Infrastructure	Energy, water and other utility infrastructure	Disruption of essential services including telecommunications, power and water due to more frequent extreme weather events.	Transfer ownership of public infrastructure assets to a local partner for greater control over the design, operation and management of assets.	Transfers risk to local owners. This would be costly, possibly lead to fragmented management.	4	4	2	3	13	13

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