

Adapting to change – forming new habits

A Climate Change Adaptation Plan for the RDA Barossa Region

**"We first make our habits, then our habits make us."
— John Dryden**



Government of South Australia

Adelaide and Mount Lofty Ranges
Natural Resources Management Board



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Preface

The Barossa RDA (Regional Development Australia) Region is famous for wine production, its regional food culture and livestock, grains and horticulture farming. It has a wealth of natural assets and a community that is rapidly growing on the fringes of the Metropolitan Adelaide. These characteristics underpin our vision for the region which is "enhanced quality of life for all, derived through quality jobs in quality environments: cultural, social, ecological and economic."

A variable climate is a feature of where we live: it has shaped our community, landscape and farming practices for generations. Yet we also need to prepare for a different future climate. This is recognised in our regional roadmap, with building climate change resilience one of our strategic approaches.

In March 2011, RDA Barossa entered into a Climate Change Sector Agreement with the Premier of South Australia. That agreement identified a number of strategic actions required for us to meet the challenges of a changing climate, including:

- collaborating to undertake adaptive option assessments as a first step to developing and implementing a regional climate change adaptation plan;
- working together to gain a better understanding of climate change risks and issues for the region's communities, promote and showcase the Barossa's achievements and explore and communicate learning and opportunities;
- encouraging broader community awareness of sustainability and climate change issues;
- facilitating community engagement and participation in climate change and sustainability programs;
- promoting resource conservation and efficiency and the uptake of environmentally sustainable technologies;
- exploring the potential for joint demonstration projects and funding; and
- advancing cultural change in respect of sustainability and resource management along the value chain.

Working with key project partners in the region, this Plan represents a major step forward in determining how our region can best adapt to climate change and fulfil this agreement.

Whilst some members of the community find difficulty in committing to measures that have a global context, they can relate to and engage in measures that benefit the region. With strong underpinnings, the Barossa region is well positioned to take a whole of community approach to sustainability and environmental stewardship.

This Plan will guide action by business, the community and government to develop well-informed and timely adaptation responses. Appropriate investment in research, innovation, skills and workforce development can improve our adaptive capacity, enabling us to not only minimise the negative impacts of climate change but also to create new opportunities for our community and the economy.

Anne Moroney
Chief Executive, RDA Barossa

Executive summary

The RDA Barossa Region is known locally and internationally for its unique farming, cultural and natural history: from the famous wine regions of the Barossa and Eden valleys, the livestock, grains and horticulture farming areas of the western Barossa and northern Adelaide Plains to the urbanised areas of Gawler and Roseworthy with their associated industries.

As for other parts of South Australia, the Region experiences a variable climate between seasons and years. In addition to this natural variability is climate change, which will present new challenges and opportunities for the Region and importantly a different future climate. The Region can expect warmer summers and drier winters, more frequent heatwaves and higher sea levels on the coast. On the other hand winters will be warmer on average and frosts may occur less frequently.

The RDA Barossa, The Barossa Council, Light Regional Council, the District Council of Mallala, Barossa Grape & Wine Association and the Adelaide and Mount Lofty Ranges NRM Board have developed this Regional Climate Change Adaptation Plan. The Plan reflects the Region's commitment to adapting to climate change and continues the work started following signing of the Barossa Regional Sector Agreement on climate change in March 2011 by RDA Barossa.

The Plan has been developed by undertaking an Integrated Vulnerability Assessment and an adaptation options assessment, informed by a stakeholder workshop.

The Integrated Vulnerability Assessment identified six key areas of decision making to focus adaptation actions on for the Region covering the following themes:

1. Viticulture
2. Water resources management
3. Community services
4. Biodiversity management
5. Emergency services management
6. Manufacturing

Addressing the impact of sea level rise on coastal settlements was also identified as a priority for this region, however, this is being addressed through a complementary planning process being led by District Council of Mallala.

A combination of project team, stakeholder and steering committee input was used to identify the highest priority adaptation actions for the region. Of these, the following were found to have regional scale significance:

1. Whole property management (integrated, property scale fire, water, native vegetation and infrastructure planning);
2. Water efficiency measures;
3. Back-up water and power supplies;
4. Community scale emergency response planning;
5. Climate sensitive design of infrastructure, especially buildings; and
6. Water reuse, with a focus on stormwater management and aquifer storage and recovery.

The cross sectoral priorities suggest that coordinated preparation and planning for climate extremes (i.e. whole property management, community scale emergency response planning, climate sensitive design) and continued innovation in water resources management (water efficiency measures, backup power and water supplies, water reuse) are central to the region's adaptation strategy. These actions are (a) consistent with the region's requirements as its population grows in the coming 30 years and (b) will also assist with other key sectors in the Region that were not specifically addressed in this Plan (because their vulnerability was assessed as being lower), such as tourism, broadacre cropping and management of open space and public realm.

Implementing adaptation options identified in this Plan should consider:

- linking new actions with existing programs;
- showing that some actions provide benefits beyond just climate change adaptation;
- developing a clear business case to address concerns that the cost of acting is too high;
- presenting adaptation strategies as part of a broader plan to build economic resilience;
- reviewing policies to ensure that they support emerging adaptation actions;
- educating professionals about new and innovative responses (e.g. building design); and
- community awareness raising to address perception issues, such as fit for purpose water quality requirements.

The Plan needs to be periodically reviewed, in the spirit of adaptive management, preferably within the framework provided by the Regional Sector Agreement. Review of the Plan can be assisted by developing and implementing a regional monitoring and evaluation framework.

1 Introduction

1.1 Context

The RDA Barossa Region (the "Region") is known locally and internationally for its unique farming, cultural and natural history: from the famous wine regions of the Barossa and Eden valleys, the livestock, grains and horticulture farming areas of the western Barossa and northern Adelaide Plains to the urbanised areas of Gawler and Roseworthy with their associated industries.

The Region also supports a diverse range of native ecosystems: mangroves, chenopod shrubland and samphire communities on the coast, mallee communities in lower rainfall areas on the plains to woodland and open forest in the hills in the eastern part of the region.

As for other parts of South Australia, the Region experiences a variable climate between seasons and years. The development of significant and innovative water management infrastructure to respond to variability in rainfall and water supply is testimony to this.

In addition to this natural variability is climate change, which will present new challenges and opportunities for the Region and importantly a different future climate. The Region can expect warmer summers and drier winters, more frequent heatwaves and higher sea levels on the coast. On the other hand winters will be warmer on average and frosts may potentially occur less frequently.

1.2 This Plan

The RDA Barossa, the Barossa Council, Light Regional Council, the District Council of Mallala, Barossa Grape & Wine Association and Adelaide and Mount Lofty Ranges NRM have developed this Regional Climate Change Adaptation Plan. The Plan reflects the Region's commitment to adapting to climate change and continues the work started following signing of the Barossa Regional Sector Agreement on climate change in May 2011 by RDA Barossa and the Premier of South Australia (Box 1). The Plan focuses on identifying ways to build the resilience of the Region so that it can continue to prosper under a changing climate. It also aims to identify the highest adaptation priorities from across selected sectors in the region, providing a focus for future Region wide funding of climate change adaptation. Development of the Plan also helps the Region address the requirement of the South Australian Climate Change Adaptation Framework for the preparation of a regional adaptation plan.

Significant work has already been undertaken in the Region to understand how the climate may change in the future and how different sectors can respond (eg. Balston *et al.* 2011). This has been drawn on to inform a vulnerability assessment and

adaptation options analysis, which helped to identify region wide priorities for adaptation.

Box 1. Barossa Region Sector Agreement

Regional Development Australia is a partnership between the Australian, State, Territory and Local Governments to develop and strengthen the regional communities of Australia. It has a role in ensuring the long-term sustainability of Australia's regions. There is a network of 55 Regional Development Australia bodies throughout Australia. Regional Development Australia – Barossa covers the local government areas of Barossa, Gawler, Light and Mallala.

In March 2011, Regional Development Australia – Barossa (RDAB) entered into a Climate Change Sector Agreement with the Premier of South Australia. That agreement identified a number of strategic actions required to meet the challenges of a changing climate, including:

- collaborating efforts to undertake a regional approach to adaptive option assessments as a first step to develop and implement a regional climate change adaptation plan;
- working together to support the State Government and the Barossa Region to gain a better understanding of climate change risks and issues for the region's communities, promote and showcase the Barossa and RDA Barossa's achievements and explore and communicate learning and opportunities;
- encouraging broader community awareness of sustainability and climate change issues;
- facilitating community engagement and participation in climate change and sustainability programs;
- promoting resource conservation and efficiency and the uptake of environmentally sustainable technologies;
- exploring potential for joint demonstration projects and funding; and
- advancing culture change in respect of sustainability and resource management along the value chain.

2 The Region

The RDA Barossa region (henceforth the "Region") stretches from the Gulf St Vincent 80 kilometres east through the Mount Lofty Ranges to the western edge of the Murray-Darling Basin. From south to north the Region extends from the boundaries of northern Adelaide through the central Mount Lofty Ranges, a distance of 65 kilometres. Within its boundaries are four councils: Light Regional Council, The Barossa Council, District Council of Mallala and the Town of Gawler.

In 2012, the population of the Region was 66,541 people or about 4% of the State's population (SACES 2012). Over the last 12 years the Region has experienced steady population growth of 19% (higher than for the State which had almost 10%).

South Australian Government projections are that the population in the Region will increase by more than 60% by 2026, almost three times the projected growth rate for the State. The largest growth is predicted for Roseworthy although the timing and rate of this growth is not clear. However, over time, Roseworthy is predicted to grow to become a major residential, educational and commercial centre north of Adelaide. Although the population growth is relatively high, in the Barossa wine region the spread of population beyond the boundaries of existing townships is expected to be low because of the prioritisation of land in these areas for agriculture and tourism.

The Region includes some of the most fertile broad acre cropping and wine growing country in South Australia. It contributed \$2,155 million in gross value added to the State economy in 2006/07 or 3.2% of gross state product (SACES 2012). The three largest employing industries are manufacturing (21.2%), retail trade (14.3%) and agriculture and forestry (11.6%), compared with the overall state where retail trade (14.9%), manufacturing (13.4%) and health and community services (13.1%) are the three largest employing industries.

Within the agriculture and forestry sector a number of important categories are represented: wine grape growing, grains and legumes, livestock, dairy, poultry, wool, and horticulture including market gardens, in ground and hydroponic covered horticulture. Next to wine production, horticulture is the largest employment group in the Region and has considerable room to grow, particularly through access to reliable water, niche branding, local processing and agri-tourism.

The RDA's vision for the Region is *enhanced quality of life for all, derived through quality jobs in quality environments: cultural, social, ecological, built and economic*. The Region aspires to a *future with a sophisticated and stimulating built environment where the design of community spaces reflects confidence and innovation, a bio-diverse and actively used environment and a thriving economy built on smart specialisation and collaborative value chains*.

RDA Barossa Region (Barossa, Light and Lower North)

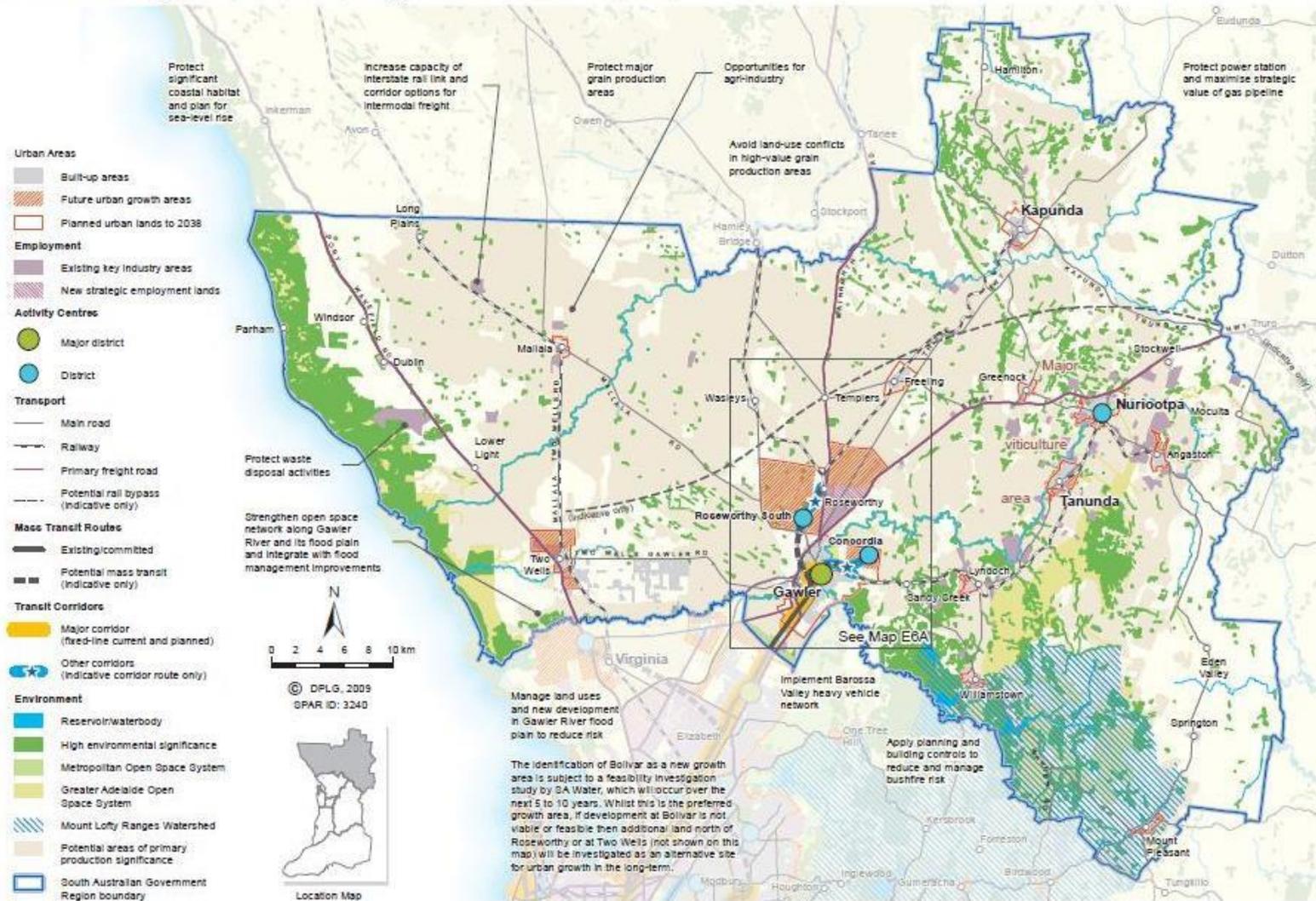


Figure 1. Map of the RDA Barossa Region.

3 How was this Plan developed?

The Plan was developed by combining adaptation planning processes with a participatory based engagement strategy. Project direction was provided by RDA Barossa and the Barossa Sustainable Environs Committee. Targeted engagement occurred through several interviews combined with a stakeholder workshop which invited people representative of organisations from key sectors in the Region (e.g. agriculture, local government, natural resources management).

The process followed two main steps:

Step 1 – Integrated Vulnerability Assessment:

An Integrated Vulnerability Assessment (IVA) was undertaken consistent with the approach described in the Local Government Association of South Australia's *Guidelines for Developing a Climate Change Adaptation Plan and Integrated Climate Change Vulnerability Assessment* (LGA SA 2012). The assessment commenced by reviewing the results of the Central Government Region IVA (Balston *et al.* 2011). While the RDA Barossa Region is located within this area, a Barossa focussed IVA was undertaken given the unique nature of the Region's economy, environment and community compared with the broader Central Government Region.

The Barossa Region IVA drew on the Central Government Region IVA report where relevant, modifying the list of indicators to represent the values of the Region based on review of the RDA Roadmap, relevant Council Plans and the project team's knowledge of the Region (27 indicators were removed and 14 added). The assessment contained indicators that related to all of the RDA Barossa Roadmap priorities (except for Innovation and Entrepreneurship).

Scoring of exposure, sensitivity and adaptive capacity to generate vulnerability scores was informed by available literature and knowledge of the project team and then reviewed by the Steering Committee.

The results of the IVA were used to develop key areas of decision making on which to focus the Adaptation Plan.

Step 2 – Identifying and prioritising adaptation options:

An initial list of adaptation options was identified for key areas of decision making identified from the IVA. This was presented as a paper to key stakeholders attending a workshop (Tanunda, 5 June 2014), where participants were asked to (a) confirm the list of potential adaptation options, adding to those already identified in the discussion paper, (b) assess and prioritise adaptation options and (c) discuss conditions that would enable or act as barriers to adaptation.

The assessment and prioritisation element used a qualitative cost-benefit analysis, together with targeted questions about responsibilities for action and whether proposed actions should be delayed or commenced immediately. Given the experience and skills of people attending the workshop, it focussed on three key areas of decision making (viticulture, water resources management and community services). The remaining key areas of decision making (biodiversity management, emergency services management and manufacturing) were then assessed by the project team using knowledge of the region and considering the results of other adaptation options assessments conducted elsewhere in the State followed by review by the Steering Committee.

A summary of stakeholders who attended the adaptation options assessment workshop is provided in Attachment A.

4 How will climate change affect the Region?

4.1 Overview

Climate change is occurring as a consequence of the release of greenhouse gases like carbon dioxide, methane and nitrous oxide into the Earth's atmosphere. These gases come from a range of sources including the stationary energy, transport, industrial processing, waste management, agriculture, and land management sectors. Increasing concentrations of greenhouse gases act to trap more of the sun's energy in the Earth's atmosphere leading to changes in the global climate.

Changes in the Australian climate have already been observed over the past 100 years. The nation's annual average surface air temperature has increased since 1910 (CSIRO and BoM 2007) particularly since 1950 with a warming trend of nearly 0.2°C per decade. Annual rainfall, on the other hand, has shown a variable but gradual decline in southern Australia since 1950.

The most authoritative source of information on climate projections is the modelling undertaken for the Intergovernmental Panel on Climate Change (IPCC), the world's leading authority on assessing climate change. Unless stated otherwise, the climate projections referred to in this Plan are based on the IPCC's Fourth Assessment Report (AR4). Projections for the Region based on this information can be viewed on the *Climate Change in Australia* web site¹.

It should be noted that the IPCC Fifth Assessment Report (AR5) was released in September 2013, which provides updated information on climate projections. At the time of preparing this report, information using these new models at the scale of the Region was not available, however, the trends are broadly similar between AR4 and AR5 and are unlikely to change the relative priorities for adaptation in the Region or the potential adaptation options. Further information specifically for the Region will be available in late 2014 from CSIRO.

4.2 Regional projections

To provide further context for regional climate projections, the description below has been included using a medium emissions scenario based on data from CSIRO's *Climate Change in Australia* website (generated using AR4 models).

By 2030, the most common estimate (median model output) under a medium emissions scenario is for annual average temperatures in the Region to rise by 0.6 to 1.0°C and by 1.5 to 2°C by 2070. This applies equally to all seasons. Temperature increases could be much higher though if emissions continue to rise, with some projections suggesting a 3 to 4°C warming, by the end of the century.

¹ www.climatechangeinaustralia.gov.au

While projections on the occurrence of heat waves for the Barossa are not available, based on work completed in other regions of South Australia it can be expected that the frequency and intensity of heat waves will increase in the future (e.g. SKM 2013). In contrast, the number of days experiencing frost should decline.

The Region is likely to experience a drying trend under future climate change, although there is more confidence in modelled projections of temperature than rainfall. By 2030, the best estimate under a medium emissions scenario is that annual rainfall will decline on average by 2 to 5% and by 10 to 20% by 2070, with a more pronounced reduction in winter (10 to 20% reduction) compared to summer (5 to 10% reduction).

Climate change projections suggest that the waters of St Vincent's Gulf will increase in height, become warmer, and pH will fall. Rising sea levels will occur as a result of thermal expansion of the oceans as they warm and additional water entering the world's oceans from melting ice. The recent IPCC 5th Assessment Report suggests that global mean sea level rise for 2046–2065 relative to 1986–2005 could be 0.26 m for more moderate emissions outlooks and up to 0.48 m by 2081–2100. Under a high emissions outlook sea level could rise by as much as 0.98 m by 2100.

The world's oceans will continue to warm in the coming century as they absorb heat from the atmosphere. By 2046–2065 this could result in about a 1.4°C rise in global sea surface temperatures under a medium emissions outlook relative to 1986–2005 and a 1.8–2.2°C rise by 2081–2100 (IPCC 2013). While these projections may apply to the Great Southern Ocean, the extent of change in water temperatures in St Vincent's Gulf is less clear given that this area is shallower than the surrounding ocean and more directly influenced by air temperatures and incident solar radiation.

The IPCC Assessment Report 5 suggests that the earth's oceans will become more acidic (pH units decrease from the usual slightly alkaline values of 7.5 to 8.0 towards more neutral levels at pH =7) under all scenarios assessed. Projections for decreasing pH range from 0.06 to 0.32 by 2100, with a best estimate more likely to be in the order of a 0.2 pH unit decrease (IPCC 2013). This compares with a 0.1 pH unit decrease that has already been experienced since the beginning of the industrial era about 250 years ago.

Key points:

- Temperature to rise by 0.6 to 1.0°C by 2030 and 1.5 to 2°C by 2070
- Rainfall to decline by 2 to 5% by 2030 and 10 to 20% by 2070
- Frequency and intensity of heatwave and bushfire conditions to increase
- Sea levels to rise by up to 0.48 m by 2081–2100

5 Identifying priority areas for adaptation

5.1 Results of the Integrated Vulnerability Assessment

Regional scale climate change adaptation planning needs to focus on issues fundamental to a region's long term viability and resilience. These issues can include factors that affect the economy, how the community functions, the condition of native ecosystems and the way in which these interact. Narrowing down the suite of possible issues for adaptation planning was undertaken for this Region by applying an IVA.

The IVA used 33 primary indicators and 85 secondary indicators. Following the approach outlined in the LGA Guidelines (LGASA 2012) the vulnerability score was then calculated as follows: exposure (score out of 5) + sensitivity (score out of 5) – adaptive capacity (score out of 10) +10 = vulnerability. For the purpose of communicating the IVA results, vulnerability scores were then summarised as very high to very low (Attachment B).

The analysis found that landscape fragmentation, regional native fauna and regional native flora were the most vulnerable environmental issues in the Region. This is a consequence of high potential impact of climate change and low adaptive capacity, with vegetation communities for example being sensitive to changes in temperature and rainfall and increased bushfire frequency while having limited opportunity to move through the landscape to more suitable conditions. Effectively addressing these environmental factors is relevant to the entire Region given that many of its social and economic values rely on a healthy natural landscape.

Some of the more vulnerable social and economic indicators were:

- Access to community centres;
- Level of viticultural production;
- Access to education facilities;
- Gross regional product for manufacturing;
- Resourcing and governance of emergency management; and
- Availability of water for irrigation in the Eastern Mt Lofty Ranges, Barossa and Western Mt Lofty Ranges.

The IVA aimed to identify the assets or services most vulnerable to climate change, however, this does not mean that sectors not specifically identified as a high priority in the Region should not consider their response to climate change. For example, the level of production of broadacre crops was assessed as not being as vulnerable to climate change as those factors listed above because the declines in rainfall and increases in temperature are not considered to be as significant as will be experienced elsewhere in the State. Despite this, dryland (rainfed) farmers in the Region will still need to consider how best to respond to a changing climate and will benefit significantly from adaptation efforts in region's more susceptible to warming and drying trends e.g. the Eyre Peninsula and Murraylands.

An IVA is limited to the extent that it may not always be possible to obtain information for climate variables that are of interest to a community. For example, flooding and the frequency of storms are known to be of interest to stakeholder in the Region, however, there is no information currently available that would allow for these variables to reliably be considered in this analysis. Future vulnerability assessments may need to first consider whether such information can be obtained.

5.2 Key areas of decision making

Key areas of decision making have been identified so as to provide a focus for identifying adaptation options in the Region. Their development has been informed by the indicators of higher vulnerability identified in the IVA and by considering values for the Region as expressed in the RDA Roadmap and Councils Strategic Plans. Where possible, the key areas of decision making have been structured to address multiple indicators that ranked as having very high to high vulnerability and are as follows.

1. **Viticulture:** How can viticulture maintain quality and production levels given changing climatic conditions that are likely to result in warmer and drier conditions and more frequent bushfires?
2. **Water resources management:** How can we maintain water security and increase the availability of reuse water for irrigation given projected declines in future average rainfall and increasing evaporation? AND How can we maintain water security and increase the availability of water for irrigation given projected declines in future average rainfall and increasing evaporation, which will impact water from all sources, local groundwater levels, and the quantity and quality of surface water in creeks, rivers and dams?
3. **Community services:** How can we support flexible and adaptive services to maintain access to community centres and educational facilities during hotter summers and extreme events such as heat waves and bushfires?
4. **Biodiversity management:** How can we maintain biodiversity and habitats for native flora and fauna in the Region given the rising threats of a warmer and drier climate, increased risk of bushfire and rising sea levels?
5. **Emergency services management:** How can we maintain resources and governance arrangements required for emergency services management in the Region as supply of volunteers potentially declines and there is increasing demand for support because of extreme events like bushfires and heat waves?
6. **Manufacturing:** How can we maintain gross regional product from manufacturing in the face of increasingly frequent extreme events like heat

waves and bushfires and projected unreliability of electricity supplies as well as risks to inputs (e.g. grapes)?

In addition to the key areas of decision making listed above, how coastal settlements in the Region will respond to sea level rise and associated storm surge impacts was also identified as a priority for adaptation in the region. However, this was not assessed through the stakeholder workshop process because a separate, complementary project was already underway to address this issue through the District Council of Mallala (Western and Kellett 2014).

6 Priority adaptation options for key areas of decision making

Adaptation options were identified for each key area of decision making at the stakeholder workshops. Priority options were selected by stakeholders attending the workshop and then assessed using a qualitative cost benefit analysis, which rated social, economic and environmental costs and benefits for each option as high, medium or low. The results of this analysis were then reviewed following the workshop with input from the Steering Committee to identify immediate and high priorities.

6.1 Viticulture

Key area for decision making

How can viticulture maintain quality and production levels given changing climatic conditions that are likely to result in warmer and drier conditions and more frequent bushfires?

Context

The Barossa is one of the premier wine producing regions in the world, making viticulture an essential focus of the Region's adaptation plan. Climate change is likely to impact viticulture through changes in mean and extreme temperatures and a reduction in the quality and quantity of water. For example, changes in growing season temperatures are likely to see more warmer than cooler vintages and increases in growing degree days that affect plant development rates are likely to affect phenological development (Hayman and Thomas 2013). On the other hand, climate change could make the Region more popular for wine-grape growing as other regions in Australia become less suitable for certain varieties.

A warmer and drier climate could also lead to the following impacts (Hayman and Thomas 2013):

- heat waves causing damage to plants and fruit, although the degree of impact will be dependent on the timing of the heat wave relative to the phenological stage of grapevines;
- greater frequency of bushfires creating increased risk of smoke taint in wine (particularly relevant for crops located in growing region's margins) and damage to physical assets and vines; and
- pest and disease risk changing because of fewer frosts, extreme low temperatures, and changing rainfall patterns creating more favourable conditions.

Adaptation options

A wide range of adaptation options (41) were identified by stakeholders that provide a response to some of the different types of impacts of climate change. A summary of all options identified is provided in Attachment C. These include:

- Labour - Improve management of labour resources (health and scheduling) in response; to shorter duration harvests and more potential extreme weather like heatwaves;
- Irrigation management – Use improved weather forecasting to determine timing and amount of irrigation and improved infrastructure (e.g. moving from inline to sub-surface drip);
- Biodiversity management - planting trees to provide shade and biodiversity benefits;
- Water resource management - diversifying water sources
- Biosecurity - improved response to emerging pests and diseases
- Managing extremes – develop strategies for managing heatwaves or rain at the time of harvest and reducing fuel loads to manage bushfire risk
- Varieties - plant new varieties and consider changing the style of wine grown in the Region
- Vine management - Use lower fire risk mulch, improve canopy management, investigate alternative rootstocks and apply clay based sunscreen.

Three adaptation options were identified as the highest priority by stakeholders, and require immediate attention.

Community scale fire prevention planning (and implementation) will see the whole community become more aware in preparing for fires, recognising how fire could affect the entire region. It is the only adaptation option for which benefits outweighed costs on all measures: economic benefits are considered substantial because of the avoided impacts on primary production such as viticulture (e.g. asset loss and smoke taint) as well as other industries; social benefits are significant because of reduced disruption to community services and effects on human health; and environmental benefits are high given the potential effect fire could have on natural landscapes in the region.

The planning process is considered important because of the apparent uncertainty as to what type of management actions will be most effective. Stakeholders believed that a project should be initiated through the Zone Emergency Management Committee for the Region with possible support from DEWNR (Fire management) and the Bushfire CRC.

Whole property management addresses integrated planning and managing the various elements of a property for fire risk, water resources, native vegetation, biodiversity, ecosystem services, vineyards and infrastructure. The benefits were seen as outweighing the costs: it can create social capital and reduce social negative costs offsite (e.g. bushfires spreading); it has a moderate economic cost if done widely in the community; and should realise environmental benefits to water management and ecosystem services.

This option could be progressed by organisations like Barossa Viticultural Technical Group and Barossa Grape and Wine with the support of NRM, Local Government, RDA and DEWNR (Sustainable Soils and property management planning services). It would require:

- a template of what a farm plan looks like;
- explanation of why it will benefit individual growers; and
- a regional coordinated roll out programs.

To increase adoption, a whole farm plan program would need to link with other plans in the Region (e.g. RDA Roadmap, NRM Plan, Barossa Wine and Grape Plan) and build on existing programs like Entwine and Freshcare.

Water demand management focussed on how to manage the interaction between water demand and electricity supply. Extreme heat periods can create a supply/demand problem because of insufficient volume (pressure) of water available to respond to the extreme heat impact on viticulture. This can damage fruit and plants. Solutions need to consider back-up power supplies or alternative peak power supplies. Stakeholders were of the opinion that this could provide high economic benefits by increasing the resilience of existing industry to changing future conditions.

Progressing this issue could be done by developing a power supply (peak) risk assessment and scoping paper for provision of water resources to vineyards. This could be led by the RDA with support from Local Government, State Government, other manufacturers and industries (e.g. intensive livestock), utilities and Barossa Grape and Wine.

Power demand management will consider feasibility and application of small scale renewable, solar and waste to energy co-generation technologies.

Key points

Immediate priorities for adaptation for viticulture are community scale fire prevention planning, whole property management and water demand management focussed on how to manage the interaction between water demand and electricity supply.

6.2 Water resources management

Key areas for decision making

- How can we maintain water security and increase the availability of reuse water for irrigation given projected declines in average rainfall and increasing evaporation?
- How can we maintain water security and increase the availability of water for irrigation given projected declines in average rainfall and increasing evaporation, which will impact water from all sources, local groundwater levels, and the quantity and quality of surface water in creeks, rivers and dams?

Context

Climate change will lead to a decline in annual average rainfall with larger declines during winter and autumn (nearly 10% by 2030). Declining rainfall will impact run-off and hence stream flow in the region. For example, it has been suggested in other catchments in Australia that a single unit reduction in rainfall could lead to a two to three unit reduction in streamflow (Chiew and McMahon 2002). If this occurs in the Barossa region, the decline in run-off would be a significant economic and environmental issue for the region.

The decline in annual average rainfall is predicted to have similar impacts on recharge to underground aquifers. Modelling in the Mount Lofty Ranges and the Clare Valley suggests that by 2030 the percentage reduction in average annual recharge could be between two and a half to four times the median projected reduction in average winter rainfall in those regions. This equates to a 20% reduction in annual average recharge in the Mount Lofty Ranges and 30% in the Clare Valley

Groundwater impacts from climate change in the unconfined fractured rock aquifers of the Western Mount Lofty Ranges (WMLR) are also relevant to the Northern Adelaide Plains Prescribed Wells Area in the southern part of the Barossa RDA region (e.g. near Two Wells). Rock aquifers of the WMLR are an indirect source of recharge to the confined sedimentary T1 and T2 aquifers of the Adelaide Plain. Modelling conducted by DEWNR suggests that even after 90 years any lowering in water levels in response to climate change in the fractured rock aquifers of the WMLR would have impacted pressure in the T1 and T2 aquifers no further west than Elizabeth."

Changes to the availability of water resources in the Region could impact irrigated agriculture as well as reduce the availability of water for open space and public realm areas.

Adaptation options

Addressing water security issues in the Region will not only assist with securing irrigation based enterprises in the future but also provide more water to help develop and maintain open space (including street trees and urban forests) in

urban areas, which will become increasingly important with an expanding regional population.

Maintaining water security and increasing the availability of water for irrigation will require a range of supply and demand side actions to be addressed, including:

- Water use efficiency – focusing on technology as well as crop physiology and improving soil structure through the addition of organic matter;
- Research and development - improving understanding about what is fit for purpose for each proposed use;
- Infrastructure and technology – Retrofitting piping to carry reuse water and developing a variety of desalination methods;
- Water reuse – Investigating ways to improve the quality of wastewater;
- Governance – Providing a better framework for water allocation planning which gives voice to local knowledge and values and accounts for social and economic as well as environmental uses of water
- Regulation – A review of rural urban stormwater regulations.

An immediate priority is continued focus on research into new water use efficiency measures. Stakeholders believe that the case for this is strong given that it reduces the risks posed by a warmer and drier climate. To initiate this action, funding options (including co-funding) need to be explored and growers need to be able to influence research and development decision-making. This action should be led by a partnership of industry members, research and development corporations and the RDA with support from South Australian Research and Development Institute, the Grape and Wine Research Development Corporation, the University of Adelaide and PIRSA.

Promoting water reuse schemes is a high priority action that will provide more water for a variety of different users in the region. While the economic costs and benefits are expected to be high, the social and environmental benefits are likely to outweigh the costs, making this an attractive option (e.g. opportunity to increase green space areas). It is recognised that some such schemes are currently being developed and that their implementation will be influenced by market drivers such as the cost per megalitre compared with water from traditional sources (e.g. Barossa Infrastructure Limited).

Water reuse can be initiated through a better understanding of:

- market drivers;
- fit for purpose user requirements; and
- the cost of transitioning to new sources, including the need for new skills and systems.

Stakeholders believe that the lead responsibility for water reuse schemes should be taken by Local Government, industry users and the RDA. Regulators will also need to

be involved in the design of such schemes, which may include the need for a review of existing water allocation and regulatory frameworks.

Water reuse may present challenges to current zoning arrangements relating to the type and volume of reuse sources (i.e. stormwater versus recycled water and the future capacity and infrastructure of existing townships and agricultural systems to treat and receive this water). Re-use is likely to present a higher security option as an additional water source for the future (identified in the region's water adaptation plan, Seed 2014), given that in general, local water resources availability may decrease in the future. Creating a diverse range of water sources within the Region is also considered to be a resilience strategy. Stakeholders believe that the cost-benefit balance of this approach is likely to favour the region's economy, providing that infrastructure and demand charges are costed according to regional population growth targets and are included in development costs.

Stakeholders consider that reviewing zoning requirements for water reuse should be led by local government with a view to creating regional consistency and that this may extend outside of the Region to Playford and Salisbury Councils and the Northern Adelaide Plains (Bolivar) water reclamation scheme.

Key points

High priority actions for water resource management are to maintain water security and increase the availability of water for irrigation; conduct further research into new water use efficiency measures; and promote water reuse schemes to provide more water for a variety of different users in the region.

6.3 Community services

Key area for decision making

- How can we support flexible and adaptive services to maintain access to community centres and educational facilities during hotter summers and extreme events such as heat waves and bushfires?

Context

People living in the Barossa benefit from the delivery of services from Local and State Government and other providers such as NGOs that help create well connected communities. Important community services include emergency services, educational facilities such as schools, libraries, and TAFE facilities and community centres that provide meeting places for sporting and church groups.

Facilities may also be unavailable on extreme bushfire risk days and bushfires themselves could cause direct damage to physical assets periodically reducing their availability. Yet, under such extreme conditions, the availability and access to

community facilities may be in high demand, particularly in evacuation situations. The increased community demand for such services in summer months may also be replicated in slightly warmer winters predicted under climate change, which may require a change to the usual provision and availability of services at that time of the year.

Adaptation options

Stakeholders identified a number of types of adaptation options that can help the delivery of community services adapt to a changing future climate, including:

- Infrastructure (soft) - Establishing mobile service/response and continuing to build the volunteer base;
- Infrastructure (hard) - Increasing access to distant areas via sealed roads and encouraging new infrastructure to be located in existing low bushfire risk areas;
- Service providers – Providing special health services for at risk groups (e.g. elderly, people with diabetes);
- Communications – Educating people on how to act in case of heatwaves;
- Development planning – Categorising existing land-use and identifying areas at high risk; and
- Knowledge audit - Establishing protocols to identify vulnerable communities and individuals and auditing existing community facilities to determine future needs.

One of the highest priority adaptation actions identified by stakeholders was for all levels of Government to **mandate appropriate climate sensitive design of infrastructure**, especially buildings. Although the initial cost of this is expected to be high, costs are expected to become lower as designs and materials become more standardised. The social benefits are both perceived as high because of the benefits for human health e.g. buildings that are inherently cooler.

Work on this action should commence now if implementation is to occur within 10 years. It is recognised that it will take time for policies on building design to be developed and adopted and for industry to develop new skills or source necessary materials. This action could be initiated by (a) working with State and Federal government to identify changes that could be made mandatory in the building code or (b) working with industry to identify voluntary changes. This work should be lead by the Local Government Association with the support of the Planning Institute of Australia, architects, building designers, local construction and design industries and educational bodies.

An adaptation priority that will help community services respond to extreme events is the **development and implementation of an emergency response plan**. This would consist of a tiered set of actions for vulnerable members of the community. While there may be some local level response plans, a regional plan has not been prepared. A regional plan could be developed through the same process that is

preparing the Barossa (RDA) Zone Emergency Management Plan with a focus on "at risk" community members.

Development of the Plan should commence within 12 months and be led by councils in the Region and State Government agencies with support from emergency services authorities (State and local), local service groups (e.g. Rotary, sporting groups, church groups) and NGO care providers. The initial focus should be on high risk or "black spot" areas with respect to power, telecommunications and road access.

An extension to the emergency response plan is to investigate how to **provide back-up water and electricity supplies during emergencies**, with the focus on off-grid electricity. It is recognised that the economic cost of this may be high, but the social benefits will also be high. While installation of new infrastructure may be 5-10 years away, an audit of facilities needs to be conducted first (refer to "response plan" option). This action could be incentivised by State or Local Government grants and roll out would need to be supported by facility co-ordinators and building owners.

Key points

Immediate priorities for adaptation for community services in the Region are to: commence work on mandating climate sensitive design in private and public infrastructure, especially buildings; and develop a community services oriented emergency response plan which outlines how to provide back-up water and electricity supplies.

6.4 Biodiversity management

Key area for decision making

How can we maintain biodiversity and habitats for native flora and fauna in the Region given the rising threats of a warmer and drier climate, increased risk of bushfire and rising sea levels?

Context

Biodiversity in the Region such as native flora and fauna is recognised for its environmental value as well as the ecosystem services that it provides, such as pollination, water filtration, storing carbon in the landscape, soil generation and stabilisation, recreation and amenity.

The Region contains three natural landscape types:

- Coastal – includes areas of land along the coast on the western edge of the region, including chenopod shrub land and samphire communities that will be impacted by sea level rise;

- Plains – low gradient landscape characterised by lower rainfall and higher temperatures than those areas further east in the Mount Lofty Ranges. Native vegetation communities include areas of Mallee species (e.g. *E. dumosa*; *E. socialis* and *E. incrassate*)². While much of the native vegetation in this landscape has already been cleared and so is biologically stable, the climate velocity³ is high, meaning that remaining native flora and fauna are highly exposed to climate change. The fragmented nature of this landscape also means that adaptive capacity is low; and
- Hills face and hills - these higher rainfall parts of the Region have greater amounts of native vegetation including areas of woodland, grassy woodland and open forest (e.g. *E. camaldulensis*, *E. leucoxydon*, *E. odorata*, *Allocasuarina verticillata*). Climate change impacts are expected to be slower in this landscape because of their topographic and microclimatic diversity which will offer refuge from changing conditions.

Adaptation options

A range of adaptation options exist for protecting or managing biodiversity and habitat in the three natural landscape types in the region. In general, there are:

- passive (e.g. fine tuning systems for more incremental change);
- active (e.g. accelerated or planned changes to a system); and
- transformational adaptation strategies (major, purposeful change).

All three natural landscape types will benefit from passive adaptation measures like:

- **bushfire management and recovery plans;**
- **supporting landholders to manage native vegetation on private properties;**
- **community awareness raising; and**
- **addressing current and emerging threats (pest plant and animal control).**

Supporting landholders to manage native vegetation on private properties also has a strong connection with one of the priorities for viticulture, which is whole property planning that includes consideration of biodiversity management (Section 6.1).

Active adaptation will be achieved primarily through **protecting and improving refugia** for native flora and fauna. This will prove more challenging in the coastal and plains landscapes because of the lack of remnant vegetation. In contrast, the hills face and hills parts of the Region have more remnant vegetation, meaning that

² Barossa Infrastructure Ltd (2001). Barossa pipeline project - Environmental assessment. Prepared for Barossa Infrastructure Ltd by Eco Management Services Pty Ltd, Water Search Pty Ltd and PIRSA Rural Solutions. October 2001.

³ Climate velocity describes the local speed and direction of shifting climate contours as an expectation of how species' distributions would have to shift to track the location of their preferred temperature zones.

more opportunities to protect refugia exist. Support and involvement of private landholders will be important for this action to be successful, such as through programs like Landcare.

Passive and active adaptation actions for biodiversity management should be led by Natural Resources Adelaide and Mount Lofty Ranges with support from councils, each of which has their own biodiversity objectives.

Transformational adaptation is more relevant to the coastal and plains areas, which because of their limited adaptive capacity, are likely to be significantly impacted by future climate change. Potential options include **species and ecosystem translocations** (e.g. moving species found in the Region to new, more suitable locations) or **ecosystem engineering** (i.e. replacing ecosystems no longer viable in the region with new ones). Such actions would be expensive and require significant coordination, but are not required now and may be delayed for some decades. While this may be the case, preliminary planning could be initiated now, led by DEWNR (including Natural Resources Adelaide and Mount Lofty Ranges), with the support of research institutions.

Key points

High priority actions for all three landscape types are passive and active adaptation measures such as bushfire planning, supporting landholders to manage native vegetation on private properties, community awareness raising, addressing current and emerging threats and protecting and improving refugia. Transformational adaptation measures are more relevant to the coastal and plains areas and will require preparatory work to begin now for what could be major changes in biodiversity management strategies in the future.

6.5 Emergency services management

Key area for decision making

How can we maintain resources and governance arrangements required for emergency services management in the Region as supply of volunteers potentially declines and there is increasing demand for support because of extreme events like bushfires and heat waves?

Context

Emergency services management draws on volunteer resources from the community and plays a vital role in protecting social, economic and environmental assets. Being involved in providing emergency services helps build community connectedness which can also benefit other sectors in the Region.

Climate change is expected to increase the demand for emergency services in a number of ways, for example, the threat of bushfire will increase and flooding of low lying coastal areas - as has already been observed for settlements in District Council of Mallala during storm surge events – may become more frequent. Increasing demand for emergency services could occur at the same time as volunteer resources are in decline, especially if there are competing demands for volunteers.

Important in the Region will be changing settlement patterns, as urban and peri-urban areas expand, potentially increasing the demand for emergency services but also increasing the supply of volunteers.

Adaptation options

Adaptation options for continuing to meet the growing demand for emergency services management include:

- Preparation – Improving community connectivity and building individuals' resilience to extreme events;
- Response management - Building more health care facilities (e.g. hospitals) and providing more emergency response centres; and
- Volunteerism – Increasing the volunteer numbers through actions like reducing administrative barriers to volunteering for organisations like State Emergency Service and the Country Fire Service.

A priority action, consistent with the SES approach to hazard management, is to **improve community awareness of, and preparation for, hazards**. This could include working with: aged care providers to ensure emergency response plans are on place; providing services for aged members of the community such as gutter cleaning; schools to develop and implement extreme heat policies; and the SES to develop early warning systems for flood and fire.

Preparing in advance for hazards can be done together with the SES, connecting with their operational planning. For example, the SES's Extreme Heat Plan is triggered when the Bureau of Meteorology forecasts average temperatures (maximum and minimum daytime temperatures together divided by two) of above 32°C for three days or more in a row.

Another priority adaptation action is to **increase volunteering in the community** in order to be able to meet expected increases in demand for emergency services. A volunteer strategy should be developed drawing on learnings from national strategies and action plans for the retention of volunteers in the emergency services sector (e.g. AGD 2012), considering:

- leadership training to support emergency management volunteers;
- alternative learning approaches;

- formal recognition and reward frameworks for employers of emergency management volunteers;
- community awareness of the role and value of emergency management volunteers;
- strategies that attract, support and retain young people and those from culturally and linguistically diverse backgrounds in emergency management volunteer roles;
- ways to minimise the amount of non-operational and administrative work being imposed on local level volunteers; and
- legal issues that may inhibit the attraction and retention of volunteers.

Key points

High priority actions for adaptation for emergency services management are to improve community awareness of, and preparation for, hazards and to increase volunteering in the community, starting with the development of a Barossa Volunteering Strategy.

6.6 Manufacturing

Key area for decision making

How can we maintain gross regional product from manufacturing in the face of increasingly frequent extreme events like heat waves and bushfires and projected unreliability of electricity supplies?

Context

Manufacturing is one of the Barossa region's top employment sectors and important to the region's economy. Whilst this is predominantly associated with wine manufacturing there are important other manufacturing activities in the region, including mine materials processing, glass production, engineering & steel fabrication, extrusion and cement. There is opportunity for the expansion of manufacturing services and products to support wine production as well as to generate additional revenue and jobs created in processing and packaging the region's produce (e.g. vegetables and livestock in the Northern Adelaide Plains).

Some of the climate change related issues for manufacturing include the impact of extreme events on operating hours (e.g. during heatwaves) or direct damage to physical assets. Secondary impacts could also arise from disruptions to the supply of essential services such as electricity due to strategic outages in parts of the Region or worker availability due to catastrophic fire weather events.

Adaptation options

Adaptation options for maintaining the gross regional product from manufacturing include:

- Operations - changing employment conditions such as start and finish times and altering manufacturing schedules;
- Essential services supply – developing alternate water supplies and back-up power; and
- Restructuring – relocating some manufacturing facilities and diversifying the industry base.

Seasonality of the wine industry may be influenced by future climate creating shorter quicker vintages, resulting in time pressures to process wine products in a short period of time. This may lead to labour shortages or requirements for non-standard work times, disruption to work flows and labour markets. RDA should collaborate with industry groups to consider appropriate planning to manage future shifts in local labour markets.

Surging up the supply of water and electricity are high priorities for manufacturing. This has two aspects – provision of supplies during extreme events, but also making sure power and water are supplied at a reasonable price for general operations in the future. Further assessments are required to determine the business case for:

- distributed power solutions, including greater use of solar on large roof areas for manufacturing sites or possibly development of local micro grids stand alone micro generation units;
- greater use of alternate water supplies, such as rain harvesting from large roof areas and regional provision of treated storm water and or water reuse schemes; and
- how the water and electricity needs of the Region relate to future plans for service providers (e.g. SA Power Networks, SA Water) associated with the greater Adelaide plan and regional population projections.

Another priority strategy is to identify approaches for diversifying the range of businesses in the region, including those that value add to existing industries, take advantage of opportunities that may increase as population in the Region grows or that grow existing industries (e.g. horticulture in the Northern Adelaide Plains). Diversity of the manufacturing and business base in the Region is considered to be a key resilience strategy in that it places less risk on one key industry to ensure the economic base of the Region and provides greater regional employment and wealth opportunity. This should be led by the RDA with support from industry groups.

Key points

High priority actions for manufacturing include planning to manage future shifts in local labour markets; developing alternate water supplies and back-up power; and diversifying the range of businesses in the region, including those that value add to existing industries.

7 Implementing of the Plan

7.1 Region scale priorities

This Plan identifies adaptation actions that relate to six key areas for decision making. These actions typically relate to individual sectors and will require further work within those sectors to be implemented. Of those adaptation actions identified in Section 6, a number were identified that were also a priority for other sectors and as such can be seen as cross sectoral or Region scale adaptation priorities. These are as follows:

1. Whole property management – Initially identified for viticulture but also provides benefits to water resources management, biodiversity management and emergency services management because of the focus on integrated farm planning and management for fire, water, native vegetation and infrastructure;
2. Water efficiency measures – Initially identified for viticulture but will also benefit water resources management and manufacturing where local businesses can provide technology for water efficiency technology. This requires significant investment in new research and development given that water efficient technology is already well adopted;
3. Back-up water and power supplies – Identified for community services, but will also provide benefits for viticulture and manufacturing. This is connected with general issues regarding supply of essential services and how they will be impacted by emergencies such as heatwaves and bushfires;
4. Community scale emergency response planning – This combines two separate actions of “Community scale fire prevention planning” and “Developing a response plan incorporating a tiered set of actions for vulnerable community members”. This would benefit all six key areas of decision making in the region;
5. Climate sensitive design – This involves design of buildings and infrastructure that is more resilient to climate extremes like heatwaves or bushfires. This was initially proposed by stakeholders considering community services and vulnerable members of the community, but will also provide benefit to emergency services by reducing demand and potentially for manufacturing, by reducing climate related impacts on labour resources; and
6. Water reuse – Various water reuse actions were proposed by stakeholders focussed on water resource management. Reuse schemes will also benefit biodiversity management, manufacturing, viticulture and community services.

The cross sectoral priorities suggest that coordinated preparation and planning for climate extremes (i.e. whole property management, community scale emergency

response planning, climate sensitive design) and continued innovation in water resources management (water efficiency measures, backup power and water supplies, water reuse) are central to the region's adaptation strategy. Notably, this adaptation focus will also assist with other key sectors in the Region that were not specifically addressed in this Plan (because their vulnerability was assessed as being lower), such as tourism, broadacre cropping and management of open space and public realm.

7.2 How can adaptation be initiated?

Adaptation occurs as part of current best practice in most communities, however, planned or intentional adaptation can be more challenging, especially when the decision making context is not well understood. In implementing adaptation options identified in this Plan consideration should therefore be given to:

- linking with existing programs that are already accepted by stakeholders in the Region e.g. whole farm planning linked with programs like Entwine or Freshcare;
- ensuring that adaptation actions are shown to deliver benefits for more than just climate change adaptation;
- developing a clear business case using cost benefit analyses to address concerns that the cost of some actions is too high;
- presenting adaptation strategies as part of a broader plan to build economic resilience;
- reviewing policies to ensure that they support emerging adaptation actions, such as with respect to stormwater capture and water reuse schemes;
- educating professionals about new and innovative practices e.g. approaches for climate sensitive housing construction; and
- community awareness raising to address perception issues, such as fit for purpose water quality requirements.

7.3 Periodic review

This Plan presents adaptation priorities based on published information available at the time of its development and the opinions and local knowledge of the Steering Committee and stakeholders who attended the adaptation options assessment workshop.

The Plan needs to be periodically reviewed, in the spirit of adaptive management, every 2-3 years to consider new information on climate change projections and impacts and to account for changes in adaptive capacity. This should be done through the Regional Sector Agreement process.

Future planning needs to focus more on understanding whether climate related thresholds exist for social, economic or environmental systems. The Region also needs to consider how it will monitor and evaluate its adaptation performance. This

should involve identifying lead indicators (i.e. that show trends in exposure to future climate extremes) and lag indicators (i.e. that explain the effect of climate hazards on regional features, for example, wine grape yields). The *Proposed National Adaptation Assessment Framework* provides a useful starting point for developing a regional monitoring and evaluation framework (DIICCS RTE 2013).

8 References

Attorney General's Department (2012). National Emergency Management Volunteer Action Plan. April 2012.

Balston, J.M., Billington, K., Cowan, H., Hayman, P., Kosturjak, A., Milne, T., Rebbeck, M., Roughan, S., Townsend, M. (2011). Central local government region integrated climate change vulnerability assessment. Central Local Government Region of South Australia, Crystal Brook, SA. pp.331.

Chiew, F.H., and T. A. McMahon 2002, 'Modelling the impacts of climate change on Australian streamflow', *Hydrological Processes*, vol. 16, pp. 1235–1245.

CSIRO and Bureau of Meteorology (2007). *Climate Change in Australia*. Technical Report 2007. CSIRO, Melbourne.

Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (2013). *Climate Adaptation Outlook: A Proposed National Adaptation Assessment Framework*. Commonwealth of Australia.

Intergovernmental Panel on Climate Change (2013). Summary for Policymakers. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Local Government Association of South Australia (2012). *Guidelines for Developing a Climate Change Adaptation Plan and Integrated Climate Change Vulnerability Assessment*. November 2012. Prepared by Jacqueline Balston & Associates with input from LGA South Australia, Department Environment Water and Natural Resources, CSIRO Climate Change Adaptation Flagship, Bureau of Meteorology SA.

Seed Consulting Services (2014). *An Adaptation Plan for Water Barossa RDA Region*. Produced for Regional Development Australia Barossa by Advanced Viticulture and Management (AV&M) & Seed Consulting Services Pty Ltd. April 2014.

South Australian Centre for Economic Studies (2012). *Regional Development Australia Barossa – Region profile*. Adelaide and Flinders Universities.

SKM (2013). *Climate change adaptation to vulnerability project*. South Australian Murray-Darling Basin NRM region. Climate change scenarios report. Project VW07280.

Western, M. and Kellett, J. (2014). Coastal Settlements Adaptation Study. Stage 1: State of Play. University of South Australia, School of Natural and Built Environments Institute for Urban Renewal.

Attachment A – Workshop participants

The people identified in the table below attended the adaptation options assessment workshop held in Tanunda on 5 June 2014.

Name	Organisation
Ian Baldwin	Barossa Council
Tina Brew	Climate Change Unit, Department of Environment, Water and Natural Resources
Cecil Camilleri	Yalumba Wine Company
Travis Coombe	Henschke Eden Valley Project & Vineyard manager
Kathy Coombs	Barossa Environmental
Mandy Gerhardy	Pernod-Ricard Winemakers
Simon Goodhand	Sustainable Agriculture Facilitator, South Australia; Department of Agriculture
Gayle Greiger	Natural Resources Adelaide and Mount Lofty Ranges, Department of Environment, Water and Natural Resources
Craig Grocke	RDA Barossa
Brian Hughes	PIRSA - Rural Solutions
Chris Kaufmann	Infrastructure & Funding Advice
Leon Koch	Koch Pilgrim Vineyards
Grant Lomman	Natural Resources Adelaide and Mount Lofty Ranges, Department of Environment, Water and Natural Resources
Paul Mikan	Barossa Council
Carol Muzyk	District Council of Mallala
Andrew Philpott	Light Regional Council
Elena Shchepina	RDA Barossa
Meg Sommerville	Zero Waste SA
Susan Sweeney	Department of Environment, Water and Natural Resources
Andrew West	Natural Resources Adelaide and Mount Lofty Ranges, Department of Environment, Water and Natural Resources
Charlotte Williams	RDA Barossa

Attachment B – Integrated Vulnerability Assessment results

This Plan has been informed by the results of an Integrated Vulnerability Assessment (IVA). The IVA followed the method described in the Local Government Association of South Australia's *Guidelines for Developing a Climate Change Adaptation Plan and Integrated Climate Change Vulnerability Assessment*.

For the purpose of communicating the results, vulnerability scores have been summarised as Very low (<4); Low (greater than or equal to 4 but less than 8), Medium (greater than or equal to 8 but less than 12), High (greater than or equal to 12 but less than 16) or Very high (greater than 16).

The indicators described in the table below have been assigned to one element of the triple bottom line, noting that a number of the indicators could appear in multiple categories e.g. surface water could be presented under environmental or economic.

Primary Indicator	Vulnerability description
Social	
Education	High
Emergency Management	Medium
Health	Medium
Land assets	Medium
Existing social capital	Medium
Community Planning and Development	Medium
Social inclusion	Medium
Economic	
Viticulture	High
Forestry	High
Surface water	High
Irrigated agriculture	High
Manufacturing	High
Horticulture (fresh produce/vegetables)	Medium
Electricity supply	Medium
Telecommunications	Medium
Buildings	Medium
Rail	Medium
Horticulture (tree crops)	Medium
Broadacre crops	Medium
Construction and engineering	Medium
Tourism	Medium
Mining	Medium
Roads	Medium
Retail trade	Medium

Primary Indicator	Vulnerability description
Economic (continued)	
Beef, dairy, sheep and wool production	Medium
Water infrastructure	Medium
Business and personal services	Low
Environment	
Landscape fragmentation	High
Regional Native Fauna	High
Regional Native Flora	High
Surface water	High
Regional Native Vegetation Communities	Medium
Water dependant ecosystems	Medium
Land condition	Medium

Attachment C – List of adaptation options

The full list of adaptation options identified in relation to key areas of decision making is listed below. The numbering in the table does not relate to any ranking of actions. Categories of actions were identified by workshop participants for the first three key areas of decision making while categories for the last three were developed by the project team and reviewed by the Steering Committee.

Key area of decision making	Adaptation options
<p>Viticulture: How can viticulture maintain quality and production levels given changing climatic conditions that are likely to result in warmer and drier conditions and more frequent bushfires?</p>	<p><u>Labour/resources</u></p> <ul style="list-style-type: none"> • Sharing resources with other regions • Manage labour health <p>Irrigation management</p> <ul style="list-style-type: none"> • Improved weather forecasting • Construct more dams • Change inline dripper to sub-surface • Increase individual's capacity to generate alternative energy • Install distributed power • Upgrade water delivery infrastructure to provide greater capacity to deliver large volumes when needed • Access recycled water from urban growth • Maintain continuity of power supply • Install battery storage for distributed energy systems • Adopt whole property management practices <p>Biodiversity catchment management</p> <ul style="list-style-type: none"> • Plant trees for shading (not Eucalypts because of water competition and potential flavour effects) • Promote and show the benefits of biodiversity for viticulture <p>Water resource management</p> <ul style="list-style-type: none"> • Diversify water sources to decrease risk • Source additional water (e.g. Murray) • Improve water demand management, including related power supplies issues • Continued adoption of water trading • Use desalination to polish (clean) waste water <p><u>Biosecurity</u></p> <ul style="list-style-type: none"> • Response to emerging pests and diseases • Manage spray drift from broadacre <p><u>Managing extremes</u></p> <ul style="list-style-type: none"> • Develop strategies for managing heatwaves or rain at the time of harvest • Reduce fuel load to manage bushfire risk • Community scale fire prevention planning

Key area of decision making	Adaptation options
	<p><u>Varieties</u></p> <ul style="list-style-type: none"> • Plant new varieties • Change the style of wine the Region grows • Market new wine styles • Investigate other rootstock options <p><u>Vine management</u></p> <ul style="list-style-type: none"> • Use lower fire risk mulch • Improve canopy management • Investigate other rootstock • Apply clay based sunscreen • Improve trellis management • Continued adoption of soil moisture monitoring • Consider row orientation • Manage or reduce the potential for soil erosion • Investigate ways to increase leaching of salt from soil profile • Improve inter-row management
<p>Water resources management: How can we maintain water security and increase the availability of reuse water for irrigation given projected declines in future average rainfall and increasing evaporation? AND How can we maintain water security and increase the availability of water for irrigation given projected declines in future average rainfall and increasing evaporation, which will impact water from all sources, local groundwater levels, and the quantity and quality of surface water in creeks, rivers and dams?</p>	<p>Water use efficiency</p> <ul style="list-style-type: none"> • Continued investigation and engagement around water use efficiency measures • Increase soil organic matter • Investigate how organic material can be added to broad acre farms in a cost-effective manner • Further investigate crop physiology <p>Research and development</p> <ul style="list-style-type: none"> • Better understanding and research into what is fit for purpose for each proposed use (e.g. potential uses for recycled water) • Ongoing research into water use efficiency measures <p>Infrastructure and technology</p> <ul style="list-style-type: none"> • Retrofitted piping to carry reuse water • Promote water reuse • Investigate, develop, and promote a variety of desalination methods • Provide fit for purpose dual water system i.e. potable and recycled water <p><u>Water reuse</u></p> <ul style="list-style-type: none"> • Investigate ways to improve the quality of wastewater • Undertake an urban stormwater impact assessment • Investigate (recycled) water reticulation options • Investigate wetland stormwater storage options • Investigate aquifer storage and recharge • Develop and promote water reuse schemes <p><u>Governance</u></p> <ul style="list-style-type: none"> • Provide greater local support from agencies with respect to water allocation planning and management

Key area of decision making	Adaptation options
	<p><u>Regulation</u></p> <ul style="list-style-type: none"> • Continue to assess stormwater regulations • Review effect of local and State development plan regulations • Consider zoning in new water reuse infrastructure developments
<p>Community services: How can we support flexible and adaptive services to maintain access to community centres and educational facilities during hotter summers and extreme events such as heat waves and bushfires?</p>	<p><u>Infrastructure (soft)</u></p> <ul style="list-style-type: none"> • Establish mobile service/response teams (volunteers) • Maintain training/skill levels of mobile response teams (volunteers) • Continue to build the volunteer base • Engage transport operators to provide access to facilities when needed • Establish flexible operating hours for community facilities <p><u>Infrastructure (hard)</u></p> <ul style="list-style-type: none"> • Increase access to distant areas via sealed roads • Encourage new infrastructure to be located in existing low bushfire risk areas • Construct or retro-fit buildings to ensure that they are appropriate refuges during extreme events • Ensure back-up water and power supplies are available <p><u>Service providers</u></p> <ul style="list-style-type: none"> • Support and promote Red Cross (REDiPLAN) linking with emergency services for incident communication • Provide special health services for at risk groups (e.g. elderly, those with cardio issues, diabetes etc.) <p><u>Communications</u></p> <ul style="list-style-type: none"> • Educate people on how to act in case of heatwaves • Develop a response plan incorporating a tiered [staged] set of actions for vulnerable community members <p><u>Development planning</u></p> <ul style="list-style-type: none"> • Categorise existing land-use identifying areas at high risk • Identify and map risk areas across the Region in a consistent way • Encourage Government to mandate appropriate climate sensitive design for public and private infrastructure <p><u>Knowledge audit</u></p> <ul style="list-style-type: none"> • Establish protocols to identify vulnerable communities and individuals • Audit existing community facilities to determine future needs • Identify facilities for stock management • Provide support for companion animals • Undertake regular reviews of incidents to gain intelligence on appropriate responses

Key area of decision making	Adaptation options
<p>Biodiversity management: How can we maintain habitats for native flora and fauna in the Region given the rising threats of a warmer and drier climate and increased incidence of bushfire?</p>	<p><u>Planning</u></p> <ul style="list-style-type: none"> • Develop bushfire management, response and recovery plans • Incorporate into planning the relative importance of habitat area, environmental diversity, connectivity, isolation, and different types of refuges • Review and amend development plan policy <p><u>Community engagement</u></p> <ul style="list-style-type: none"> • Support landholders managing native vegetation on private properties • Raise community awareness about biodiversity management issues <p>Threat management</p> <ul style="list-style-type: none"> • Undertake prescribed burns • Address current and emerging threats (pest plant and animal control) <p>Research</p> <ul style="list-style-type: none"> • Monitoring and research to undertake situation appraisal and review • Identify and develop linkages to enable species migration <p>On-ground management of priority areas</p> <ul style="list-style-type: none"> • Maintain habitat values in non-conservation areas • Protect and improve refugia • Manage parts of the environment that provide refuge for species during climatic extremes and ecological disturbance <p>Transformational adaptation</p> <ul style="list-style-type: none"> • Move species and ecosystems • Implement ecosystem engineering
<p>Emergency services management: How can we maintain resources and governance arrangements required for emergency services management in the Region as supply of volunteers potentially declines and there is increasing demand for support because of extreme events like bushfires and heat waves?</p>	<p>Emergency preparation</p> <ul style="list-style-type: none"> • Improve community awareness of, and preparation for, hazards • Develop and deploy early warning systems for flood and fire • Improve community connectivity • Build individual's resilience to extreme events <p><u>Response management</u></p> <ul style="list-style-type: none"> • Build new hospitals • Provide more emergency response centres <p><u>Volunteerism</u></p> <ul style="list-style-type: none"> • Increase volunteer numbers • Reduce red-tape and occupational health and safety barriers to volunteering for organisations like State Emergency Service and the Country Fire Service

Key area of decision making	Adaptation options
<p>Manufacturing: How can we maintain gross regional product from manufacturing in the face of increasingly frequent extreme events like heat waves and bushfires and projected unreliability of electricity supplies?</p>	<p><u>Operations</u></p> <ul style="list-style-type: none"> • Change employment conditions such as start and finish times • Change manufacturing scheduling • Increase air-conditioning in buildings <p><u>Essential services supply</u></p> <ul style="list-style-type: none"> • Develop stormwater capture and reuse • Install solar power on large roof areas • Develop alternate water supplies i.e. not potable water <p>Develop back-up power supplies</p> <p><u>Restructuring</u></p> <ul style="list-style-type: none"> • Relocate some manufacturing facilities • Attract a greater diversity of businesses