A World With Less Water
RERORC
23 June 2011

Scenario Planning: Potential Impacts of Reduced Water Availability

Discussion Paper 4

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Prepared for

R
EROC

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Quality Information

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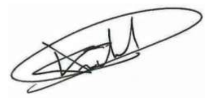
Senior Environmental Scientist</td><td></td></tr>
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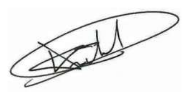
Senior Environmental Scientist</td><td></td></tr>
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1.0 Introduction

This paper characterises the risks associated with reduced water availability for key industries within the Riverina Eastern Regional Organisation of Councils (REROC) Local Government Areas (LGAs) participating in the Strengthening Basin Communities (SBC) study. This paper is the second step of the second phase of the study looking specifically at key industries in the REROC region (see Figure 1).

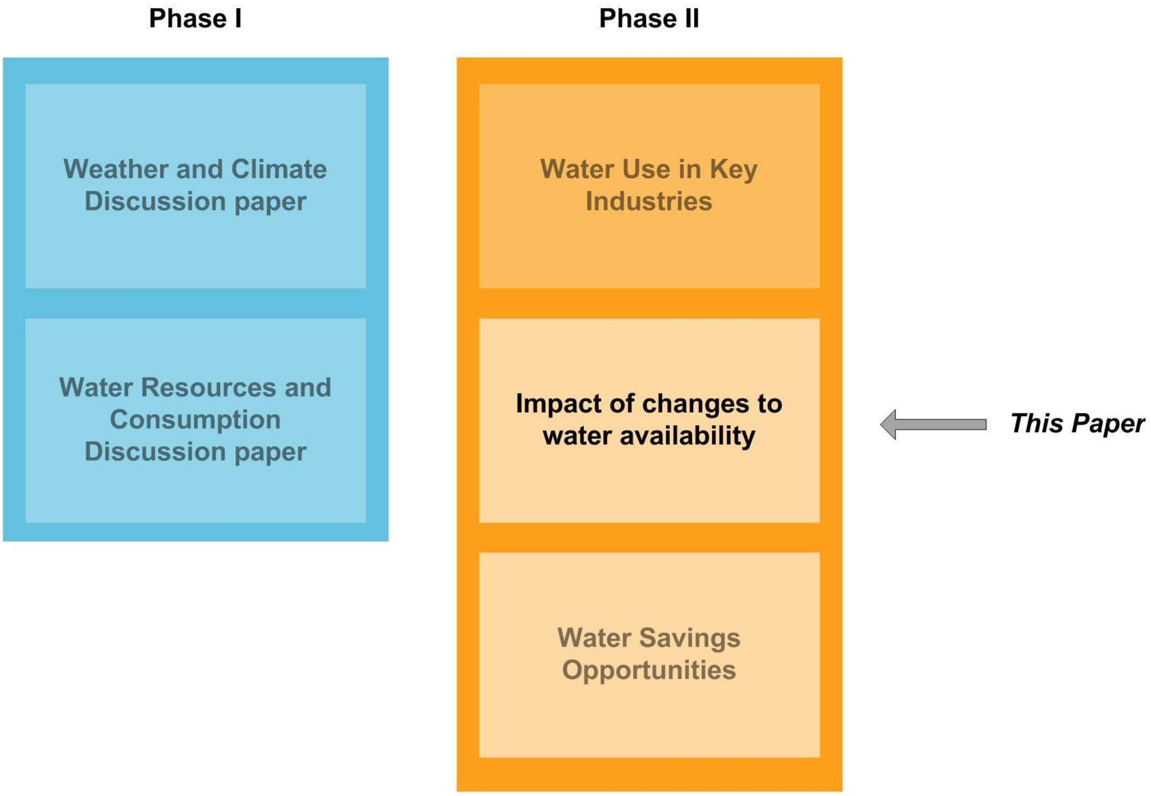

Figure 1 – Conceptual diagram of the REROC SBC project and its phases

This paper provides risk profiles for industries in the REROC region based on projected changes to water availability due to climate change and potential changes to the regulatory framework for water management within the Murray Darling Basin. Reduced water availability was considered with five scenarios: a low and a high climate change scenario, a low and a high reduction in water allocation scenario and a more frequent drought scenario. The paper focuses on the key industries identified within Paper 3 and also outlines the broader economic and social implications for the region.

2.0 Approach

2.1 Overview

This paper has included the following stages:

1) A risk profile for each industry has been developed based on upon:

- Consequence of each risk type based on water sensitivity and usage profile of each industry as established in Paper 3 and the
- The likelihood of exposure to water availability constraints due to climate change or potential changes to the Murray Darling Basin regulatory framework (As the previously released guide to the basin Plan is undergoing review, a range of conditions that are expected to capture the likely outcome have been considered and a best /worst case).

2) Implications for the REROC region

3) Adaptation options

2.2 Methodology for the Risk Assessment

2.2.1 Selection of Key industries

Industry water dependency profiles have been developed within Paper 3 – Business and Industry Water Consumption. The following key industries were considered for more detailed assessment within this paper:

- Dry land agriculture
- Meat processing
- Mining and extractive industries
- Forestry, timber and pulp processing

The importance of each industry per LGA has been determined based on ABS data and shown below in Table 1.

Table 1 – Importance of key industries per LGA

	Bland	Coolamon	Cootamundra	Gundagai	Junee	Lockhart	Temora	Tumbarumba	Tumut	WWCC
Agriculture										
Livestock Grazing	H	H	H	H	H	H	H	H	H	H
Intensive Agriculture	M	L	L	L	L	M	H	L	L	M
Dry Land Cropping	H	H	M	M	M	H	H	L	L	H
Horticulture (Orchards/Nuts)	L	L	L	L	L	L	L	H	M	L
Livestock Processing	L	L	H	H	H	L	L	L	L	H
Forestry										
Plantation	-	-	-	H	-	-	-	H	H	-
Timber Processing	-	-	-	-	-	-	-	H	-	-
Paper and Pulp	-	-	-	-	-	-	-	-	H	-

	Bland	Coolamon	Cootamundra	Gundagai	Junee	Lockhart	Temora	Tumbarumba	Tumut	WWCC
Mining and Extractive Industry										
Gold	H	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	L-M			-	-
Other	M	-	-	-	-	-	-	-	-	-

2.2.2 Risk Assessment Framework

Risks were analysed as a function of the consequences associated with the risk occurring, the likelihood of the risk occurring, and the effectiveness of the control systems in place to address the risk. The risks and impacts were assigned likelihood and consequence ratings from 1 to 5 (1 being low and 5 being high) to create a combined rating out of 25. Table 2 provides a generic overview of the consequence levels. These levels represent the degree or level of consequences likely to be exposed if a given impact occurs.

Table 2 – Qualitative measures of consequences

Level	Consequence category	Local Industry	Regional Economy	Community and Social
1	**Insignificant**	Reduced water availability can be accommodated within efficiency measures with minimal cost	Minor reduction in industry specific output with minor local economic impact	There would be minor areas in which the region was unable to maintain its current services
2	**Minor**	Reduced water availability can be accommodated within efficiency measures with moderate cost	Individually significant but isolated areas of reduction in economic performance relative to current forecasts	Isolated noticeable examples of decline in services
3	**Moderate**	Reduced water availability cannot be accommodated with efficiency measures Additional/alternative water purchase required at significant cost	Significant general reduction in economic performance relative to current forecasts	General appreciable decline in services
4	**Major**	Inability to provide water security to new industrial development	Regional stagnation such that businesses are unable to thrive and employment does not keep pace with population growth	Severe and widespread decline in services and quality of life within the community
5	**Catastrophic**	Inability to provide water security to existing industry Widespread decline of industry	Regional economic decline leading to widespread business failure, loss of employment and hardship	The region would be seen as very unattractive and unable to support its community

Table 3 provides a generic overview of the likelihoods of recurrent risks and single events. No scoring was assigned to the control aspects of the risk. The team workshop helped inform the ratings applied to the final risk assessment.

Table 3 – Qualitative measures of likelihoods

Level	Descriptor	Recurrent risks	Single events
5	**Maybe several times every year**	Could occur several times per year	More likely than not / Probability greater than 50%
4	**Maybe once every year**	May arise about once per year	As likely as not / 50/50 chance
3	**Maybe a couple of time in a generation**	May arise once in 10 years	Less likely than not but still appreciable / Probability less than 50% but still quite high
2	**Maybe once in a generation**	May arise once in 10 years to 25 years	Unlikely but not negligible / Probability low but noticeably greater than zero
1	**Maybe once in a lifetime**	Unlikely during the next 25 years	Negligible / Probability very low, close to zero

Table 4 provides a generic overview of the risk ranking. A detailed analysis of the risks is presented in Section 3.0 to Section 7.0.

Table 4 – Risk rating matrix

		Consequences				
		Insignificant (1)	**Minor (2)**	**Moderate (3)**	**Major (4)**	**Catastrophic (5)**
Likelihood	**Almost certain (5)**	Medium (5)	Medium (10)	High (15)	Extreme (20)	Extreme (25)
	Likely (4)	Low (4)	Medium (8)	High (12)	High (16)	Extreme (20)
	Possible (3)	Low (3)	Medium (6)	Medium (9)	High (12)	High (15)
	Unlikely (2)	Low (2)	Low (4)	Medium (6)	Medium (8)	Medium (10)
	Rare (1)	Low (1)	Low (2)	Low (3)	Low (4)	Medium (5)

2.2.3 Potential reduction in water availability because of changes in regulation

Regulatory regime

The Murray–Darling Basin Authority (the Authority) is charged with developing a Basin Plan for the Minister's consideration, this occurs within the framework of the *Water Act 2007* (Cwlth). The Commonwealth Parliament in 2007 and 2008 clearly laid out the general objectives of the Water Act, and prescribed how the Basin Plan was to be developed. The Water Act requires the Authority to determine the volume of water required to maintain and restore environmental assets, using best available science and the principles of ecologically sustainable development.

The Guide provides an overview of the proposed Basin Plan, and the rationale behind the proposals presented by the Authority for discussion. The Guide sets out discussions on environmental water requirements, volumes of water that can be taken for consumptive use — known as long-term average sustainable diversion limits (SDLs) — for surface water and groundwater, and transitional arrangements to support implementation of the SDLs. The Guide also outlines how the Authority proposes to put the Basin Plan into effect.

The Guide is currently being subject to consultation within the community, and further assessment in relation to the social and economic impacts of the proposal. As such the information contained within the Guide is likely to be subject to change and has been used as an indication of potential direction of changes in this discussion paper.

Sustainable Diversion Limits

Sustainable Diversion Limit (SDL) proposals will apply to all forms of water extraction (surface and ground) and include watercourse diversions such as for town and community water supplies, irrigation and industries, floodplain harvesting and interception activities such as farm dams and forestry plantations. The current limits on the volumes of water for these uses are referred to as the current diversion limits. In setting the SDLs the Authority is required to:

- Deliver additional water to the environment to meet the environmental water requirements, consistent with the *Water Act 2007* (Cwlth). At this point the MDBA anticipate the range of additional water needed for the environment is between 3,000 GL/y and 7,600 GL/y
- Optimise economic, social and environmental outcomes from these changes.

The development of SDLs as proposed within the Guide, are based on three scenarios for providing additional water to the environment at the lower end of the range. These scenarios are for an increase in water available to the environment of 3,000 GL/y, 3,500 GL/y and 4,000 GL/y. This represents proposed average reductions of between 22 per cent and 29 per cent in current diversion limits for surface water at the Basin scale. For the purposes of this assessment, and recognising the different catchments across the region, a spectrum of reductions from 10 per cent to 35 per cent has been utilised in the scenario modelling.

Water Licence buybacks

Australia has the largest cap and trade water market in the world. It exists in the Murray-Darling Basin (MDB). A cap new water extraction in the MDB commenced in 1995. So, any new business which requires irrigation water in the MDB, will need to enter the market to purchase water. The market has grown in activity and value of water traded since its inception. In 2007-2008 financial year $2.74 billion was traded. This is an increase of 75% compared to 2007 - 2008.

The Federal Government's purchase of water licences and water entitlements for the environment means that less water will be available for cities, industry and irrigation. Many water market forecasters expect that the Government 'buy-back' of water will force the price of water licences higher over the long term. The Federal Government has allocated $3.1 billion to purchase water for the environment and by the end of last year 651 gigalitres (GL) of water has been bought at a cost of just over $1 billion. This year, $270 million has been allocated for the purchase of more water licences.

2.2.4 Potential reduction in water availability because of climate change

Paper 1 of the REROC SBC project provides a detailed assessment of current weather patterns, past climate trends and future climate scenarios for the REROC region as well as the individual LGAs. This technical paper and associated annexes is a few hundred pages long but the key findings have been highlighted below. For more details on the results and the methodology please see the Discussion Paper 1

Current climate

REROC is a large and contrasted region in terms climate. At the REROC scale, there is a very clear south-east to north-west gradient. The mountainous south-east region presents the coldest and wettest climate with the lowest evaporation and the highest number of days <0°C. On the other hand, the plains of the north-west are extremely drier and hotter and present logically much higher rate of evaporation and lower annual number of days <0°C.

Past climate

The observed evolutions in the climate across the REROC are different and tend to highlight the local variations in the climate across such a large and diversified area. However the following general trends can be drawn for REROC:

- Mean annual minimum and maximum temperature increased at all weather monitoring stations within REROC;
- Mean seasonal minimum and maximum temperature increased at most weather monitoring stations within REROC with some local variations in Wagga Wagga (slight decrease in autumn minimum temperature) and Tumbarumba (no changes in maximum summer temperature and minimum autumn temperature);
- Annual rainfall decreased at most weather monitoring stations within REROC
- Seasonal rainfall showed varying evolution which can not result in an overall trends for REROC
- The annual number of rainfall days decreased at most weather monitoring stations within REROC
- The seasonal number of rainfall days again show varying evolution which can not result in an overall picture for REROC; some similar trends were found in several LGAs. For instance the summer and/or autumn rainfall have been increasing in Cootamundra, Tumbarumba, Tumut and Wagga Wagga while the summer and/or autumn number of days with rain decreased. These trends suggest than summer and autumn rainfall tended to be less frequent but either more intense or longer in duration.

- The only station with consistent evaporation data shows an increased evaporation rate at the annual and spring scale while it remained stable for the other seasons.

Projected changes in rainfall and evaporation

For the purpose of this study AECOM commissioned the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to generate locally relevant climate projections. Two emissions scenarios representing both end of the emission scenario spectrum were chosen: A1FI for the “high” emission scenario and B2 for the “low” emission scenario. These emission scenarios were used by CSIRO as input data to run a pool of 18 global climate models. The results of the models were then distributed between the “most likely future” (i.e. most of the recognised global climate models are consistent, with this scenario representing the most likely evolution of the climate in REROC) and the “worst case scenario” (i.e. a limited number of models agrees and this scenario represents the worst case evolution of the REROC climate but remain plausible). The climate variables considered in these scenarios included: air temperature, mean rainfall, relative humidity and potential evaporation. The general trends for each scenario are:

- **An increase in air mean annual and seasonal temperature** for all time horizons ranging between + 0.85°C (2030) and + 3.9°C (2070 High) for annual values in the most likely scenario and ranging between + 1.4°C (2030) and + 6.6°C (2070 High) for annual values in the worst case scenario).
- **A decrease in mean annual rainfall** for all time horizons ranging between -5% (2030) and -24% (2070 High) for annual values in the most likely scenario and ranging between -6% (2030) and -26% (2070 High) for annual values in the worst case scenario); seasonal trends show similar trends except autumn in the most likely scenario (no changes) and summer in the worst case scenario (increase between 3% and 13%).
- **A limited increase in mean annual evaporation** for all time horizons ranging between +1% (2030) and +6% (2070 High) for annual values in the most likely scenario and ranging between +2% (2030) and +11% (2070 High) for annual values in the worst case scenario); seasonal trends show similar trends except spring in the most likely scenario with a decrease ranging between -1% (2030) and -5% (2070 High) and spring in the most likely scenario with a decrease ranging between -1% (2030) and -3% (2070 High).
- **A decrease in mean annual and seasonal humidity** for all time horizons ranging between -2% (2030) and -11% (2070 High) for annual values in the most likely scenario and ranging between -5% (2030) and -21% (2070 High) for annual values in the worst case scenario.

Drought frequency and intensity

Assessment of changes in drought frequency and intensity was not part of the Discussion Paper 1 but some understanding of possible changes in drought patterns was required to conduct the risk assessment. Australia is recognised as the driest inhabited continent and more than 60% of Australia is considered as arid or semi-arid (LeHouerou, 1996). Australia is also exposed to recurring droughts and the past decade has been characterised by long lasting drought conditions especially in the south-eastern region of Australia (see Figure 2).

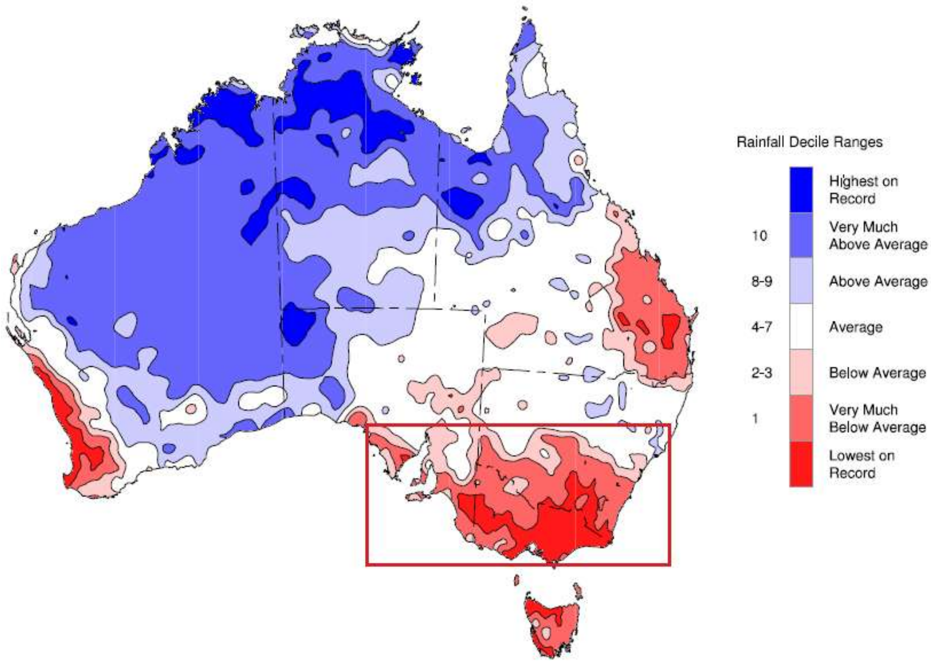

Figure 2 – Rainfall deciles across Australia between January 1997 and December 2009 (SEACI, 2010)

This drought was notably characterised by the following particulars: it was largely confined to the southern Australian region; there was year to year variability in rainfall with no "wet years" during that period; the decline was the strongest in autumn but with reduction in winter and spring as well (like in previous droughts). Some of the key changes explaining these long lasting drought conditions included: a disproportionate fall in rainfall amount during autumn resulting in very dry soil conditions are the beginning of the runoff season (with little infiltration in the first horizons of the soil and limited recharge of aquifers); a decline in rainfall during winter and spring when most of the runoff usually occurs, higher air temperature and lack of high rainfall events (SEACI, 2010).

Changes in runoff

As part of the Discussion Paper 2 "Water Resources and Consumption" data in terms of historical and projected runoff was sourced from the SEACI project and used to map runoff patterns across the REROC region. The differences between historical and projected runoff was also mapped. As shown in Figure 3, the highest changes in runoff are expected for the central region of REROC from Cootamundra to Wagga Wagga.

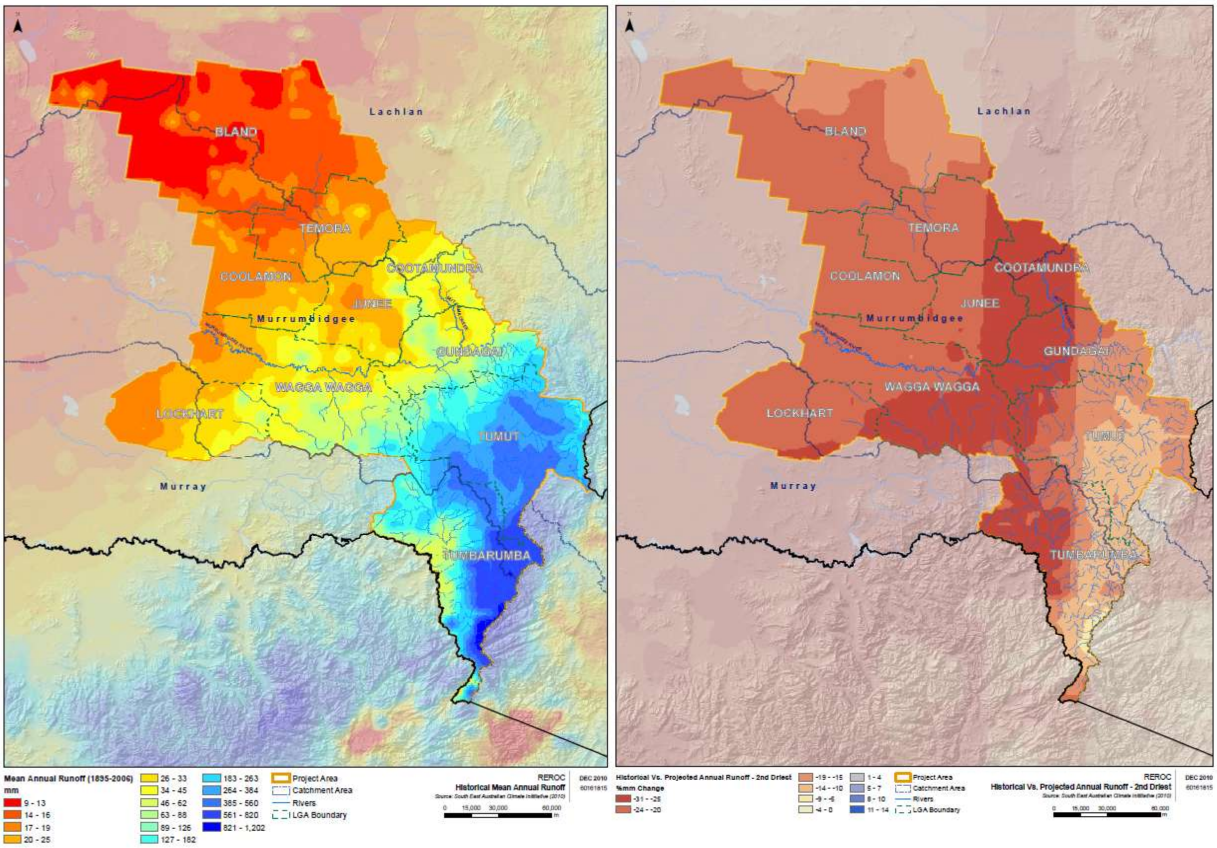

Figure 3 – Historical (left) and historical vs. projected runoff (right) for the 2nd driest scenario (SEACI/AECOM, 2010)

2.3 REROC Socio economic profiles

2.3.1 Regional Profiles for REROC

This section of the report provides a brief socio-economic overview of each of the 10 Councils in the Riverina area. Each profile accounts for population and education as socio demographic trends and then examines economic demographics such as key industries and employment and income in the LGAs. These profiles will most importantly emphasise the numbers of people and areas of industry whose water consumption will be analysed through this report. Table 5 presents key figures for the REROC region.

Table 5 – REROC socio-economic data (ABS, 2007-2008)

	Population	Unemployment Rate (%)	Annual Average Taxable Income (per person)	Number of Businesses	Key Industries	Secondary Industries
Bland	6,289	N/A	N/A	972	• Agriculture	• Construction • Retail trade • Property and other business services • Mining
Coolamon	4,177	2.7	$27,754	507	• Agriculture	• Construction • Property and other business services • Retail trade
Cootamundra	7,530	4.3	$32,818	795	• Agriculture	• Construction • Property and other business services • Retail trade • Transport
Gundagai	3,827	3.1	$30,437	486	• Agriculture	• Construction • Property and other business services
Junee	6,073	5.0	$35,673	456	• Agriculture	• Construction • Retail trade • Property and other business services • Transport and storage
Lockhart	3,275	3.0	$30,342	384	• Agriculture	• Construction • Property and other business services • Transport and Storage • Tourism
Temora	6,022	3.6	$27,824	780	• Agriculture	• Construction • Retail trade • Property and business services • Transport and storage • Aviation
Tumbarumba	3,672	2.4	$32,325	465	• Agriculture • Forestry	• Retail trade • Transport and storage • Tourism • Viticulture
Tumut	11,236	4.1	$35,114	1,080	• Forestry • Agriculture	• Construction • Retail trade • Property and business services
Wagga Wagga	61,656	3.9	$37,907	4,833	• Agriculture • Defence • Education	• Property and business services • Construction • Retail trade

2.3.2 Bland

Demographic Trends

While Bland has one of the largest REROC populations (6289 residents in 2008) because of its vast geographic area, the population density is the lowest of the LGAs with only 0.7 person per squared kilometre. The majority of the population is centred around West Wyalong, the central hub of the Shire. Bland's population is fairly young with the two largest population groups aged 5 to 9 and 10 to 14 years of age.

Education

There are a number of schools and education facilities in the Bland Shire from day care to high schools with six public schools across the different towns of the Shire. TAFE NSW Riverina Institute also has a campus in West Wyalong which is the only tertiary education institution in the Shire. While there are no available statistics on post-school qualifications if Bland could be considered a microcosm of the whole Riverina area, it could be estimated that around 35per cent of the Bland population over the aged of 15 would have a tertiary qualification. With education being a strong determinant on income and social status it is important to examine tertiary attainment as a socio demographic trend.

Key Industries

With 555 businesses of 972 in Bland in agriculture, forestry and fishing this stands out as the dominant key industry. This is much higher than other secondary industries such as property and business services, construction and retail trade. The Bland rural economy is built on sheep, cattle, wheat and other crop varieties. Alongside these primary agribusinesses, in the last few years there has been the development of other new agribusiness and mining opportunities such as the creation of the $ 220 million Cowal Gold Mine by Barrick Gold. There has also been the development by Pace Farm of its egg producing facilities which is the largest in the southern hemisphere.

Employment and Income

The main employers in the Bland Shire are agribusinesses. Larger wheat, cattle and sheep producers create opportunities for locals and the new developments mentioned above have also provided a boost in employment levels. The Australia Wheat Board also has a large facility outside West Wyalong which has improved levels of efficiency for local grain growers and provided employment to the town.

2.3.3 Coolamon

Demographic Trends

As of 2008 Coolamon had a population of 4177 with the largest age groups between 10 to 14 years and 45 to 49 years (each around 8per cent of the total). It was suggested in the 2006 census that 1.3per cent of this population is Indigenous. The majority of the Coolamon households are family households with only 26per cent in lone person or group households in either inner or outer regional areas.

Education

The Coolamon Shire has kindergarten through to Year 6 school education available in each of the six towns and two central schools in Coolamon and Ardlethan offering classes from kindergarten through to year 12. While there is no university in the LGA, the Riverina Community College and other training providers deliver outreach services to the Coolamon community. At the 2006 census 40.4per cent of the Coolamon population over the age of 15 had a post school qualification, with the highest group, 16per cent, having a Certificate Level qualification. Only 1.5per cent of the population over the age of 15 had either a Postgraduate or Graduate Diploma Degree.

Key Industries

Of the 507 businesses in Coolamon in 2008, the majority of these, 321, were in the agriculture, forestry and fishing industry. Coolamon LGA not only produces cereal crops and hay but also has animal products such as wool, lamb and beef. There has also been the emergence recently of new agricultural enterprises including the production of alpacas, ostriches, turkeys, olives and farm forestry. Other industries that have some businesses in Coolamon include construction, property and business services, retail trade, accommodation, cafes and restaurants, transport and storage. There are also some businesses in wholesale trade and finance and insurance.

Employment and Income

With the strong dominance of the rural economy, employment in Coolamon is generally with businesses in agriculture. The other main industries are also major employment providers especially in construction and retail trade. In 2008 the unemployment rate in Coolamon was 2.7per cent, well below the national average of 4.2 suggesting that most of the eligible workforce in Coolamon is usually employed. In 2007 the average taxable income (for both taxable and non-taxable individuals) was $ 27,754 and the average wage and salary income for the same year was $ 32,964.per cent.

2.3.4 Cootamundra

Demographic Trends

The Cootamundra Shire has medium sized population when compared to the other shires in the Region, 7,530 in 2008. Over the three years from 2006 to 2008 ABS statistics demonstrate that this population has been slowly declining but by no more than 30 to 80 people per year and previous to this was slowly increasing. At the last census in 2006, 3.6per cent of the Cootamundra population was Indigenous. As a smaller geographic area the population is somewhat dense for the Riverina with 4.9 persons per square kilometre. The majority of the population are also in family households (70per cent in 2006) rather than lone persons or group.

Education

In Cootamundra there are four public schools with a high school as well as a Sacred Heart Central School in Cootamundra. The Shire also hosts one higher education institution, the Cootamundra College of TAFE. At the last census in 2006 43.6per cent of the Cootamundra Shire population over the age of 15 had some type of post school qualification. The largest numbers have a Certificate Qualification and the smallest have a Post Graduate of Graduate Diploma qualification.

Key Industries

In Cootamundra the key industry, as determined by number of businesses, is agriculture with 258 of 795 businesses in the Shire. The major agribusinesses include cattle, grains, fat lambs and wool on a large scale. There has been, however, the expansion of ‘boutique’ farming which sees agriculture products prepared for both the local and export markets. In secondary industries Cootamundra is dominated by construction, retail trade and property and business services. Positioned on the main rail route between Melbourne and Sydney and only two hours from Canberra by road, Cootamundra Shire is a transportation hub for bus, rail and truck services.

Employment and Income

While agriculture is the main opportunity for employment in Cootamundra there has been a number of value added agricultural industries emerging recently which offer new types of work. Some of these include fellmongering, tanning, an abattoir and the making of speciality products such as jerky, wool skin and gourmet oils Other developing industries that have been increasing their employment opportunities include primary produce processing, small farm enterprises, waste management, recycling and agricultural research. Even with the rise of new businesses and employment, unemployment in Cootamundra was around the national average of 4.3per cent in 2008. The average annual taxable income in 2007 was $ 32,818 and the average wage and salary income in the shire in 2007 was $ 34,611.

2.3.5 Gundagai

Demographic Trends

The population of Gundagai Shire in 2008 was 3827 with approximately 1.8per cent of these people identifying as Indigenous. The largest age groups in the last few years have been those aged between 5 to 9 and 45 to 49. Unlike some of the other shire councils in REROC that have been profiled in this report, Gundagai Shire has quite a high percentage (26per cent) of people living in either lone person households or group households compared to family households. The population density in Gundagai was 1.6 persons per square kilometres in 2008.

Education

There are only a few schools in the Gundagai LGA mostly in the town of Gundagai including a parish primary school. In regards to higher education Gundagai Shire hosts both the Gundagai CTC and a Riverina Employment and Training Division. In the 2006 Census 42.1per cent of the Gundagai shire council population over the age of 15 were recorded to have a post school qualification, the majority of these being a Certificate Level qualification.

Key Industries

Similar to the other LGAs in REROC, the dominant industry in Gundagai (as throughout the region) is agriculture, forestry and fishing with almost half of the 486 businesses in Gundagai in this industry in 2008. Some of the agribusinesses include wool, lamb and beef, honey, lucerne hay and cereal crops. Recently viticulture has also become an increasingly important crop in the region. A growing use of technology in agribusinesses has seen the modern Gundagai Meat Processes Plant established. Secondary industries measured by number of businesses could be considered to be property and business services and construction. One of the major construction firms D J Lynch Engineering has been working on a number of major constructions in the area and around Australia.

Employment and Income

In examining wage and salary earners by occupation, the largest employee group in Gundagai is labourers and related workers who are engaged in work in agriculture and construction. In Gundagai the average annual wage and salary income in 2007 was $ 31,761 while the average annual taxable income (for taxable and non-taxable individuals) was $ 30,437. In 2008 Gundagai had an unemployment rate of 3.1per cent, one of the lower rates in the region.

2.3.6 Junee

Demographic Trends

The population of Junee Shire in 2007 was 6,073. It has a population close to the state and regional average, however, the Shire has a slightly higher proportion of residents in the 25- 64 age group. The population density is fairly similar to other shires in the area with 3 persons per square kilometre who live within Junee, Bethungra, Illabo and Old Junee.

Education

Junee has a number of schools across the Shire, however being quite a small shire there are no higher education facilities. Regardless of this Junee has a much higher percentage of its population over 15 with a post school qualification, 53.2per cent compared to the Riverina average of 35per cent. The largest of these groups contains those with a Certificate Level qualification according to the 2006 Census however 26.4per cent of the 53 did not describe or state what level of qualification had been attained.

Key Industries

Agriculture is the major industry in Junee and it is an area well known for its lamb and crops of wheat, canola, oats, barley and triticale. There is also quite a large manufacturing-agricultural sector especially for meat processing and organic flour. Secondary industries of Junee are similar to other LGAs with construction, retail trade, property and business services having large numbers of businesses in the Shire. Junee also has a strong transport industry with not just commercial but freight rail services passing through from Junee to Sydney and also down to Melbourne

Employment and Income

Two of the largest employers in the Junee Shire are the agriculture and transport and storage industries. While there is a wide variety of employment available in 2008 the level of unemployment at 5.2per cent was slightly above the average in Australia of 4.2. In 2007 the average taxable income was $ 32,827 per annum and the average wage and salary income was $ 36,474.

2.3.7 Lockhart

Demographic Trends

As one of the smaller LGAs, geographically, in the Riverina, Lockhart has a fairly modest population of 3,275 across the main towns of Lockhart, The Rock, Yerong Creek and Milbrulong. The Shire also has quite a low population density of 1.1 persons per square kilometre. The age groups from 35 to 59 are some of the larger groups but the largest group in 2008 was 10 to 14 years. The 2006 census counted that 1.3per cent of the whole population identified as Indigenous. In regards to living arrangements almost 75per cent of the Shire's households are family households while the rest are either lone or group households.

Education

There are a number of primary schools in the different towns in the Shire with the township of Lockhart also having a Central school for kindergarten to year 12 and a primary school and The Rock having a Central school for kindergarten to year 10. The Shire has no tertiary education facilities with students having to study via correspondence or travelling/moving to other towns or cities out of the Shire.46.6per cent of the population over the age of 15 has some level of post school qualifications, a small number in the postgraduate/graduate diploma area, slightly more in bachelor or advanced diploma and then the largest with a certificate level.

Key Industries

Lockhart LGA has a predominately rural based industry with 260,000 hectares used for agricultural purposes. Cattle and sheep production is spread throughout the district as well as crops such as canola, wheat and barley. In regards to number of businesses out of a total of 384 in 2008 there were 207 in agriculture, 45 in property and business services, 30 in construction and 27 in transport. Tourism is also an emerging new industry in the LGA especially with an increasing emphasis on its historical and heritage based industries. Lockhart and The Rock are in easy driving distance from larger towns like Wagga Wagga and Albury.

Employment and Income

Lockhart Shire has strong levels of employment with low unemployment rates of 3per cent in 2008. The strong rural economy provides valuable employment opportunities, especially with seasonal work in November and December during harvesting of crops. The average taxable income (for taxable and non-taxable individuals) in 2007 was $ 30,342 and the average wage and salary income was $ 32,389 per person.

2.3.8 Temora

Demographic Trends

Temora has one of the bigger populations in the Region with 6,022 people with the largest age groups aged 45 to 49 and 10 to 14 which is a similar trend to some of the other shires like Coolamon. The low distribution of 2.1 persons per square kilometre could be considered fairly standard across regional Australia. In the 2006 census 68per cent of the Shire’s households were family households with 30per cent as lone person households and the final 2per cent as group households. The town of Temora and villages of Ariah Park and Springdale are home to non-rural dwellers.

Education

Temora has a pre-school, four primary schools, both private and public, and three high schools. While there are no tertiary institutions, the Wagga Wagga campus of Charles Sturt University is less than an hour’s drive from the town of Temora. In the 2006 Census 42per cent of the Temora shire population over the age of 15 were recorded to have a post school qualification, the majority of these being a Certificate Level qualification.

Key Industries

The main industries in the Temora Shire are based on agriculture and grazing with Temora in the heart of the grain growing areas of southern NSW. The LGA is one of the largest producers in NSW of cereal gains, canola, wheat and wool. The agriculture industry includes a number of support industries including wool storage and brokerage, bulk wheat storage and brokerage, chemical and fertiliser suppliers and agricultural equipment suppliers. Secondary industries according to the number of businesses include construction, property and business services and retail trade as well as transport and storage. Aviation is considered an important industry in Temora on account of growing success of air show related tourism.

Employment and Income

Employment opportunities in the Temora Shire, like all shires in the Riverina, are strongly centred towards the primary and secondary industries with large numbers of employers in transport, retail, service and professional services. In 2008 Temora had a lower than the national average unemployment rate of 3.6per cent. The average annual taxable income in 2007 was $ 27,824 and average wage and salary income was $ 31,575 which is slightly lower than some of the other Shire incomes.

2.3.9 Tumbarumba

Demographic Trends

Despite covering quite a large geographical area, Tumbarumba has one of the smaller populations in the Region with only 3,672. The Shire also has the lowest population density with only one person per square kilometre. This may be in part attributed to the quite mountainous geography that is unsuited to settlement. 70per cent of the population live in family households, 28per cent in lone person households and only 2per cent in group households.

Education

The Tumbarumba Shire has two preschools, five public schools and one high school. With no tertiary education providers in the Shire, people wishing to access further study must do so via remote studies. The closest institutions are the Riverina TAFE campuses in Wagga Wagga and Tumut and the Charles Sturt University also in Wagga Wagga. Levels of post school qualifications in the Shire are relatively high with 47.2per cent of the population over the age of 15 attaining anything from a Certificate level qualification to a Postgraduate Degree.

Key Industries

Tumbarumba's largest industry is in softwood timber processing and plantation with the Hyne and Sons Timber Mill being one of the largest single employers. Other traditional agriculture industries in the LGA include beef and dairy products as well as wool production, pasture seed, cultivated turf, pasture hay and pome fruit. New agricultural industries include blueberries and strawberries. The Tumbarumba Shire is also quickly establishing itself as one of Australia's prime cool-climate wine growing regions with over 30 vineyards now operating. Other secondary industries in the Shire include retail trade, transport and storage and tourism.

Employment and Income

Tumbarumba in 2008 had one of the lowest unemployment rates of all the REROC shires at 2.4per cent which is unsurprising with the strong industry base and ongoing expansion of the Timber industry. The annual average taxable income in Tumbarumba was $ 32,325 in 2007 with the average wage and salary income at $ 30, 249. This is similar to the averages in the other Shires in REROC.

2.3.10 Tumut

Demographic Trends

Tumut Shire has the second largest population, after Wagga Wagga, out of the REROC councils. Despite this the population density is still quite low at 2.5 persons per square kilometre spread out across the towns of Tumut, Adelong and Batlow as well as rural areas. Similar to other towns in the Region at the 2006 census most households are family households (around 70per cent) and there is only a very small amount in group households.

Education

There are a large number of schools across the Tumut region to account for the large population including nine primary schools, three high schools, pre-schools and also the Gadara support school for students with a disability. The Tumut campus of TAFE Riverina is the only tertiary institute in the LGA. It offers a range of courses for the community and industry and is also recognised as a leading trainer for the NSW Forestry sector. The level of post school qualifications in Tumut LGA is fairly similar to some of the other shires with 45per cent of the population aged 15 years and over having attained some type of qualification with a majority of these with Certificate levels.

Key Industries

Forestry and forest products are the predominant source of economic activity in the Tumut shire with activities ranging from seedling development, planting and harvesting through to the export of manufactured paper products. Carter Holt Harvey Wood Products Pty Ltd, and Visy are the two companies that dominate the market. Apart from forestry the diverse industry also includes agriculture, construction, transport, tourism, retail trade, horticulture and aquaculture.

Employment and Income

Average industry growth in the Tumut Shire is extremely high and it is expected that hundreds of direct and indirect jobs will be created over the next few years across timber and forestry, construction, transport, engineering and power. The timber industry is currently, and expected to stay the largest employer in the area. In 2008 the unemployment rate was 4.2per cent with the average annual taxable income at $ 35,114 and the average wage and salary income at $ 36,672.

2.3.11 Wagga Wagga

Demographic Trends

Wagga Wagga LGA has a very different profile to the other REROC LGAs because of the main city Wagga Wagga, which is one of the largest regional cities in Australia and the largest in NSW. In 2008 the population in Wagga Wagga LGA was well above the other councils in the Region with 61,656 people and a population density of 12 persons per square kilometre. It also has a large percentage of Indigenous people compared to the other LGAs with 4.2per cent of the population identifying as Indigenous in the 2006 census. Wagga Wagga has quite a young population with a high proportion of persons under the age of 24.

Education

Wagga Wagga has a wide variety of schooling on offer from pre-school through to high school with private and public options available as well as schools for children with disabilities. Wagga Wagga also has the largest variety of tertiary education institutions in the Region with both a TAFE campus and a campus of Charles Sturt University. Of all the REROC LGAs, Wagga Wagga has the largest percentage of people aged 15 and over with a post school qualification. While it still has a high proportion of Certificate achievers like the otherLGAs there is a larger cohort of people with the highest education attainments such as postgraduate degrees and graduate diplomas.

Key Industries

The key industries in Wagga Wagga are defence, agriculture, education, manufacturing and tourism. The sheep, cattle (dairy and beef) and grain farming sectors have historically been the backbone of the local economy with other smaller agricultural businesses around floriculture production and deer farming. It is an LGA that has been well supported by industry facilities as well as a strong supply chain and access to export infrastructure. The key industry of defence is a unique industry for Wagga Wagga LGA with the city of Wagga Wagga being one of Australia’s most significant defence force bases, comprising the Kapooka army recruit training base and the Royal Australian Air force training base.

Employment and Income

Similar to the other LGAs the main employers in the Wagga Wagga Shire are agribusinesses. With the growth of these industries, especially tourism and retail it is expected that the job market will continue to offer a variety of opportunities for those living in the LGA. Over the last few years unemployment has been similar to that of the national average or just under with a rate of 3.9per cent in 2008. Incomes are higher than others in the REROC area with the annual average taxable income for taxable and non taxable individuals at $ 37,907 in 2008 and the average wage and salary income at $ 37, 135.

3.0 Agriculture

Predicted changes in climate present challenges to all sectors and agriculture will be particularly vulnerable as the sector is heavily reliant on natural resources. Climate change impacts are likely to vary geographically and between agricultural sectors, with the potential for both positive and negative impacts. For crops and pastures, climate change could lead to plants facing both extremes of water stress (i.e. drought and water logging) and changes in the distribution, abundance and severity of insect pests, pathogens and weeds.

3.1 Importance of Agricultural Activities per LGA

	Bland	Coolamon	Cootamundra	Gundagai	Junee	Lockhart	Temora	Tumbarumba	Tumut	WWCC
Dry Land Cropping										
Cereals for grain	**High**	**High**	**Med**	**Med**	**Med**	**High**	**High**	**Low**	**Low**	**Med**
Non-cereal broadacre crops	**Med**	**Med**	**Med**	**Low**	**Med**	**High**	**Med**	**Low**	**Low**	**Med**
Horticulture										
Orchard trees (including nuts)		**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**High**	**Med**	**Low**
All fruit (excluding grapes)		**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**High**	**Med**	**Low**
Livestock Grazing										
Meat cattle	**Med**	**Med**	**Med**	**High**	**Med**	**Med**	**Med**	**High**	**High**	**Med**
Sheep and lambs	**High**	**High**	**High**	**High**	**High**	**High**	**High**	**Med-High**	**Med-High**	**High**
Milk cattle (excluding house cows)	**Med**	**Low**	**Low**	**Low**	**Low**	**Low**	**Low**	**Med**	**High**	**Low**
Intensive Agriculture										
Pigs	**Med**	**Low**	**Low**	**Low**	**Low**	**Med**	**High**	**Low**	**Low**	**Med**

3.2 Livestock Grazing

<table>
<tr><th>Risk of Reduced Water Availability</th><th>Risk Rating 2030</th><th>Risk Rating 2070</th><th>Risk Description</th><th colspan="2">Likelihood</th><th colspan="2">Consequences</th></tr>
<tr>
<td rowspan="2">Reduced rainfall – Most likley scenario

<u>2030</u>
Annual: ↘ (-5%)
Summer:↘ (-3%)
Autumn: No changes
Winter: ↘↘ (-11%)
Spring: ↘↘ (-13%)

<u>2070 High</u>
Annual: ↘↘ (-24%)
Summer↘↘ (-12%)
Autumn: ↘ (-1%)
Winter: ↘↘ (-50%)
Spring: ↘↘ (-59%)

<u>Note</u>: 2070 Low is relatively close to 2030 in terms of rainfall projections</td>
<td rowspan="2">Medium (8)</td>
<td rowspan="2">Medium (9)</td>
<td rowspan="2">Risks of reduced feeding potential from pasture

Within the REROC study area, open grazing is the primary form of livestock production with sheep and cattle being the predominant stock. Many of the pastures used are ‘improved pastures’. An improved pasture is a sown pasture that includes introduced pasture species, usually grasses in combination with legumes. These are generally more productive than the local native pastures, have higher protein and metabolisable energy and are typically more digestible. Improved pastures can play an important role in lifting the productivity and profitability of an enterprise, provided they are suited to the environment and are managed well from establishment through to grazing. Compared to native grasses, many of the improved pasture components are less drought tolerant and therefore may become more susceptible. The risk of reduced rainfall is for impacts to pasture load and nutritional quality.</td>
<td>4</td>
<td>Likely by 2030 – This rainfall scenario is considered likely because 18 out of 19 climate models show consistent projections. Additionally there are fewer uncertainties associated with projections by 2030 than by 2070 (notably due to higher confidence in emission scenarios).</td>
<td>2</td>
<td>Minor by 2030 - The pastures mixtures are likely to require some adjustment to accommodate increased temperature, reduced rainfall and increased evaporation if productivity is to be maintained.</td>
</tr>
<tr>
<td>3</td>
<td>Possible by 2070 – The likelihood is similar to 2030 (18 climate models out of 19 show consistent projections) however there are higher uncertainties associated with projections by 2070 (notably linked to emission scenarios).</td>
<td>3</td>
<td>Moderate by 2070 - Under the high emission scenario, the reduction in underlying average rainfall is substantial and critically shortages occur most prominently in winter and spring, which currently are the most important seasons for strong rainfall. Reduction in rainfall of this magnitude would moderately alter the landscape and may affect the suitability of currently common pasture grasses.</td>
</tr>
</table>

Risk of Reduced Water Availability	Risk Rating 2030	Risk Rating 2070	Risk Description		Likelihood		Consequences
Reduced rainfall – Most likley scenario <u>2030</u> Annual: ↘ (-5%) Summer:↘ (-3%) Autumn: No changes Winter: ↘↘ (-11%) Spring: ↘↘ (-13%) <u>2070 High</u> Annual: ↘↘ (-24%) Summer↘↘ (-12%) Autumn: ↘ (-1%) Winter: ↘↘ (-50%) Spring: ↘↘ (-59%) <u>Note</u>: 2070 Low is relatively close to 2030 in terms of rainfall projections	**Medium (8)**	**Medium (9)**	**Impacts to water availability for stock watering** Most farms are able to utilise a combination of water supply options (in order of lowest – highest cost): 1. Farm dams (basic harvestable rights) 2. Bore water (licensable) 3. Surface water extraction (licensable) 4. Town water supply The impact of a failure to provide water to stock is severe and within days stock losses can occur. The reduction in rainfall and increased evaporation projected would impact on the ability of farm dams to be replenished and therefore a higher cost source would be required to be utilised more often. This could impact on profitability and potential job losses.	**4**	**Likely by 2030** – This rainfall scenario is considered likely because 18 out of 19 climate models show consistent projections. Additionally there are fewer uncertainties associated with projections by 2030 than by 2070 (notably due to higher confidence in emission scenarios).	**2**	**Minor by 2030** – As a result of the diversification of supply that has occurred as an adaptation measure during the recent extended drought - the underlying reduced annual averages of rainfall may be accommodated - although increased costs would be incurred. Based on the work in Paper 3 it is clear livestock grazing is highly water intensive for each dollar of output. As such, where the input cost for water increases this is expected to impact on profitability. The projected reduction in rainfall and consequently harvestable runoff by 2030 is substantial although it may be a less prominent threat than the natural variation that is currently accounted for in the system.
				3	**Possible by 2070** – The likelihood is similar to 2030 (18 climate models out of 19 show consistent projections) however there are higher uncertainties associated with projections by 2070 (notably linked to emission scenarios).	**3**	**Moderate by 2070** – The high scenario shows reductions of 59% in spring. This is significant as it is during this season that dams are filled to provide capacity during drier summer months. To offset this loss a reliance on alternative sources at great cost will be required.

Risk of Reduced Water Availability	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Most likely scenario 2030 Annual: ↘ (-5%) Summer: ↘ (-3%) Autumn: No changes Winter: ↘↘ (-11%) Spring: ↘↘ (-13%) 2070 High Annual: ↘↘ (-24%) Summer ↘↘ (-12%) Autumn: ↘ (-1%) Winter: ↘↘ (-50%) Spring: ↘↘ (-59%) Note: 2070 Low is relatively close to 2030 in terms of rainfall projections	**Medium (8)**	**Medium (9)**	**Risks of reduced feeding potential from pasture** Within the REROC study area, open grazing is the primary form of livestock production with sheep and cattle being the predominant stock. Many of the pastures used are 'improved pastures'. An improved pasture, is a sown pastures that includes introduced pasture species, usually grasses in combination with legumes. These are generally more productive than the local native pastures, have higher protein and metabolisable energy and are typically more digestible. Improved pastures can play an important role in lifting the productivity and profitability of an enterprise, provided they are suited to the environment and are managed well from establishment through to grazing. Compared to native grasses, many of the improved pasture components are less drought tolerant and therefore may become more susceptible. The risk of reduced rainfall is for impacts to pasture load and nutritional quality.	**4**	**Likely by 2030** – This rainfall scenario is considered likely because 18 out of 19 climate models show consistent projections. Additionally there are fewer uncertainties associated with projections by 2030 than by 2070 (notably due to higher confidence in emission scenarios).	**3**	**Moderate by 2070** - Under the high emission scenario, the reduction in underlying average rainfall are severe and critically shortages occur most prominently in winter and spring, which currently are the most important seasons for strong rainfall. Reduction in rainfall of this magnitude would significantly alter the landscape and suitability of currently common pasture grasses.
				3	**Possible by 2070** – The likelihood distribution is similar to 2030 (18 climate models out of 19 show consistent projections) however there are higher uncertainties associated with projections by 2070 (notably linked to emission scenarios).		

Risk of Reduced Water Availability	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Worst case scenario 2070 High Annual: ↘↘ (-26%) Summer↗↗ (13%) Autumn: ↘↘ (-29%) Winter: ↘↘ (-103%) Spring: ↘↘ (-72%) Note: 2070 Low is relatively close to 2030 in terms of rainfall projections	-	**Medium (8)**	**Impacts to water availability for stock watering** The pasture load and quality is dependent upon the availability of rainfall and evaporation. The conditions in 2030 'worst case' are consistent with the 'most likely' case although with more severe reductions during the important winter and springs seasons.	**2**	**Unlikely by 2030 and 2070** – This rainfall scenario is unlikely as only 5 models out of 19 show consistent projections. The probability is low but not negligible.	**4**	**Major by 2070** – Under the high emission scenario, the reduction in underlying average rainfall are severe (103% in winter) and critically shortages occur most prominently in winter and spring, which currently are the most important seasons for strong rainfall. Reduction in rainfall of this magnitude would severely alter the landscape and suitability of current improved pasture grasses and livestock selection.
Increased frequency of droughts	**12 (High)**	**16 (High)**	**Risks to drinking water and decrease availability of feedstock** The potential impact includes: • Impacts to feedstock from reduced rainfall, increase evaporation and soil moisture reduction • Reduced natural rain fed water supply into dams and increased evaporation With increased frequency of drought there are greater risks in long term planning and stocking rates as destocking may be required during extended dry periods.	**3** **4**	**Possible by 2030** – Drought frequency could increase as a result of rainfall decrease during autumn, winter and spring and increased air temperature. **Likely by 2070** – Drought frequency is more likely by 2070 as reduction in autumn, winter and spring are projected to be more pronounced and air temperature are modelled to be significantly warmer.	**4**	**Major by 2070** – With reduced reliability of rainfall, the sustainable productive capacity becomes more uncertain and output reduces. Variability has been demonstrated to be a key driver in economic output from agricultural related activities. The capacity for livestock production to respond to more frequent drought is reduced by the need for long term planning in breed selection and herd management.

Risk of Reduced Water Availability	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduction in allocation of 10%	**Medium (8)**	**Medium (8)**	**Decrease availability/increased cost of drinking water** During dry periods alternative (non rain fed dams) water supply options are utilised by graziers to water their stock. During the recent extended drought many farmer relied on town water supply. Pressure to reduce water extraction across the basin will place greater pressure on farmers relying on alternative supply during dry periods to supply their stock.	**4**	**Likely by 2030 and 2070** – Reduction in allocation by 10% is as likely as not. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**2**	**Minor by 2030 and 2070** – The risk of changes to the regulatory regime in the basin will have less impact upon dry land farmingdue to the primary reliance upon rainfall. However during extended periods of reduced rainfall where allocations are also reduced the ability to supply livestock may be impacted. A failure to provide alternative supply would be critical to livestock and could result in significant loss or offloading of stock. Typically is expected there are enhancements in efficiency that can be achieved through demand management and improved techniques for the delivery of water may achieve 10-15%. Across the wider network achieving savings of up to 10% may be achieved at relatively modest cost.

Risk of Reduced Water Availability	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduction in allocations of 35%	**Medium (6)**	**Medium (6)**	**Decrease availability/increased cost of drinking water** During dry periods alternative (non rain fed dams) water supply options are utilised by graziers to water their stock. During the recent extended drought many farmer relied on town water supply. Pressure to reduce water extraction across the basin will place greater pressure on farmers relying on alternative supply during dry periods to supply their stock.	**2**	**Unlikely by 2030 and 2070** – Reduction in allocation by 35% is unlikely but not negligible. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**3**	**Moderate by 2030 and 2070** – The risk of changes to the regulatory regime in the basin will have less impact upon dry land farmingdue to the primary reliance upon rainfall. However during extended periods of reduced rainfall where allocations are also reduced the ability to supply livestock may be impacted. A failure to provide alternative supply would be critical to livestock and could result in significant loss or offloading of stock. It is expected that enhancements in efficiency that can be achieved through demand management and improved techniques for the delivery of water may achieve 10-15%. Across the wider network achieving savings of up to 35% could significantly impact the ability to provide water to livestock.

3.3 Intensive Livestock Production

Risk of Reduced Water Availability	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Most likley scenario 2030 Annual: ↘ (-5%) Summer:↘ (-3%) Autumn: No changes Winter: ↘↘ (-11%) Spring: ↘↘ (-13%) 2070 High Annual: ↘↘ (-26%) Summer↘↘ (-12%) Autumn: ↘ (-1%) Winter: ↘↘ (-50%) Spring: ↘↘ (-59%) Note: 2070 Low is relatively close to 2030 in terms of rainfall projections	**Medium (8)**	**Medium (6)**	**Risks to availability of grains and other feedstock** Reduced rainfall impacts the availability of grain and other feedstock, which impact productivity and profitability resulting in potential job losses.	4	**Likely by 2030** – This rainfall scenario is considered likely because 18 out of 19 climate models show consistent projections. Additionally there are fewer uncertainties associated with projections by 2030 than by 2070 (notably due to higher confidence in emission scenarios).	2	At 2030 the reductions are modest and manageable with improved tilling techniques and land management practices. The impact will be primarily cost.
				3	**Possible by 2070** – The likelihood distribution is similar to 2030 (18 climate models out of 19 show consistent projections) however there are higher uncertainties associated with projections by 2070 (notably linked to emission scenarios).	2	At 2070, the impacts of winter and spring rainfall reductions are significant and the subsequent impact on grain production would be expected to result in price increases.

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<u>2070 High</u>
Annual: ↘↘ (-26%)
Summer↘↘ (-12%)
Autumn: ↘ (-1%)
Winter: ↘↘ (-50%)
Spring: ↘↘ (-59%)
<u>Note</u>: 2070 Low is relatively close to 2030 in terms of rainfall projections</td><td rowspan="2">Low (4)</td><td rowspan="2">Medium (6)</td><td rowspan="2">Risks to availability of drinking water
Reduced rainfall reducing the volume of water available from rain fed dams and other storage impacting upon water supply costs which affects profitability and potential job losses.</td><td>4</td><td>Likely by 2030 – This rainfall scenario is considered likely because 18 out of 19 climate models show consistent projections. Additionally there are fewer uncertainties associated with projections by 2030 than by 2070 (notably due to higher confidence in emission scenarios).</td><td>1</td><td>Insignificant by 2030 – Due to the intensity of feedlot or piggery operations they tend to current utilise a variety of water sources including, rain fed dams, groundwater, surface water and town water. The consequence of 5% annual average reduction is not expected to be of minor cost only.</td></tr>
<tr><td>3</td><td>Possible by 2070 – The likelihood distribution is similar to 2030 (18 climate models out of 19 show consistent projections) however there are higher uncertainties associated with projections by 2070 (notably linked to emission scenarios).</td><td>2</td><td>Minor by 2070 – The 2070 High scenario would during the winter and spring result in significant water reduction for rain fed dams. However given the exiting supply diversity the impact on operations are expected to be moderate cost only.</td></tr>
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<tr><td rowspan="2">Reduced rainfall – Worst case scenario
<u>2070 High</u>
Annual: ↘↘ (-26%)
Summer↗↗ (13%)
Autumn: ↘↘ (-29%)
Winter: ↘↘ (-103%)
Spring: ↘↘ (-72%)
<u>Note</u>: 2070 Low is relatively close to 2030 in terms of rainfall projections</td><td>-</td><td>Low (4)</td><td>Risks to availability of grains and other feedstock
Reduced rainfall impacting the availability of grain and other feedstock, which impact productivity and profitability resulting in potential job losses.</td><td>2</td><td>Unlikely by 2030 and 2070– This rainfall scenario is unlikely as only 5 models out of 19 show consistent projections. The probability is low but not negligible.</td><td>2</td><td>Minor by 2070 – The impacts of winter and spring rainfall reductions are significant and the subsequent impact on grain production would be expected to result in price increases.</td></tr>
<tr><td>Low (2)</td><td>Low (4)</td><td>Risks to availability of drinking water
Reduced rainfall reducing the volume of water available from rain fed dams and other storage impacting upon water supply costs which affects profitability and potential job losses.</td><td>2</td><td>Unlikely by 2030 and 2070– This rainfall scenario is unlikely as only 5 models out of 19 show consistent projections. The probability is low but not negligible.</td><td>12</td><td>Minor by 2070 – The 2070 High scenario would during the winter and spring result in significant water reduction for rain fed dams. However given the exiting supply diversity the impact on operations are expected to be moderate cost only.</td></tr>
</table>

Risk of Reduced Water Availability	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Increased drought frequency and climate variability	**Medium (6)**	**Medium (8)**	**Secondary risks to intensive livestock** The potential impact of drought on livestock processing includes: • Reliability and increased cost of animal feedstock due to broadacre cropping impacts • Reduced rainwater harvesting opportunities creates a need for more expensive ware sources to be utilised • Restrictions upon water allocations can impact operations and productivity • The cost of water to attain higher security yields can impact profitability and jobs Increased water demand from animals due to increased temperature and evaporation	**3**	**Possible by 2030** – Drought frequency could increase as a result of rainfall decrease during autumn, winter and spring and increased air temperature.	**2**	**Minor by 2030 and 2070** – The intensive livestock production within Riverina accommodates primarily feedlot cattle and piggeries. The reliance upon broadacre cereals for feedstock places the industry at risk to downturns in this broadacre cropping cause feed shortage and increased costs. During extended periods of drought water demand increases. Wider water restrictions can become more severe and costs of alternative water supply can impact the day to day operations. The current diversity of supply options and higher value for water usage for this industry creates greater adaptive capacity to respond to drought and variability. However the impact of drought may still result in significant cost impacts for feed and water.
				4	**Likely by 2070** – Drought frequency is more likely by 2070 as reduction in autumn, winter and spring are projected to be more pronounced and air temperature are modelled to be significantly warmer.		

Risk of Reduced Water Availability	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduction in allocation of 10%	**Low (4)**	**Low (4)**	**Overall impacts on business operations** Reductions of 10% in allocations across the wider catchment passed on to end users impacting productive capacity resulting in potential for job losses.	**4**	**Likely by 2030 and 2070** – Reduction in allocation by 10% is as likely as not. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**1**	**Insignificant by 2030 and 2070** - Intensive agriculture is a relatively high water user. The ability of intensive agriculture to find savings through in water usage through more efficient practice and recycling are high.
Reduction in allocations of 35%	**Medium (6)**	**Medium (6)**	**Overall impacts on business operations** Reduced rainfall reducing the volume of water available from rain fed dams and other storage impacting upon water supply costs which affects profitability and potential job losses.	**2**	**Unlikely by 2030 and 2070** – Reduction in allocation by 35% is unlikely but not negligible. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**3**	**Moderate by 2030 and 2070** - A reduction of 35% would be very difficult for intensive agriculture to achieve. For savings above 10-15% water efficiency devices and a high level of alternative water capture and recycling would be required at considerable costs.

3.4 Broadacre Cropping

<table>
<tr><th>Risk Titled</th><th>Risk Rating 2030</th><th>Risk Rating 2070</th><th>Risk Description</th><th colspan="2">Likelihood</th><th colspan="2">Consequences</th></tr>
<tr>
<td rowspan="2">Reduced rainfall – Most likley scenario

<u>2030</u>
Annual: ↘ (-5%)
Summer: ↘ (-3%)
Autumn: No changes
Winter: ↘↘ (-11%)
Spring: ↘↘ (-13%)

<u>2070 High</u>
Annual: ↘↘ (-26%)
Summer ↘↘ (-12%)
Autumn: ↘ (-1%)
Winter: ↘↘ (-50%)
Spring: ↘↘ (-59%)

<u>Note</u>: 2070 Low is relatively close to 2030 in terms of rainfall projections</td>
<td rowspan="2">Medium (8)</td>
<td rowspan="2">High (12)</td>
<td rowspan="2">Reduced rainwater resources for rain fed agriculture

The primary crops considered for this assessment are canola and grain crops (using wheat as a proxy).

Typically the prime growing season is from April – October. As such, impacts to the Winter and Spring rainfall will be more relevant than annual average reductions.

Studies have indicated 175mm per April – October growing season is a key requirement for productive dry land cropping. Currently the average winter and Spring rainfall based on Wagga Wagga rainfall is 330 mm.

This risk relates to reduced rainfall impacting the productivity and profitability of dryland cropping and potential for job losses.</td>
<td>4</td>
<td>Likely by 2030 – This rainfall scenario is considered likely because 18 out of 19 climate models show consistent projections. Additionally there are fewer uncertainties associated with projections by 2030 than by 2070 (notably due to higher confidence in emission scenarios).</td>
<td>2</td>
<td>Minor by 2030 – In 2030 the projected reductions in Winter and Spring rainfall will reduce the productivity current cropping practices. Based on the work by French and Shultz this reduction could be in the order of 20%.</td>
</tr>
<tr>
<td>3</td>
<td>Possible by 2070 – The likelihood distribution is similar to 2030 (18 climate models out of 19 show consistent projections) however there are higher uncertainties associated with projections by 2070 (notably linked to emission scenarios).</td>
<td>4</td>
<td>Major by 2070 – In 2070 the projected reductions in Winter and Spring rainfall will significantly reduce the productivity current cropping practices. By reducing the rainfall by around 50% during the Winter and Spring cropping season the feasibility of dry land cropping becomes questionable.</td>
</tr>
</table>

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Worst case scenario <u>2070 High</u> Annual: ↘↘ (-26%) Summer↗↗ (13%) Autumn: ↘↘ (-29%) Winter: ↘↘ (-103%) Spring: ↘↘ (-72%) <u>Note</u>: 2070 Low is relatively close to 2030 in terms of rainfall projections	-	**Medium (10)**	**Reduced rainwater resources for rain fed agriculture** The primary crops considered for this assessment are canola and grain crops (using wheat as a proxy). Typically the prime growing season is from April – October. As such, impacts to the Winter and Spring rainfall will be more relevant than annual average reductions. Studies have indicated 175mm per April – October growing season is a key requirement for productive dry land cropping. Currently the average winter and Spring rainfall based on Wagga Wagga rainfall is 330 mm. This risk relates to reduced rainfall impacting the productivity and profitability of dryland cropping and potential for job losses.	**2**	**Unlikely by 2030 and 2070** – This rainfall scenario is unlikely as only 5 models out of 19 show consistent projections. The probability is low but not negligible.	**5**	**Catastrophic by 2070** – The high emission scenario projects reductions of up to 72-103% in spring and winter. This is a critical reduction and would for average or below average rainfall seasons prevent viable dryland cropping.
Increased drought frequency and climate variability	**Medium (9)**	**High (12)**	**Impacts of drought conditions on dryland agriculture** The potential impact of drought on broadacre cropping includes: - Fewer seasons suitable for planting due to reduced rainfall and increased evaporation impacting soil moisture - Reduced productivity of crops planted due to variable rainfall missing key growth stages of crops resulting in crop stress	**3** **4**	**Possible by 2030** – Drought frequency could increase as a result of rainfall decrease during autumn, winter and spring and increased air temperature. **Likely by 2070** – Drought frequency is more likely by 2070 as reduction in autumn, winter and spring are projected to be more pronounced and air	**3**	With reduced reliability of rainfall, the sustainable productive capacity becomes more uncertain and output reduces. Variability has been demonstrated to be a key driver in economic output from agricultural related activities. For cropping, potential exists for alternative low water dependant plants to be

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
					temperature are modelled to be significantly warmer.		grown or smaller scale irrigated agriculture as alternatives. Drought tolerant species may also be more suitable such as those with deeper root zones that can draw upon more stable groundwater resources.
Reduction in allocation of 10%	**Low (4)**	**Low (4)**	**Impacts of reduced water allocations** The broad acre agriculture in the REROC region relies entirely on rainfall and as such would not be impacted by reduced water allocations.	**4**	**Likely by 2030 and 2070** – Reduction in allocation by 10% is as likely as not. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**1**	**Insignificant** – reduction in water allocation should not have impacts on braod acre agriculture in the REROC region
Reduction in allocations of 35%	**Low (2)**	**Low (2)**	**Impacts of reduced water allocations** The broad acre agriculture in the REROC region relies entirely on rainfall and as such would not be impacted by reduced water allocations.	**2**	**Unlikely by 2030 and 2070** – Reduction in allocation by 35% is unlikely but not negligible. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**1**	**Insignificant** – reduction in water allocation should not have impacts on braod acre agriculture in the REROC region

3.5 Orchards and Fruit Production

<table>
<tr><th>Risk Titled</th><th>Risk Rating 2030</th><th>Risk Rating 2070</th><th>Risk Description</th><th colspan="2">Likelihood</th><th colspan="2">Consequences</th></tr>
<tr>
<td rowspan="2">Reduced rainfall – Most likley scenario
<u>2030</u>
Annual: ➘ (-5%)
Summer:➘ (-3%)
Autumn: No changes
Winter: ➘➘ (-11%)
Spring: ➘➘ (-13%)
<u>2070 High</u>
Annual: ➘➘ (-26%)
Summer➘➘ (-12%)
Autumn: ➘ (-1%)
Winter: ➘➘ (-50%)
Spring: ➘➘ (-59%)
<u>Note</u>: 2070 Low is relatively close to 2030 in terms of rainfall projections</td>
<td rowspan="2">Low (4)</td>
<td rowspan="2">Medium(6)</td>
<td rowspan="2">Impacts of reduced rainfall on fruit tree production
Fruit growing occurs in five distinct phases and each ahs different water needs:
1. Budding
2. Shoot Growth
3. Fruit filling
4. Harvest
5. Leaf fall
It is particularly critical to have water accessible during the budding and fruit filling stages. Budding tends to occur in Spring and Fruit filling across the late Spring and Summer months.
The risk is that the reduction in rainfall may impact the productivity of orchard crops. It is worth noting for orcharding operations it is currently common to draw upon both natural rainfall and irrigation water supply.</td>
<td>4</td>
<td>Likely by 2030 – This rainfall scenario is considered likely because 18 out of 19 climate models show consistent projections. Additionally there are fewer uncertainties associated with projections by 2030 than by 2070 (notably due to higher confidence in emission scenarios).</td>
<td>1</td>
<td>Insignificant by 2030 – The reductions are modest. The impact would primarily be associated with costs from greater use of alternative supply sources. From a broader climate perspective, the occurrence of frost and humidity are of prime concern in relation to impacting the quality of fruits. The climate change projections indicate fewer frost days and reduced humidity. This creates preferable conditions for fruit growing.</td>
</tr>
<tr>
<td>3</td>
<td>Possible by 2070 – The likelihood distribution is similar to 2030 (18 climate models out of 19 show consistent projections) however there are higher uncertainties associated with projections by 2070 (notably linked to emission scenarios).</td>
<td>2</td>
<td>Minor by 2070 – The impacts of winter and spring rainfall reductions are significant and the subsequent impact the budding and filling phases could affect fruit quality. However given the current diverse water supply options for orcharding it is expected impact would be primarily cost.</td>
</tr>
</table>

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Worst case scenario 2070 High Annual: ↘↘ (-26%) Summer↗↗ (13%) Autumn: ↘↘ (-29%) Winter: ↘↘ (-103%) Spring: ↘↘ (-72%)	**Medium (6)**	**Medium (6)**	**Impacts of reduced rainfall on fruit tree production** Fruit growing occurs in five distinct phases and each ahs different water needs: 1. Budding 2. Shoot Growth 3. Fruit filling 4. Harvest 5. Leaf fall It is particularly critical to have water accessible during the budding and fruit filling stages. Budding tends to occur in Spring and Fruit filling across the late Spring and Summer months.	**2**	**Unlikely by 2030 and 2070** – This rainfall scenario is unlikely as only 5 models out of 19 show consistent projections. The probability is low but not negligible.	**3**	**Moderate by 2070** – Under the high emission scenario, the impacts of winter and spring rainfall reductions are significant are would be expected to affect soil moisture. As such to maintain productivity a heavy reliance upon alternative water supply sources would be required.
Increased drought frequency and climate variability	**Medium (9)**	**High (12)**	**Impacts of drought conditions on orchards** The potential impact of drought on orcharding includes: • Reduced security of water supply with catchment wide drought impacting overall allocations • Increased cost to enhance security of water supply Reduced productivity of harvest with higher evaporation and unreliable supply of key rains during spring and budding phases	**3** **4**	**Possible by 2030** – Drought frequency could increase as a result of rainfall decrease during autumn, winter and spring and increased air temperature. **Likely by 2070** – Drought frequency is more likely by 2070 as reduction in autumn, winter and spring are projected to be more pronounced and air temperature are modelled to be significantly warmer.	**3**	**Moderate –** With reduced reliability of rainfall, the productive capacity becomes more uncertain and output may reduce. The current diversity of supply options and higher value for water usage for this industry creates greater adaptive capacity to respond to drought and variability. However the impact of drought may still result in significant cost impacts and potential risks to long term plantation assets.

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduction in allocation of 10%	**Medium (8)**	**Medium (8)**	**Impact of reduced water allocation on the broader economy** Reductions of 35% in allocations across the wider catchment passed on to end users impacting productive capacity resulting in potential for job losses.	4	**Likely by 2030 and 2070** – Reduction in allocation by 10% is as likely as not. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**2**	**Minor by 2030 and 2070** – Orcharding has proven itself to be a relatively efficient water user. In the past they have found opportunity to reduce their water needs and sell surplus water allocations. The ability of intensive horticulture to find savings through in water usage through more efficient practice and recycling are limited given the existing efficiency level current achieved. However given the relative high value to water intensity, the cost securing water may be possible.
Reduction in allocations of 35%	**Medium (6)**	**Medium (6)**	**Impact of reduced water allocation on the broader economy** Reductions of 35% in allocations across the wider catchment passed on to end users impacting productive capacity resulting in potential for job losses.	**2**	**Unlikely by 2030 and 2070** – Reduction in allocation by 35% is unlikely but not negligible. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**3**	**Moderate by 2030 and 2070** – A reduction of 35% would be very difficult for intensive horticulture to achieve. For savings above 10-15% water efficiency devices and a high level of alternative water capture and recycling would be required at considerable costs.

3.6 Viticulture

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Most likley scenario 2030 Annual: ➘ (-5%) Summer: ➘ (-3%) Autumn: No changes Winter: ➘➘ (-11%) Spring: ➘➘ (-13%) 2070 High Annual: ➘➘ (-26%) Summer ➘➘ (-12%) Autumn: ➘ (-1%) Winter: ➘➘ (-50%) Spring: ➘➘ (-59%) Note: 2070 Low is relatively close to 2030 in terms of rainfall projections	**Low (4)**	**Medium(6)**	**Risks of reduced water availability for grape production** A French study (ONERC, 2006) assessed impacts of climate change and reduced water availability on wine and liquor production. The vines' water needs are relatively limited in comparison to other agricultural production such as wheat, corn or horticulture production. A slight water deficit is even necessary for a good maturation of grapes; allowing a good sugar concentration and a correct sugar/acidity ratio. However, if the water deficit is excessive the result can be catastrophic for the grape. If the water stress is strong, the sugar content is good but the yield is low and the usual characteristics of the wine are altered without dramatic decrease in the wine quality. It might have consequences for "branded" wines as they will not taste as the customer is expecting. When the water stress is excessive, the maturation of the grapes is stopped, the sugar content is significantly lower and the overall wine quality is poor (ONERC, 2006).	**4**	**Likely by 2030** – This rainfall scenario is considered likely because 18 out of 19 climate models show consistent projections. Additionally there are fewer uncertainties associated with projections by 2030 than by 2070 (notably due to higher confidence in emission scenarios).	**1**	**Insignificant by 2030** – Insignificant rainfall changes are expected to occur during the critical seasons for grapes production (later summer-early autumn).
				3	**Possible by 2070** – The likelihood distribution is similar to 2030 (18 climate models out of 19 show consistent projections) however there are higher uncertainties associated with projections by 2070 (notably linked to emission scenarios).	**2**	**Minor by 2070** – Limited rainfall changes are expected to occur during the critical seasons for grapes production (later summer-early autumn) and could be easily managed with existing techniques.

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Worst case scenario 2070 High Annual: ↘↘ (-26%) Summer↗↗ (13%) Autumn: ↘↘ (-29%) Winter: ↘↘ (-103%) Spring: ↘↘ (-72%) Note: 2070 Low is relatively close to 2030 in terms of rainfall projections	-	**Medium (6)**	**Risks of reduced water availability for grape production** A French study (ONERC, 2006) assessed impacts of climate change and reduced water availability on wine and liquor production. The vines' water needs are relatively limited in comparison to other agricultural production such as wheat, corn or horticulture production. A slight water deficit is even necessary for a good maturation of grapes; allowing a good sugar concentration and a correct sugar/acidity ratio. However, if the water deficit is excessive the result can be catastrophic for the grape. If the water stress is strong, the sugar content is good but the yield is low and the usual characteristics of the wine are altered without dramatic decrease in the wine quality. It might have consequences for "branded" wines as they will not taste as the customer is expecting. When the water stress is excessive, the maturation of the grapes is stopped, the sugar content is significantly lower and the overall wine quality is poor (ONERC, 2006).	**2**	**Unlikely by 2030 and 2070** – This rainfall scenario is unlikely as only 5 models out of 19 show consistent projections. The probability is low but not negligible.	**3**	**Moderate by 2070** – While the projected slight increase in summer rainfall could be beneficial during the early maturation period of the grape, the projected decease in rainfall during the second half of the maturation season could bring significant impacts to the grape production. It is unclear whether these impacts could be managed with existing production techniques.
Increased drought frequency and climate variability	**High (12)**	**High (16)**	**Risks to drought conditions on wineries' prediction** During prolonged drought conditions, the impacts on wine production tend to be very disparate from one winery to the other. While some "branded" wines can benefit from these atypical years the overall wine production is usually negatively impacted. During previous	**3** **4**	**Possible by 2030** – Drought frequency could increase as a result of rainfall decrease during autumn, winter and spring and increased air temperature. **Likely by 2070** – Drought	**4**	**Major** by 2030 and 2070 – Due to a combination of reduced water availability during the critical season, extreme stress on the vines plants and very hot temperature the consequences of wineries

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
			drought period a decrease in the overall wine production was observed up to -20% in certain regions (ONERC, 2006). If the drought conditions last for several years there is a risk of the wine plant reaching a state beyond extreme stress resulting in the wine plant being "burned". During these periods wineries not usually irrigated require additional water inputs (ONERC, 2006).		frequency is more likely by 2070 as reduction in autumn, winter and spring are projected to be more pronounced and air temperature are modelled to be significantly warmer.		could be major. Current techniques might not be sufficient to limit the impacts of drought. Furthemore because of possible limits on the ability to access water
Reduction in allocation of 10%	**Low (4)**	**Low (4)**	**Risks to alternative sources of water for wineries** Most wineries rely mostly on rainwater for the water needs of the wine plants although bore water is used as a complementary source of water. A reduction in water allocation could impact this complementary source of water.	**4**	**Likely by 2030 and 2070** – Reduction in allocation by 10% is as likely as not. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**1**	**Insignificant by 2030 and 2070** – A 10% reduction of complementary water would have no significant impacts on grape production.
Reduction in allocations of 35%	**Low (4)**	**Low (4)**	**Risks to alternative sources of water for wineries** Most wineries rely mostly on rainwater for the water needs of the wine plants although bore water is used as a complementary source of water. A reduction in water allocation could impact this complementary source of water.	**2**	**Unlikely by 2030 and 2070** – Reduction in allocation by 35% is unlikely but not negligible. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**2**	**Minor by 2030 and 2070** – A 35% reduction of complementary could have some impacts on grape production as this would reduced the ability to counteract seasons with low rainfall.

4.0 Livestock Processing

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Most likley scenario 2030 Annual: ↘ (-5%) Summer:↘ (-3%) Autumn: No changes Winter: ↘↘ (-11%) Spring: ↘↘ (-13%) 2070 High Annual: ↘↘ (-26%) Summer↘↘ (-12%) Autumn: ↘ (-1%) Winter: ↘↘ (-50%) Spring: ↘↘ (-59%) Note: 2070 Low is relatively close to 2030 in terms of rainfall projections	**Low (4)**	**Medium(9)**	**Impact of reduced rainfall on livestock production impacting through input to abattoirs** The abattoirs are reliant upon the local livestock production to sustain their business. Abattoirs are impacted by high meta prices and rely upon throughput to maintain production and jobs. During severe and long term drought conditions many livestock owners will de stock. This results in temporary increase in throughput for abattoirs. However, after the initial destocking the throughput reduces. This impact than take extend time to improve and the destocking process can take several seasons to recover to full productivity in improved rainfall conditions.	**4**	**Likely by 2030** – This rainfall scenario is considered likely because 18 out of 19 climate models show consistent projections. Additionally there are fewer uncertainties associated with projections by 2030 than by 2070 (notably due to higher confidence in emission scenarios).	**1**	**Insignificant by 2030** – Given the modest average rainfall reductions by 2030 projected, the effect of variability and drought would have a greater impact than the reduced annual rainfall.
				3	**Possible by 2070** – The likelihood distribution is similar to 2030 (18 climate models out of 19 show consistent projections) however there are higher uncertainties associated with projections by 2070 (notably linked to emission scenarios).	**3**	**Moderate by 2070** – In the event of a reduction in rainfall on average of 50-59% in the important spring and winter seasons, a significant reduction in livestock production would be expected. However, with adaptation measures such as changing stock types to more drought tolerant breeds, adjustments in the techniques and management of pasture grazing and improved pasture species to those more drought tolerant, impacts may be minimised.

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Worst case scenario <u>2070 High</u> Annual: ↘↘ (-26%) Summer↗↗ (13%) Autumn: ↘↘ (-29%) Winter: ↘↘ (-103%) Spring: ↘↘ (-72%) <u>Note</u>: 2070 Low is relatively close to 2030 in terms of rainfall projections	**Medium (6)**	**Medium (8)**	**Impact of reduced rainfall on livestock production impacting through input to abattoirs** The abattoirs are reliant upon the local livestock production to sustain their business. Abattoirs are impacted by high meta prices and rely upon throughput to maintain production and jobs. During severe and long term drought conditions many livestock owners will de stock. This results in temporary increase in throughput for abattoirs. However, after the initial destocking the throughput reduces. This impact than take extend time to improve and the destocking process can take several seasons to recover to full productivity in improved rainfall conditions.	**2**	**Unlikely by 2030 and 2070** – This rainfall scenario is unlikely as only 5 models out of 19 show consistent projections. The probability is low but not negligible.	**3**	In the event of a reduction in rainfall on average of 50-59% in the important spring and winter seasons, a significant reduction in livestock production would be expected. However, with adaptation measures such as changing stock types to more drought tolerant breeds, adjustments in the techniques and management of pasture grazing and improved pasture species to those more drought tolerant, impacts may be minimised.
						4	The long lasting recent drought has major impact on many livestock processing facilities. Given the project winter and Spring reductions would be equivalent of drought conditions it is expected the consequences of this occurrence would be significant in terms of live stock processing operations

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Increased drought frequency and climate variability	High (12)	High (16)	**Impact of drought on input to abattoirs** The potential impact of drought on livestock processing includes: - Reliability of animal throughput volumes due to broadacre grazing impacts - Reduced rainwater harvesting opportunities creates a need for more expensive ware sources to be utilised - Restrictions upon water allocations can impact operations and productivity - The cost of water to attain higher security yields can impact profitability and jobs - Increased water demand for stockyard animals due to increased evaporation and temperature	3	**Possible by 2030** – Drought frequency could increase as a result of rainfall decrease during autumn, winter and spring and increased air temperature.	4	**Major** – The long lasting recent drought has major impact on many livestock processing facilities. Given the project winter and Spring reductions would be equivalent of drought conditions it is expected the consequences of this occurrence would be significant in terms of live stock processing operations
				4	**Likely by 2070** – Drought frequency is more likely by 2070 as reduction in autumn, winter and spring are projected to be more pronounced and air temperature are modelled to be significantly warmer.		
Reduction in allocation of 10%	**Medium (8)**	**Medium (8)**	**Risks of critical water sources for abattoir operations** Abattoirs have a need for a secure supply of high volume and high quality water for many of the processes due to the hygiene requirements. However, there are also a number of processes that could accept lower quality water without any impact on operations (stock yards, amenities etc). Reductions of 10% in allocations across the wider catchment passed on to end users impacting productive capacity of the abattoir operations.	4	**Likely by 2030 and 2070** – Reduction in allocation by 10% is as likely as not. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	2	**Minor** – Work by Meat and Livestock Australia identified several basic water efficiency devices that would enable significant improvement (10-20%) at relatively modest cost. If reductions of 10% were imposed upon these types of operations, many of the facilities have the technical capacity to adjust operations with modest investment to fixtures and best practice water management.

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduction in allocations of 35%	**Medium (8)**	**Medium (8)**	**Risks of critical water sources for abattoir operations** Reductions of 35% in allocations across the wider catchment passed on to end users impacting productive capacity of the abattoir operations resulting in potential for job losses and closure	**2**	**Unlikely by 2030 and 2070** – Reduction in allocation by 35% is unlikely but not negligible. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**4**	**Major** – Livestock processing is a highly water intensive operation compared to the income produced. This limits the economic capacity to undertake major structural adjustment to operations and drive water efficiency. By reducing the water usages allowance of abattoirs by 30% significant cost implications would arise in developing alternate water use regimes. A greater focus on water recycling and water usage hierarchy to limit the usage of high quality potable water would be required.

5.0 Minerals and Extractive Industries

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Most likley scenario <u>2030</u> Annual: ➘ (-5%) Summer:➘ (-3%) Autumn: No changes Winter: ➘➘ (-11%) Spring: ➘➘ (-13%) <u>2070 High</u> Annual: ➘➘ (-24%) Summer➘➘ (-12%) Autumn: ➘ (-1%) Winter: ➘➘ (-50%) Spring: ➘➘ (-59%) <u>Note</u>: 2070 Low is relatively close to 2030 in terms of rainfall projections	**4** **(Low)**	**9** **(Med)**	**Reduced availability of rainwater for mining operations** Gold mining operations tend to be water intensive and a warming and drying climate presents considerable challenges. Water is used particularly for the gold extraction and processing, dust control and construction and or compaction. Currently water is drawn from a combination of rainfall/ runoff, surface water and groundwater extraction. Climate change and the reduced rainfall projections have the potential to impact on water in the forms of precipitation and the flow on impact upon surface or groundwater resources. This restriction can impact the mining processes and adaptation measures may be a requirement. Given the seasonality of rainfall is not critical and onsite storage capacity can be developed to sustain operations, a degree of drought tolerance is inbuilt.	**4**	**Likely by 2030** – This rainfall scenario is considered likely because 18 out of 19 climate models show consistent projections. Additionally there are fewer uncertainties associated with projections by 2030 than by 2070 (notably due to higher confidence in emission scenarios).	**1**	**Minor by 2070** – By 2030 the average annual projected reduction is 5%. Onsite storage capacity and alternative groundwater and surface water source diversity would be expected to provide capacity to accommodate this impact with minimal cost.
				3	**Possible by 2070** – The likelihood distribution is similar to 2030 (18 climate models out of 19 show consistent projections) however there are higher uncertainties associated with projections by 2070 (notably linked to emission scenarios).	**3**	**Moderate by 2070** – By 2070 the average annual projected reduction is 24%. If local surface or groundwater becomes an unviable source, piped-in water would impact on profitability (where pipping water in is actually feasible). The technical capability of staff and relatively high value of output in comparison to water inputs provides greater capacity to adapt.

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Worst case scenario 2070 High Annual: ↘↘ (-26%) Summer↗↗ (13%) Autumn: ↘↘ (-29%) Winter: ↘↘ (-103%) Spring: ↘↘ (-72%) Note: 2070 Low is relatively close to 2030 in terms of rainfall projections	-	6 (Med)	**Reduced availability of rainwater for mining operations** Gold mining operations tend to be water intensive and a warming and drying climate presents considerable challenges. Water is used particularly for the gold extraction and processing, dust control and construction and or compaction. Currently water is drawn from a combination of rainfall/ runoff, surface water and groundwater extraction. Climate change and the reduced rainfall projections have the potential to impact on water in the forms of precipitation and the flow on impact upon surface or groundwater resources. This restriction can impact the mining processes and adaptation measures may be a requirement. Given the seasonality of rainfall is not critical and onsite storage capacity can be developed to sustain operations, a degree of drought tolerance is inbuilt.	2	**Unlikely by 2070** – This rainfall scenario is unlikely as only 5 models out of 19 show consistent projections. The probability is low but not negligible.	3	**Moderate by 2070** – By 2070 the average annual projected reduction is 26%. If local surface or groundwater becomes an unviable source, piped-in water would impact on profitability (where pipping water in is actually feasible). The technical capability of staff and relatively high value of output in comparison to water inputs provides greater capacity to adapt.
Increased drought frequency and climate variability	6 (Med)	8 (Med)	**Reduced availability of rainwater for mining operations** The impact of drought is to reduce the natural inflow of rain fall and harvestable surface flow currently used in mine processes. This creates greater reliance upon more expensive water resources. The increase in temperature and evaporation can increase demand for water to control dust and construction purposes (concreting /	3 4	**Possible by 2030** – Drought frequency could increase as a result of rainfall decrease during autumn, winter and spring and increased air temperature. **Likely by 2070** – Drought frequency is more likely by 2070 as reduction in autumn, winter and spring	2	**Minor by 2030 and 2070** – Mining operations are relatively resilient to drought conditions due to onsite storage capacity and diversity of supply options. Extended drought may impact on water restrictions and costs for maintaining security of supply.

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
			compaction)		are projected to be more pronounced and air temperature are modelled to be significantly warmer.		
Reduction in allocation of 10%	**8 (Med)**	**8 (Med)**	Currently much of the mining within REROC is reliant upon groundwater resources. Historically many groundwater resources have not been regulated. However in future SDLs are proposed to capture both surface and groundwater supplies. As such a 10% reduction may reduce a key water supply option.	**4**	**Likely by 2030 and 2070** – Reduction in allocation by 10% is as likely as not. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**2**	**Minor by 2030 and 2070** – Reduction in groundwater allocations pose a risk to operation of regional gold mining operations as this is a key resource. Mining tends to be a high user of water and typically this has resulted in relatively efficient operations. Moderate costs may be incurred to achieve the efficiency measures.

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduction in allocations of 35%	**6 (Mod)**	**6 (Mod)**	Reduced rainfall reducing the volume of water available from rain fed dams and other storage impacting upon water supply costs which affects profitability and potential job losses.	**2**	**Unlikely by 2030 and 2070** – Reduction in allocation by 35% is unlikely but not negligible. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**3**	**Moderate by 2030 and 2070** – Reduction in groundwater allocations pose a risk to operation of regional gold mining operations as this is a key resource. Mining tends to be a high user of water and typically this has resulted in relatively efficient operations. As such it is unlikely a 35% efficiency can be found within operations and a combination of management responses would e required. Significant costs may be incurred to achieve the efficiency measures or secure alternative supply.

6.0 Forestry, Timber and Pulp Processing

6.1 Forestry/Plantations

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Most likley scenario <u>2030</u> Annual: ↘ (-5%) Summer:↘ (-3%) Autumn: No changes Winter: ↘↘ (-11%) Spring: ↘↘ (-13%) <u>2070 High</u> Annual: ↘↘ (-26%) Summer↘↘ (-12%) Autumn: ↘ (-1%) Winter: ↘↘ (-50%) Spring: ↘↘ (-59%) Note: 2070 Low is relatively close to 2030 in terms of rainfall projections	High (12)	High (12)	**Impacts of reduced rainfall on forestry production** Most forest areas are located in areas with mean annual rainfall above 500 mm per year and rainfall is usually considered as a critical constraint in the commercial exploitation of forests. According to the Garnaut Review (2008), any sustained or dramatic reduction in rainfall would have negative impacts on forest net primary production including for some commercial plantations. European research (Lieth, 1974) has shown a direct correlation between water availability and forest production. During stand development, reduced availability of water will lead to a disproportionate development of the root system and a reduced development of the leaf system (Mohren, 2002). Drier conditions tend to result in lower tree heights and sparser stands (Mohren, 2002). While reduced water availability has significant impacts on small stands it also brings stress to tall trees due to hydraulic limitation in water transport. Access to groundwater or irrigation might be required to sustain production in areas currently relying on rainfall.	4	**Likely by 2030** – This rainfall scenario is considered likely because 18 out of 19 climate models show consistent projections. Additionally there are fewer uncertainties associated with projections by 2030 than by 2070 (notably due to higher confidence in emission scenarios).	3	**Moderate by 2030** – Impacts of reduced rainfall would be moderate as rainfall changes would not bring dramatic changes in forest dynamic and could be overcome by additional water sources for some plantations. However due to the long life of tree plantation there are risks of loosing values on some species.
				3	**Possible by 2070** – The likelihood distribution is similar to 2030 (18 climate models out of 19 show consistent projections) however there are higher uncertainties associated with projections by 2070 (notably linked to emission scenarios).	4	**Major by 2070** – Impacts of reduced rainfall would be more significant due to higher rainfall changes that could have more dramatic impacts on forest dynamic. Availability of alternative water sources would be reduced. The long life of tree plantation there would still be an obstacle.

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Worst case scenario 2030 Annual: ↘ (-6%) Summer: ↗ (3%) Autumn: ↘ (-6%) Winter: ↘↘ (-22%) Spring: ↘↘ (-16%) 2070 High Annual: ↘↘ (-26%) Summer↗↗ (13%) Autumn: ↘↘ (-29%) Winter: ↘↘ (-103%) Spring: ↘↘ (-72%) Note: 2070 Low is relatively close to 2030 in terms of rainfall projections	-	**Medium (8)**	**Impacts of reduced rainfall on forestry production** Most forest areas are located in areas with mean annual rainfall above 500 mm per year and rainfall is usually considered as a critical constraint in the commercial exploitation of forests. According to the Garnaut Review (2008), any sustained or dramatic reduction in rainfall would have negative impacts on forest net primary production including for some commercial plantations. European research (Lieth, 1974) as shown a direct correlation between water availability and forest production. During stand development, reduced availability of water will lead to a disproportionate development of the root system and a reduced development of the leaf system (Mohren, 2002). Drier conditions tend to result in lower tree heights and sparser stands (Mohren, 2002). While reduced water availability has significant impacts on small stands it also brings stress to tall trees due to hydraulic limitation in water transport. Access to groundwater or irrigation might be required to sustain in areas currently relying on rainfall.	**2**	**Unlikely by 2030 and 2070**– This rainfall scenario is unlikely as only 5 models out of 19 show consistent projections. The probability is low but not negligible.	**4**	**Major by 2070** – Impacts of reduced rainfall would be more significant due to higher rainfall changes that could have more dramatic impacts on forest dynamic. Availability of alternative water sources would be reduced. The long life of tree plantation there would still be an obstacle.
Increased drought frequency and climate variability	**High (12)**	**High (12)**	Impacts of reduced water availability and secondary drought conditions on forest plantation On top of the effects mentioned above in terms of reduced water availability on forest plantation there are additional risks including: - Increased potential for bushfire associated	**3**	**Possible by 2030** – Drought frequency could increase as a result of rainfall decrease during autumn, winter and spring and increased air temperature.	**4**	**Major by 2070** – Combined impacts of reduced water availability and secondary impacts could have major impacts on the forestry plantations in the REROC regions. Such impacts could

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description		Likelihood		Consequences
			with hotter and dried conditions - Development and proliferation of pests and diseases - Increased risks of de-rooting of trees as observed during drought conditions				require extensive irrigation for which water might not be available.
				4	**Likely by 2070** – Drought frequency is more likely by 2070 as reduction in autumn, winter and spring are projected to be more pronounced and air temperature are modelled to be significantly warmer.	4	**Major by 2070** – Combined impacts of reduced water availability and secondary impacts could have major impacts on the forestry plantations in the REROC regions. Such impacts could require extensive irrigation for which water might not be available.
Reduction in allocation of 10%	**Low (4)**	**Low (4)**	**Reduction in potential for complementary water** Currently forest plantations in the REROC region rely entirely on rainfall for water. Water resources through water allocations would be mostly used as a complementary resource to overcome reduction in rainfall.	4	**Likely by 2030 and 2070** – Reduction in allocation by 10% is as likely as not. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	1	**Insignificant by 2030 and 2070** – A reduction of water allocation by 10% would have marginal to the potential of alternative water sources for forest plantations.
Reduction in allocations of 35%	**Low (4)**	**Low (4)**	**Reduction in potential for complementary water** Currently forest plantations in the REROC region rely entirely on rainfall for water. Water resources through water allocations would be mostly used as a complementary resource to overcome reduction in rainfall.	2	**Unlikely by 2030 and 2070** – Reduction in allocation by 35% is unlikely but not negligible. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	2	**Insignificant by 2030 and 2070** – A reduction of water allocation by 35% could have marginal effects as forest plantation currently relies 100% on rainwater.

6.2 Timber Milling and Pulp Processing

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Most likley scenario <u>2030</u> Annual: ↘ (-5%) Summer:↘ (-3%) Autumn: No changes Winter: ↘↘ (-11%) Spring: ↘↘ (-13%) <u>2070 High</u> Annual: ↘↘ (-26%) Summer↘↘ (-12%) Autumn: ↘ (-1%) Winter: ↘↘ (-50%) Spring: ↘↘ (-59%) Note: 2070 Low is relatively close to 2030 in terms of rainfall projections	**Medium (8)**	**High (12)**	**Impact of reduced rainfall on forestry production impacting inputs to transformation industries** Both the timber processing mill and the pulp mill are reliant upon the local production to sustain their business in the long term. While sourcing timber from other region could be a short term option, the cost associated with transport and concurrence from other business with local supply would result in impacts on the viability of the business. These impacts are quite unlikely to occur in short timeframe because of the long life of forest plantations; however over the medium to long terms these indirect impacts could become dramatic to the processing business.	**4**	**Likely by 2030** – This rainfall scenario is considered likely because 18 out of 19 climate models show consistent projections. Additionally there are fewer uncertainties associated with projections by 2030 than by 2070 (notably due to higher confidence in emission scenarios).	**2**	**Minor by 2030** – The impacts would be limited in this short time frame because of the long life of forestry plantation. If significant impacts start to occur on mature trees they could still be processed.
				3	**Possible by 2070** – The likelihood distribution is similar to 2030 (18 climate models out of 19 show consistent projections) however there are higher uncertainties associated with projections by 2070 (notably linked to emission scenarios).	**4**	**Major by 2070** – In the longer terms the impacts of reduced water availability (both rainfall and alternative water sources) for forestry could result in major impacts to these transforming industries. There is limited alternative in terms of timber sourcing as a long term solution.

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduced rainfall – Worst case scenario <u>2070 High</u> Annual: ↘↘ (-26%) Summer↗↗ (13%) Autumn: ↘↘ (-29%) Winter: ↘↘ (-103%) Spring: ↘↘ (-72%) <u>Note</u>: 2070 Low is relatively close to 2030 in terms of rainfall projections	**Medium (8)**	**Medium (8)**	**Impact of reduced rainfall on forestry production impacting inputs to transformation industries** Both the timber processing mill and the pulp mill are reliant upon the local production to sustain their business in the long term. While sourcing timber from other region could be a short term option, the cost associated with transport and concurrence from other business with local supply would result in impacts on the viability of the business. These impacts are quite unlikely to occur in short timeframe because of the long life of forest plantations; however over the medium to long terms these indirect impacts could become dramatic to the processing business.	**2**	**Unlikely by 2030 and 2070** – This rainfall scenario is unlikely as only 5 models out of 19 show consistent projections. The probability is low but not negligible.	**4**	**Major by 2070** – The projected long term rainfall changes under the worst case scenario could have dramatic effects on the forestry plantation and ultimately on the transforming industries.
Increased drought frequency and climate variability	**High (12)**	**High (16)**	**Impact of drought on forestry production impacting inputs to transformation industries** Significant decrease in forestry production as a result of drought conditions would have extensive impacts on the local economy (including on supporting town industries). See above.	**3** **4**	**Possible by 2030** – Drought frequency could increase as a result of rainfall decrease during autumn, winter and spring and increased air temperature. **Likely by 2070** – Drought frequency is more likely by 2070 as reduction in autumn, winter and spring are projected to be more pronounced and air temperature are modelled to be significantly warmer.	**4**	**Major by 2070** – The projected long term rainfall changes under the worst case scenario could have dramatic effects on the forestry plantation and ultimately on the transforming industries.

Risk Titled	Risk Rating 2030	Risk Rating 2070	Risk Description	Likelihood		Consequences	
Reduction in allocation of 10%	**High (16)**	**High (16)**	**Risks to critical water needs for business operations** Timber processing requires significant amount of water to operate. As water was getting scarcer over the past decade local businesses such as Hyne Timber in Tumbarumba have improved water efficiency. For some of these businesses there is limited room for further improvement as they have implemented state of the art water monitoring and re-use. Reduction in water allocation, even limited could have detrimental impacts on the viability of the business and ultimately on the local economy.	**4**	**Likely by 2030 and 2070** – Reduction in allocation by 10% is as likely as not. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**4**	**Major** – A reduction of water allocation even by 10% could significantly impacts the timber transformation business and the local economy in the south of REROC.
Reduction in allocations of 35%	**Medium (10)**	**Medium (10)**	**Risks to critical water needs for business operations** Timber processing requires significant amount of water to operate. As water was getting scarcer over the past decade local businesses such as Hyne Timber in Tumbarumba have improved water efficiency. For some of these businesses there is limited room for further improvement as they have implemented state of the art water monitoring and re-use. Reduction in water allocation, even limited could have detrimental impacts on the viability of the business and ultimately on the local economy.	**2**	**Unlikely by 2030 and 2070** – Reduction in allocation by 35% is unlikely but not negligible. As it is not possible to project future regulatory changes 60 years into the future, the same likelihood has been assumed for 2070.	**5**	**Catastrophic** – A reduction of water allocation by 35% could have tremendous impacts on the timber transformation business and deep reaching consequences for the local economy in the south of REROC.

7.0 Implications for the REROC Region

The most tangible implication of less water availability on the Region's agricultural industry is a potential decrease in production, in terms of both land use and yield of crops. Affected subsectors would be dry land farming, livestock processing and to a degree, forestry. Clearly, these subsectors would consider deploying strategies, as they have in the past, to adapt to water cutbacks to lessen the impact.

However, water availability reductions, whether they are temporary (due to increased weather volatility) or permanent (due to SDL cutback or government buyback of entitlements), will negatively affect the agricultural sector. For example, water reductions place constraints on farm operations, and can affect their cost and profitability. It is likely that reduced supply and higher prices of water may induce farmers to shift to crops or farming methods that need less water but require increased labour or capital investment. Agricultural land values represent the expected long-run profitability of farming and thus may also fall in response to water supply cutbacks. Climate-driven water scarcity may generally lead to some increase in farm gate prices; on the contrary, change of crops may not deliver adequate commercial outcomes if this results in an oversupply of products and lower prices e.g. vegetables.

Lower levels of primary production would flow through first to a reduction in activity across a number of industries which support agriculture including food processing, transport and logistics, equipment manufacturing and a number of other agribusiness subsectors. The impact of reduced primary production could potentially flow through to all sectors of the regional economy from construction to retail to personal services.

The impact of substantial water cutbacks on employment in the agricultural and related sectors is likely to be significant if the correct adjustment/adaptation strategies are not implemented. Lower agricultural profitability could drive farm workers to seek job opportunities in other economic sectors. Shifts to more labour-intensive crops or irrigation systems may partly offset the reduction in farming activities and in the amount of acreage farmed.

Reduced primary production due to lessened water availability also has the potential to impact regional economies and communities as the population in the rural areas decline with people leaving farms and the region for major regional or metropolitan centres in search of better economic opportunities. Their departure also equates to a loss of skills for the region, potentially exacerbating the already evident skill shortage prevalent throughout regional New South Wales and Australia. A decreased pool of labour and workforce skill set can in turn limit opportunities for future investment attraction, economic diversification and development as well as affecting the social fabric of regional communities. Decreased productivity of the Region's primary producers could lead to increased cost of inputs for businesses and increased grocery prices for the retail consumer.

Households and non-agricultural related industry will be asked to take part in the implementation of a sustainable water adaptation and management strategy through rationing and water restrictions. A future with less water availability could bring about an exclusion of certain activities (home irrigated gardening, maintenance of sports grounds, parks and other recreational facilities, non-essential water intensive industrial activities, etc.) and a rise in water prices, particularly if the purchase of additional water entitlements is required in order to maintain industry or business-specific requirements. Less water availability would have an impact on prices of goods, particularly a demand driven increase in the price of more water efficient equipment and appliances. Less water availability without an adaptive framework can also potentially affect the Region's ability to accommodate population growth and its housing sector, which would in turn detrimentally affect a number of industry sectors and subsectors including construction, building supplies manufacturing and various trades.

Table 6 below provides an overview of the potential economic implications of less water availability on key sectors in the REROC region.

Table 6 – Economic Implications of Less Water Availability on REROC Region

Industry or Sector	Likely Water Availability Compared to Present	Likely Price Increase	Impact on Output	Impact on Employment	Investment
Agriculture – Low Value Add	Less	Significant Increase	Decreasing output	Decline	Less investment
Agriculture – High Value Add	Less (partially offset from transfer from low value sector)	Significant Increase	Increasing output	Increase (from low value sector)	More investment
Mining	Most demands are met	Significant increase	Increasing output (based on increased exploration in region)	Increase (based on increased exploration in region)	More investment
General Industry	Most demands are met Certain exclusions apply Changing mix of supply	Higher due to cost of demand management	Stable output	Potential decline in supporting industries for low value add agriculture Potential increase in supporting industries for high value add agriculture	Higher cost of more water efficient equipment More investment if sustainable demand management strategy is implemented
Households	Most demands are met Water restrictions retained Changing mix of supply	Higher due to cost of demand management	Not applicable	Not applicable	Higher cost of more water efficient appliances and housing

The level of the impacts of less water availability on the REROC region as a whole will be higher without the implementation of a more effective management framework for the efficient allocation of the Region's water to higher value-add activities and economic development purposes. Without this framework, the Region might not have the capacity to support growth, both in terms of its economy and its population. If the region cannot efficiently and effectively allocate water where it is most needed, then it could encounter difficulties with attracting new industries, thus hindering its potential for economic diversification and employment growth.

The above analysis has largely focused on the potential detrimental implications of a future with less water availability in the REROC region. However, there are several positive implications of this future should the Region develop and implement a sustainable water adaptation and management strategy.

1. In adopting more water efficient practices and strategies, the regional agricultural sector has the opportunity to diversify itself and broaden its options through the selection of less water intensive crops and more technological inputs into primary production.

2. More efficient allocation of water would enhance water availability and security of supply, which in turn could allow for new higher value-add industries to be attracted to the Region. This means the Region would

continue to maintain its comparative advantage of water resource and lower costs, compared to other regions within Australia and Internationally. This could also support continued economic diversification, allowing for a gradual transference of skills from lower value-add agricultural activities to higher value-add economic activities. The shift to less water intensive practices for households and industry could foster innovation and lead to a more efficient utilisation of Region’s allocation or water.

8.0 Adapting to the Risks

8.1 Overview of an Adaptation Strategy

A climate change adaptation strategy can be defined as "*Actions in response to actual or projected climate change and impacts that lead to a reduction in risks or a realisation of benefits. A distinction can be made between a planned or anticipatory approach to adaptation (i.e. risk prevention) and an approach that relies on unplanned or reactive adjustments. The adaptation can be private or public*".

The adaptation strategy aims to (i) protect persons and assets by acting on public health and risk management, (ii) integrate the social dimension and avoid inequalities when facing risks, (iii) limit costs and take advantage of opportunities and (iv) preserve the natural environment.

Usually priority is given to "win-win" and "no-regrets" treatments. Win-win refers to measures that address the targeted climate change risks while also having other environmental, social or economic benefits. No-regrets refers to measures that should be taken anyway; regardless of whether climate change is an issue. Figure 4 highlights the key processes involved developing an adaptation strategy.

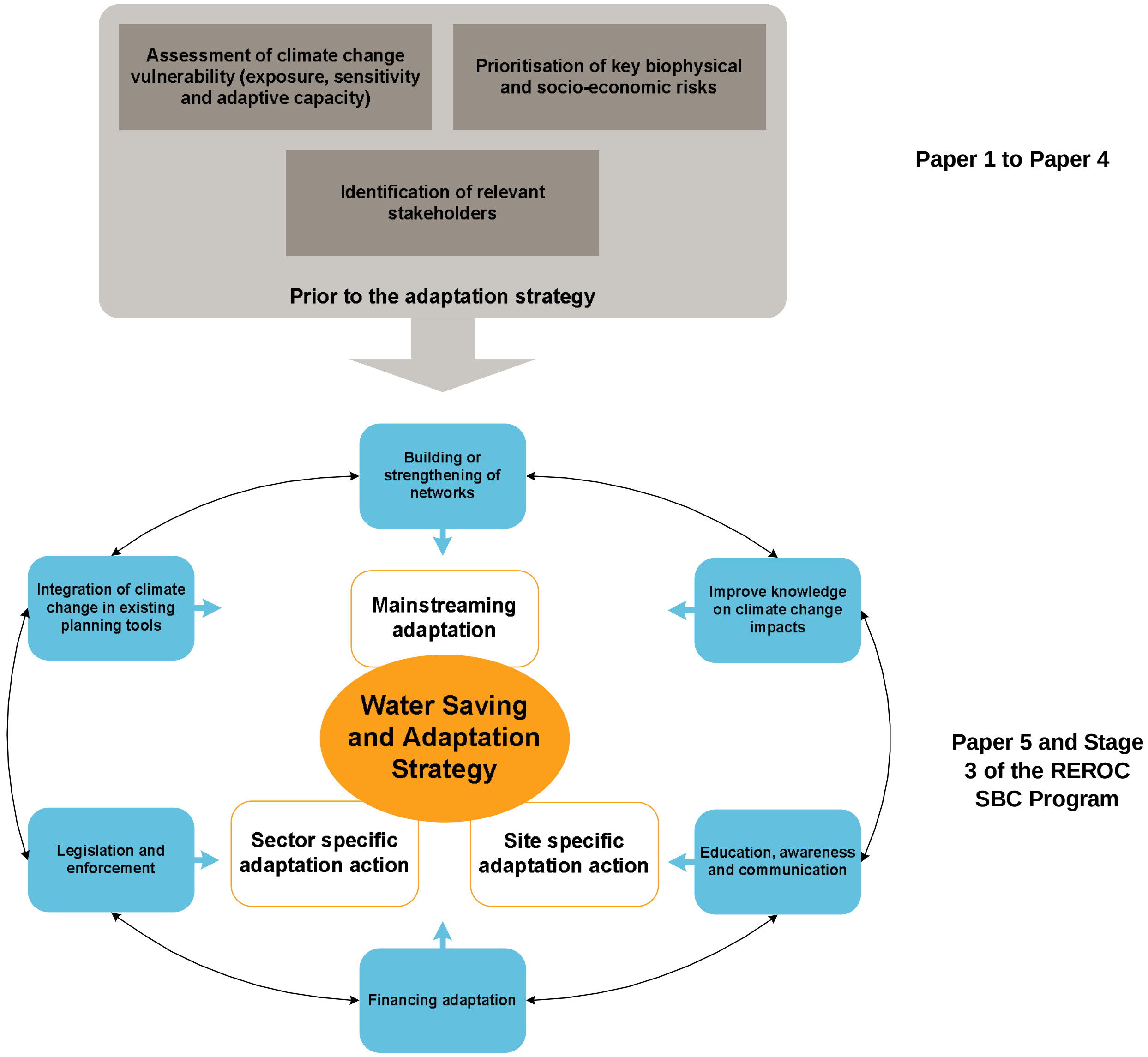

Figure 4 – Strategic axis for adaptation

8.2 Prioritisation of Water Saving Initiatives and Adaptation Options

Adapting to reduced water availability involves preparing for, responding to, and coping with climate or other induced changes. This is best achieved when government and community work together to improve the ability of communities to cope with or respond to the impacts. As both human and financial resources are finite, it is important to act on the most threatening risks but also to give priority to the options.

A range of water saving initiatives and adaptation options were identified and analysed as part of Discussion Paper 5 “Water Saving Initiatives”. A total of 23 options were grouped in nine aspects:

- Residential water program
- Industry water program
- Community awareness
- NSW Office of Water best practice guidelines
- Diversification and increased security of water supply
- STP Efficiency Improvement
- Climate change risk assessment
- Regional Water Trading Forum
- Economic Diversification

AECOM proposes to use the analytic framework shown in Table 7 to analyse and compare the different adaptation options that could be implemented to address key climate change risks. This framework can assist in prioritising adaptation options and revising this scoring as frequently as necessary. This action could be the first step of the Stage 3 of the SBC REROC project.

Table 7 – Indicative adaptation options analytic framework

	High	Medium	Low
Effectiveness	High potential to reduce risk	Moderate potential to reduce risk	Potential to reduce risk is low or uncertain
Cost	No additional budget is required / Low costs	Additional budget is required but can be covered by Council’s budget / Medium costs	Additional budget is required and involves complementary external funding / High costs
Speed	Can be completed within the next 12 months	Can be completed in the medium term (1-3 years)	Long term actions (3+ years)
Technical Feasibility	Proven adaptation approach / Widespread technical skills	Limited application of adaptation approach to date / Moderately available technical skills	Adaptation approach not applied to date / Niche and rare technical skills
Human Capability	Capability exists within Councils	Some external expertise or support is required	Delivery is dependent on external expertise
Consistency with Council Policy	Adaptation option fits with existing Councils’ planning and policy	Adaptation option could fit with existing Councils’ planning and policy	Adaptation option would require new Councils’ planning and policy
Community Acceptance	Potentially no conflict with communities for implementation	Possible conflict with communities for implementation	Likely conflict with communities for implementation