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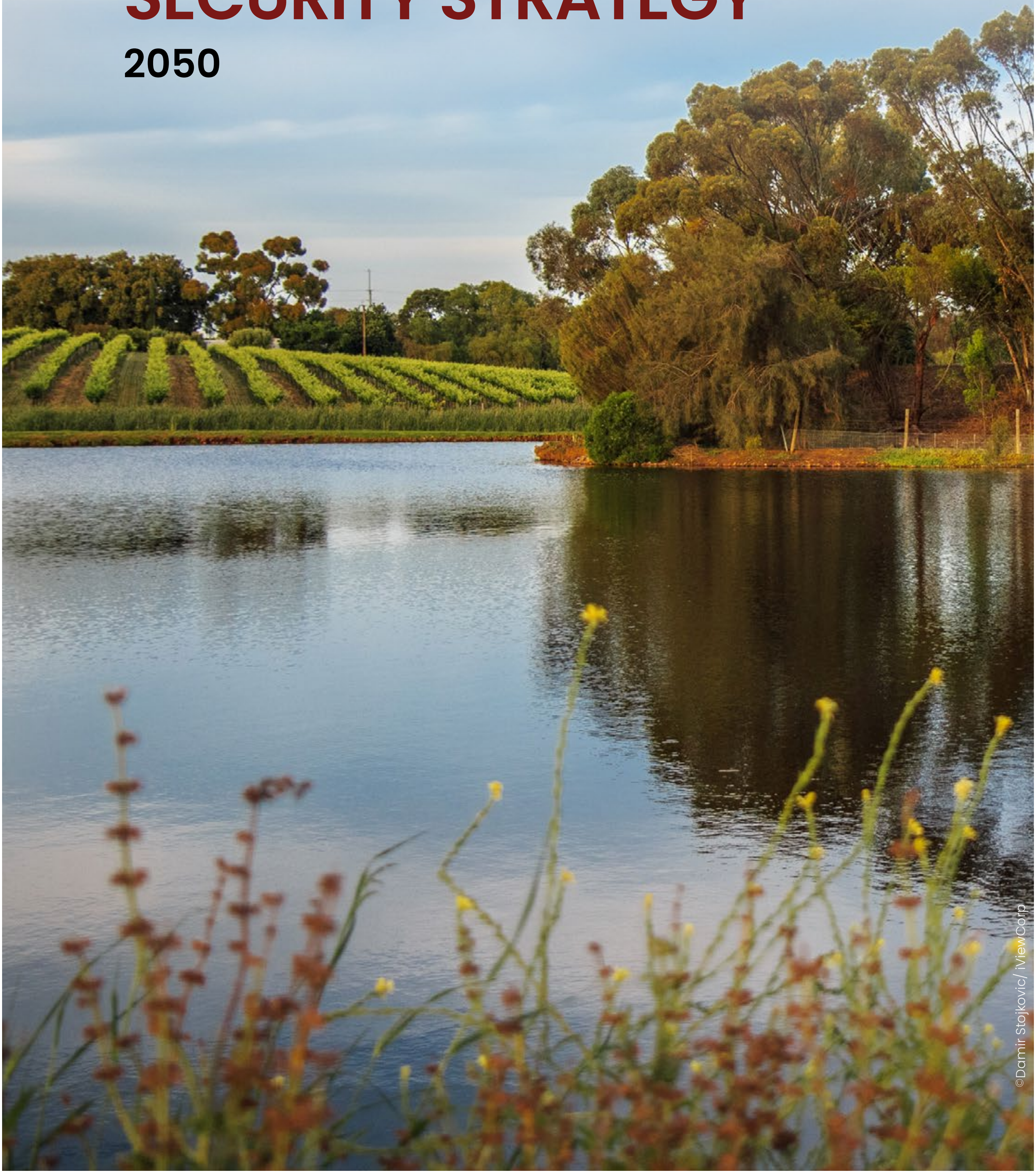
GUIDE TO THE BAROSSA WATER SECURITY STRATEGY

2050



Acknowledgement of Country

The land and waters to which the Barossa Water Security Strategy relates is Ngadjuri, Peramangk and Kaurna Country and these Aboriginal nations are the traditional custodians and carers of the region. It is acknowledged that Aboriginal peoples' spiritual, social, cultural and economic practices are intrinsically linked to their lands and waters and the continuing connection to their lands and waters is recognised and respected.

Actions set out in the strategy reflect a commitment to integrating Aboriginal peoples' wisdom into the management of land, water and biodiversity in Barossa and ensuring direct involvement and representation in regional decision-making. Ongoing meaningful engagement with Aboriginal peoples will be important to continue to raise awareness and respect for Aboriginal history, knowledge and wisdom and to ensuring that the contribution of Aboriginal nations to caring for Country is valued.

Contents

Executive Summary

This *Guide to the Barossa Water Security Strategy* is a complement to the *Barossa Water Security Strategy*. It provides a detailed overview of the process to develop the strategy, the climate analysis undertaken and further discussion on the strategic actions that have been identified to achieve a water secure future.

Barossa is a world-renowned premium food, wine and agricultural region located to the north-east of Adelaide in South Australia. It is home to some of the oldest continuously producing vineyards in the world, planted generations ago, when dry-farming techniques required careful site selection.

Since those early days, availability of water has been key to supporting the economic wellbeing of the region. As viticulture expanded beyond parts of the region that historically supported dry-farming techniques, grape and wine production has significantly increased. So, too has the diversity of the water supply portfolio and the volume of water used.

With a proud history, Barossa is committed to ensuring its ongoing prosperity. Long-term water security is a vital part of that commitment.

Previous long-term planning and investment in Barossa has contributed to a portfolio of water supplies that today includes rainfall, watercourses, farm dams, groundwater, imported River Murray water and recycled water. However, significant challenges remain, notably in relation to climate change including impacts on water availability and reliability, affordability of water, changing global markets, governance and ecological sustainability. The recent decade (2011-2020) had on average 10% less annual rainfall and 4% greater potential evapotranspiration than the preceding 30 years. This reflects a mid-range scenario of what might be expected in future decades as the climate continues to change.

In consultation with a cross section of Barossa stakeholders, the Barossa Water Security Strategy sets out a vision for a water-secure Barossa. This vision positions Barossa as an internationally-recognised food, wine and agricultural region that supports diverse businesses, communities and ecosystems, and where innovation and the ability to adapt to future opportunities and challenges is embedded. This is achieved through access to affordable, reliable, fit-for-purpose water for people and industry and the existence of healthy flowing waterways. Great opportunity exists to build on previous investment in water security to bring this vision to fruition.

The process to develop the strategy involved a blended qualitative and quantitative approach to identify actions to address water security. A strategic foresight and resilience-based planning approach allowed

for the systematic consideration of key uncertainties faced by the region, their impact on both the supply and demand for water, and on the success or failure of strategic actions and adaptive measures. Plans were made for a set of diverse yet plausible futures. The results of stress-testing actions under climate change projections then informed the final set of priorities included in the strategy.

Stress-testing adaptation pathways found that, under all climate scenarios, additional volumes of imported water are required to meet reliability requirements to underpin existing plantings and allow for future growth.

Following a reduction in rainfall, surface water use has declined by more than 50% in the past decade. Groundwater extraction has more than tripled. With both resources being sensitive to climatic changes, modelling suggests that from a water security and ecological perspective, imported water will play a critical role in the future.

All pathways provide the capacity for greater consistency and expansion (either in terms of yield or planted area) under mid-range climate projections in both the Barossa and Eden Valleys, improving as volumes of imported water increase.

While the modification of high-impact dams in catchments was identified as an important potential intervention to improve environmental flows through catchments, other complementary actions would be required to achieve improved environmental conditions. Should additional imported water become available, under most climate scenarios there is an opportunity to reduce reliance on native water sources, providing opportunities for stream restoration.

With no action, the majority of climate projections show reliability of water will decrease and environmental flow metrics will decline. In turn, this will put current activity, sustainable economic growth, as well as the vision for healthy waterways, at risk.

The development and implementation of the strategy is about building resilience, planning for uncertainty and ensuring opportunities can be capitalised upon. It is about supporting mechanisms that improve coherence between water security infrastructure and policy development and between private and public sector decision making. The strategy includes priorities for action, identified by community members and stakeholder organisations, which support attainment of the vision over the next 30 years.

Priorities include:

- addressing the availability of imported water to improve system reliability and support economic growth
- establishing a region-wide water distribution network
- implementing policy to support sustainable and integrated management of groundwater, surface water and imported water
- developing a healthy waterways plan to increase catchment health and flows through the system
- implementing on-farm strategies that improve soil health and maximise economic returns per unit of water, including adopting emerging agricultural technologies
- using planning tools to support healthy, cohesive water-secure communities
- supporting business by providing opportunities to diversify, embrace the circular economy and maximise efficiency of water use.

1. Introduction

This document supports the Barossa Water Security Strategy and provides a detailed overview of the process to develop the strategy, the climate analysis undertaken and further discussion on the strategic actions that have been identified to achieve a water secure future.

Water is essential to Barossa[1] and underpins a world-class premium food, wine and agricultural region. It supports a vibrant tourism sector and a successful grazing industry. The region is home to approximately 170 wine companies and 450 independent grape growers and on average accounts for 27% of the total economic value of the South Australian grape and wine sector. In addition, the region supports a successful grazing industry. It is home to around 35,000 South Australians.

However, the continued success of Barossa depends on access to secure, affordable and fit-for-purpose water for people, industry, agriculture, amenity, cultural values and the environment, now and into the future.

Barossa has recently experienced water scarcity due to a number of consecutive dry years, highlighting the risks to water availability. Impacts have been especially severe in Eden Valley. Emergency water supply measures, including the installation of standpipes in 2021 and water carting, assisted with access to water for irrigation and stock use in the short-term. This scarcity also highlighted the need for a long-term and strategic approach to water security, especially in the context of a warming and drying climate.

The Barossa community has proactively highlighted water security issues. The need for a water security strategy has been identified a number of times, including through a Regional Water Forum held in September 2019, and more recently as part of the review of the Water Allocation Plan for the Barossa Prescribed Water Resources Area (Barossa WAP).

The development of the 30-year water security strategy builds on previous work and studies to achieve water security in Barossa. Work on the strategy began after receiving support from key stakeholders and community members at a water security workshop in February 2021.

The Barossa Water Security Strategy has been developed to complement other water infrastructure and policy projects and has been co-designed with a broad range of stakeholders and community members.

The strategy sets out a shared vision for a water-secure Barossa, identifying strategic actions that will help achieve that vision and support current demand and future growth to 2050. The 30-year time period aligns with the long-term nature of water infrastructure, business investment decisions and ecosystem restoration, and also provides for the deliberate consideration of the impacts of climate change.

The strategy aims to provide confidence to business and the community that there will be sufficient water security to support their vision. The process for developing the strategy also aims to build future resilience and the capacity in the region to prepare for uncertain futures.

Alongside work in Barossa, at a state and national level, governments' are investing in water security as new challenges arise, particularly due to a changing climate. Regional water security planning is a key strategic priority identified in the of the State Governments' Water Security Statement 2022 (Government of South Australia 2022), as is exploring investment in alternative sources of water. At an Australian Government level a funding program is in place through the National Water Grid Authority to invest in infrastructure planning and development to improve water security and support thriving regions.

1 Geographically, this strategy covers 'Barossa', which includes both the Barossa Valley and the Eden Valley.

1.1. Vision for a water-secure Barossa

A vision for a water-secure Barossa in 2050 was developed with stakeholders in mid-2021.

The vision is that *Barossa is an internationally-recognised food, wine and agricultural region that supports diverse businesses, communities and ecosystems.*

This is enabled by access to affordable, reliable water, fit-for-purpose water for people and industry and the existence of healthy flowing waterways. This is supported by the use of 100% renewable energy, adoption of regenerative agricultural practices and improved biodiversity and strengthened by its unique indigenous and non-indigenous cultural heritage. Barossa will continue to be resilient and innovative, and able to effectively adapt to future opportunities and challenges.

A narrative version of this vision is included on page 7. A narrative vision is an easily understood detailed description of a desirable future.

A WATER STORY: BAROSSA IN 2050

The Barossa region remains world famous in 2050. The region has built on its reputation for premium wines and enhanced its brand using principles of quality, sustainability and respect for its unique and diverse cultural and natural heritage - while actively building new cultures of innovation, collaboration and adaptability.

Alongside wine, it is now famous for its diversified, mosaic agricultural landscapes - teeming with biodiversity, producing a range of the world's best boutique products and experiences, and drawing on the wisdom and cultural traditions of the range of peoples who call Barossa home, most notably its First Nations peoples.

The region is also famous for its innovative use of ancient and modern technology.

As far back as the early 2020s, community, government and industry came together to help support the region to build its capacity to adapt to significant challenges including climate impacts, water security, navigating the energy transition and explosion of agricultural technology and data, and adapting to changing consumer preferences and global trade patterns. Conscious investment was made in building the adaptive capacity of the region through collaborative governance and the establishment of knowledge management, training and support structures that enable ongoing innovation and learning. These days people travel to Barossa as knowledge tourists, as well as food and wine tourists, to visit their innovation centres and learn from their culture of collaboration and innovation.

Water supply options have been diversified to achieve a water-secure Barossa. People use water efficiently and within limits, considering the second and third use of water for appropriate purposes. Farmers integrate supply and demand side management to achieve the best outcomes in terms of cost, quality, the health of their land, and their commitment to keeping creeks and rivers flowing. There is enough quality water to sustain industry, environmental and community needs. The predictability and security of water is coupled with equitable and affordable distribution.

The local economy and industry has been diversified to meet local needs and achieve a regional circular economy. This includes local composting, recycling, repair centres, local distributed energy generation, integrated water treatment, AgTech and data management cooperatives and enterprises, and small-scale manufacturing, alongside regenerative agriculture and sustainable food and wine production. The circular economy means businesses recover value from "waste streams".

Across the region, farmers and other landholders have embraced regenerative and Indigenous agricultural approaches and technologies that enhance soil quality and soil water retention. Habitat has been consciously restored between farmlands. Hillsides long ago planted with native plants and trees now flourish. The waterways in the region are healthy and flowing.

The region has managed to maintain its village structure and charm while integrating new knowledge, practices, technologies and people - allowing the region to stay at the forefront in a world that has gone through almost unimaginable changes since 2021. Conscious urban planning included the design of green, well shaded, walkable spaces throughout the towns in the region. Increased tree cover lowers ambient temperatures in summer and it is pleasant to walk the streets of the towns. There are many wonderful, inclusive indoor and outdoor spaces where different members of the community interact throughout the day and night.

The diversification of the local economy has led to diversification of the community. Inclusive, accessible transport infrastructure allows for increased mobility between towns and the Adelaide Metropolitan region. The regional community is vibrant, multi-cultural and connected. First Nations wisdom and knowledge is integrated into education systems and people actively learn to use it for management of land, water, natural resources and biodiversity. First Nations communities and businesses are thriving. Younger people take part in meaningful work and enjoy a flourishing creative arts sector. The well-being of the community is a priority.

Change is embraced and regular processes of review and future-orientated planning are implemented to meet the evolving needs of the population, while preserving heritage and character.

1.2. Approach and structure

1.2.1. How has this strategy been developed?

This strategy has been developed through a partnership between Barossa Australia, Barossa Infrastructure Limited, The Barossa Council, Light Regional Council, Northern and Yorke Landscape Board, Regional Development Australia Barossa Gawler Light Adelaide Plains, Primary Industries and Regions SA, SA Water, Environment Protection Authority and Department for Environment and Water. Representatives from these organisations formed a Steering Committee, which provided multidisciplinary contextual knowledge and guidance throughout the strategy development process.

Many uncertainties face the region including in relation to - as the climate changes, global markets change, as digitisation and technology, progresses at a rapid pace, as the population growth and s, as decarbonisation and the energy transition plays out. To allow for the consideration of key uncertainties, and to plan for these in the context of a water security strategy, a strategic foresight and resilience-based planning approach was takenadopted.

The integration of strategic foresight and resilience-based planning allowed for systematic consideration of the key uncertainties facing the region, their impacts on both demand and supply of water, and on the success or failure of strategic actions and adaptive measures. The process aims to help build future resilience and prepare for uncertain futures.

A workshop-based approach drew on the deep expertise of Barossa stakeholders. More than 40 participants with strong representation from grape growers, winemakers, graziers, academia and various levels of government were involved. Organisations represented by workshop participants are included in Appendix A.

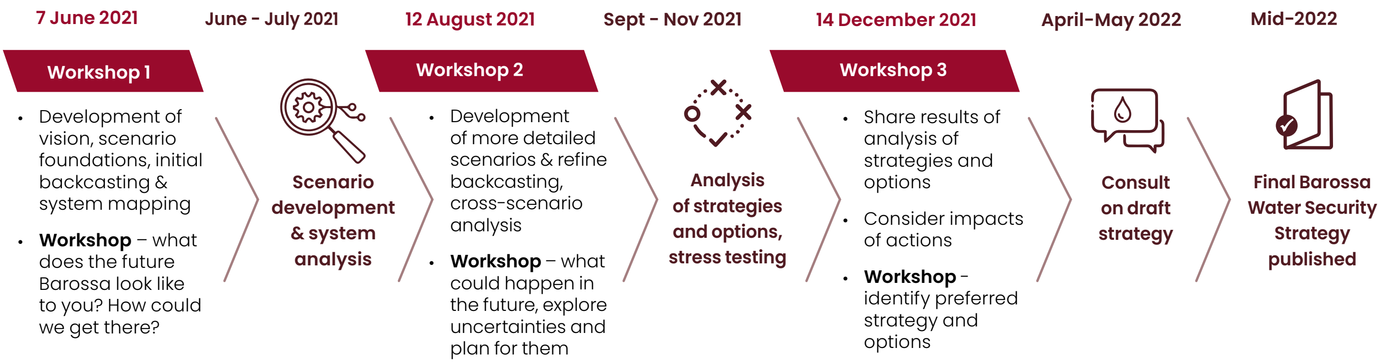


Figure 1 – Workshop and analysis process

Figure 2 – Vision development in workshop 1

Workshops were held to:

- **develop a shared vision** of the future of Barossa (workshop 1)
- **create** plausible future scenarios (workshops 1 and 2)
- **identify options** and actions to achieve the shared vision under the range of plausible future scenarios (workshops 1 and 2)
- **review outputs** from quantitative analysis (workshop 3)
- **review the strategic pillars** and actions and endorse broader public consultation on a strategy (workshop 3).

In addition to the workshops, extensive research and analysis was undertaken to support the strategy development, particularly around the impacts of climate change on water resources in Barossa, analysis of future water demand, assessment of soil quality in Barossa, as well as sharing information across the various projects and investigations underway at the time. Figure 1 outlines the process undertaken.

A shared vision for Barossa was co-designed at the first workshop (see figure 2). A series of actions to achieve the future vision were then developed and refined by testing the actions over 4 diverse plausible scenarios for 2050. By looking across scenarios, plans were developed that take into account the key uncertainties facing Barossa in the future, resulting in a portfolio of options as circumstances unfold. This process provided the opportunity to learn, challenge assumptions and have important conversations about the future.

The strategy development was also informed by quantitative assessment of the impacts of climate change and water-related investments on water security metrics. The quantitative assessment involved developing a system model and then applying a climate 'stress test' to assess performance and identify situations under which water demand exceeded supply. Actions and pathways identified through the workshop process were evaluated using the system model developed for Barossa (discussed further in Section 3.3.1). Results of this assessment are included in this strategy and further information regarding the methodology and results are provided in *Assessment of current and future water security in the Barossa and Eden Valleys using the Climate Resilience Assessment Framework and Tools* (Westra et al. 2021).

1.2.2. Strategy structure

This Guide to the Barossa Water Security Strategy includes five sections. This section (Section 1) provides an introduction and outlines the vision for Barossa in 2050. Section 2 provides background information on Barossa including a description of water resources and their historical use. Section 3 explores the future of Barossa through the creation of plausible future scenarios and through the evaluation of water availability under projected futures. Section 4 includes strategic actions, grouped under pillars that will contribute to achieving the vision set out in Section 1. Section 5 provides further recommendations and next steps to implement this strategy.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1804
3/10

2. Background

The Barossa region has been proactive in investing in water and climate change adaptation. Studies such as Vision 2045 (1996) and ReVision 2045 (2010), commissioned by the Barossa and Light Regional Development Board (now Regional Development Australia Barossa), set out a strategic plan for water security for the Barossa and Light Region in the face of a changing climate, a growing population and increasing pressure on water resources.

A Regional Climate Change Adaptation Plan was also developed in 2014 to explore how best to adapt to a changing climate and improve the adaptive capacity of the region. This plan was developed through a collaboration between Regional Development Australia Barossa, The Barossa Council, Light Regional Council, District Council of Mallala, the former Barossa Grape & Wine Association (now Barossa Australia) and the former Adelaide and Mount Lofty Ranges Resources Management Board.

The region also proactively introduced additional water via the Barossa Infrastructure Limited Scheme in 2001, to provide a reliable and high-quality source of water suitable for viticulture. The scheme, fully funded by viticulturists, has grown over the years and can now provide up to 11 GL a year and makes up more than half of the irrigation volume used in the Barossa Valley.

A timeline of the key events and documents developed is provided at Figure 3.

A Regional Water Forum held in September 2019 highlighted water security issues, which led to the development of this strategy following endorsement from key stakeholders and community members at a water security workshop in February 2021.

At the time of instigating the development of a water security strategy a number of water projects and investigations were underway in Barossa. The most significant include developing a business case for the provision of recycled wastewater from the Bolivar Wastewater Treatment Plant to Barossa, a business case for supplying water from the River Murray to Eden Valley via the Mannum-Adelaide pipeline, and the review and amendment of the Water Allocation Plan for the Barossa Prescribed Water Resources Area (Barossa WAP). Downstream of Barossa, a Gawler River Stormwater Management Plan was also being developed and investigations were underway around flood mitigation measures for the Gawler River.

The development of this strategy took place just over 10 years on from Revision 2045 and builds on the water resources and climate change studies undertaken in the region. It intends to continue to build adaptive capacity in the region and continue to progress towards a water-secure future.

Key resources that informed the strategy include:

- Water Allocation Plan for the Barossa Prescribed Water Resources Area (AMLR NRM Board, 2009)
- Revision 2045: A Water Strategy for the Barossa and Light Region (AWE, 2010)
- An Adaptation Plan for Water Barossa RDA Region (Seed Consulting, 2014)
- Economic Profile of the Barossa Regional Development Australia Region (Econsearch, 2016).

A RECENT HISTORY OF WATER MANAGEMENT

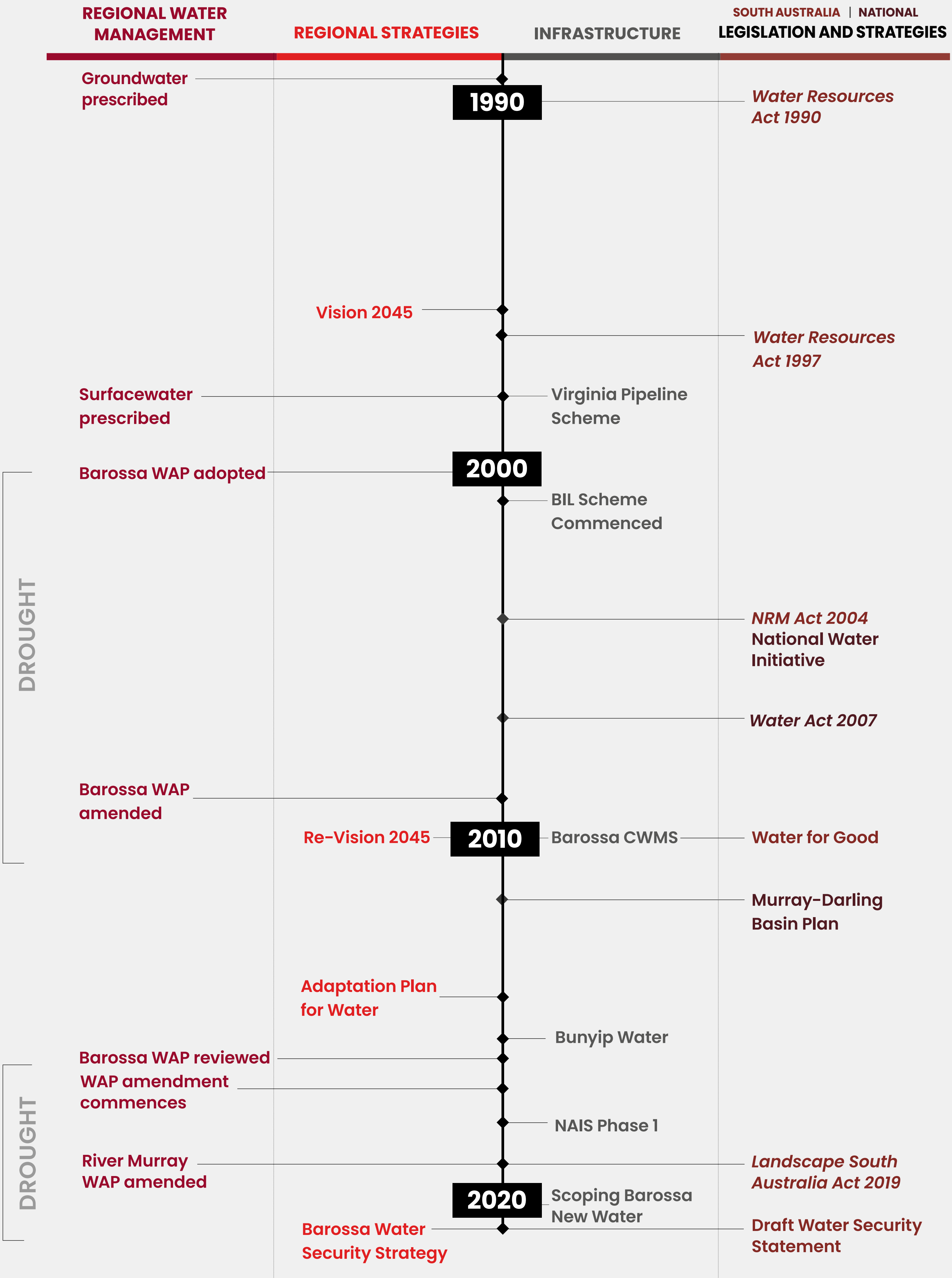


Figure 3 – Timeline of key events and documents in Barossa

2.1. The region

The land and waters to which the strategy relates is Ngadjuri, Peramangk and Kaurna Country and these Aboriginal nations' are the traditional custodians and carers of the regions. It is acknowledged that Aboriginal peoples' spiritual, social, cultural and economic practices are intrinsically linked to their lands and waters and their continuing connection to their lands and waters is recognised.

The water security strategy applies to the Barossa GI Zone, which incorporates two distinct wine regions – the Barossa Valley GI Region (the Barossa Valley), located approximately 60 km north-east of Adelaide, and the Eden Valley GI Region (the Eden Valley), located in the northern part of the Mount Lofty Ranges and approximately 70 km north-east of Adelaide. Both have different geography, climate and water sources. A summary of each of the valleys is provided below. A map of the area covered by the strategy, the Barossa GI Zone, is provided at Figure 4.

The majority of water use is from the Barossa Prescribed Water Resources Area, however, a significant portion of the Eden Valley is within the Marne Saunders Prescribed Water Resources Area. Surface water and groundwater are managed under water allocation plans, with supplementary water provided by the River Murray as well as recycled water.

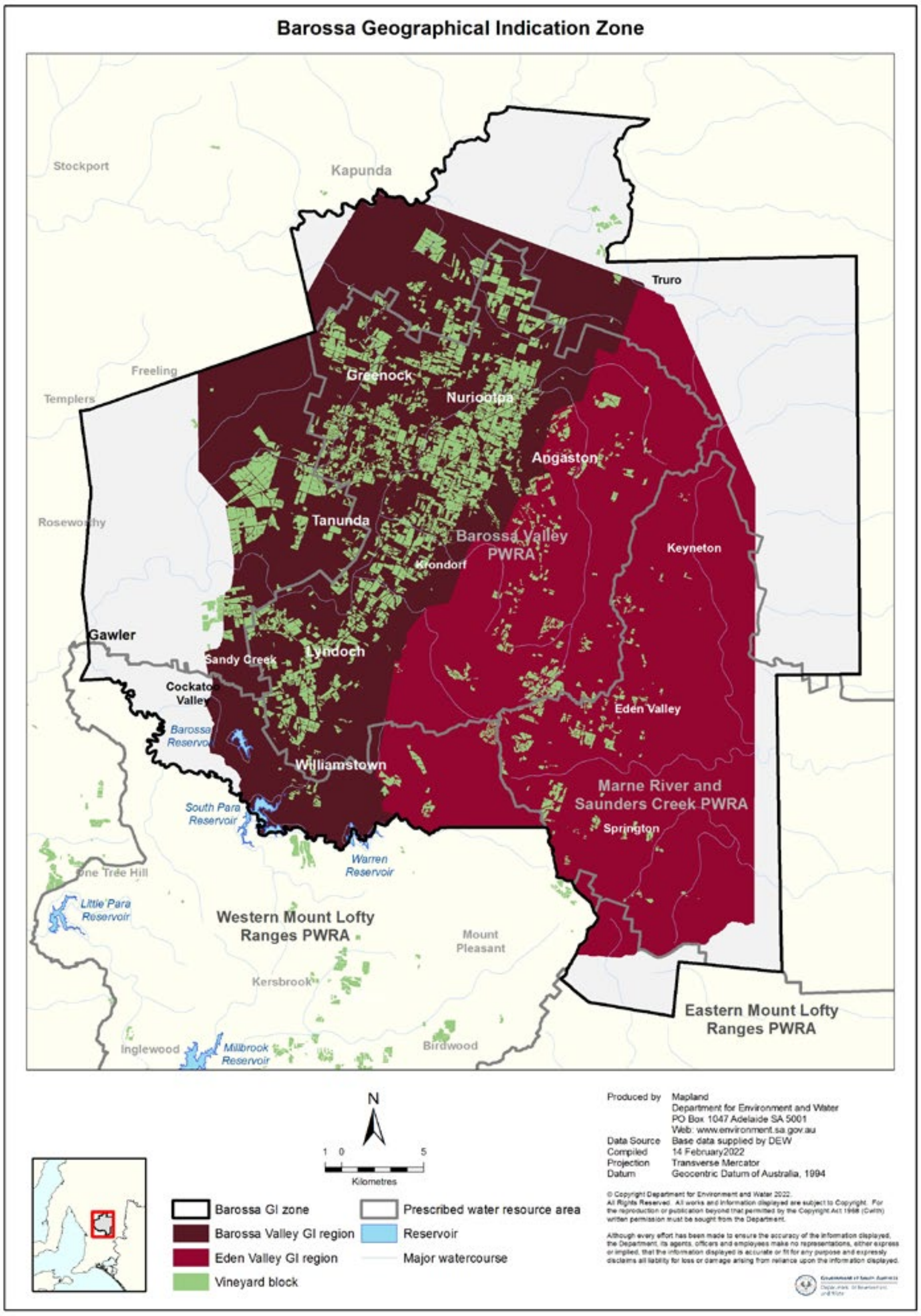


Figure 4 – Map of the Barossa GI Zone covered by the strategy

2.2. People and industry

The current population of the Barossa region is about 35,000. The wine industry provides a significant contribution to the economy of the region, with flow-on benefits to local retail, food and accommodation services as well as the transport and manufacturing industries. The wine and viticulture sectors provide a high proportion of the gross regional product as well as a high proportion of employment. Barossa supports around 14,000 hectares of viticulture, with around 11,600 hectares grown in the Barossa Valley and around 2,300 hectares grown in Eden Valley. The region grows some of the world's oldest grapevines with plantings dating back to the early 1840s.

Over the past five years (up to 2020), the average crush for the Barossa Valley and Eden Valley has been 51,535 tonnes and 8,647 tonnes respectively. The total estimated value of wine grapes in 2021 was just under $140 million for Barossa Valley and $21 million for Eden Valley[2]. Around 24% of the wine produced in the Barossa Valley in 2020-21 was exported with the value of these exports being approximately $96 million[3]. Around 11% of the wine produced in the Eden Valley in 2020-21 was exported with the value of these exports being approximately $9.5 million[4]. The value of output generated directly from wine industry activities for Barossa was estimated to be approximately $941 million in 2019-20[5].

[2]Tourism also contributes to the region's economy with visitors enjoying the history, culture, local food and wine as well as the picturesque and varied landscape. In March 2021, the annual value of tourism to the Barossa was $208 million, compared with $235 million in 2019. Tourism directly employs around 800 people, with an additional 400 people indirectly employed[6]. Visitor numbers have recently dropped due to the COVID-19 pandemic, with no international traffic due to borders being closed. As borders open and international arrivals return, the industry is expected to grow to a potential value of $371 million7 by 2030.

Agriculture and grazing also makes a signification contribution to the region. More than 100 sheep, cattle and dairy farming businesses operate in the Barossa. In 2019-20, cattle, lamb and mutton had a production value of $19.9 million.

2 https://vinehealth.com.au/wp-content/uploads/Barossa-zone-report-2021.pdf
3 www.wineaustralia.com/Barossa-Valley-Snapshot-2020-21
4 www.wineaustralia.com/Eden-Valley-Snapshot-2020-21
5 Industry sector analysis | RDA BGLAP | economy.id
6 Barossa (tourism.sa.gov.au
7 satc_corporate-affairs_research-and-insights_the-value-of-tourism_october-2021_barossa.pdf

Barossa at a glance in 2022

POPULATION
~35,000

TOURISM

$225 million value to the Barossa in 2019-20

LOCATED

within the Mid North Region of South Australia

FIRST NATIONS

Ngadjuri, Peramangk and Kaurna nations

WINE GRAPES

~$140 million value in Barossa Valley and ~$21 million value in Eden Valley in 2021

NATIVE WATER SOURCES

Surface water - Dams, watercourses , roof runoff

Groundwater – sedimentary and fractured rock aquifers

AGRICULTURE AND GRAZING

$19.9 million production value in 2019-20

14,000 HECTARES OF VITICULTURE

~$941 million value of output from wine industry activities in 2019-20

IMPORTED WATER SOURCES

- River Murray
- Recycled Water from Bolivar WWTP & the Nuriootpa Community Wastewater Scheme
- Stormwater runoff from urban areas in Gawler and the Gawler River

100 SHEEP, CATTLE AND DAIRY FARMING BUSINESSES

OTHER INDUSTRIES

Retail, food, accommodation, transport, creative economy, equine, health & allied health

KEY STORAGES

Warren Reservoir

2.3. Historical development of water infrastructure

Water infrastructure in Barossa has developed significantly over recent decades, with native and imported water sources accessed. A brief summary is provided below and a map showing the location of water sources is provided at Appendix B.

2.3.1. Farm dams

Farm dams allow for the storage of surface water across the region and are used for irrigation, stock and domestic uses.

Dam development increased significantly during the period from the early 1970s to 1991, with development slowing upon prescription of water resources. It is estimated that the Barossa GI Zone has a total of 3,230 dams, with a total storage capacity of 14.34 GL. Of these, the Barossa Valley has 1,346 dams with a total capacity of 5.89 GL; the Eden Valley has 1,884 dams with a capacity of 8.45 GL. Farm dams are filled by runoff from rainfall and some are used to store water from imported sources such as the Barossa Infrastructure Limited (BIL) scheme.

2.3.2. Groundwater

Groundwater is accessed via wells and pumping systems predominantly for irrigation, with small volumes extracted for stock and domestic water supply. Groundwater is accessed via an 'upper' unconfined/confined sedimentary aquifer, a 'lower' confined sedimentary aquifer, and fractured rock aquifers. There are 520 licensed wells in Barossa, with 354 of these being in the Barossa Valley and 166 in the Eden Valley. Salinity varies across the region, with groundwater from the upper sedimentary aquifer generally being too saline for irrigation. Groundwater within the lower sedimentary and fractured rock aquifers is generally of a lower salinity and is suitable for irrigation. Groundwater is sometimes 'shandied', for example with surface water in dams, to reduce the salinity.

BIL pump station

2.3.3. Imported water systems

The Barossa Valley uses water from external sources for irrigation. These sources include the River Murray and stormwater harvested from urban areas in Gawler. River Murray water is delivered through the Barossa Infrastructure Limited Scheme (BIL) pipeline and the SA Water mains pipeline. BIL has an annual capacity of 11 GL as at 2020. The BIL scheme has progressively expanded its pipeline capacity to meet increasing demand for water since its inception in 2001.

Urban stormwater runoff from the Gawler River is harvested at Wingate Road and delivered to storages in the western Barossa Valley through the Bunyip Water pipeline, which has a transfer capacity of up to 13 ML/day. The Bunyip Water scheme began operation in 2016 and provides water from a variety of sources including stormwater the Gawler River, stormwater from roadway catchments, Northern Adelaide Plains groundwater and recycled water from the Bolivar Waste Water Treatment Plant (WWTP) via the Virginia Pipeline Scheme. Annual delivery volumes from the Bunyip Water scheme have averaged around 2 GL since commencement, however can be easily expanded with additional storage and water inputs to achieve delivery capacity of up to 5 GL per year, which is the capacity of the main transfer pipeline.

Eden Valley is supplied small volumes of River Murray water via the SA Water pipeline.

2.4. Barossa Valley water and climate

2.4.1. Region and climate

The Barossa Valley consists of the valley floor, through to the undulating hills of the lower Flaxman Valley and Duck Ponds Creek, to the steeper and more elevated areas of Tanunda Creek and Jacob's Creek. It is located approximately 60 km north-east of Adelaide and lies within the Northern and Yorke Landscape Region. The area has been extensively cleared. Viticulture is the predominant land use on the valley floor, with grazing occurring in the hills and elevated areas. Much of the urban and industrial development is on the valley floor and within the main towns of Tanunda, Nuriootpa and Angaston.

The Barossa Valley has mild, wet winters and hot, dry summers, which are typical of a Mediterranean climate. Annual rainfall varies from more than 750 mm at high points in the Barossa Ranges to about 300 mm north of Angaston. Streamflow is also highly variable as a result of the variability of rainfall across the area. There has been a steady decline in the long-term average annual rainfall.

2.4.2. Water sources

Water in the Barossa Valley is sourced from groundwater, surface water (including dams and watercourses), recycled water (stormwater and wastewater) as well as water imported from the River Murray via BIL and SA Water pipelines. Dams are replenished via rainfall and some farm dams are also used to store recycled water and water imported via the BIL scheme and SA Water pipelines.

The BIL scheme has been in operation since 2001 and has progressively increased in capacity up to a current annual capacity of 11 GL. The Bunyip Water scheme delivers stormwater from Gawler as well as groundwater from the Northern Adelaide Plains and recycled wastewater from the Bolivar WWTP via the Virginia Pipeline Scheme. The scheme currently has the current capacity to deliver 2 GL a year.

Most of the groundwater and surface water sources in the Barossa Valley fall within the Barossa Prescribed Water Resources Area (PWRA). The Barossa PWRA includes the highland areas of the Mount Lofty Ranges and the Barossa Valley. Groundwater and surface water resources are prescribed and managed under a water allocation plan that was adopted in 2009. At the time of drafting this strategy, the water allocation plan was in the process of being amended.

2.4.3. Historical water use

Historically, water for agriculture has been sourced predominantly from native water sources replenished by rainfall. Over the past 10 years, overall water use has increased significantly, largely as a result of an increase in the use of imported water. Over the past five years, on average twice as much imported water was used compared to groundwater and surface water (see Figure 4). The increase in water use has been a result of increased planted area combined with decreasing levels of rainfall. A decrease in overall water use in 2016-17 reflects a higher rainfall year.

Water use within the Barossa Valley in 2018-19 was the highest water use recorded in the past

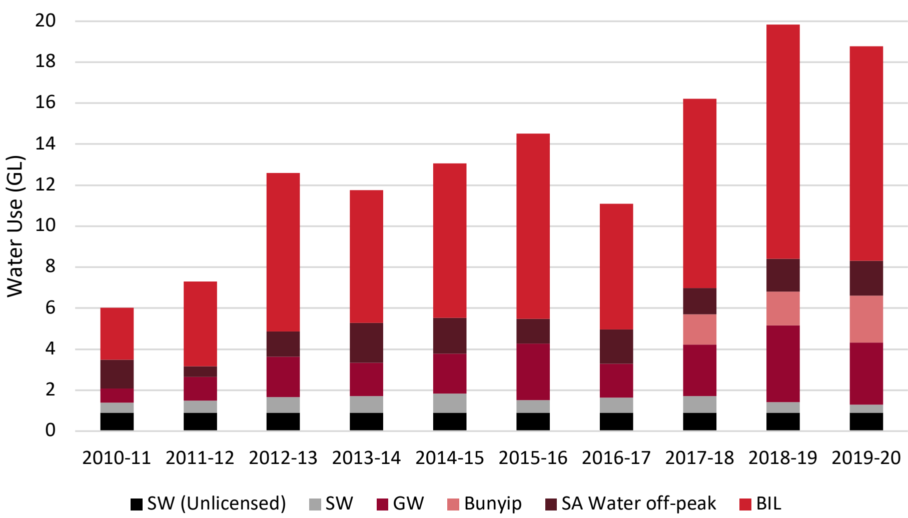


Figure 5 – Water use in the Barossa Valley 2010-11 to 2019-20

10 years, with close to 20 GL used across all sources. Very low rainfall and hot temperatures contributed to the levels of water use. The total volume of imported water into the Barossa Valley makes up a high proportion of total water used. Surface water use is minimal compared to other sources and has declined over the past two years.

Potential exists to increase the volume of recycled water supplied to the Barossa and Eden Valleys from Bolivar WWTP. Plans also exist to harvest additional volumes of stormwater through increased runoff via the Roseworthy Township Expansion (additional 500-800 ML a year) and the Concordia development proposed on 500 hectares of land to the east of Gawler.

MEDITERRANEAN CLIMATE WITH MILD WET WINTERS AND HOT DRY SUMMERS

Rainfall varies from 750mm at high points to 300mm north of Angaston

LOCATION

Northern part of the Mount Lofty Ranges ~**60km** north-east of Adelaide

The valley floor primarily supports viticulture, with grazing in the hills and more elevated areas, and cropping in the west.

MAIN TOWNS

Tanunda, Nuriootpa, Angaston, Lyndoch, Williamstown and Greenock

RIVER MURRAY WATER

11 GL of non-potable water delivered via BIL

SA Water also supplies River Murray water through the mains network.

SURFACE WATER

- North Para River | Greenock Creek
- Permanent pools predominantly sustained by groundwater
- Streamflow primarily rainfall driven
- **1346** dams with total capacity of ~5.89 GL

In 2018-19 streamflow recorded to be the lowest on record at three out of four gauging stations. Trends are showing a long-term decline in streamflow.

GROUNDWATER

- **2** sedimentary aquifer systems and fractured rock aquifers.
- **354** licensed extraction wells
- **Bunyip Water scheme** delivers groundwater from the Northern Adelaide Plains

In 2018-19 groundwater levels in all three aquifer systems were at their lowest on record.

RECYCLED WATER

- **Bunyip Water scheme** delivers water from the Gawler River, stormwater runoff and recycled water from Bolivar Wastewater Treatment Plant.
- **BIL supplies recycled water** from the Community Wastewater Schemes.

In the last few years, water through the Bunyip Water scheme has primarily been sourced from Bolivar due to lack of rainfall

2.5. Eden Valley water and climate

2.5.1. Region and climate

The Eden Valley lies in the northern part of the Mount Lofty Ranges, immediately east of the Barossa Valley, and consists of undulating hills and valleys with the main townships being Keyneton, Eden Valley and Springton. Eden Valley sits across the headwaters of the North Para River in the Flaxman Valley (which is part of the Barossa PWRA) and the headwaters of the Marne River and Saunders Creek (which is part of the Marne Saunders PWRA). Eden Valley is located approximately 70 km north-east of Adelaide and lies within the Northern and Yorke Landscape Region.

The Eden Valley has a cooler climate than the Barossa Valley and a higher elevation above sea level. Annual rainfall can reach 800 mm due to the high elevation. Streamflow is primarily rainfall driven. The last few years have been dry with lower than average rainfall and streamflow much below the recorded long-term average. Long-term data trends indicate a decline in rainfall and in streamflow.

2.5.2. Water sources

Water in the Eden Valley is sourced from groundwater, surface water (including dams and watercourses), with small volumes provided from the River Murray via SA Water pipelines. Unlike the Barossa Valley, the Eden Valley is heavily reliant on native water resources, with very little imported water currently available.

The groundwater and surface water sources in the Eden Valley fall within the Marne Saunders Prescribed Water Resources Area (PWRA). The Marne Saunders PWRA includes the highland areas of the Mount Lofty Ranges and the Murray Plains that meet the River Murray. This strategy relates only to the Eden Valley portion of the prescribed area. Groundwater and surface water resources are prescribed and managed under a water allocation plan that was adopted in 2010. The water allocation plan was reviewed in 2019 and it was recommended that no amendment be undertaken at that time.

2.5.3. Historical water use

Eden Valley has limited access to water sources – water use from 2010-11 to 2019-20 shows a much larger proportion of use from surface water and groundwater resources as compared to the Barossa Valley (see Figure 5). Only small volumes are currently provided by SA Water. In dry years water use is limited by the quality and availability of surface water and groundwater. Surface water use has declined over the past few years due to a number of dry years, which has limited the availability of water. The maximum use was just over 3GL in 2015-16.

The main issues facing Eden Valley water users are due to low levels of rainfall. Low rainfall over the past few years has resulted in low dam water levels and less volumes of water captured via roof-runoff, as well as increasing salinity of groundwater. There is potential to increase the volume of water provided to Eden Valley via the River Murray, or via recycled water from the Bolivar WWTP.

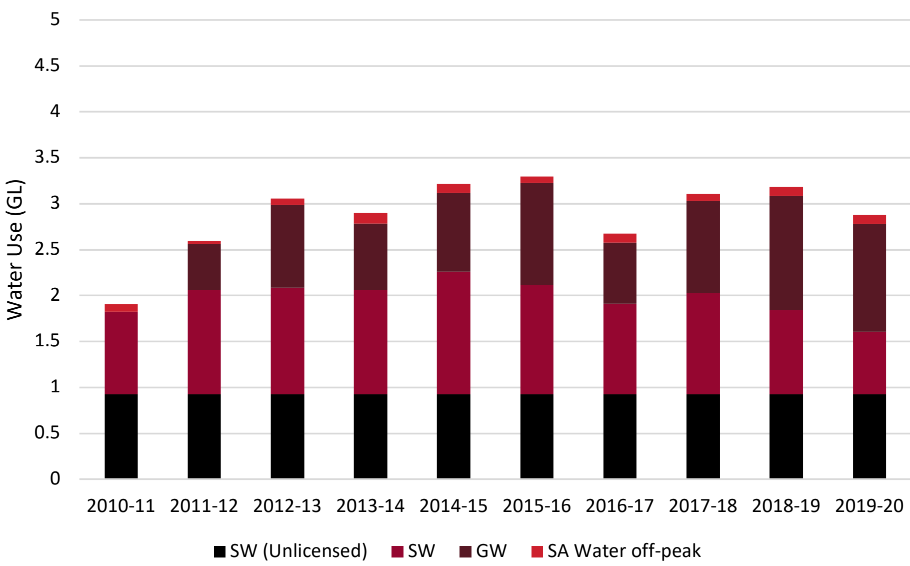


Figure 6 – Water use in the Eden Valley 2010-11 to 2019-20.

LOCATION

Approximately **~70km** north-east of Adelaide

Undulating hills and valleys supporting viticulture and grazing

MAIN TOWNS

Keyneton, Eden Valley and Springton

COOLER AND WETTER CLIMATE THAN THE BAROSSA VALLEY

Rainfall can reach 800mm due to high elevation

RIVER MURRAY WATER

- SA Water supplies limited River Murray water through the mains network.
- Reticulated water is supplied to Keyneton, Springton, Eden Valley and Cambrai and is also available along the pipe routes to those towns.

SURFACE WATER

- Marne River & Saunders Creek
- Streamflow primarily rainfall driven
- **1884 dam**s with total capacity of ~8.45ML
- Water also captured and used via rainfall runoff from houses and sheds

!

The last few years have been dry with lower than average rainfall and streamflow much below the recorded long-term average.

GROUNDWATER

- Fractured rock aquifers recharged by rainfall.
- Wells are typically low yielding and quality is variable.
- **166** licensed extraction wells

!

In 2018-19 groundwater levels were either at their lowest on record or at a below-average water level.

2.6. Land use and soils

The Barossa is known for its premium wine making and this section provides an overview of vineyard areas and varieties planted, as well as the potential for growth in planted area based on soil types.

Viticulture has been in place in the Barossa since the 1840s. The decade from 2000 to 2010 experienced a significant increase in areas planted to vines, with the total area increasing slightly since then (see Figure 6).

Winegrape varieties

Figure 7 and Figure 8 set out the varieties of winegrapes planted over time in the Barossa and Eden Valleys.

- Shiraz has remained the most common winegrape planted, however the composition of varieties has changed over the past 20 years.
- In the Barossa Valley red varieties increased over this period and white varieties decreased (see Figure 7).
- In the Eden Valley, white and red varieties have remained steadier over the same period (see Figure 8).
- The Barossa Valley has already predominantly made the shift to varieties with lower water requirements.
- There is some capacity to convert varieties in the Eden Valley should the climate become less amenable to white grapes in future.

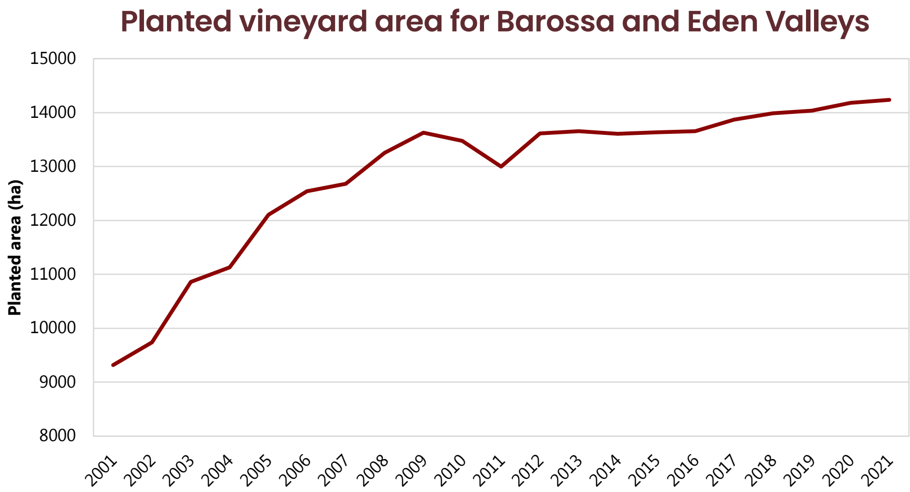


Figure 7 – planted to vineyards from 2001 to 2021

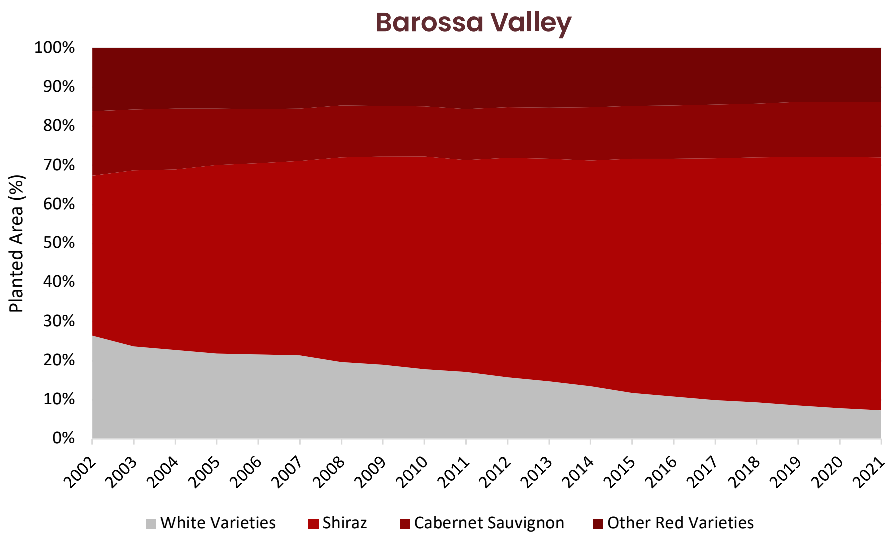


Figure 8 – Varieties planted in the Barossa Valley

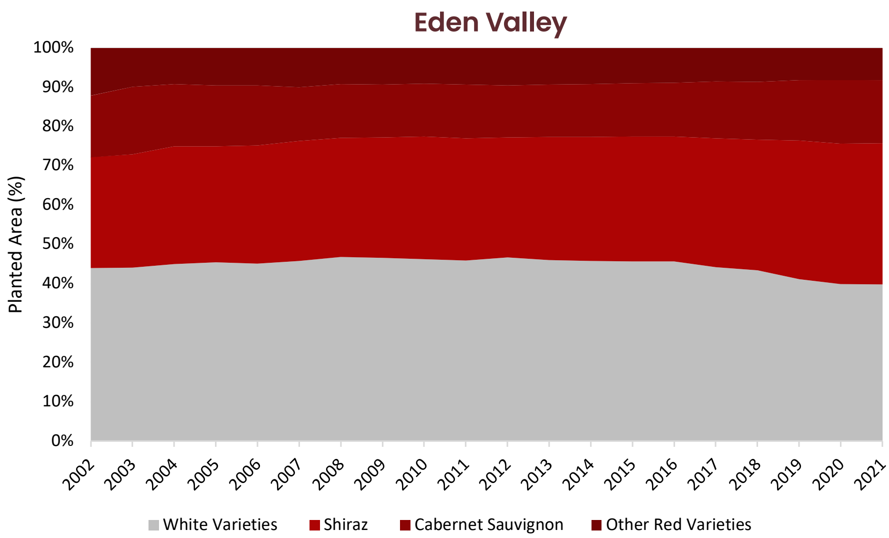


Figure 9 – Varieties planted in the Eden Valley

Soil types

Figure 9 shows the range of soils across the Barossa GI Zone, based on the available water holding capacity of soils (i.e. how much water can be effectively available for crop growth) and whether there are unplanted areas that would be suitable for vineyards or other crops.

Figure 10 sets out the areas of high and moderate soil water holding capacity in the Barossa and Eden Valleys. This indicates:

- the potential to expand vineyard areas, or plant other crops, in areas with high or moderate water holding capacity, not withstanding other limitations
- current vineyard plantings are a small proportion of plantings on land with suitable soil holding capacity.

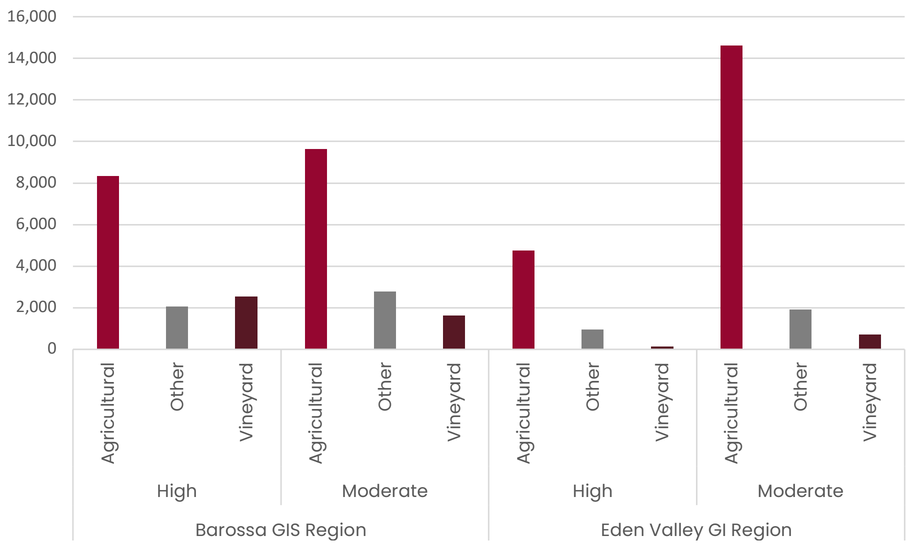


Figure 11 –Soil types and categorisation across the Barossa and Eden Valley GI Zones

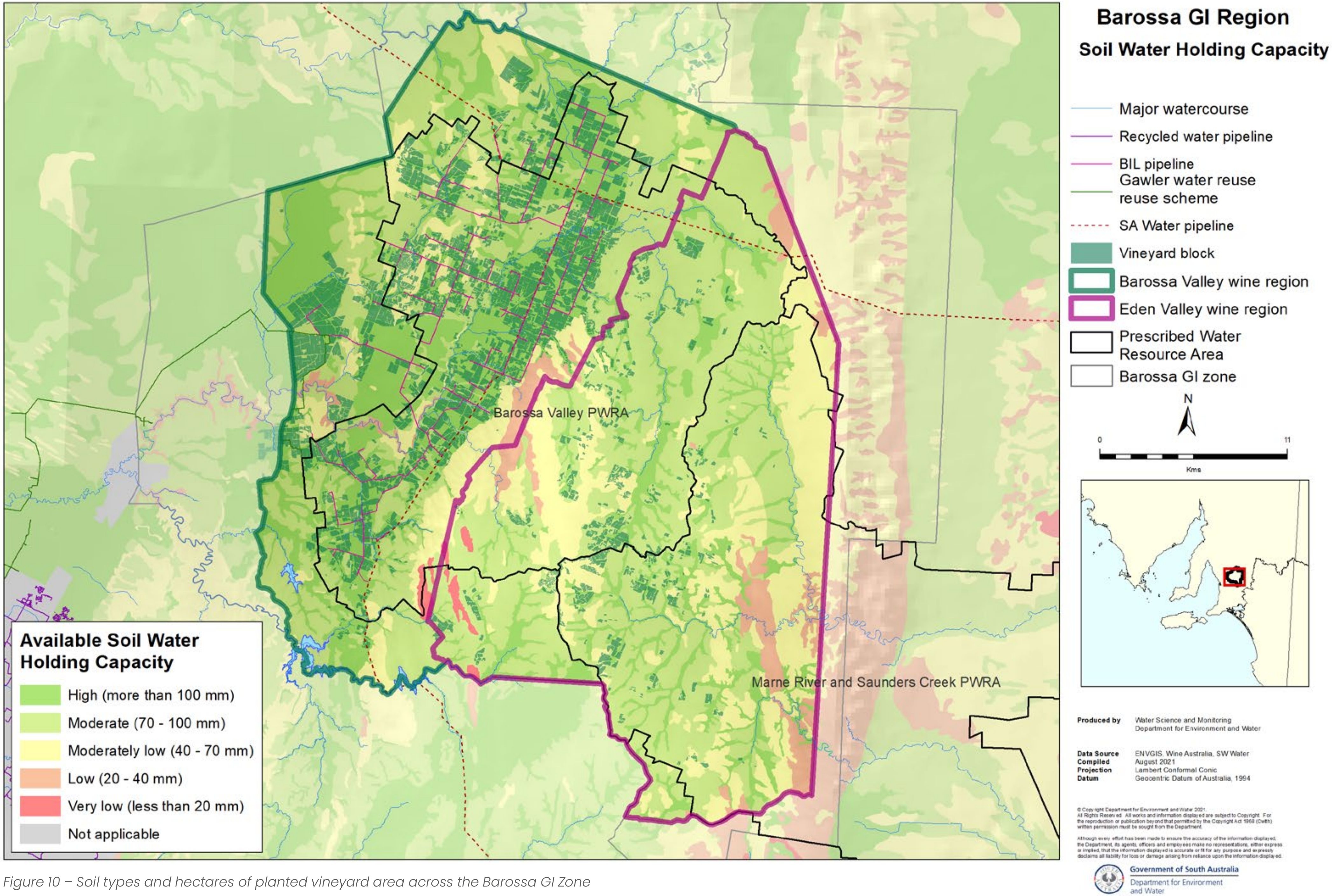


Figure 10 – Soil types and hectares of planted vineyard area across the Barossa GI Zone

Yield

As outlined in Figure 6, the area planted to winegrapes grew in the early 2000s and plateaued to around 14,000 ha in the last decade. Water use has been variable in the past 10 years, based on rainfall and water availability and yield has also been variable from year-to-year (see Figure 11). Water use peaked in 2018-19 however yield declined in that year and recovered in 2020-21.

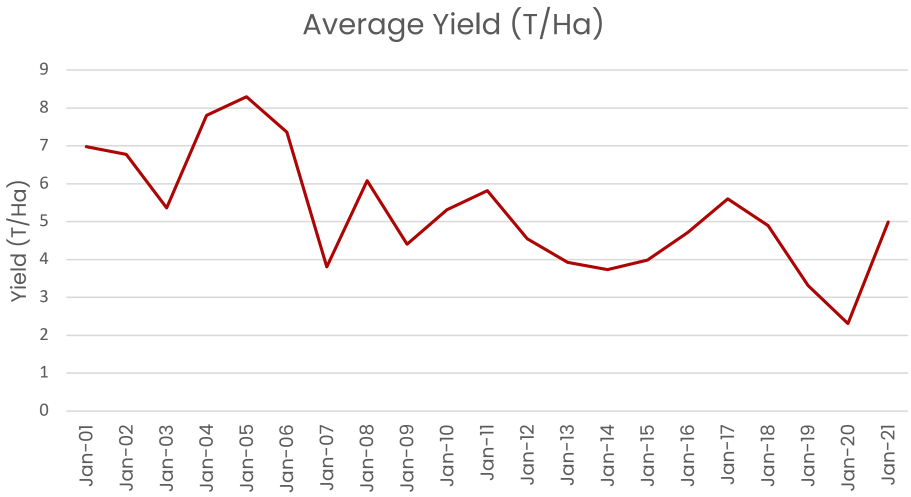


Figure 12 – Average grape yield per hectare for the Barossa region

A general trend of declining yield per hectare is generally attributed to changes in climate and an associated increase in water scarcity, as well as a trend towards 'premiumisation' of wine production. The planted area, the grape variety and the yield all impact on overall demand for water. With secure access to water, there would be potential for both the planted area and yield to increase while maintaining the desired quality of grapes.

2.7. Ecosystems

Ecosystem condition varies across the region. Rainfall and streamflow are highly variable across catchments, with some catchments naturally having perennial flows and others flowing for less than 30% of the time. The area has been extensively cleared, with remnants of native vegetation only found along drainage channels. Ecology in the region is already heavily modified with resilient species in place. However some areas with good habitat and native species are still in place, ecosystems that include river red gums, an understorey of native plants and the presence of native fish and macroinvertebrate species.

Flow regime

Local streams are characterised by a variable flow regime. In long, dry summers, streamflow would naturally stop in many reaches, with permanent pools becoming critically important habitat. During dry periods, low flows and baseflow from groundwater are important to freshen up these pools and maintain pool connection. Higher flows then flush out sediments and organic matter and also provide water for flood plain vegetation.

Ecosystems rely on flow regime to remain healthy (see Figure 12 for an overview of flow components). How often and how long flow periods occur are critical to water-dependent ecosystems. Changes in flow are linked to the decline of aquatic plants and animals, impacts on transport of sediments and nutrients, ecological functioning and water quality, and connection. Shorter flowing seasons and increases in 'zero flow' days impacts on permanent pools as well as the ability for aquatic plants and animals to complete their lifecycle.

Impacts on flow regime

Without redressing impacts to water-dependent ecosystems, the decline of aquatic plants and animals are expected to continue, ultimately resulting in localised extinctions.

- The level of dam development and the use of groundwater and surface water has had an impact on water-dependent ecosystems.
- On-stream dams have also resulted in barriers to fish movement and fragmented habitats.
- In the past few years, changes in ecological condition have been observed as a result of reductions in both surface water flows and groundwater baseflow.

Increasing flow periods will have tangible ecological benefits including increased diversity of waterbugs and increased likelihood of successful native fish recruitment, among other benefits. Increased flowing days are also linked in increased resilience of the ecosystem, providing a buffer against other stressors including water quality and climate change. Flow in the watercourse is clearly identified as a social and cultural priority, as flowing rivers are identified as healthier and having higher value, both spiritually and ecologically.

Impact of water resource availability on ecosystems

Surface water availability is heavily reliant on rainfall. The last few dry years have resulted in reduced runoff – dry soils take time to wet up and for runoff to fill and spill dams.

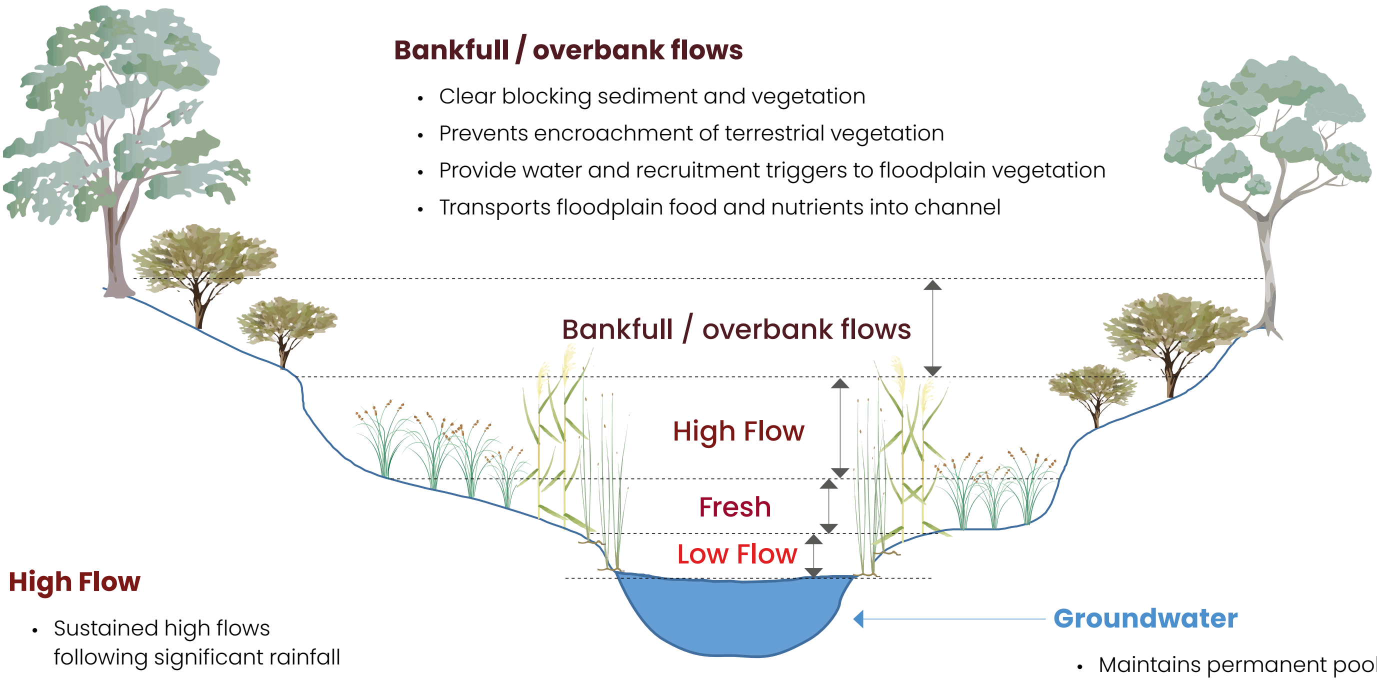
Groundwater is more susceptible to impacts from extraction but is also reliant on rainfall for recharge. In dry years, less recharge and increases in volumes of water used results in the lowering of water levels and salinity increases. Groundwater also provides important baseflow, so declining groundwater levels can further exacerbate reduced flows in dry years.

The combination of reduced rainfall and hotter temperatures is expected to reduce runoff, reduce recharge of groundwater, and increase irrigation demand, which will result in further ecological decline. Interventions will be required to achieve the vision of a future where ecosystems are healthy and waterways are flowing.

Why are natural flow patterns important?

Bankfull / overbank flows

- Clear blocking sediment and vegetation
- Prevents encroachment of terrestrial vegetation
- Provide water and recruitment triggers to floodplain vegetation
- Transports floodplain food and nutrients into channel



High Flow

- Sustained high flows following significant rainfall
- Provide water to riparian vegetation
- Moves silt and debris from channel and pools
- Provides breeding and migration triggers

Fresh

- Pulse of flow following rainfall event
- Top up and freshen permanent pools
- Provide water to riparian vegetation

Low Flow

- Refill pools with fresh water
- Link pools together
- Enables aquatic fauna movement

Groundwater

- Maintains permanent pools
- Groundwater driven flow (baseflow)
- Maintains refuge habitat over cease-to-flow period

3. Futures

The strategy development process dedicated a significant amount of time and effort to considering the future. Questions we can ask about the future include:

1. **What do we think will happen?**
   Expectations based on our lived experiences and values
2. **What is predicted to happen?**
   Projections, often mathematical models and probabilities
3. **What do we want to have happen?**
   The vision
4. **What could possibly happen?**
   Plausible scenarios
5. **What are we going to do about it?**
   The planning questions

We are best placed to answer strategic planning questions after we have put some effort into the previous questions.

This strategy was informed by a strategic foresight and resilience-based planning approach that allowed for the systematic consideration of key uncertainties facing the region, their impacts on both demand and supply of water, and on the success or failure of strategic actions and adaptive measures. This allowed for systematic consideration of as broad a range of uncertainties as possible.

Strategy development was also informed by quantitative assessment of the projected impacts of climate change and water-related investments on water security. This developed an understanding of the scale of impact of key behaviours and actions that directly affect water demand or supply.

Together the participatory workshop process and quantitative analysis are used to develop strategies that can help build resilience and prepare for uncertain futures. This section describes how the future was considered and the linkages to the identification of strategic priorities.

3.1. Key current and future challenges and risks

A number of challenges and uncertainties face Barossa, both locally, regionally and globally. There are many future uncertainties around advances in technology and digitisation, trade agreements across the globe, as well as around access to water and the impacts of climate change.

Locally, demand from viticulture is projected to increase and there are opportunities for further irrigation expansion, however this is dependent on access to secure, affordable and fit-for-purpose water. With water availability from native water sources projected to decline, and seasonal variability in rainfall already having an impact on production, the availability of alternative water sources will become increasingly important for the viticulture and agriculture industries and for the amenity of the region.

Significant issues facing water users in the Barossa Valley are the reducing reliability of native water sources, the relatively high cost of imported water sources and increased demand due to climate change.

In the Eden Valley, the main issues facing water users are low levels of rainfall impacting on surface water availability, increasing salinity of groundwater and limited access to alternative sources of water.

The last few years have seen a decline in the condition of local ecosystems, and without action, condition is expected to further decline in response to the impacts of climate change.

The next section sets out how the strategic foresight process allowed for consideration of key uncertainties and the development of strategic plans for a range of plausible futures.

3.2. Plausible futures

Key drivers of change that may impact the region were identified from surveys and from a diverse range of Barossa stakeholders at the first strategy development workshop. The important and uncertain factors are included in Figure 13. Subsequent analysis and one-on-one interviews prioritized 7 key uncertainties and drivers of change, as follows:

- climate change, weather and drought
- global trade and tourism
- population growth
- consumer preferences for Barossa products
- cultural and ethnic diversity and inclusion
- the regulatory environment
- impacts of AgTech and digitisation

Climate was excluded from the scenario generation, as it was agreed that all scenarios would be impacted by climate change and that the uncertainty in relation to climate change impacts would be explicitly considered through the complementary quantitative analysis. Four diverse states were designed for each of the 6 remaining uncertain factors and these were used to design the outline of the most diverse set of potential plausible futures[8]. This process ensures the scenarios developed are as challenging as possible, and cover the broadest possible range of uncertainties, while remaining plausible.

8 The final phase of this analysis involved eliciting "compatibility matrices" for all of the factors and states. The factors, states and combined compatibility matrix are input into a piece of software that is able to identify the four most diverse scenario skeletons from within the entire plausible set (Lord, Helfgott, Vervoot, 2016).

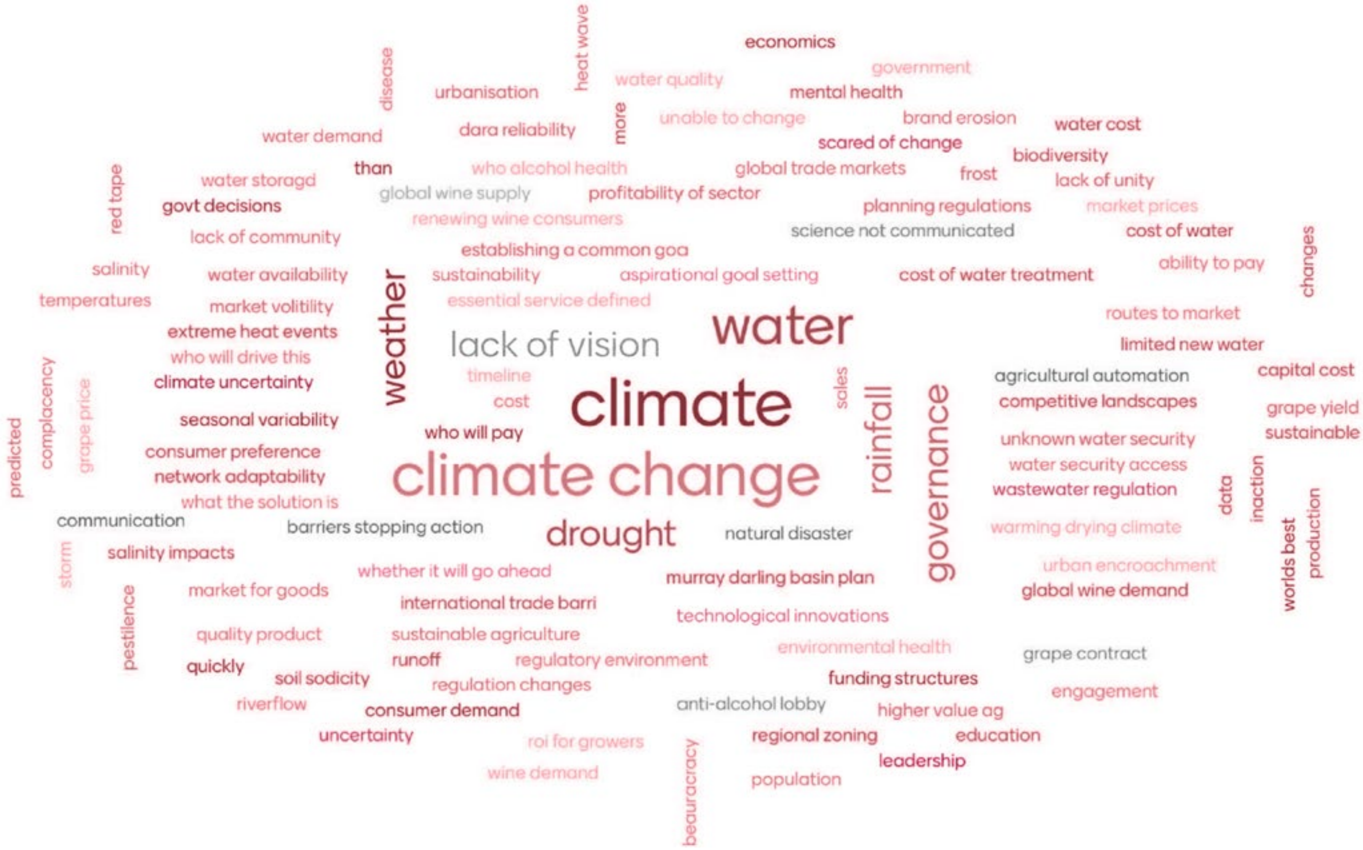


Figure 14 – Key uncertainties facing the Barossa

At the second workshop the scenario outlines were built into 4 very different plausible future scenarios. These scenarios describe potential contexts in which the strategy may be implemented. The scenarios developed in workshop 2 are a key output of the strategy development process. They are a regional resource that could be used to inform future regional planning. A summary of each scenario narrative is described in the remainder of this section with more detail in Appendix C.

The initial 'back casting' process from workshop 1 was revisited based on the 4 future scenarios to consider whether the initial strategy was fit-for-purpose. An example of a back cast is included in Figure 14. This process supported the identification of actions and priorities and allowed for the identification of actions to manage risks in relation to future social, governance and economic drivers that are not well suited to quantification but are nonetheless important.

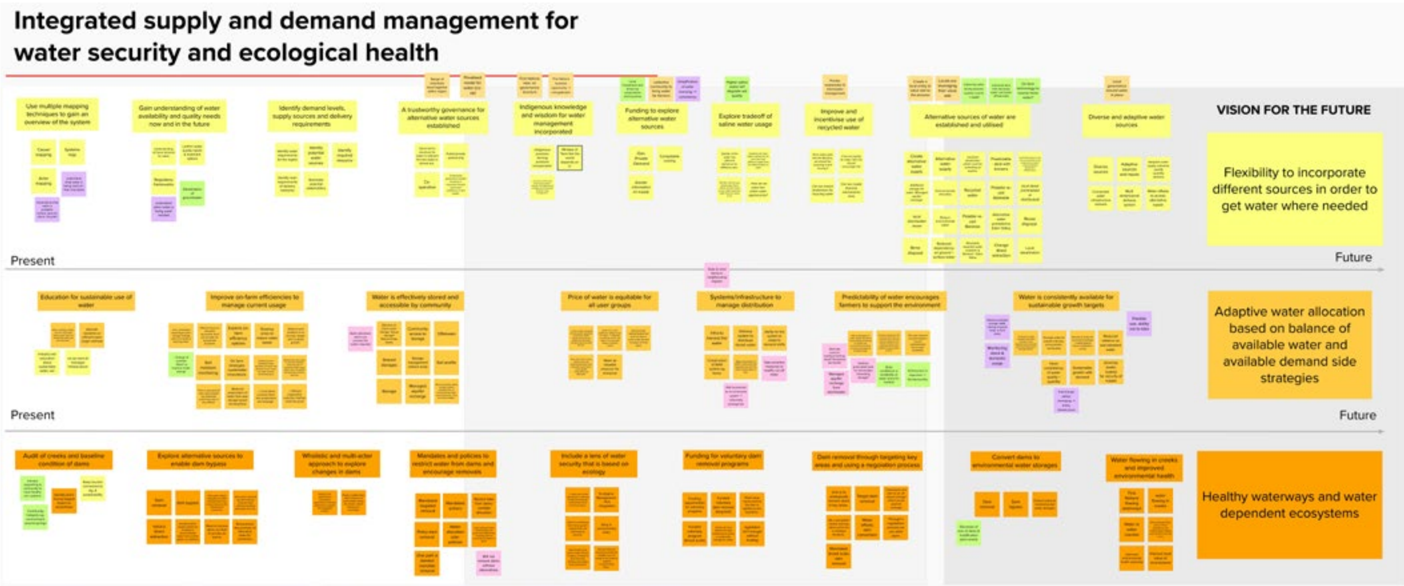


Figure 15 –An example back cast outlining a series of actions that contribute to achieving the vision for integrated system of water supply and demand management for water security and ecological health

By considering what would or would not work in each scenario and revising the initial plans, updates were made in order to deal with the challenges and opportunities provided by each particular scenario. In this way, scenario testing allowed for innovation and built capacity to cope with uncertainty.

3.2.1. Scenario 1: Global growth, urbanisation and limited regulation

The world is highly interconnected, free trade agreements with our major trading partners are in place, there is a tariff free trade environment and no restrictions on tourism. Globally there is a growth in preference for the Barossa brand irrespective of sustainability and local concerns, leading to pressures for expansion. The region experiences population growth through increased urbanisation, sprawl, encroachment and commuters living in the region but working elsewhere. There is a decline in social cohesion and connection to place. The regulatory environment is weak, essentially an unregulated free for all in terms of water allocations, salinity and land use planning. There was slow uptake of AgTech in the region, so the dominant companies are elsewhere, Barossa eventually buys in tech but loses control of its data.

3.2.2. Scenario 2: Strong domestic markets, social cohesion and sustainability

In terms of trade and tourism, there is increased focus on domestic markets, and on certain bilateral agreements, in the midst of increasingly protected markets across the globe. Consumer preference continues to move towards high-end wine plus sustainability credentials – sustainable products with minimal environmental footprints. The focus is on premium clean-and-green products, responsibly and locally produced. Population growth in the region is contained within the existing urban footprint. Indigenous and non-indigenous people of different ethnicities call the Barossa home. The region has embraced multiple cultural narratives. Diversity is valued as it visibly enriches the region in different ways. Corporate sustainability policies drive the regulatory environment, with private companies imposing tougher environmental regulation than our State or Federal Governments in order to meet their legal/compliance/trade requirements and consumer demands. Proactive uptake of AgTech, local innovation and sector development means farmers are now producers of water, energy, food, wine and data.

3.2.3. Scenario 3: Shifting demand, cohesive community, healthy ecosystems

All trade and tourism is heavily restricted on a global scale. There is a contracted global economy, nationalism, trade barriers to protect internal markets and some relocalisation. Consumer preferences focus on both sustainability and health. It has been shown that no amount of alcohol is good for you, and alcohol consumption drops. There are ideological shifts towards plant-based diets. Consumers look for sustainable products with minimal environmental footprints, verified with blockchain credentials. Population growth within the region stays within the existing urban footprint. Indigenous and non-indigenous people of different ethnicities call the Barossa home. The region has embraced multiple cultural narratives and values diversity as it enriches the region in different ways. The regulatory environment is regionally driven, water allocations are managed within local sustainability limits as the climate changes and native water sources diminish, and allocations are adapted to these conditions. There was proactive uptake of AgTech, including local innovation and sector development. The new farmers are producers of water, energy, food, wine and data.

3.2.4. Scenario 4: Global growth and centralised regulation

The world is highly interconnected, free trade agreements with our major trading partners are in place, there is a tariff free trade environment and no restrictions on tourism. Climate drivers impact varietal shifts in the region. Consumer preferences are driven by global factors that are disconnected from local climate realities and varietal feasibility. Historical Barossa families remain tightly knit but newcomers are not readily integrated, increasing the numbers of alienated outsiders. Over time, population in the region declines, with people moving out of this (and other regions) and into the cities. Regulatory functions are increasingly centralised, meaning regions have less influence over the water and land-use policies which are impacting them. There has been slow uptake of AgTech in the region. The Barossa now buys in the technology it needs from external companies.

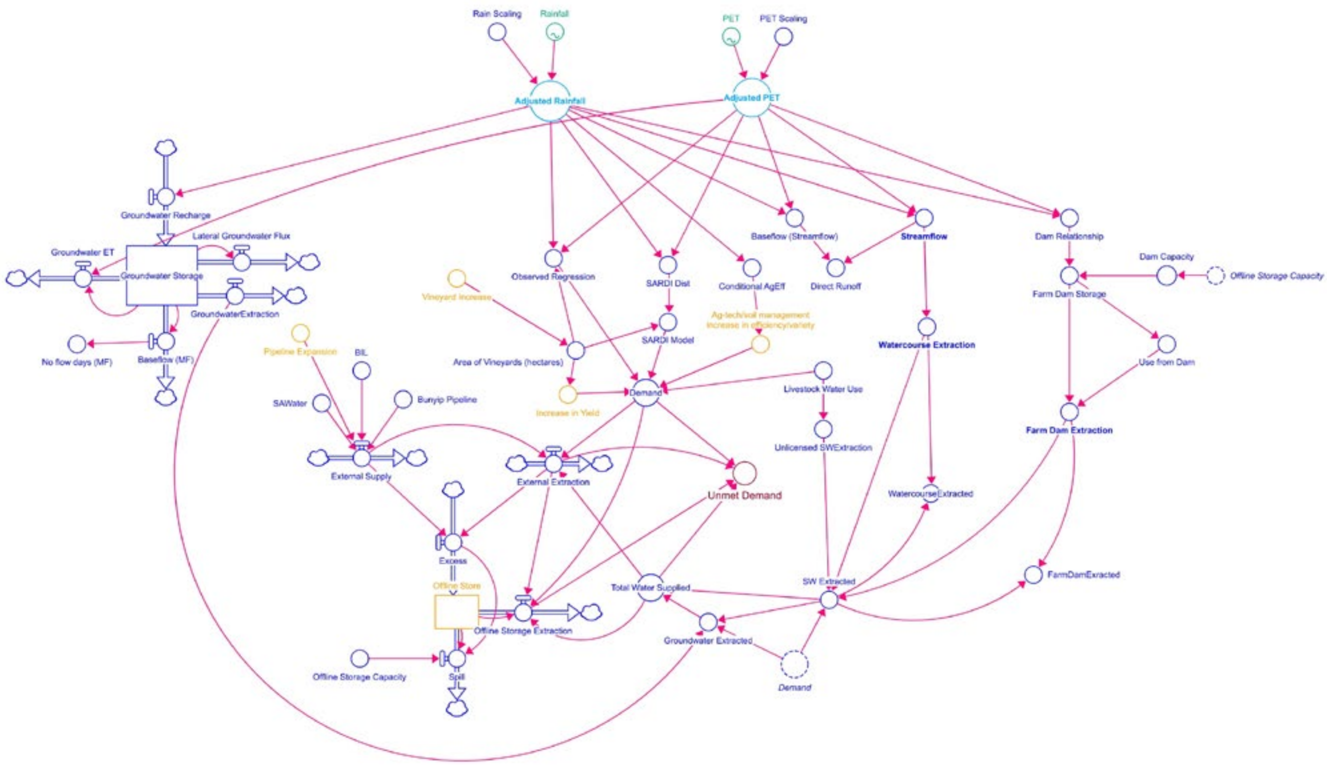


Figure 16 – A system model for the Barossa (Westra et al., 2021)

3.3. Projected Futures

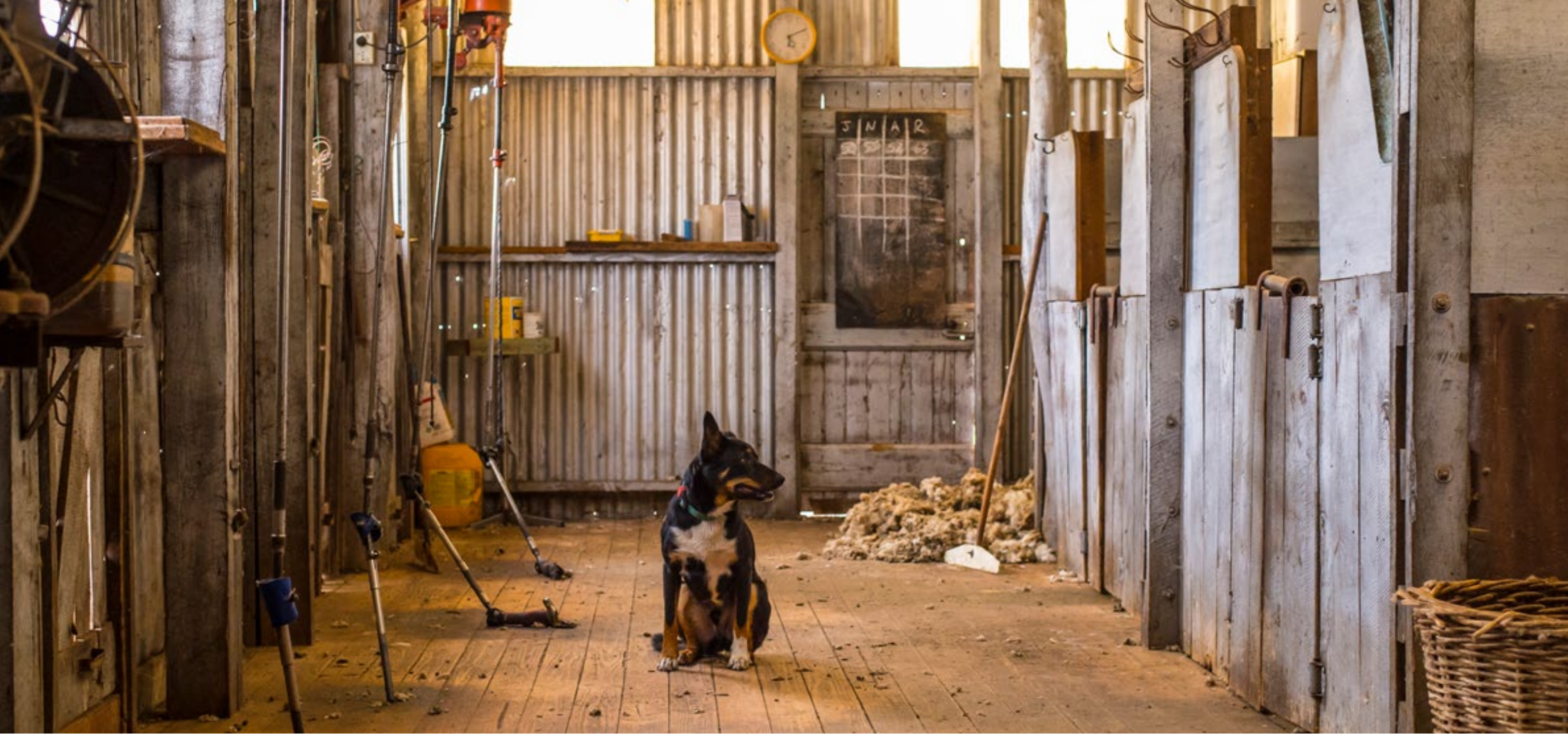
To complement the plausible scenarios and analysis, projections of future water demand and availability were developed. To support the development of the strategy, a climate 'stress test' of water resources in the region both now and over the next 30 years to the year 2050 was undertaken, with consideration of:

- current and projected future availability of native water resources (surface water and groundwater) under present and changing climate conditions
- current and projected future demand for water, with a particular focus on irrigation demands from the viticultural industry
- implications of a set of possible adaptation pathways identified as part of the Barossa water security strategy.

Given the significant climate uncertainty over the 30-year future horizon, the strategy has utilised the Climate Resilience Assessment Framework and Tools (Bennett et al, 2018) to formally stress-test the Barossa water supply and demand system under a range of climate scenarios, considering both the 'baseline' system configuration and a range of adaptation pathways. Building on significant prior investigations into surface water, groundwater and imported water resources, as well as an understanding of demand patterns (including but not limited to vineyard irrigation), an integrated systems modelling framework was developed (Westra et al., 2021). The modelling framework enables exploration of interactions under current and future climates, and allows the investigation of both current system performance (Section 3.3.1) and the performance of alternative adaptive pathways (Section 3.3.2).

3.3.1. Representing Barossa – a water system model

The overall conceptual representation of the Barossa water system is summarised in Figure 15 using a system dynamics representation. This figure shows the significant complexity of the Barossa water resources system, with multiple interactions between surface and groundwater and between supply and demand. This approach has the advantage of highlighting a number of possible system interventions such as increasing overall capacity of the imported water system or improving overall irrigation efficiency. These enable implementation of the adaptive pathways.



3.3.2. Water demand

Understanding water demand is a key element of developing this water security strategy. Consumptive demand represents a key element of the overall system water balance, with viticulture representing the most significant component of the overall demand. Two approaches to modelling demand were developed, both with their own strengths, with the year-to-year variability in irrigation demand between the two models showing consistent patterns (see Figure 16 and Figure 17).

The development of a relationship between climate and demand represents a key foundation for understanding the impacts of climate change on water security. This approach is complemented by the survey-based approach being used to inform the detailed business case for the Barossa New Water project, where individual growers have been asked to estimate future water demands at a range of price points.

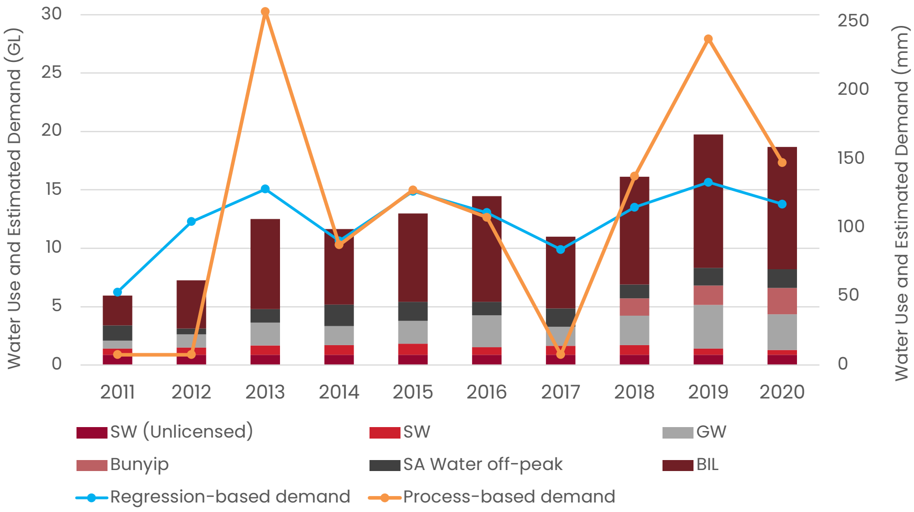


Figure 17 - Comparison of recent water use from different sources (coloured bars) and estimated demand from regression model (black line) and FAO56-DCC model (orange line) shown as depths (mm; right vertical axis) and volumes (GL; left vertical axis) in the Barossa Valley (Westra et al., 2021)

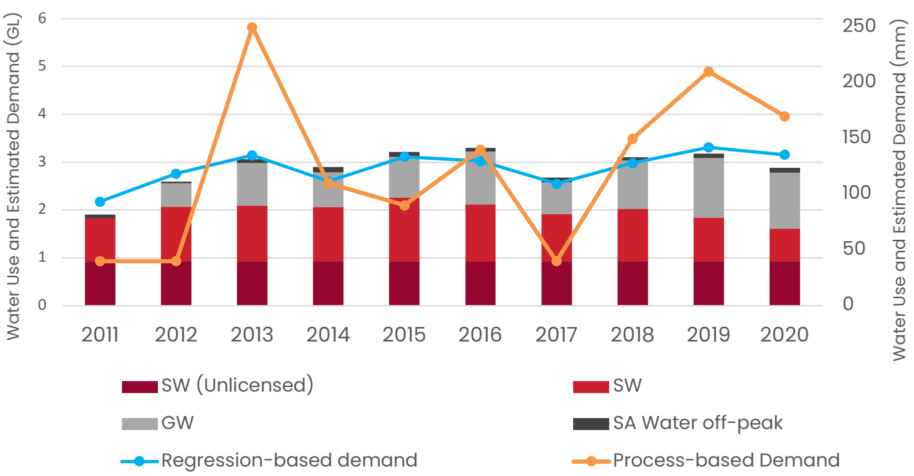


Figure 18 - Comparison of recent water use from different sources (coloured bars) and estimated demand from regression model (black line) and FAO56-DCC model (orange line) shown as depths (mm; right vertical axis) and volumes (GL; left vertical axis) in the Eden Valley (Westra et al., 2021)

3.3.3. Climate change projections

Three sources of information were available to inform our understanding of the projected impacts of climate change on water security (Climate Change in Australia, Climate Ready-SA and NARCliM). Climate variables that have most potential to impact water supply and demand in the Barossa and Eden Valleys are rainfall, potential evapotranspiration and temperature. The strength of the seasonal cycle of precipitation was also analysed in key sections, given the seasonal nature of both the hydrology and the irrigation cycle. A baseline period of 1976-2005 has been used, with the level of change assessed in 3 future time periods (2006 to 2035, 2021 to 2050 and 2036 to 2065). Projections are based on a subset of the CMIP5[9] suite of model simulations. Two emissions pathways are considered (RCP[10] 4.5 and 8.5, representing 'intermediate' and 'high' greenhouse gas concentration pathways).

Significant consistency exists among the majority of projections for a drier and hotter future climate. However there is a large degree of uncertainty regarding the magnitude of future changes. A minority of projections were identified that suggest an increase in precipitation relative to the baseline.

3.3.3.1. Projected changes in rainfall

Rainfall is critical to both water supply and demand as it impacts on surface and groundwater volumes as well as crop water requirements and other demands. The annual and seasonal rainfall projections show declining rainfall across both the intermediate emissions and high emissions scenarios (see Figure 18). The annual number of wet days is also projected to decline. Light to moderate rainfall events are likely to decline at a higher rate than heavy rainfall events. Climate change is also expected to impact on when rainfall occurs and the seasonal rainfall volume. A decrease in rainfall in dry months is expected to be greater than the decrease in wet months.

Mid-range climate model projections suggest that annual average rainfall in the Barossa could decline in the order of 7.4% to 15% by 2050. The largest decline is projected to occur in spring. Numerical values for annual and seasonal rainfall for each RCP and time slice are summarised in Appendix D.

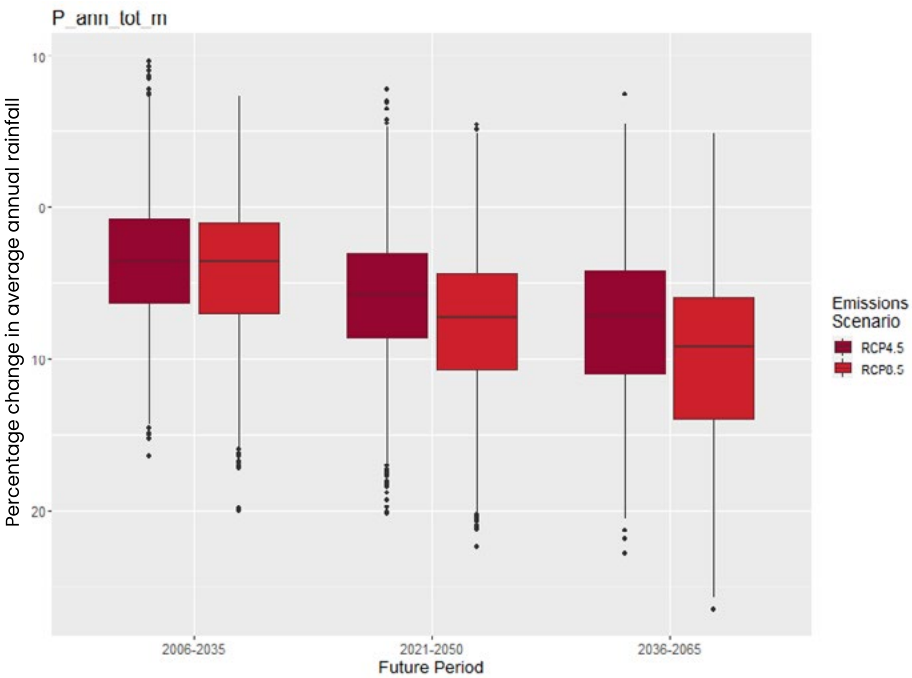


Figure 19 - Annual changes in rainfall relative to a 1976-2005 climatological baseline[11].

9 The Coupled Model Intercomparision Project (CMIP) is a global collaborative scientific effort for collecting and analysing climate model outputs. CMIP Phase 5 was used to inform the Intergovernmental Panel on Climate Change's Fifth Assessment Report completed in 2014.

10 The Representative Concentration Pathways (RCPs) are used to understand how climate may change in future based on how concentration of greenhouse gases in the atmosphere will change as a result of human activities

11 Each box-and-whisker plot represents the variability from 4,500 separate time series. The median value is represented by the horizontal black line, the boxes are bounded by the upper and lower quartiles. The dots above and below the whiskers represent outlying points.

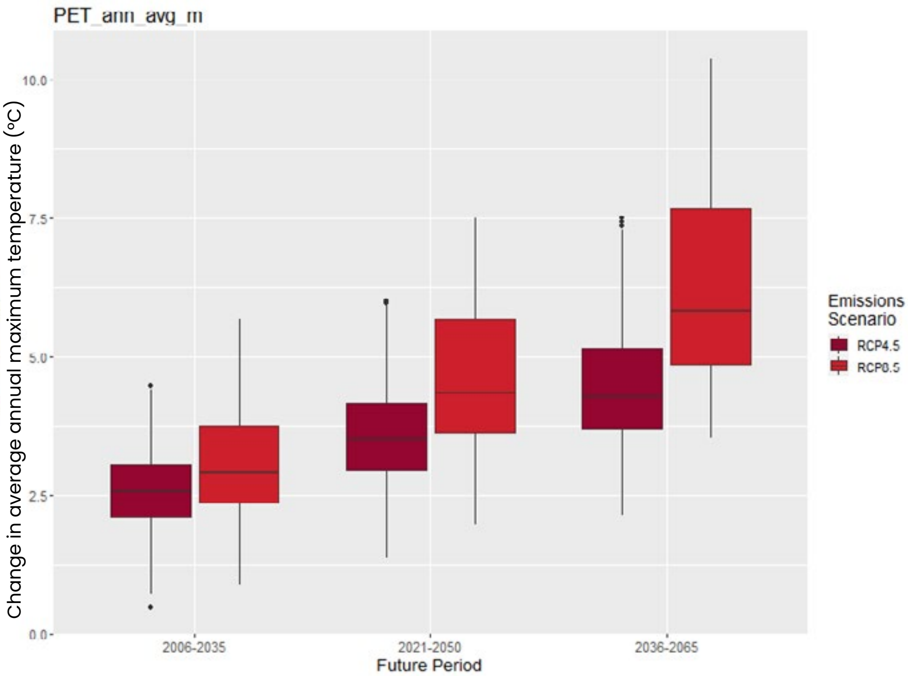


Figure 20 - Percentage change in annual average maximum temperature for RCP4.5 and RCP8.5 emission scenarios, relative to a 1976-2005 climatological baseline. See caption for Figure 18 for further details.

3.3.3.2. Projected changes in temperature

Changes in the daily maximum temperature are expected to increase, potentially by as much as 3.1°C by mid-century (see Figure 19). For RCP 4.5, a 0.6 to 0.9°C increase is projected over the next 3 decades. The number of hot days (days over 35°C) is projected to increase, with a significant number of projections showing the possibility of 50% more hot days by mid-century. By 2050, increases in average maximum temperatures are projected across all seasons with high emissions scenarios consistently projecting the greatest temperature increases. Warming in the spring is projected to be the largest.

Under an intermediate emissions scenario, the average temperatures could increase by 1.1°C by 2035 and 1.4 to 1.7°C by 2050. Greater temperature increases are projected under the high emissions scenario, with an average of 1.4°C by 2035 or 1.8 to 2.0°C by 2050. Warming in the spring is projected to be the largest.

3.3.3.3. Projected changes in Potential Evapotranspiration (PET)

Almost all projections show an increase in PET, with projections ranging from a 1.3% to 9.6% increase. Larger increases are represented the further out into the future the projections are.

Under an intermediate emissions scenario, PET may increase by 4.3% by 2050, or by 5.9% under high emissions. The greatest change in PET is projected to occur in spring, with increases of 5.9% under intermediate emissions and 7.7% under high emissions scenarios.

3.3.3.4. Range of climate change impacts evaluated.

Decreases in rainfall, increases in temperature and PET and rainfall seasonality are all projected to impact on water supply and demand. The projection ranges considered in the assessment of water security outcomes over the coming 30 years are as follows:

- Average annual precipitation: -23% to +5%.
- Average annual potential evapotranspiration: +1.4% to +9.5%.
- Rainfall seasonality (positive values representing a strengthening of the seasonal cycle, implying wetter winters and drier summers): -12% to +44%.

A mid-range estimate for the next 30 years is 6% less rainfall and 3.5% more potential evapotranspiration than a 1976 to 2005 baseline period. However some climate change models suggest it could be wetter while others indicate it could be much hotter and drier.

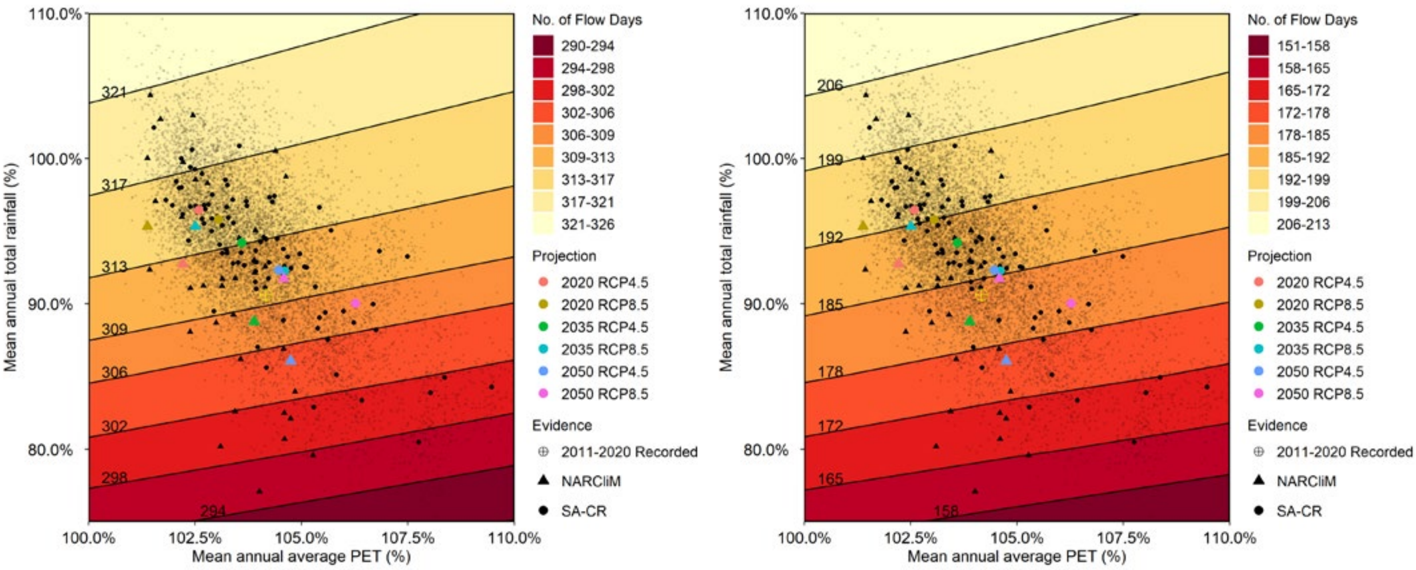


Figure 21 - The performance space of the absolute change in the number of flowing days for the Barossa Valley Gorge Zone (left) and Upper Flaxman Valley Zone (right).

3.3.4. Changes in native water sources

A 10% reduction in rainfall over the recent decade relative to a 1976 to 2005 climatological baseline has meant total surface water extractions have decreased by more than 50% over this period. In contrast to surface water, groundwater extractions have more than tripled over the last decade, with a maximum extraction of 5 GL in 2018/19 across the combined Barossa and Eden Valley regions. Modelling results showed significant sensitivity of groundwater recharge to climate conditions, with total recharge in the recent decade approximately 28% below the climatological baseline. Moreover, net recharge (groundwater recharge minus groundwater evapotranspiration fluxes) was well below the average annual groundwater extraction for at least some years in the recent record.

Native surface water resources represent a small and diminishing resource from an irrigation supply perspective over the past decade. This has been partially offset by increased utilisation of groundwater resources. The sensitivity of groundwater recharge to climatic changes, and the importance of preserving groundwater levels from both ecological and water security perspectives, suggests that recent groundwater extractions may not be sustainable over the longer term. This is likely to be the case particularly for the more severe climate change projections. It may also apply for more moderate projections. Combined with the surface water findings, these results imply imported water — which is already a dominant source of water for the Barossa Valley — will continue to play a critical role in supporting water security for most future climate scenarios, particularly if accompanied by an objective of preservation or improvement of aquatic ecosystem health.

Streamflow is projected to decrease for an increase in PET and decrease in rainfall. An important ecological metric is the number of flowing days. Flowing days are defined as days with flow above 0.05ML. The change in number of flowing days for the Barossa Valley Gorge outflow (end of system) is presented below and for the Upper Flaxman Valley outflow in Figure 20. The results show relatively low sensitivity for Barossa Valley Gorge across the different possible climate scenarios, whereas some sensitivity is observed in the Upper Flaxman Valley (range from approximately 200 flowing days under baseline climate conditions to 160 flowing days under severe climate projections).

Each of the streams in the Barossa has a threshold flow rate which indicates the volume of flow required to generate a flow depth of 12cm. This flow depth is considered a minimum flow depth for multiple ecological functions (Jones-Gill and Savadamuthu, 2014). The change in this metric for the Upper Flaxman Valley is presented in Figure 21. These results show the number of days over the threshold for that location varying from approximately 100 days under baseline climate conditions, down to about 55 days under more severe conditions.

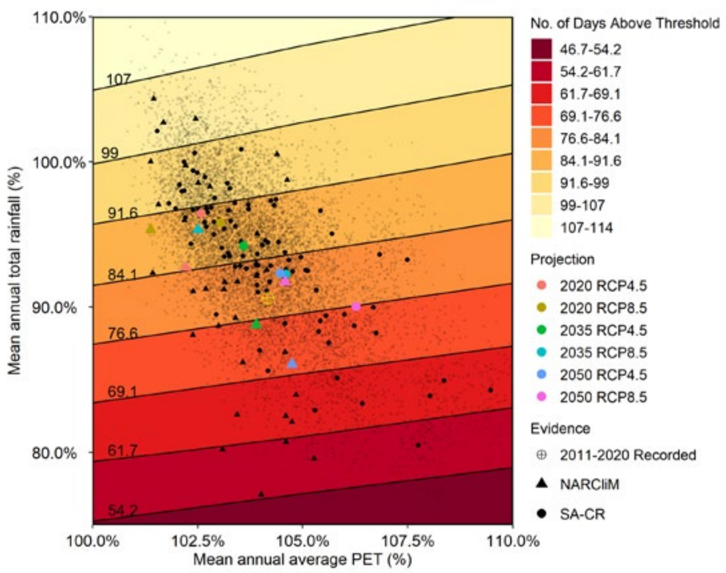


Figure 22 - The performance space of the absolute change in the number of days over threshold flow for the Upper Flaxman Valley Zone.

3.3.5. Projected changes in water demand

Climate change is projected to increase irrigation water demand. If the current planted area and viticultural practices are maintained the average irrigation water demand is projected to increase by approximately 23% (3 GL a year) in Barossa under a mid-range climate change scenario for the 2050s compared to the baseline period. This increases to a 27% (4.4 GL a year) increase in demand under a high end climate change scenario.

3.4. Projected impacts of climate change on water security

3.4.1. Current system

Unmet demand is assessed by simulating the system's ability to meet estimated demand under various climate conditions. Estimated demand comes from both estimated vineyard irrigation requirements as well as stock and domestic use, and demand varies both year-to-year and with alternative climate conditions.

Supply is derived from a combination of surface water, groundwater and external sources (BIL, SA Water off-peak and Bunyip Water pipelines). Surface water varies annually based on climate conditions, whereas groundwater and external sources are assumed constant and do not vary year-to-year or with climate. The full imported water supply capacity is assumed to be available to the Barossa Valley, as opposed to the Eden Valley. The Eden Valley has a small contribution from the SA Water off peak amount, but otherwise has no external sources[12].

In the Barossa Valley under a mid-range climate change scenario, it is projected that full demand will not be met in more than 30% of years in the 2050s[13]. A more extreme, yet plausible scenario projects an unmet average demand of close to 2.5 GL in 50% of years. In the absence of further investment in water security, this is projected to increase in volume and frequency (potentially above 55% of years) (see Figure 23). The maximum annual average unmet demand in years with unmet demand is around 5.5 GL across all the projections modelled.

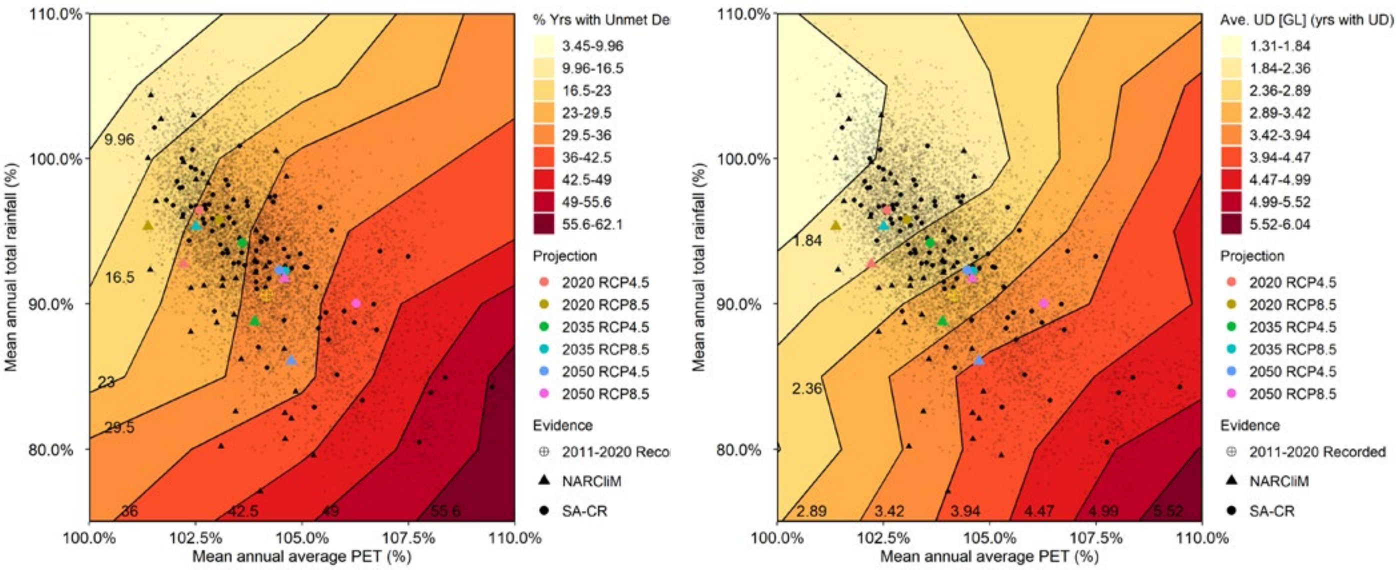


Figure 23 - Projected unmet demand for the Barossa Valley. Left: percentage of years with unmet demand. Right: average unmet demand in years with unmet demand [GL].

12 11 GL, 1.5 GL and 2 GL based on BIL capacity, SA Water off-peak averaged over the last decade, and reported Bunyip capacity, respectively. It is assumed that the stock and domestic use can be supplied regardless of year-to-year and long-term climate conditions; this assumption may not hold particularly under the more severe climate conditions.

13 The annual likelihood is projected to increase to 50% in the Barossa Valley, compared to ~30% in the last decade.

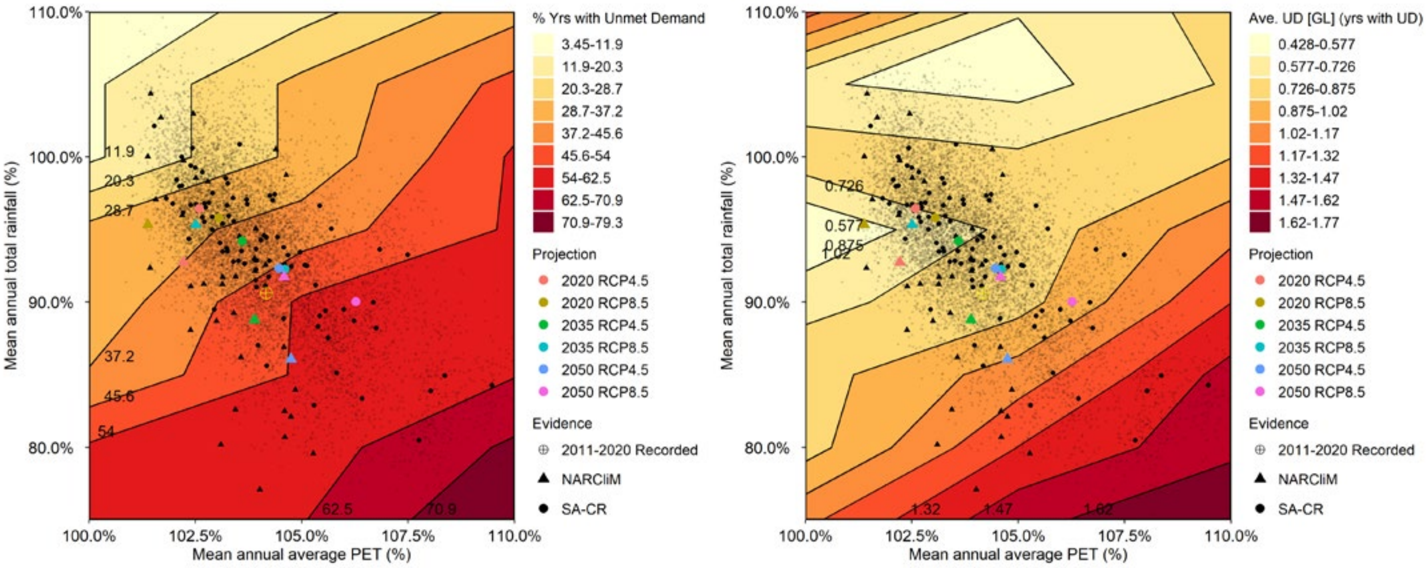


Figure 24 - Projected unmet demand for the Eden Valley. Left: percentage of years with unmet demand. Right: average unmet demand in years with unmet demand [GL].

Eden Valley has experienced irrigation shortfalls in at least 4 years of the past decade, demonstrating its higher vulnerability to climate change. This is in large part due to the lack of external supply in the Eden Valley and reflects the recent experience of many living in Eden Valley. The average volume of unmet demand in years with unmet demand is around 0.8 GL for the recent decade and is around 1 GL for the 2050 average projections[14] (see Figure 23). However, there is potentially significant latent demand for expansion of planted area and/or for increased irrigation application rates to achieve more consistent yields – if a suitable source of additional water can be made available in the Eden Valley.

The magnitude of future water demands over multi-decadal time periods is highly uncertain, and will depend on factors such as (1) performance requirements, including desired reliability; (2) future irrigation requirements, including irrigation strategies on established vineyards as well as possible expansion of vineyard area; (3) other water requirements (e.g. town water and/or industrial needs); (4) objectives related to environmental flow restoration; and (5) future climate.

For most combinations of these factors, it is clear that likely demands for water exceed current supplies for most climate scenarios – with the scale of any augmented water requirements significantly dependent on those variables.

Water security across the last decade provides a good guide to projected water security challenges under a mid-range 2050 climate change scenario.

With no action to address water security the reliability of water for irrigation will decrease and environmental flows will decline.

14. This is in the absence of further investment in water security nor any changes in planted area.

3.4.2. Impacts of actions on water security

To achieve the vision of increased reliability for water users and a healthy environment – adaptation measures are required. This may be achieved through a range of actions that affect the supply or demand for water. The strategy has considered both supply and demand actions that support achieving the 2050 water security vision.

Four potential portfolios of actions or 'adaptation pathways' have been identified that set out potential changes to the current system configuration. Each have different assumptions regarding imported water sources, farm dam strategy, groundwater extractions and the use of balancing storages, among other changes. These are not plans for the future, but rather scenarios that can help in understanding the scale of the effectiveness of water-related actions that have been identified through the workshop process. The economic costs and benefits of the pathway implementation have not been assessed through the strategy development[15]. Narratives describing the pathways evaluated are set out in Table 1[16]. The results of stress-testing these adaptation pathways have been built in to the strategic actions set out in Section 4.

Table 1 - Description of water security pathways.

Business as usual (see Section 3.4.1)	No additional actions are taken to adapt to a changing climate, at a farm or regional scale, nor are any specific actions taken to enhance the local environmental outcomes. Imported water continues to be available from the River Murray in the Barossa Valley but it is limited by both supply and infrastructure constraints. In the Eden Valley minimal imported water is available.
Pathway 1: Infrastructure investment supports existing industry and behaviours.	The current area of vineyards is slightly expanded and optimal yields are supported by the use of imported water to both the Barossa and Eden Valleys. An additional 8 GL a year is imported which is expected to be sufficient to meet viticultural demand in future hot and dry years and an expanded viticultural footprint in the Barossa Valley. An additional 3.5 GL a year of raw water is imported to the Eden Valley. Existing dams continue to be utilised to capture surface water and balancing storages are utilised to supply imported water. No specific actions are taken to enhance the local environmental outcomes and amenity.
Pathway 2: Sustainable economic growth - clean and green production	The current area of vineyards is maintained and optimal yields are supported by imported water to both the Barossa and Eden Valleys. Volumes imported are expected to be sufficient to meet viticultural demand in future hot and dry years (2050s) for the current planted area. The 20 most environmentally impactful dams, predominantly in the upper reaches of the Barossa Valley, are repurposed as off-stream storages. Water use efficiency on-farm is maximised through precision irrigation and application of emerging agricultural technologies.
Pathway 3: Healthy waterways and soils	The current area of vineyards is maintained and optimal yields are supported by imported water to both the Barossa and Eden Valleys. Volumes imported are sufficient to meet expected viticultural demand in future hot and dry years (2050s) for the current planted area. The 40 most environmentally impactful dams, predominantly in the upper reaches of the Barossa Valley, are repurposed as off-stream storages. Viticultural outcomes are optimised through drought tolerant varietals, precision irrigation, mulching, increased soil carbon, canopy cooling and adoption of emerging agricultural technologies.
Pathway 4: Maximum water availability and expansion	The current plantings target optimal yields, while expanded areas target higher yields. An additional 16 GL a year is available to meet viticultural demand in the Barossa Valley and an additional 5 GL a year of raw water is imported to the Eden Valley. The current area of vineyards is expanded (to current areas of high soil water holding potential) in proportion to increased imported water availability (while ensuring no water shortages are experienced for the median 2050s climate - RCP4.5). Existing dams continue to be utilised to capture surface water and balancing storage tanks are utilised to supply imported water. No specific actions are taken to enhance the local environmental outcomes and as a result environmental condition and overall amenity are likely to degrade. Water use efficiency on-farm is maximised through precision irrigation and application of emerging agricultural technologies.

15 The costs of investment in water security for the Barossa are being considered as part of the detailed business case for Barossa New Water.
16 Detailed information on system configuration is available in Westra et al., 2021.

3.4.2.1. Results: Pathway 1 – Enhanced infrastructure investment

Pathway 1 is largely the same as 'business as usual' with the only difference being that additional imported water is provided (8 GL to Barossa Valley and 3.5 GL to Eden Valley). The additional imported water has a large impact on the ability to meet demand. For a mid-range climate scenario (which is broadly analogous to climate conditions prevailing over the most recent decade), this pathway would result in zero years where demand is not met in both the Barossa and Eden Valleys. In more extreme climate scenarios, for the Barossa Valley this increases up to 15% of years where demand is not met, with average annual unmet demand being 1.9 GL in those years. For Eden Valley, this increases up to 3.5% of years with unmet demand, with an average annual unmet demand of 0.7 GL in the most extreme climate scenarios.

As per Table 4 and 5 in Appendix E, in this pathway there is capacity for expansion (either yield or planted area) in the Barossa Valley under mid-range climate projections (up to 15%). In the Eden Valley, in both the mid-range and worst-case climate projections, there is capacity for expansion (48% and 15% respectively). There is no change in the environmental flow metrics as a result of this pathway.

Results: Pathway 2 – Sustainable economic growth

As per Pathway 1, Pathway 2 involves providing additional imported water (8 GL to the Barossa Valley and 3.5 GL to Eden Valley) while also converting high impact dams into an off-line balancing storage. This pathway also includes actions to improve water use efficiency. The actions in Pathway 2 further improves the number of years with unmet demand in both the Barossa and Eden Valleys and in Eden Valley supply exceeds demand. However, in the Barossa Valley, in the years with unmet demand, the average annual unmet demand in an extreme climate scenario is 1.8 GL.

In this pathway, as per Appendix E, there is also capacity for expansion in the Barossa Valley under mid-range climate projections (up to 18%). In the Eden Valley, in both the mid-range and worst-case climate projections, there is capacity for expansion (80% and 45% respectively).

The environmental flow metrics are improved in this pathway, more so in the Upper Flaxman Valley Zone (Eden Valley). The results appear to be marginal in the Barossa Valley Gorge Zone (Barossa Valley). The additional flow days and volumes achieved are fairly small when compared to the impacts that climate change will have on environmental flows. This suggests that other actions will be required to improve environmental benefits, in conjunction with converting high impact dams to off-line storages.

Results: Pathway 3 – Healthy waterways through investment

Pathway 3 builds on from Pathway 2 by also removing medium impact farm dams and converting them to an off-line balancing storage. In this pathway the total additional imported water volume is 8 GL, giving Barossa Valley and Eden Valley an additional 5.6 GL and 2.4 GL respectively. Groundwater use is halved (supported by the provision of imported water). Water use efficiency is the same as Pathway 2 and the use of more drought tolerant species improves demand by 5%.

In this pathway, the ability to meet demand is negatively impacted by the reduction in the volume of water imported and the decrease in groundwater extraction. For the Barossa Valley and a mid-range climate change scenario around 5% of years would result in unmet demand, and in more extreme climate scenarios this would increase to around 21% of years. The average annual unmet demand in those years is 3 GL. The Eden Valley experiences similar impacts but still has a relatively small unmet demand, even for the most extreme climate scenario – around 0.4 GL of unmet demand in the 3% of years where demand is not met.

In this pathway, as per Appendix E, there is capacity for expansion in the Barossa Valley under mid-range climate projections, however it is reduced as compared to Pathway 2 (up to 6%). In the Eden Valley, in both the mid-range and worst-case climate projections, there is capacity for expansion, however it is also reduced as compared to Pathway 2 (53% and 20% respectively).

The removal of high and medium impact dams has a positive result on environmental flow metrics. Consistent with Pathway 2, the improvements are more significant for the Upper Flaxman Valley and also improved from the results of Pathway 2.

Results: Pathway 4 – Maximum water availability and production outcomes

This pathway involves both the addition of a large volume of imported water (16 GL to Barossa Valley and 5 GL to Eden Valley) and increased groundwater extractions. The significant volumes of additional water allow for expansion of vineyards (either yield or planted area).

With no additional expansion of vineyards, in both the Barossa and Eden Valleys there are no years with unmet demand.

To achieve a 90% reliability in meeting demand, in the Barossa Valley a 35% increase in vineyard area can be supported in the majority of climate scenarios. Alternatively, a 2 tonne per hectare increase in yield could also be supported. For the Eden Valley, a 05100% increase in vineyard area can be supported in a severe, but not the most extreme, climate scenario. Alternatively, a 2 tonne per hectare increase in yield could also be supported. As per Appendix E, this pathway provides the largest capacity for expansion.

There are no improvements to the environmental flow metrics in this pathway.

3.4.3. Summary of adaptation pathway results

All pathways provide improvements to reliability of water security in both the Barossa and Eden Valleys. Pathways 2 and 3 provide the most improvement in environmental flows.

Under a mid-range estimate for the 2050s it is estimated an additional 8 GL per annum of imported water would be needed to ensure on average there is no irrigation shortfall for the existing planted area in Barossa in the driest years. A high-end climate change projection for the 2050s corresponds to a 20% reduction in rainfall and 7.5% increase in potential evapotranspiration (compared to a 1976 to 2005 baseline period). Under this scenario more than 14 GL of imported water is estimated to be required to meet the full water demand of the existing planted area within Barossa in the driest of years.

The adoption of more drought tolerant varietals is able to reduce water use, but in Barossa the potential is limited. Due to the high water use efficiency of Shiraz vines, which are the dominant varietal in Barossa[17], any improvements are unlikely to exceed five percent. Viticultural outcomes may be optimised through the adoption of precision irrigation, mulching, increased soil carbon, canopy cooling and adoption of emerging agricultural technologies. It has been assumed that water use could reduce by up to 10 percent in wet years, however in dry years there is limited potential to increase efficiency in Barossa due to the high value already placed on water. Total planted area is the biggest factor that will affect future viticultural demand for water.

Overall, water reliability improves with increases in imported water, with all adaptive pathways achieving greater than 90% reliability for mid-range climate projections. As expected, the magnitude of the imported water volumes dominate the reliability estimates (in the sense that more imported water leads to enhanced reliability, as per Pathway 4). However, the presence of balancing stores may also make an important contribution, particularly to environmental flows. Several pathways involve converting farm dams to balancing stores and this strategy was shown to produce benefits in terms of key environmental flow metrics.

The relatively low use of native water sources (both surface water and groundwater) in the recent decade and under most climate change scenarios suggests the potential for reducing reliance on these sources and achieving stream restoration benefits should additional imported water become available. However, the scale of climate change impacts on environmental flows suggest that, in order to achieve stream restoration objectives, the farm dam strategy would need to be accompanied by other strategies (e.g. linked to groundwater system management and/or

17 Red varieties expanded from 68.5% to 87.3% of the total crush over the period from 2001 to 2021 across Barossa and Eden Valleys, with shiraz in particular increasing rapidly from 37.9% to 59.5% across the two valleys over this period. https://vinehealth.com.au/news/sa-winegrape-crush-survey/

more active environmental flow management)to restore flows. Pathway 4 involves a very large addition of imported water, as well as a significant increase in groundwater extraction up to the allocation amount. This significant increase in available water supplies to meet demand allows for expansion of vineyards, either in terms of yield or planted area.

Results of stress-testing Pathway 4 indicate that even in an extreme climate projection (from those tested), increases in planted area or yield in both the Barossa and Eden Valleys can be supported while maintaining 90% reliability. It is noted that Pathway 4 does not include actions to enhance environmental outcomes and, as such, environmental condition and amenity are likely to degrade.

In the Eden Valley, all pathways support the expansion of vineyards (yield or planted area) even under worst case climate projections. In the Barossa Valley all pathways support the expansion of vineyards (yield or planted area) under mid-range climate scenarios. However, under worst case climate projections, only Pathway 4 supports expansion.

Full results of the assessment of each pathway are provided in *Assessment of current and future water security in the Barossa and Eden Valleys using the Climate Resilience Assessment Framework and Tools* (Westra et al., 2021), with summary results provided in Appendix E.

Key Points

- With no action to address water security, modelling indicates that the reliability of water will decrease under future climate projections and environmental flow metrics will decline.
- The occurrence of unmet demand could increase to from 30% to 55% of years in the Barossa Valley, with the average unmet demand in these years by 2050 being around 5.5 GL across all the climate projections modelled.
- For the Eden Valley, unmet demand has been experienced in around 40% of years in the past decade; the average volume of unmet demand in these years by 2050 could be around 1 GL.
- All adaptive pathways show that additional volumes of imported water are required to meet reliability requirements. To ensure on average there is no irrigation shortfall for the existing planted area in Barossa in the driest years an additional 8 GL of imported water is estimated to be needed for a mid-range climate change projection, or more than 14 GL per annum for a high-end climate change projection, for the 2050s.
- Expansion (either in terms of yield or planted area) is possible under all pathways in both the Barossa and Eden Valleys for mid-range climate projections. The capacity for vineyard expansion increases corresponding roughly to additional volumes imported and more so in the Eden Valley. There is limited scope for increasing planted area or yield unless additional cost effective water can be secured.
- Dam modifications result in positive outcomes for environmental flows, but the impacts of climate change will offset much of these improvements. Other complementary actions will be required to see significant improvements.
- The provision of additional imported water provides opportunities to explore options to enhance environmental benefits.

4. Strategic pillars and key actions for a water-secure Barossa in 2050

Qualitative and quantitative analysis undertaken throughout the development of the strategy have identified six strategic pillars that will help achieve a water-secure future.

Each pillar sets out key actions to achieve the shared vision for the future. The actions have been robustly tested through the diverse and plausible futures of the Barossa (as set out in Section 3.1) to ensure the actions included are robust. Actions that have a direct impact on supply or demand have been quantified and interventions (adaptive pathways) stress-tested across climate change projections (as set out in Section 3.4.2). The results of analysis have informed the actions presented here.

In combination, the 6 pillars support the achievement of the future vision for the Barossa as set out in Figure 24. Three of these are directly related to water and the actions set out will help to secure a system of integrated supply and demand, land and water management outcomes, and healthy waterways and water-dependent ecosystems. Two supporting pillars will help to diversify businesses in the region, progress innovation, build adaptive capacity and ensure education and training is in place around future skills and water management approaches needed. The remaining pillar is foundational – partnerships and collaboration will underpin effective delivery of all activities in the region to achieve the vision for the future.

A collection of actions are included under each of the pillars. These will be covered in subsequent sections. Note that a strategy is not a plan. Detailed planning for the water-related pillars will still be required to for the relevant actions within each heading. The supporting pillars have existing plans and frameworks that will be further developed with reference to the vision and objectives of this strategy. The strategic pillars, elements of the vision and key actions are summarised in Table 2.

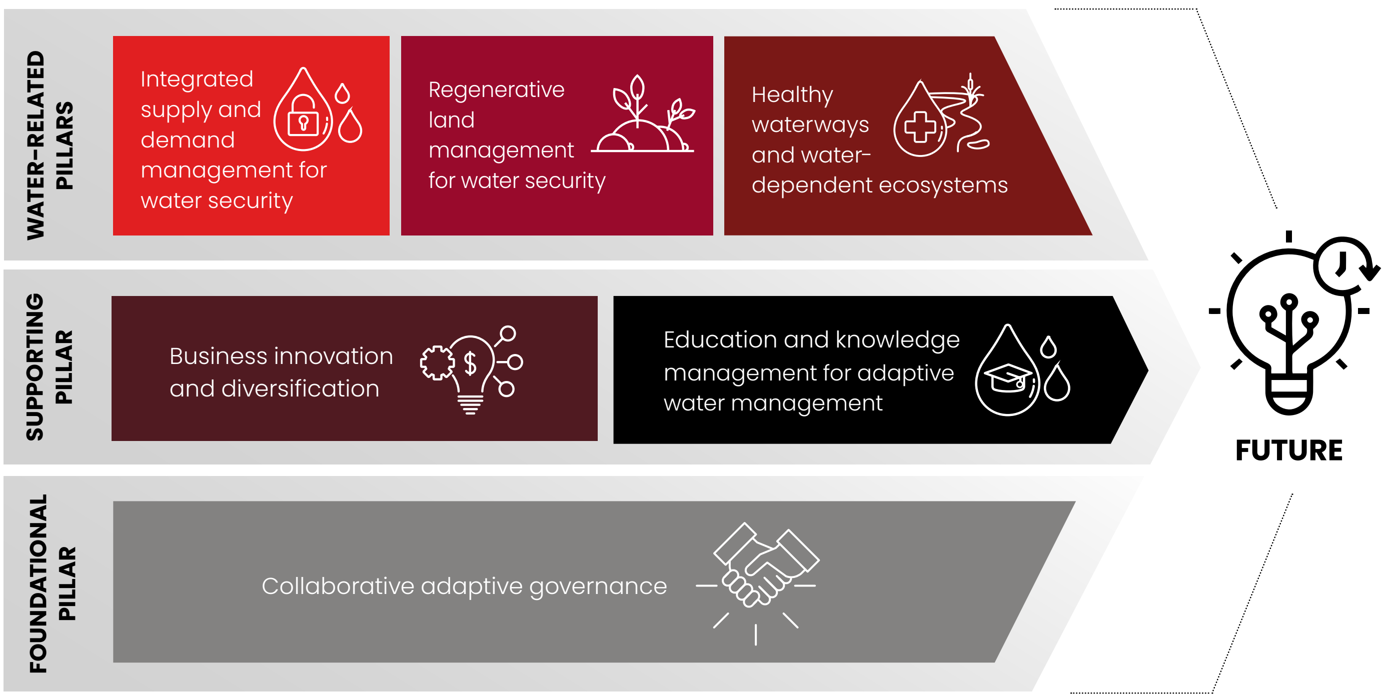


Figure 25 – Strategic pillars to achieve the future vision for the Barossa

Table 2 – Summary of strategic pillars, vision elements and key actions

Strategic Pillars	Vision element	Actions
Integrated supply and demand management for water security	Management of water resources integrates strategies that manage demand, offer flexible use of multiple sources and ensures reliable, affordable, fit-for-purpose and climate resilient water is available for the region	1.1 Increase availability of imported water to improve system reliability and support sustainable economic growth 1.2 Establish an equitable region-wide distribution network that ensures critical needs can be met 1.3 Implement sustainable and integrated management of groundwater, surface water and imported water 1.4 Optimise water storage to balance environmental impacts, water supply infrastructure costs and reliability of supply 1.5 Implement on-farm demand-side management strategies 1.6 Undertake further research on the effectiveness of potential water security actions 1.7 Update the region's sustainability and climate change plans and collaborate for delivery of priority actions
Regenerative land management for water security	Barossa has healthy, cohesive water-secure communities, a diversity of land uses, widespread uptake of regenerative agriculture and integrated Aboriginal wisdom and practice into land and water management	2.1 Use planning tools to support healthy, green and cohesive water-secure communities 2.2 Support the creation of a Barossa soil strategy to promote healthy soils 2.3 Maintain and improve biodiversity by supporting maintenance and expansion of native vegetation 2.4 Support diversification of crops and land uses 2.5 Incorporate Aboriginal knowledge and wisdom into the regional model for regenerative land and water management
Healthy waterways and water-dependent ecosystems	Water is flowing in creeks and the environmental health of ecosystems is improved	3.1 Improve understanding of ecological condition and needs of local ecosystems 3.2 Develop and implement a healthy waterways plan to increase flows through the system 3.3 Explore and leverage access to alternative sources of water to encourage and enable the return of flows to the environment and to support amenity and cultural values 3.4 Undertake actions to improve catchment health, including managing pest plants and animals in and around waterways and fencing off watercourses

Strategic Pillars	Vision element	Actions
Business innovation and diversification	Barossa has diversified businesses, increased adaptive capacity and economic prosperity	4.1 Continue to support business by providing opportunities to diversify, embrace the circular economy and maximise efficiency of water use 4.2 Continue to progress innovation through partnerships, education and training and connection with innovation hubs 4.3 Provide opportunities for Aboriginal nations' businesses and demand for Aboriginal products
Education and knowledge management for adaptive water management	Barossa has the capacity to respond to challenges enabled by its commitment to leadership, education and innovation	5.1 Identify and map future skills and expertise needed for water management and innovation in the region and consider how best to deliver 5.2 Advocate for regional education and training to include a focus on the skills, attributes and knowledge required to deliver long-term water security 5.3 Create an interactive knowledge hub with sector specific nodes that provides opportunities for peer-to-peer information sharing, mentoring, and knowledge exchange to leverage training and education programs 5.4 Explore options to increase the translation of research into practice 5.5 Plan for an accessible Centre of Excellence in sustainable viticulture and agriculture to showcase and enable best practices and innovation
Collaborative adaptive governance	Governance arrangements support effective regional decision-making in water security	6.1 Building on existing regional governance coalition, explore options for collaborative, flexible and resilient governance of this strategy. 6.2 Identify future monitoring, data and information requirements 6.3 Implement a data and information strategy to support learning and decision-making

4.1. Integrated supply and demand management

4.1.1. Vision element/relevant goal

Management of water resources integrates strategies that manage demand, offer flexible use of multiple sources and ensure reliable, affordable, fit-for-purpose and climate resilient water is available for the region.

A diverse portfolio of sources is available and delivered through a connected infrastructure network that is supported by planning and supply agencies. Water users in the region are empowered stewards of their water resources, actively integrating demand management with flexible use of supplies and innovative water trading options.

4.1.2. Strategic actions

Supply and demand management measures are essential to ensuring there is enough water of the right quality for industry, environmental and community needs. The vision describes equitable access to a range of diverse sources of water that are interconnected, used and traded efficiently and adaptively, to ensure water is reliably available where and when it is needed. In turn, this allows the community to make decisions about additional volumes of water to be provided to the environment to support healthy waterways and water-dependent ecosystems. Equitable and affordable water supply would be underpinned by a regional collaborative governance structure that is trusted and promotes awareness of socially, environmentally and economically responsible water use.

Through the development of this water security strategy an the Barossa New Water detailed business case, a comprehensive understanding of Barossa historical water demand, availability and use has been established, as set out in Section 2. The strategy development highlighted future supply and demand are unlikely to remain static, as the region aspires to healthier ecosystems, diversified agricultural systems and economic prosperity in a warming and drying climate as set out in Section 3.

Increase availability of imported water to improve system reliability and support sustainable economic growth

Water security is necessary to support sustainable economic growth in Barossa. The water security vision stipulates all water users in Barossa Valley and Eden Valley can draw on a diverse range of affordable water supply options to ensure their economic sustainability.

Both the Barossa New Water project, through its survey-based demand analysis, and the strategy development process, which involved qualitative scenario exploration and the model based projected demands at a regional scale, support the notion significant demand for an alternative water source in Barossa.

Under a mid-range estimate for the 2050s it is estimated an additional 8 GL per annum of imported water would be needed to ensure on average there is no irrigation shortfall for the existing planted area in Barossa in the driest yearsmosts[18].

The amount of water needed will depend on a range of factors, including future irrigation requirements for established and future vineyard areas, desired reliability, the cost of water, other water requirements, and future climate. Any additional water

18 Assuming the existing planting area and yield characteristics are maintained. See Westra et al. 2022 for further detail.

source should be adaptive and have the capability to change over time.

Detailed consideration is being given to the investment case for importing additional water into Barossa from Bolivar Wastewater Treatment Plant and/or the River Murray (for Eden Valley) as part of the Barossa New Water detailed business case. This includes identifying an equitable balance between government, irrigators, community and private sector in terms of who pays for improved water security outcomes.

Subject to the outcome of the detailed business case, further investigation of alternative smaller scale water supply options may need to be considered. Alternative water sources that could be established include:

- increased re-use of recycled wastewater within the region, including both from additional council schemes[19] and from commercial producers of wastewater, including wineries
- additional local stormwater harvesting from within Barossa, particularly from proposed urban developments
- desalination of groundwater.[20]

Further exploration can be undertaken into how the system can utilise solar and wind farms in neighbouring areas to make alternative water sources affordable and sustainable. .

Establish equitable region-wide distribution network that ensures critical needs can be met

The vision for the future is to create an equitable region-wide system of shared storage and distribution infrastructure to ensure critical water needs can be provided.

An expanded regional delivery network that covers Eden Valley is an important part of this vision. Consideration is being given to the feasibility of investing in an Eden Valley supply and distribution network as part of the Barossa New Water detailed business case.

In addition, future consideration should be given to operating the network in a manner in which individuals can be both water users and suppliers, as is the case in the electricity network when households with excess electricity from solar generation send it back to the network.

A strong, trustworthy and sustainable local governance model is desired to adaptively manage and inform the range of supply options implemented. A range of stakeholders involved in both the supply and demand sides of water need to work together, including public, private and community entities and delivery agencies relevant to Barossa. Further detail is provided under the Collaborative Adaptive Governance pillar of this strategy.

19 BIL currently distributes treated wastewater from the Nuriootpa and Tanunda Community Wastewater Management Systems (CWMS); this makes up less than 4% of total supply.

20 Whilst not widespread, multiple instances of grape growers installing small scale desalination systems to treat groundwater have been identified. Brine management options for various desalination configurations require further exploration and links with the circular economy. Global best practice approaches can be drawn upon, including the EU Zero Brine project.

Sustainable and integrated management of groundwater, surface water and imported water

Having access to diverse supply options will reduce dependency on native groundwater and surface water sources. Flexibility to adaptively use a diverse range of water sources and demand side measures gives water users the safety and security they need to support environmental flows and it becomes more socially acceptable to consider applying such measures in the region.

This opens the possibility of changes to existing direct extraction patterns and the potential to secure benefits to the amenity and ecosystems of Barossa.

These benefits should be secured as part of an innovative approach to the integrated management of imported and native water sources. Further detail on environmental water, including the potential to support environmental releases, is included under the Healthy Waterways and Water-Dependent Ecosystems pillar.

Optimise water storage to balance environmental impacts, water supply infrastructure costs and reliability of supply

A future water network should have the capacity to access available water and store it efficiently. To meet the vision elements around healthy ecosystems, this system should also support releasing flows to the environment. It should take into account adjacent and relevant water management projects such as the Gawler River Flood Management Authority and storages proposed under its projects.

Effective storage options have the potential to reduce the size of distribution infrastructure required to deliver water when it is needed (i.e. peak demands in summer), directly reducing the costs of supply infrastructure. New storage options could potentially include large off-stream dams (such as Hill Dam) and/or managed aquifer recharge schemes. In addition, rather than building new storages in the landscape, a potentially feasible option to be explored further is the repurposing of existing catchment dams into storages for imported water.

While the cost to individuals of reduced ability to capture surface water flows[21] in these dams would need to be considered, there would be significant benefits in reducing capital costs of infrastructure to store and distribute imported water sources. In addition to water security and reliability benefits for water users from having access to alternative water sources, early studies have shown that repurposing strategic dams would increase the volume and timing of flows through the system, having significant environmental and amenity benefits.

21 Surface water is already a small proportion of overall water used in the Barossa. Climate change modelling indicates that in the majority of future scenarios, the availability of surface water will decline in the future.

Implement on-farm demand-side management strategies

In the vision, all water users have access to a range of education, training, and extension services. This links with the Education and Knowledge Management pillar and includes public and private industry led education about sustainable water use.

Investing in actions around education, training and extension would result in region-wide uptake of best-practice demand side water management practices, which could include:

- experimenting with alternative varietals to meet local environmental conditions
- increased water recycling and reuse on farm and within wineries
- enhancing soil quality and structure to improve water retention
- use of AgTech, including advanced visual monitoring and soil moisture sensing to increase efficiency
- shading to reduce evaporation losses
- use of Indigenous farming practices
- building on work done to date around regenerative agricultural practices including mulching, composting, ground covers and minimizing tractor passes
- further adaptively managing the irrigation/yield equation to maximise financial return per unit of water applied.

Many other actions are discussed further under the Regenerative Land Management for Water Security and Education and Knowledge Management for Adaptive Water Management pillars.

Undertake further research on the effectiveness of potential water security actions

A number of factors will impact on demand in the future and further research is required to understand their implications at a Barossa regional scale. This could include consideration of:

- the impact of carbon sequestration on water demand and usage
- the impacts of mosaic landscapes and regenerative agricultural practices on water use
- the impact of changes in varietal and crop types on water demand and usage patterns
- the impact of extreme demands within seasons, for example due to heatwaves and the impact on infrastructure sizing
- targeted release of water to support environmental outcomes (this may require bringing in environmental water)
- links between residential and other uses, including factoring in residential demand increases and potential for localised reuse supply for amenity horticulture in future demand planning.

Spatially mapping and assessing future water needs in terms of quality, demand and usage, across a range of different future scenarios for the region, would provide a more nuanced understanding of how the system may evolve.

Further research exploring trade-offs in saline water usage (and links to soil type) would improve understanding of future use, as different uses have different tolerances for salinity. Research into the impacts of varying degrees of salinity on livestock is important, as it has material impacts on livestock well-being. There is also a need to understand the impact of saline water on soil quality, to ensure soils are improved and not degraded to support long-term water security and productivity.

Update the region's sustainability and climate change plans and collaborate for delivery of priority actions

A number of existing plans are in place to progress sustainability and climate change and these should be updated to include relevant water security actions set out in this strategy.

Of note, the Barossa and wider region was a first mover in initiating a Climate Change Sector Agreement Integrated Vulnerability Analysis and Climate Change Adaptation Plan in 2009 to 2015. The Adaptation Plan should be updated for current priority projects and, with the support of the Northern & Yorke Landscape Board, brought to action.

4.2. Regenerative land management for water security

4.2.1. Vision element/relevant goal

Barossa has healthy, cohesive water secure communities, a diversity of land uses, widespread uptake of regenerative agriculture and integrates Indigenous wisdom and practice into land and water management.

Regenerative water and land management has been achieved through investing in healthier soils and ground covers for optimal water retention and diversification of crops as part of achieving a mosaic landscape, both of which improve biodiversity.

4.2.2. Strategic actions

The vision positions Barossa as an international leader in sustainable agriculture. This is part of strengthening the Barossa brand in an increasingly competitive international market. The vision describes a Barossa with a diversity of land uses, widespread uptake of regenerative agriculture and the integration of Indigenous wisdom and practice into land and water management. Regenerative land management also supports the vision for integrated supply and demand side management and healthy ecosystems and waterways.

Supporting healthy, green and cohesive water-secure communities

The vision is one in which housing is maintained largely within the existing urban footprint and the village structure is maintained with green space in between. The future vision includes villages that have green, shaded, walkable public spaces and centres where people meet. This needs to be facilitated by effective land-use planning and the availability of affordable, reliable fit-for-purpose water supplies in a changing climate.

SA Water currently supplies Barossa's domestic and industrial customers with potable water.

The Barossa Council operated Community Wastewater Treatment Systems (CWMS) takes liquid wastewater (effluent) from properties that have a septic tank system to approved treatment facilities. The water is treated as per EPA requirements to non-potable, recycled water standards, for use on Council reserves and sold to local farmers and growers. All treated wastewater is recycled. The Barossa Council's CWMS are situated at Nuriootpa, Stockwell, Tanunda, Lyndoch, Williamstown, Mount Pleasant and Springton.

Emergency water supplies are also available through standpipes installed by The Barossa Council in Eden Valley, Moculta and Mount Pleasant in 2021 to address emergency water needs under drought conditions in those communities.

The Barossa Council is seeking to facilitate urban stormwater harvesting and reuse as part of the planning and future development of the Concordia Growth Area comprising approximately 935 hectares. Council has sought to have the planning process adopt the 'One Planet Living' principles developed by Bioregional Australia.

The Gawler River Flood Management Authority, and its Constituent Councils manage flood mitigation within the Gawler River. While coordinating the planning, construction, operation and maintenance of flood mitigation infrastructure for the Gawler River is a priority, the Authority also considers opportunities to facilitate sustainable outcomes to ensure a balance between economic, social, environmental and cultural consideration associated with water within the river system.

Light Regional Council has identified surplus water from its Greenock and Freeling Community Wastewater Management System networks as priorities for improving the quality of treated water for community and agricultural use. Whilst some CWMS water is already supplied to nearby vineyards, the annual volumes available for re-use are expected to increase with further urban development and population growth within these towns. Council is sourcing funding for capital investments to upgrade existing treatment systems, together with seeking expressions of interest from nearby water users to underpin its investment in recycling the CWMS water. In addition, facilitation of the Roseworthy Township Expansion growth area will incorporate an urban stormwater harvesting and reuse scheme, making recycled water available for community and agriculture use in the western Barossa Valley, as well as to enable a healthier, cooler and greener community development.

The Barossa Council and Light Regional Council are currently part of a six-Council initiative to develop the Great Australian Wine Trail (GAWT), which aims to be Australia's first multi-day signature wine and culinary cycling experience, traversing South Australia's heritage towns and distinctive landscapes. This trail will feature rest stops with drinking fountains, providing the opportunity to promote the water security measures that are in place to support the productive landscape connecting our villages.

Support the creation of a Barossa soil strategy to promote healthy soils

Sustainable soil management and water security are strongly linked. Barossa Australia has developed a significant body of work promoting soil health. This includes actions that directly impact on water security such as mulching and composting of crops to optimise water retention, utilising cover crops and ensuring that irrigation actively considers the risks of soil salinity.

A regional soil strategy should be developed to build on that work and previous work led by PIRSA and complement this water security strategy.

Additional elements of a Barossa soil strategy would promote increased organic carbon in the soil, improving soil biota, maintaining appropriate level of nutrients, increasing living roots in the soil profile (including supporting planting native vegetation), reducing soil compaction, minimizing the use of chemical inputs and transitioning to natural pest control methods.

A regional soil strategy should identify key indictors and benchmarks for soil quality, develop appropriate data sharing agreements across the region and create a regional soil quality mapping database. A shared database for regional soil data should allow individuals to own their own data, while ensuring the benefits of regional data collaboration are achieved. Further research is required into the best soil microbiology for improved productivity with respect to crop type, soil type, geology and the impacts of irrigation on soil health.

A regional soil strategy also needs to consider education and knowledge sharing around best practices, guidelines and standards for soil quality.

Support maintenance and expansion of native vegetation

Maintenance and expansion of the area and quality of native vegetation is important for Barossa to achieve its vision of having mosaic landscapes, healthy waterways and improved biodiversity. Spatial mapping of native vegetation can be used to track and influence changes in native vegetation cover. This would be further aided by stock and pest management in priority areas, such as waterways.

Initiatives already working towards increasing native vegetation and biodiversity include Barossa Australia's Creating Resilient Landscapes program. The program works with local vignerons to restore native vegetation across the landscape and encourage improved ecology through habitat restoration and good management.

In addition, both The Barossa Council and Light Regional Council manage roadside vegetation to maintain biodiversity and protect native vegetation. The Barossa Council also has two Heritage agreement sites through the Native Vegetation Council Heritage Agreement Scheme that are managed to maintain and conserve the biodiversity of native vegetation. An application for a third site is currently in progress.

The Barossa Council is in the process of developing a long-term Strategic Management Plan for one of the two existing heritage sites. The Tanunda Native Pine Protection Project through funding from the Revitalising Private Conservation in South Australia aims to improve biodiversity (by reducing threats), and engage the local community to gain additional volunteer support.

The Barossa Council is exploring the opportunity to initiate a Significant Environmental Benefit (SEB) On Ground Offset following the requirement for native vegetation clearance as part of The Big Project. Seen as a pilot, the project could set additional offset identified for future clearances.

The Barossa Bushgardens are home to about 130 of the 400+ species of plants that can be found in the region, some of which are rare or critically endangered. It showcases different plant associations, as well as display gardens filled with a diversity of vegetation.

Light Regional Council recently purchased land located on Liebig Road Nuriootpa, off Seppeltsfield Road having significant environmental benefit. It has entered into a management agreement with the Seppeltsfield Road Business Alliance to maintain its natural significance for the benefit of the environment, the community and tourists. Light Regional Council also has strategies in place via its approved Greenock ***Stormwater Management Plan*** to manage the watercourse character and condition of Greenock Creek and its tributaries.

Support diversification of land uses

Diversification of crops and land uses contributes to the vision for the future of the region. This will contribute to resilience in the face of social, economic and environmental change. Practices which support this diversification should be linked to expanding markets for premium agricultural products that complement grape and wine production. Efforts to create additional value in these products and to 'open the door' for such diversification would help to build a commercial case for production to be established. Strengthening community support for the Farmers Markets would create opportunity for early stage distribution of new produce and products. RDA's food industry program is currently seeking out and testing opportunities for value adding with brand and premiumisation. Overcoming the challenge of a workforce for food production is also required.

Incorporate Indigenous knowledge and wisdom into the regional model for regenerative land and water management

The vision for the future of Barossa involves incorporation of Indigenous wisdom and practice into land and water management. As traditional custodians of land and waters in Barossa, Aboriginal nations' have a rich history, customary obligation and knowledge of caring for Country. Incorporating this wisdom into land and water management would have cultural and environmental benefits, land management benefits, as well as potential economic benefits for Aboriginal peoples. For this to be achieved, deeper collaborative relationships with Indigenous groups in the region need to be forged and Indigenous people included in collaborative governance and knowledge management structures.

4.3. Healthy waterways and water-dependent ecosystems

4.3.1. Vision element/relevant goal

Water is flowing in creeks and the environmental health of ecosystems is improved

The health and amenity of water-dependent ecosystems has improved by reducing the impacts of dams and water use on streamflow, collective effort has improved the management of riparian vegetation, integrating Aboriginal nations' perspectives on flowing waterways, and undertaking pest plant and animal management.

4.3.2. Strategic actions

A healthy environment is a key element of the vision for a water-secure Barossa. The vision describes a landscape where creeks are flowing and the health of catchments improves, providing valuable ecosystem services, amenity and cultural value. In combination with sustainable land management practices, actions to improve the health of waterways will help to ensure Barossa continues to be an attractive place to live, work and visit.

With climate change projected to reduce the reliability of surface water and groundwater resources, a proactive approach is needed to ensure there is room for healthy waterways in the future in a system where there are many competing demands for water.

Improve understanding of ecological condition and needs of local ecosystems

An important step in working towards a healthier ecosystem is improving the understanding of the baseline condition of the catchments. This includes mapping the location of permanent pools and springs and categorising the condition of creeks and waterways. Identifying areas of high value and areas of the catchment where streamflow condition is being most impacted will assist in targeting actions to improve flows and sustain ecosystems. In such a highly-modified landscape, this will also help to identify what 'healthy waterways' look like in 2050. Aboriginal nations' perspectives on flowing waterways should also be identified and incorporated into water management approaches.

An environmental water plan to increase flows through the system

The volume and timing of flows are critical drivers of ecosystem health. Existing dams throughout Barossa catchments and the ability to extract large volumes of water from watercourses at any time during the year are key barriers to ensuring flows progress through the system.

The opportunity to access alternative water sources to meet demand for productive purposes also provides an opportunity to explore options to reduce the impact of dams and watercourse extractions on catchments and streamflow. Access to alternative water sources would provide greater reliability and security to growers, with potential to leverage actions that support environmental outcomes.

An environmental water plan for Barossa would consider:

- reducing the use of groundwater and surface water (including direct extraction from watercourses) and returning volumes from these sources to the environment, either through negotiations or water allocation policies
- converting dams to offline storages to store alternative water sources, potentially reducing the need for new bulk storages in the catchment
- converting dams to environmental storages
- making modifications to reduce the size and/or impact of dams, or removing targeted dams from the system
- bypassing flows around targeted dams
- utilising alternative water as a source to provide environmental flows
- ensuring quality of imported water supports healthy soils, waterways and the environment.

A collaborative approach is needed to ensure any additional flows progress through the whole system and that any actions achieve maximum benefit. A shared commitment from the community, landholders, regional organisations and government would be needed to achieve this outcome and ensure the process to achieve it is equitable. Education about the importance of flows through the system and the benefits of removing barriers to flow is also suggested.

Actions to improve catchment health

Actions to manage riparian vegetation and pest plants and animals will also benefit catchments. Removing pest species, like redfin and weeds in and around watercourses, and revegetation with native plant species, are actions that will contribute to the health of waterways. Fencing off watercourses and springs and providing alternative stock drinking points can also limit the impacts of stock access on catchment health. Restoration and remediation programs, as well as education around actions that could help protect and restore ecosystems will also be important.

4.4. Business innovation and diversification

4.4.1. Vision element/relevant goal

Diversified businesses and increased adaptive capacity and economic prosperity

In 2050 multiple economic sectors are flourishing in Barossa. Circular economies have evolved, mosaic and regenerative agriculture is prevalent, AgTech and innovation data management are embraced and thriving Indigenous businesses are part of a diversified economy.

4.4.2. Strategic actions

In an uncertain future, diversity and innovation are important factors towards success, as is the ability to adapt tochange. The vision for the future is one with multiple economies in place, with sustainable enterprises a key focus. Building on its reputation for premium wines, Barossa is well placed to innovate, diversify and harness opportunities in new markets. By being proactive, building adaptive capacity and fostering a culture of innovation, Barossa can proactively shape its own future in national and global markets, rather than simply react to emerging economic and environmental trends. Importantly for the economy, flourishing landscapes and waterways support a robust recreational and tourism economy.

Continue to support business by providing opportunities to diversify, embrace the circular economy and maximise efficiency of water use

Diversification of the Barossa economy requires a continuing commitment to actively identifying and supporting future opportunities. Commercialising opportunities along agricultural value chains is a start. Leadership at every level enables this diversity, Existing leadership programs include the 'Barossa Next Crop' and 'Barossa Future Leaders' programs, which support emerging wine industry leaders to engage with community and industry leaders, identify new business opportunities and promote brand Barossa. The RDA continues to undertake initiatives that strengthen the business operating environment, improve business competitiveness and identify and promote opportunities for new investment and industry diversification. This currently includes further strengthening food businesses and food opportunities in the region, developing cultural, recreational and ecotourism opportunities and growing environmental markets, including carbon-related markets. Investment in creating communities of high amenity with accommodation to attract new investors and workers to support this industry growth should be welcomed.

As the value of water increases, industries of the future need to optimise economic returns

for the amount of water used; this will include value adding on agricultural production and the supply of hyper-premium products. It also opens up opportunities for new technology businesses in the region.

AgTech will bring efficiencies in water use and improve economic and environmental outcomes. The region is already investing in AgTech in many ways including to locate zones of water stress and soil variation enabling more efficient short and long-term management. Building on these examples and increasing access and exposure to new developments and benefits will deliver further efficiencies and wider adoption of AgTech and will also bring business opportunities in innovation and technology deployment.

Production from a sustainable base is important to Barossa and work is under way to make use of current 'waste streams'. Growing local circular economies encourages diversification provided there is an enabling regulatory environment. Current circular economy-based approaches include:

- Recycling and composting. At Henschke Wines, locally-sourced materials including the recycling of grape marc are combined to produce compost to enrich the soil and increase its water-holding capacity.
- Integrated water treatment and use. As part of the expansion of Treasury Wine Estate's Bilyara Winery the company has embraced an opportunity to utilise additional stormwater and almost 200 ML a year of treated wastewater is used to irrigate nearby vineyards and the Barossa Valley Golf Club.
- Renewable energy generation. Pernod Ricard winery has installed innovative energy storage technologies and more than 10,300 solar panels across the company's two Barossa Valley wineries, which generates 20% of their annual electricity needs. The remaining 80% is provided via solar and wind energy providers.

- Managing waste streams from packaging and working towards more sustainable packaging
- Biodiversity and regenerative soil initiatives

Continuous innovation through partnerships, education and training and connection with innovation hubs

Diversifying the economy through existing and new businesses can be strengthened via partnerships, structures and education that supports innovation. Regional cooperation is important to underpin a culture of innovation through strong collaboration and partnerships.

Data and information is essential for decision-making. Critical is the Barossa Weather Station Network, which is a repository of current and historical weather data from 16 weather stations around the Barossa region. Increased water quality monitoring of waterways is a pressing need Further work on collaborative data hubs would unlock continuing innovation and efficiencies. This could involve a regional data cooperative that enables more local data to be used to assist decision-making at the business and regional scale.

Establishing new, and connecting to existing, innovation hubs is a practical way to promote and celebrate innovation within the Barossa community. Connecting with established innovation centres, such as The University of Adelaide's Roseworthy campus, Adelaide's Lot Fourteen Precinct, Tonsley Innovation District, Future Food Systems Hub and the Office of the Chief Entrepreneur, along with regional innovation nodes and businesses, would further embed continuous innovation in Barossa. This would build on the endogenous 'innovation ecosystem', with actions set out under the Education and Knowledge Management for Adaptive Water Management pillar. Success will require interest and participation in the access opportunities provided.

Training and education is a key enabler for innovation, alongside a culture that supports risk-taking. Increasing the understanding of innovation through business collaboration, peer to peer mentoring and knowledge spillovers will supplement and give effect to learning, research, trials

and testing. Similarly, building a deeper understanding of future climate impacts will be important in considering what is possible towards 2050 and beyond and how to manage it.

Opportunities exist to develop knowledge tourism and events, as people travel into the region to learn by immersion, peer-to-peer learning, and through formal courses involving short and long stays. This already exists in many domains, including wine and food, but with facilities such as Barossa Campus and access to the breadth of tourism accommodation, executive education as well as short courses and masterclasses could be further developed.

Provide opportunities for Aboriginal nations' businesses and demand for Aboriginal products

The vision for Barossa describes thriving Aboriginal nations' businesses, providing jobs, economic opportunities and cultural reclamation for the region's Aboriginal peoples. Progressing towards this vision requires identifying, engaging with and learning from existing Aboriginal nations' businesses and practices.

Supporting and growing Indigenous enterprises would require conscious effort to learn about Aboriginal foods and culture relevant to Barossa, underpinned by better relationships with Aboriginal peoples. RDA's food program is currently developing local knowledge and food trails and a better understanding of origins and use of native foods. The Barossa Bushgardens Garden is also relevant to this work.

Meaningful dialogue with regional Aboriginal peoples is essential. Initial discussions could focus around:

- encouraging regional Aboriginal people's participation in this strategy's governance
- incorporating Aboriginal history into the Barossa brand and narrative, and
- research into locally relevant foods and plants that could develop commercial possibilities for Aboriginal businesses

4.5. Education and knowledge management for adaptive water management

4.5.1. Vision element/relevant goal

Barossa has the capacity to respond to challenges through its commitment to leadership, education and innovation

A centre of excellence has been established to showcase Barossa's expertise in connecting research to practice. Education, training and mentorship has led to a community skilled in adaptive thinking, and many successful sustainable enterprises.

4.5.2. Strategic actions

A focus on education and knowledge management is important to continue to build the capacity to address future challenges and achieve the vision. The vision describes Barossa as a leader in putting research into practice and showcasing local expertise. These attributes are important in achieving the water security vision but are relevant more broadly across the region.

Advocate for regional education and training to include a focus on the skills, attributes and knowledge required to deliver long-term water security.

Ensuring that education and training is targeted towards relevant skills will require identifying the diversity and types of skills and expertise required for a successful future as water security challenges increase. RDA monitors skills needs and gaps, has an ongoing skills facilitation program and Regional Universities Centre to support higher educational and skills achievement in the region. Through this workforce and skills development agenda, industry has the opportunity to shape future skills through tailored scholarships, internships and work experience opportunities. In addition Barossa secondary schools have industry relevant programs to build on and engage secondary students to take up locally relevant professions and Barossa Australia's viticultural management program in schools is an example of a successful industry/schools program. An education system tailored to local needs supports the development and attraction of the skills and diversity needed and supports business needs. Education and training that underpins innovation will also assist in retaining young people in the region.

As the future skills and expertise needed for the region is identified, training opportunities can be provided through RDA Workforce Development projects, Barossa Campus Regional Universities Centre, regional training and education centres, mentoring and knowledge exchange networks and programs, and peer-to-peer sharing. Adaptive skills are crucial for leading multiple technologies. Future ready skills in STEM will support the adoption of technical innovation and new agricultural technologies. A strong STEM cohort could inspire new regionally created, developed and manufactured technologies.

Many forms of leading education and training are already under way across Barossa, delivered by organisations such as Barossa Improved Grazing Group, Barossa Australia, Regional Development Australia and Barossa TAFE. These cover topics across agriculture, viticulture, conservation and ecosystem management, technologies, coding, leadership and business.

In addition, the recently established Barossa Campus provides a fit-for-purpose student hub for anyone undertaking post-secondary education, anywhere, and provides academic support in research, skills and locally delivered masterclasses.

The coordination role of the RDA Workforce Solutions program includes mapping existing programs and building on those, aiming to avoid duplication and ensure effective delivery. Sustainable funding models will also be important to ensure that programs can continue and evolve rather than disappear should funding sources change and resources be redistributed. An important partner in this coordination and delivery would be the existing regional coalition, as set out under the Collaborative Adaptive Governance pillar.

As an example, an interactive knowledge hub with sector specific nodes within a connected local education and training network would provide for applied learning engaging local knowledge and experience through case studies, materials, talks, visits, workshops, data management and targeted teaching. This would build a more robust, relevantly skilled workforce in water and soils management and could be realized through existing networks.

A school curriculum that includes adaptive, critical and systems thinking is also important. If the region is to harness emerging opportunities, then building adaptive capacity and critical and systems thinking will become increasingly important. A school curriculum based on the future needs of the region will stand the Barossa in good stead. This could be achieved by relating school to everyday challenges, maintaining a connection to land, teaching circular economy principles, teaching systems thinking and including Aboriginal traditional land management practices as part of the curriculum.

Youth programs, like the Barossa Youth Leadership Program and landscape education programs, are already providing a platform to help engage young people and build capacity to solve future problems. Barossa Australia's Operational Viticulture program provides opportunities for school-based learning and its Next Crop Leadership program aims to build the capability of young growers and viticulturists. Nuriootpa High School and Faith Lutheran College each deliver a Wine Education Program, which helps students develop industry skills and career awareness so they can enter the wine and viticulture industry. Basic agriculture courses at both schools can do the same for other forms of agriculture.

Connecting research and innovation to practice

Research extension helps ensure innovation and new technologies are accessible to growers and businesses in the region. RDA and Barossa Australia have priority actions to ensure primary producers in the region have regular updates on development opportunities to ensure best practices are being communicated, including related to value chain systems. Connecting research and innovation to best practice can also be progressed through overseas partnerships and exchanges and local knowledge transfer by government agencies.

Other opportunities include connecting with AgTech, water management and viticulture expertise available through Regenerative Agriculture Alliance (RAA), the University of Adelaide, University of South Australia, Flinders University and leading Ag-tech businesses in the region.

Barossa Australia and the University of Adelaide are already collaborating on wine education, research and industry engagement. Bringing researchers and industry together aims to build resilience and sustainability and more meaningful outcomes.

Create a centre of excellence in sustainable viticulture and agriculture

In the longer-term, building on Barossa Australia's capacity to disseminate leading technology and innovation advances to the local wine industry, a centre of excellence driven and supported by the wine industry is seen as an opportunity to build on global best practice for landscapes and farming and to nurture cutting-edge expertise in the community. Such a centre would:

- Build on and support technical research and application in the region
- highlight local innovation to address water security challenges
- share global case studies from similar regions globally
- share global industry knowledge
- share Aboriginal nations' perspectives on land management and place
- host regular think tanks on issues of local industry significance.

Once established, the centre could be used to support knowledge sharing and business decision-making, particularly in relation to communicating research and new knowledge. The centre could also help in agricultural research extension and forming a knowledge management network. The centre could form an 'innovation hub', with support from private sector partners and links to research entities.

4.6. Collaborative adaptive governance

4.6.1. Vision element/relevant goal

Governance arrangements support effective regional decision making in water security

Barossa has collaborative governance and decision-making processes in place to support transparent and efficient decision making that underpins the success of the region in achieving its vision.

4.6.2. Strategic actions

Effective governance is an important part of delivering on the future vision for a water secure Barossa. This can be achieved by ensuring structures or processes are in place with representatives from relevant organisations that support and have oversight of strategic water projects and programs. Such a group would need to be flexible and resilient to future changes.

Establishment of collaborative governance for water security

A number of organisations have a strategic interest in the long-term water security of the Barossa. These include Barossa Australia, Barossa Infrastructure Limited, The Barossa Council, Light Regional Council, Northern and Yorke Landscape Board, Regional Development Australia Barossa Gawler Light Adelaide Plains, Primary Industries and Regions SA, SA Water, Environment Protection Authority and Department for Environment and Water who have come together for the development of this strategy, as well as the Gawler River Floodplain Management Authority, and there are likely others.

In addition, central to the shared vision for the future is the incorporation of Indigenous knowledge and wisdom in water management. For this to happen, Aboriginal people must be directly represented in governance.

The governance body would be a strategic leadership group with relevant organisations, industries and agencies represented. It would become the steward of this and future Barossa Water Security Strategies. A charter or terms of reference would provide clarity around roles and responsibilities of representatives.

The existing regional coalition of Barossa Australia, The Barossa Council, Light Regional Council and Regional Development Australia is ideally placed to coordinate response to this strategy in the first instance. This group would lead considerations of the processes and partnerships required to deliver on the strategy, including with, notably, the Northern & Yorke Landscape Board, DEW and PIRSA, to specifically and comprehensively address water security..

Governance is likely to iterate over time towards 2050. Longer-term considerations include the potential to establish a Joint Planning Board (this could be established under the *Planning, Development and Infrastructure Act 2016*) and for it to have a mandate in relation to water security. Alternatively, the establishment of an Economic Development Authority is progressing (via a Regional Subsidiary under the *Local Government Act 1999*). An objective of this authority would be to facilitate the delivery of key infrastructure in the region, including water infrastructure, as part of identifying requirements that would underpin and grow the economy.

The community should continue to be engaged to share the imperative and the benefits to create support for a collaborative governance body and have a means of understanding and contributing to issues and solutions.

Collection and dissemination of evidence to support learning and decision-making

Collective agreement on what needs to be measured and what data needs to be shared will move towards evidence-based decision-making for water security in Barossa. This could be achieved by agreeing on shared outcomes, identifying the data that needs to be measured, collecting the relevant data and community engagement to disseminate the data to the broader community. Research into best practice guidelines for data agreements would help ensure that data captured in relation to the Barossa is owned and shared within Barossa for local benefit and shared more broadly for the purposes of this strategy only.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5. Further recommendations & next steps

Many established groups, partnerships and activities are in motion and proposed next steps will build on these. For example, consistent with Action 1.1 a detailed business case assessing the feasibility of providing recycled wastewater from the Bolivar Wastewater Treatment Plant to Barossa and River Murray water to Eden Valley is underway.

In addition, the Water Allocation Plan for the Barossa Prescribed Water Resources Area is being amended to further support the sustainable and integrated management of groundwater, surface water and imported water (consistent with Action 1.3).

Identifying Aboriginal peoples' cultural objectives and outcomes for water is progressing through the amendment of the Barossa Water Allocation Plan and through consultation on this strategy. This is an important step in ensuring that these are progressed and integrated into regional planning processes and on-ground projects.

To ensure efficient and integrated delivery, it is recommended an Implementation Plan be developed to progress the actions set out in this strategy, taking into account the activities that are underway.

The implementation of actions set out in this strategy require strong community leadership and oversight to ensure progress towards the shared future vision for Barossa. The Barossa Regional Partnership Group will take the lead on oversight of the region-wide actions and the partnerships required to deliver them. The Regional Partnership Group includes: Barossa Australia, The Barossa Council, Light Regional Council and Regional Development Australia Barossa Gawler Light Adelaide Plains. A government representative will also be sought.

The future is uncertain and any number of factors can and will impact on the region. This strategy will therefore need to be revisited and evaluated at regular intervals and adapted if required.

An effective monitoring and evaluation program will help ensure that key actions remain fit-for-purpose, including in the context of impacts from a changing climate. Such a program will be an important part of maintaining confidence among the Barossa community and stakeholders that they are on track to achieve their vision of a water-secure future.

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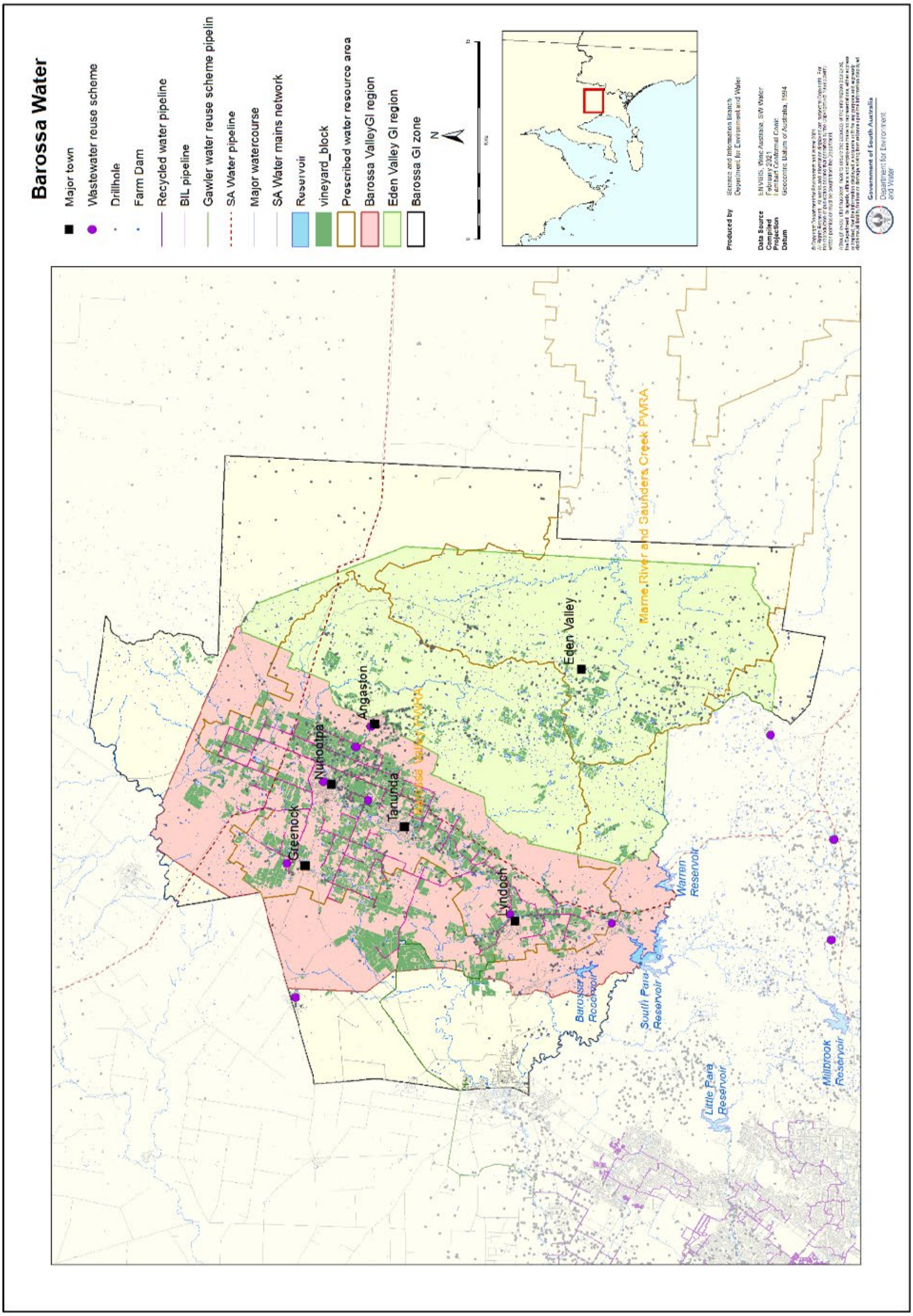
Appendix A

The following organisations were represented at one or all of the 3 workshops held in Tanunda in June, August and December 2021

Organisation	
Advanced Viticulture	Light Regional Council
Barossa Grape & Wine Association	Member for Schubert
Barossa Infrastructure Limited	Menglers Hill Vineyards
Barossa Improved Grazing Group	Ngadjuri Nation Aboriginal Corporation
Barossa Valley Estate	Northern and Yorke Landscape Board
Deans Wine Consulting	Pernod Ricard
Eden Hall	Regional Development Australia
Environment Protection Authority	Rosenvale
Gibson Wines	SA Water
Green Environmental	SARDI
Henschke Wines	Swingbridge
Kaurna Nation	Tandem Energy
Kiran and Co	The Barossa Council
Lartunga Wines	Barossa Water Allocation Plan Advisory Group

Appendix B

Map of water sources across Barossa



Appendix C

Scenario Outlines

Scenario 1	**G1** Highly interconnected world. free trade agreements with our major trading partners, tariff free trade environment and no restrictions on tourism.	**P1** The region experiences population growth through increased urbanisation, sprawl, encroachment and commuters living in the region but working elsewhere.	**C4** Globally there is a growth in preference for the Barossa brand irrespective of sustainability and local concerns, leading to pressures for expansion.	**D3** There is a decline in social cohesion and connection to place.	**R4** The regulatory environment is weak, essentially an unregulated free for all in terms of water allocations, salinity and land use planning.	**T2** There was slow uptake of ag tech in theregion, so the dominant companies are elsewhere, Barossa eventually buys in tech but loses control of its data.
Scenario 2	**G2** Increased focus on domestic markets, and on certain bilateral agreements, in the midst of increasingly protected markets across the globe	**P2** Population growth in the region is contained within the existing urban footprint.	**C2** The focus is on premium *dean and green' products, responsibly and locally produced. Sustainable products with minimal environmental footprints	**D1** Indigenous and non-indigenous people of different ethnicities call the Barossa home. The region has embraced multiple cultural narratives and values diversity.	**R1** Corporate sustainability policies drive the requlatory environment, with private companies imposing tougher environmental requlation than our State or Federal Governments	**T1** Proactive uptake of ag tech, local innovation and sector development means farmers are now producers of water, energy, food, wine and data.
Scenario 3	**G3** All trade and toursm is heavily restricted on a global scale. There is a contracted alobal economy. lots of nationalism. trade barriers to protect internal markets and cama rolasalicatian	**P2** Population growth within the region stays within the existing urban footorint.	**C1** Consumer preferences focus on both sustainability and health. It has been shown that no amount of alcohol is good for you, and alcohol consumption drops. There are ideological shifts towards plant-based diets.	**D1** Indigenous and non-indigenous people of different ethnicities call the Barossa home. The region has embraced multiple cultural narratives and values diversity.	**R3** The regulatory environment is regionally driven, water allocations are managed within local sustainability limits, as the climate changes.	**T1** There was proactive uptake of ag tech, including local innovation and sector development. The new farmers are producers of water, energy, food, wine and data.
Scenario 4	**G1** Highly interconnected world, free trade agreements with our maior trading partners, tariff free trade environment and no restrictions on tourism.	**P3** Over time, population in the region declines, with people moving out of this (and other regions) and into the cities.	**C3** Climate drivers impact varietal shifts in the region. Consumer preferences are driven by global factors that are disconnected from local climate realties and varietal feasiblity.	**D2** Historical Barossa families remain tight knit but newcomers are not readily integrated, increasing the numbers of alienated outsiders.	**R3** Regulatory functions are increasingly centralised. meaning regions have less influence over the water and land-use policies which are impacting them.	**T2** There has been slow uptake of a tech in the region. The Barossa now buys in the tech it needs from external companies.

Appendix D

Percentage change of seasonal and annual precipitation averaged across all three stations in the Barossa. The median value, upper and lower quartile (25 to 75th percentile) and 2.5 and 97.5th percentile values are quoted.

Season	Percentile	Emissions Scenario	2020		2030	2035		2050		Range of future change
Line of Evidence:			**CR-SA**	**NARCliM**	**CCIA**	**CR-SA**	**NARCliM**	**CR-SA**	**NARCliM**	
DJF	Median	RCP4.5	-3.6	-12	0	-8.3	-9.4	-7.2	-10	**-16 to 2**
		RCP8.5	-4.0	-0.18	2	-7.7	-6.1	-9.8	-16	
	25-75%	RCP4.5	-11 to 4.8	NA	NA	-16 to -0.24	NA	-17 to 1.5	NA	**-18 to 4.8**
		RCP8.5	-12 to 4.0			-14 to 0.092		-18 to -1.4		
	2.5-97.5%*	RCP4.5	-23 to 22	-13 to -12	-24 to 30	-29 to 17	-18 to 4.3	-35 to 18	-16 to 9.1	**-35 to 33**
		RCP8.5	-23 to 22	-19 to 33	-14 to 19	-27 to 17	-9.2 to 23	-31 to 17	-27 to 11	
MAM	Median	RCP4.5	-4.5	2.9	-1	-3.8	-5.4	-5.4	-9.9	**-9.9 to 2.9**
		RCP8.5	-4.5	-3.9	-3	-5.2	-3.4	-6.9	-5.2	
	25-75%	RCP4.5	-11 to 2.5	NA	NA	-11 to 2.7	NA	-12 to 2.5	NA	**-14 to 2.8**
		RCP8.5	-11 to 2.8			-13 to 2.1		-14 to 0.24		
	2.5-97.5%*	RCP4.5	-22 to 20	-22 to 16	-22 to 18	-23 to 17	-25 to 7.1	-24 to 18	-19 to 7.1	**-30 to 23**
		RCP8.5	-24 to 18	-20 to 5.9	-22 to 23	-25 to 15	-21 to 3.3	-27 to 14	-30 to 4.9	
JJA	Median	RCP4.5	-1.6	-11	-6	-3.6	-10	-5.9	-13	**-13 to 1.9**
		RCP8.5	-1.5	-8.2	-5	-4.9	-5.1	-6.7	1.9	
	25-75%	RCP4.5	-5.9 to 2.9	NA	NA	-7.5 to 1.2	NA	-11 to -0.39	NA	**2.9 to -11**
		RCP8.5	-5.5 to 1.8			-8.7 to -1.3		-11 to -2.3		
	2.5-97.5%*	RCP4.5	-12 to 12	-17 to 9.4	-16 to 6	-11 to 14	-20 to -4.7	-17 to 10	-27 to 5.7	**-27 to 18**
		RCP8.5	-13 to 8.6	-16 to 14	-16 to 5	-16 to 5.5	-10 to 18	-19 to 5.4	-15 to 12	
SON	Median	RCP4.5	-6.7	-12	-5	-10	-17	-13	-25	**-25 to -5**
		RCP8.5	-7.9	-11	-7	-14	-10	-17	-18	
	25-75%	RCP4.5	-12 to -1.7	NA	NA	-16 to -5.2	NA	-19 to -8.5	NA	**-24 to -1.7**
		RCP8.5	-13 to -1.7			-19 to -8.4		-24 to -11		
	2.5-97.5%*	RCP4.5	-20 to 8.9	-27 to -3.6	-20 to 10	-25 to 5.4	-31 to -3.2	-28 to 1.2	-32 to -12	**-36 to 10**
		RCP8.5	-20 to 8.3	-22 to 4.7	-23 to 10	-28 to 2.4	-29 to -0.52	-36 to -1.4	-33 to 1.9	
Annual	Median	RCP4.5	-3.6	-7.3	-4	-5.7	-11	-7.2	-14	**-14 to -2**
		RCP8.5	-3.6	-4.7	-2	-7.3	-4.7	-9.2	-8.3	
	25-75%	RCP4.5	-6.3 to -0.83	NA	NA	-8.6 to -3.0	NA	-11 to -4.2	NA	**-14 to -0.83**
		RCP8.5	-7.0 to -1.1			-11 to -4.4		-14 to -6.0		
	2.5-97.5%*	RCP4.5	-12 to 4.5	-19 to -0.24	-13 to 4*	-15 to 2.8	-23 to -3.4	-18 to 1.6	-19 to -8.2	**-23 to 5.0**
		RCP8.5	-14 to 4.3	-9.0 to 4.4	-13 to 5*	-18 to 0.82	-18 to 3.0	-21 to -0.39	-20 to 0.52	

* For NARCliM the values displayed in the 2.5-97.5% row is the minimum and maximum attribute values for the scenario; the CCIA report records 10th to 90th percentile uncertainty

Relative change (°C) in annual and seasonal maximum temperature

Season	Percentile	Emissions Scenario	2020		2030	2035		2050		Range of future change
Line of Evidence:			SA-CR	NARCliM	CCIA	SA-CR	NARCliM	SA-CR	NARCliM	
DJF	Median	RCP4.5 RCP8.5	0.9 1.0	1.1 1.2	0.7 0.9	1.2 1.5	1.6 1.6	1.5 2.0	1.9 1.9	0.7 to 2.0
	25-75%	RCP4.5 RCP8.5	0.70 to 1.1 0.77 to 1.4	NA	NA	0.99 to 1.5 1.2 to 2.0	NA	1.3 to 1.8 1.7 to 2.6	NA	0.70 to 2.6
	2.5-97.5%*	RCP4.5 RCP8.5	0.33 to 1.7 0.33 to 1.9	0.22 to 1.9 0.23 to 1.8	0.4 to 1.3 0.6 to 1.3	0.59 to 2.4 0.73 to 2.7	1.1 to 1.9 0.89 to 2.1	0.89 to 2.9 1.2 to 3.8	1.3 to 2.1 1.4 to 2.6	0.23 to 3.8
MAM	Median	RCP4.5 RCP8.5	0.71 0.86	0.87 0.84	0.7 0.7	0.99 1.3	1.2 1.1	1.3 1.8	1.5 1.6	0.7 to 1.8
	25-75%	RCP4.5 RCP8.5	0.51 to 0.92 0.66 to 1.1	NA	NA	0.78 to 1.2 1.1 to 1.6	NA	1.0 to 1.5 1.6 to 2.2	NA	0.51 to 2.2
	2.5-97.5%*	RCP4.5 RCP8.5	0.12 to 1.4 0.28 to 1.7	0.26 to 1.2 0.56 to 1.5	0.3 to 1.1 0.4 to 1.3	0.31 to 1.8 0.55 to 2.3	0.79 to 1.6 0.64 to 1.9	0.55 to 2.1 0.98 to 3.0	1.0 to 1.7 1.3 to 2.1	0.12 to 3.0
JJA	Median	RCP4.5 RCP8.5	0.67 0.77	0.80 0.80	0.70 0.80	0.98 1.2	1.1 1.2	1.2 1.7	1.3 1.7	0.67 to 1.7
	25-75%	RCP4.5 RCP8.5	0.52 to 0.79 0.61 to 0.95	NA	NA	0.78 to 1.1 1.0 to 1.5	NA	1.0 to 1.4 1.4 to 2.2	NA	0.52 to 2.2
	2.5-97.5%*	RCP4.5 RCP8.5	0.26 to 1.0 0.38 to 1.4	0.61 to 1.1 0.46 to 1.2	0.4 to 1.0 0.6 to 1.2	0.46 to 1.4 0.72 to 2.0	0.84 to 1.5 0.95 to 1.5	0.66 to 1.8 1.2 to 2.6	1.1 to 1.9 1.5 to 2.1	0.26 to 2.6
SON	Median	RCP4.5 RCP8.5	1.0 1.2	1.1 1.2	0.9 0.9	1.4 1.8	1.6 1.6	1.8 2.4	2.3 1.9	0.9 to 2.3
	25-75%	RCP4.5 RCP8.5	0.85 to 1.2 0.96 to 1.4	NA	NA	1.2 to 1.6 1.5 to 2.1	NA	1.6 to 2.0 2.1 to 2.8	NA	0.9 to 2.8
	2.5-97.5%*	RCP4.5 RCP8.5	0.48 to 1.5 0.62 to 1.8	0.69 to 1.5 0.21 to 1.9	0.5 to 1.1 0.6 to 1.3	0.85 to 2.0 1.1 to 2.6	1.2 to 2.4 0.56 to 2.8	1.2 to 2.4 1.6 to 3.5	1.7 to 2.8 1.6 to 2.9	0.21 to 3.5
Annual	Median	RCP4.5 RCP8.5	0.82 0.92	0.91 1.0	0.7 0.8	1.1 1.4	1.3 1.4	1.4 2.0	1.8 1.8	0.7 to 2.0
	25-75%	RCP4.5 RCP8.5	0.71 to 0.94 0.79 to 1.2	NA	NA	1.0 to 1.3 1.2 to 1.8	NA	1.3 to 1.6 1.7 to 2.4	NA	0.71 to 2.4
	2.5-97.5%*	RCP4.5 RCP8.5	0.46 to 1.2 0.61 to 1.5	0.58 to 1.4 0.51 to 1.4	0.5 to 1 0.6 to 1.2	0.72 to 1.6 1.0 to 2.2	1.1 to 1.8 0.92 to 1.8	1.0 to 2.0 1.5 to 3.1	1.4 to 2.0 1.6 to 2.3	0.46 to 3.1

* For NARCliM the values displayed in the 2.5-97.5% row is the minimum and maximum attribute values for the scenario; the CCIA report records 10th to 90th percentile uncertainty

Appendix E

A summary of key performance metrics for all pathways and several representative climate change scenarios is presented in Table 4. All pathways provide improvement to reliability of water security in the Barossa Valley, and the capacity for vineyard expansion while achieving a 90% reliability (and assuming no other system changes other than those articulated in the pathway) is also described, with increased capacity roughly corresponding to the additional imported volumes.

Table 4 - Summary of pathway results for Barossa Valley

Element	Business as usual	1. Enhanced infrastructure investment and existing behaviour	2. Sustainable economic growth - clean and green production	3. Healthy waterways through investment	4. Maximum water availability and production outcomes
Reliability* (baseline)	90%	≥97%	≥97%	≥97%	≥97%
Reliability* (mid-range climate projection)	70%	≥97%	≥97%	95%	≥97%
Reliability* (worst case)	45%	85%	90%	79%	≥97%
Capacity to change planted area** (baseline)	-4%	37%	41%	29%	95%
Capacity to change planted area** (mid-range climate projection)	-20%	15%	18%	6%	63%
Capacity to change planted area** (worst case)	-35%	-3%	-1%	-13%	33%
Number of days above threshold flow† (baseline)	272	272	273	275	272
Number of days above threshold flow† (mid-range climate projection)	261	261	262	264	261
Number of days above threshold flow† (worst case)	245	245	246	248	245

*Water supply reliability has been calculated as '1 – percentage of years with unmet demand'. Note: as reliability is calculated relative to a 30 year climate sequence, it is not possible to estimate reliability values greater than 97%.

**This metric is calculated based on an assumption of 90% reliability, and that other system attributes (e.g. yield targets and/or other types of water demand) are held constant.

† Barossa Valley Gorge zone.

Presenting the same analysis for Eden Valley (Table 5) shows that the introduction of imported water has a significant impact on ability to meet water security, with all pathways achieving high reliability. This table also highlights potential changes to planted area that can be achieved for the different pathways and climate scenarios while achieving a 90% reliability. Pathways 2 and 3 also allow for increase in environmental flows at the Upper Flaxman Valley Zone outlet, which is located within the Eden Valley delineation, although these increases are somewhat dwarfed by the decrease in environmental flows caused by the more severe climate projections.

Table 5 - Summary of pathway results for Eden Valley

Element	Business as usual	1. Enhanced infrastructure investment and existing behaviour	2. Sustainable economic growth - clean and green production	3. Healthy waterways through investment	4. Maximum water availability and production outcomes
Reliability* (baseline)	90%	≥97%	≥97%	≥97%	≥97%
Reliability* (mid-range climate projection)	70%	≥97%	≥97%	≥97%	≥97%
Reliability* (worst case)	45%	97%	≥97%	≥97%	≥97%
Capacity to change planted area** (baseline)	-9%	77%	115%	98%	163%
Capacity to change planted area** (mid-range climate projection)	-27%	48%	80%	53%	120%
Capacity to change planted area** (worst case)	-50%	15%	45%	20%	81%
Number of days above threshold flow† (baseline)	99	99	109	119	99
Number of days above threshold flow† (mid-range climate projection)	80	80	90	99	80
Number of days above threshold flow† (worst case)	54	54	63	71	54

*Water supply reliability has been calculated as '1 – percentage of years with unmet demand'. Note: as reliability is calculated relative to a 30-year climate sequence, it is not possible to estimate reliability values greater than 97%.
**This metric is calculated based on an assumption of 90% reliability, and that other system attributes (e.g. yield targets and/or other types of water demand) are held constant.

† Upper Flaxman Valley Zone.

The Barossa Water Security Strategy has been developed in partnership with the following organisations: