



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.

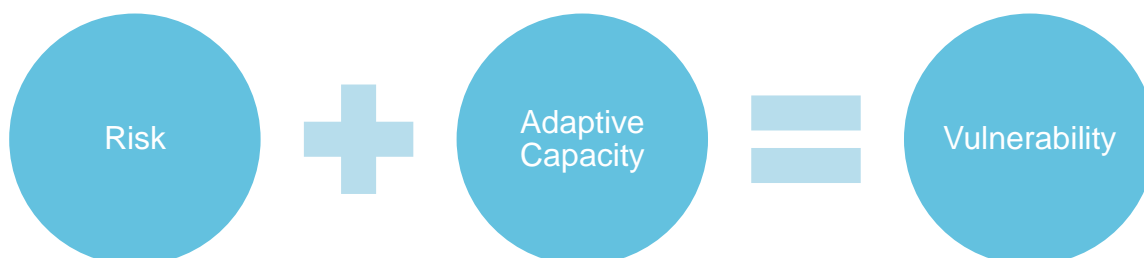
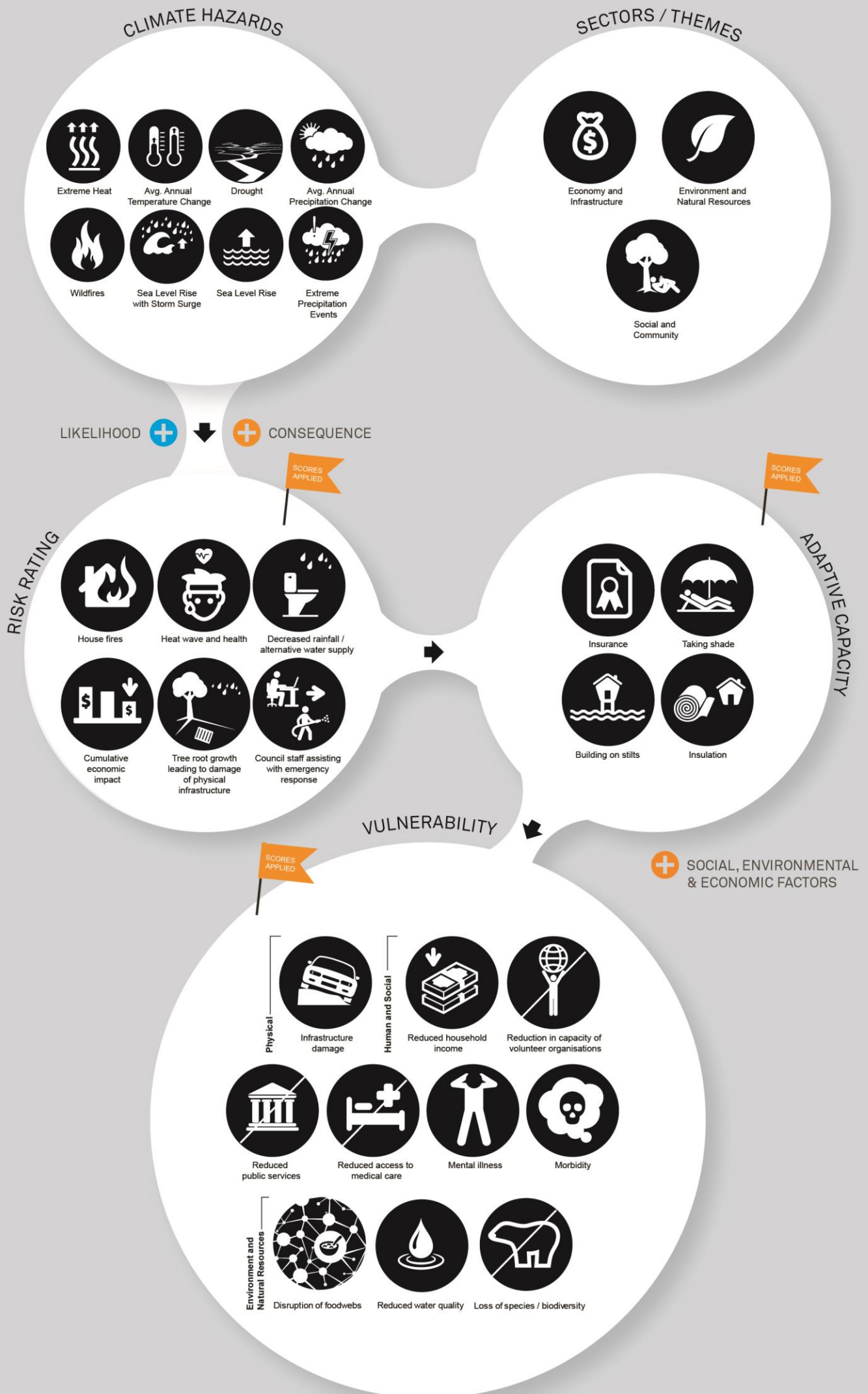


Figure 1 Process used to determine each LGA's vulnerability to climate-related risks.

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

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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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