BAROSSA & LIGHT
REGIONAL DEVELOPMENT BOARD INC.

# Revision 2045

## *A Water Strategy for the Barossa and Light Region*

Australian WATER Environments

*Barossa and Light Regional Development Board*

# ReVision 2045

## Water Security for the Barossa and Light Region

March 2010


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Australian WATER Environments

# *Forew0rd*

The critical importance of water to economic, environmental and social sustainability is well recognised, but how well is it really understood? We know we have less water than we want, probably less that we need. We therefore must modify our wants and manage our needs as well as respecting, valuing and managing our limited water resources.

Revision 2045 is a step towards best practice management of this vulnerable resource. Understanding use and waste, understanding and respecting environmental water requirements, better technology for treatment and recycling, critical infrastructure investment in treatment and recycling will contribute to better resource management. Evaluating our use of water and movement away from habits of waste is critical. We have to relearn to use water wisely. We have to learn to meaningfully address this important consideration in plans for growth, both at an enterprise and community wide level.

It is a complex subject. Many have contributed to this strategy development. In particular Peter Wall has been extremely generous in contribution of his time and knowledge to this project. The project advisory group has stayed with the project through its twists and turns as drought and emerging concerns about climate change, and then growth, have altered the course of considerations of future demand and supply. I acknowledge the excellent contribution of members Paul Shanks, Ian Baldwin, Leon Deans, Andrew Philpott and, at different stages of the project, Kym Goode, Marion Santich and Dr Gayle Grieger (all of the Adelaide & Mt Lofty Ranges Natural Resource Management Board), Councillor Patsy Biscoe and David Henderson. Specific input was received from Russell Johnson and Dr Michael McCarthy. To the many key regional business men and women who participated in the public consultation, thank you.

Our environment is under much pressure, not only from a changing climate but land clearance, growth and development, pollutants and introduced ecological imbalances. Any proposal for water security must be holistic, adaptive and responsive. As well as support by government and industry, this strategy depends upon a whole of community engagement in a sustainable waterwise future. Importantly, it is to be understood in the context of the Water for Good Strategy for state wide water management.

The financial contribution of the Government of South Australia through the Dept of Trade and Economic Development with support from the Adelaide and Mt Lofty Ranges Natural Resource Management Board, Light Regional Council and Barossa Council is gratefully acknowledged. On 1 January 2010 The Barossa & Light Regional Development Board became Regional Development Australia Barossa. I acknowledge the support of the former Board members in developing this project and the future support of our current Board and stakeholders in implementing its recommendations.

Anne Moroney,<br>
Chief Executive,<br>
Regional Development Australia Barossa Inc<br>
(formerly, Barossa & Light Regional Development Board Inc.)<br>
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# Table of Contents

# List of Figures



# Appendices

# *Executive Summary*

**Project Objectives**

ReVision 2045 is a review of *The Barossa Valley Strategic Water Management Study*, also known as Vision 2045, and the development of a new strategic plan for water security for the Barossa and Light Region. The aim of Vision 2045 was to "determine the most appropriate ways to increase the availability of water in the Barossa region so that agricultural, industrial, tourism and urban development activities can expand whilst maintaining the character and environmental assets of the Barossa Region". ReVision 2045 builds on that aim whilst assessing the current and future realities – in particular drought and climate variability, reduced certainty of River Murray flow and allocations, combined with a faster than expected growth in the region – which point to a water-constrained future unless water resources are more effectively managed and utilised.

**Economic Importance of the Region to South Australia**

The Barossa and Light region is defined by the administrative boundary of the Barossa and Light Regional Development Board, incorporating the local government boundaries of the Light Regional Council and the Barossa Council.

The region is highly economically productive with a total regional value of output in 2007 which equated to $3.08 billion. The diversified array of industries, including the wine, viticulture and tourism industries ensures the region remains critical to the economic development and social considerations of the state. The wine and viticulture industries are especially important within the region with the growth, processing and making of wine from locally and externally sourced grown grapes, ensuring a value of output in 2007 of close to $1 billion. The increasing growth in the industry sector, coupled with an anticipated significant residential development (according to some projections up to an additional 100,000 people) is intrinsically linked to the availability and use of appropriate water resources.

**Regional Growth Projections**

Projected regional directions include:

- Grape production in the region to 2045 is anticipated to grow by 5% to 100,000 tonnes per annum;

- A potential Barossa and Light regional population in the vicinity of 110,000 by 2045, a marked increase from the current figure of 35,000 and the 62,000 predicted in Vision 2045.The impact of this growth on water resources could be even greater than these predictions suggest. Whilst a 5% growth in viticultural plantings might seem modest, CSIRO climate change modelling suggests a minimum increase in water requirements of 10 – 20%; and
- The planning documents which articulate the predicted residential growth in the region do not articulate the source of water to become available for this development. For the purposes of Revision 2045 a sustainable water source for new development must be assumed. However, it is recommended that further study of this issue be carried out.

**Current State of the Water Resource**

There has been a significant decrease in the annual discharge at all gauging stations over the period 2002 – 2007, when compared to the entire record. This trend is consistent with the decrease in annual rainfall over that period and outlines the impact prolonged drought periods can have on the water resources of the region. Water quality in the region, particularly salinity, presents an ongoing area for concern, with the Light River and Greenock Creek recording brackish water quality results over the period water quality has been measured.

The groundwater resources, including the Fractured Rock Aquifer and Lower Aquifer are generally displaying downward trends in water level. This is consistent with below average rainfall over the monitored period from 1990 to 2002. An exception to this trend is in the region around Tanunda where a slight increasing trend is observed and is possibly related to a reduction in groundwater extraction due to the introduction of external water sources. It is understood that the Barossa Valley aquifer volumes are linked to recent rainfall and a diminution in water runoff translates to an almost immediate elimination of ground water availability. This distinguishes the Barossa from regions where the aquifers hold water from rain that fell up to thousands of years ago. It is generally considered that Eden Valley has a greater water stress than that within the Barossa Valley Floor, given that there is no BIL or supplementary sources other than bores.

The current climatic conditions can be viewed as an indicator of the impacts climate change may have in the region. Hence, regional growth may be constrained by a limiting water resource unless alternative strategies are developed.

**Current Water Use**

Based on the 2007/08 metered data from the Barossa, accepted application rates, soil types, local knowledge and current land use data (DWLBC 2008), water use for the entire region was calculated to be 14,400 ML.

Currently there are 371 volume based licences to extract groundwater equating to a volume of 6,000 ML and an additional 81 area based licences which equates to an additional 1,200 ML (WAP, 2009). Farm Dams in the region have the capacity to capture up to 14,750 ML of water, though this does not necessarily reflect runoff. Evaporation is estimated at about 30%.

The currency of these estimates is dependent upon measurement and reporting mechanisms, both of which need to be improved to ascertain a more rigorous view of the water balance within the region.

**Environmental Water**

Flow patterns within the region have been fundamentally altered. This change in both the volume of flow and seasonal flow patterns has had an impact on the natural environment of the river system. The heavily altered landscape has resulted in water dependent ecosystems consisting generally of species and communities tolerant of a wide range of conditions. ReVision 2045 proposes a fundamental shift away from the currency of thinking regarding determining environmental water requirements. Focus should be directed at those areas where high value remnant communities and habitats exist or where more biodiversity can be reinstated at low cost, rather than developing a blanket policy directive for the region. Rigorous assessment of "high value" is required as further discussed below.

**Climate Change**

Climate change impacts in the region by 2045 are expected to entail an annual temperature rise between 0.1 and 1.3 degrees Celsius and an annual rainfall decrease between 1% and 10%. A 10% decline in rainfall equates to approximately 30% decline in runoff. This reduction in rainfall/runoff will have multiple impacts on all users of the water resources of the region, including reduced recharge of the groundwater resources, reduced inflows to potable water supply storages (Warren, South Para, and Barossa) and reduced inflow into dams for irrigation and stock and domestic uses.

Climate change impacts could have the potential to have a profound impact on the social, environmental and economic status of the region. Planning for this will require strong leadership and engagement with all stakeholders. Developing an integrated water resource management plan, including integrating alternative water resource strategies is critical.

**Wastewater in the Region**

A significant proportion of community waste management system wastewater, operated by the two councils and SA Water is reused. This equates to 1,000 ML per annum which is generally supplied to third party irrigators in the region. Regionally, an additional 9,000 ML per annum of recycled wastewater could become available, associated with the proposed population increases.

Use of industry wastewater, including winery wastewater is increasing in the region where it is estimated that 600 ML of winery wastewater is produced per annum. A growing focus on operational efficiencies will see this amount decline.

**Diverting Water**

With an annual average precipitation of 500mm, 200,000 ML of water falls on the 400 square kilometre catchment of the North Para arm of the Gawler River.

On average, 6,600 ML per annum of potable water is used within the region. 63% is utilised by residential users, 19% by industrial users, with the remaining split between commercial, primary producers, public institutions and recreational needs. The projected increase in residential water demand for the area equates to some 15,000 ML each year. As noted, the source of this water will need to be better understood as structure plans for the proposed development evolve.

**Urban Stormwater**

Within the Barossa and Light region, there is currently an estimated 6,000 ML per annum of urban stormwater runoff from the intensive land use areas, principally the region's townships.

Assuming an increasing population to 110,000 associated with that proposed in Planning SA's 30 year Plan (2009), and assuming a reliable source of suitable water to enable this growth, this could equate to an additional 10,500 ML per annum of urban stormwater runoff. Moreover, this could equate to a yield of up to 5,250 ML per annum. Amenity horticulture is viewed as a critical social orientated development component when considering the proposed scale of residential development in the region. Assuming 15% open space (eg recreational, linear parks) for all new developments, it is estimated 800 ML per annum would be required to irrigate these open space areas.

**Water Resource Management Recommendations for the Future**

The projected future demands to 2045 for water cannot be met by native water resources within the region. The demand must be met by the use of a range of strategies including, but not limited to, inter and intra basin transfers, comprehensive recycling of wastewater and stormwater and possible use of MAR under a structured management plan. All new development must anticipate – and provide infrastructure for - recycling of water.

Significant water resource data and knowledge gaps and quality issues exist within the region. This includes incomplete data sets associated with recording stations, sub catchments without data, and a short term view of continuous salinity sampling, and this currently prevents a completely thorough understanding of the state of the water resources in the region. A complete review of data gathering is recommended to ensure decision support mechanisms are supported with appropriate data and knowledge coverage.

However, it is clear that available supply will not support projected demand and that the region will need to change the usage patterns and management of wastewater. Improved water resource management is critical.

**Recommendations**

A range of initiatives and recommendations have been developed in consultation with a number of stakeholders. They centre on the establishment of a leader in the development and implementation of innovative water security strategies for the region. The full list of initiatives and recommendations are detailed in sections six and eight respectively. The recommendations can be grouped into four overarching directives (Administrative Arrangements, Intra Region

Water Harvesting, Environmental Water and Resource Management) which will position the region as a leader in sustainable water resource management to 2045. These four directives are described below.

**Administrative Arrangements**

Effective and impartial leadership will be required to scope, develop and implement the range of water security strategies and initiatives recommended within ReVision 2045. Therefore, it is recommended that the:

- Barossa and Light Regional Development Board (BLD) take the leadership role in the competing demands facing water security for the region to 2045, in partnership with the Department for Water, Land and Biodiversity Conservation, Adelaide and Mount Lofty Ranges Natural Resources Management Board and SA Water.
- Establishment of an alternative management body and an appropriately constituted management group. It is also recommended that BLD continues to provide leadership and oversight in water security in the region once this management body is established.
- Possibility of extending the proposed water management body into a Regional Sustainable Utilities Authority be considered, incorporating sustainable water and energy management in the region to 2045.

One of the principle initiatives the region will be required to investigate is the development of a cost effective infrastructure network that enables all users access to water. Thus, it is recommended that:

- Local ownership is established through a BLD led review of the water supply infrastructure network ownership arrangements, for the purpose of establishing a coordinated regional third party access agreement for all water supply infrastructure. This review will need to consider supply capabilities, legislative consequences and commercial opportunities and liabilities (proposed Water Industry Act).

**Intra Region Water Harvesting**

ReVision 2045 states clearly that the region will require improved water resource management strategies into the future to enable access to water for all users. Incorporating Managed Aquifer Recharge, Stormwater and Wastewater Recycling initiatives into current (retrofitting) and all new developments in the region will be central to this strategy. These initiatives should include:

- Identification of potential sources of water (including wastewater and stormwater) and their availability according to legislation and plans (ie water allocation plans)
- Undertaking detailed investigation for the implementation of Managed Aquifer Recharge (MAR) in the region.
- MAR as a tool in managing impacts of climate variability (ie current drought)
- Incorporating MAR initiatives into all major residential developments in the region, where feasible.
- Development of Urban Stormwater Management Plans for the region while taking into account the requirements of the relevant water allocation plan.
- Including water sensitive urban design in local planning & development requirements.
- Capturing and recycling stormwater within all new developments (residential and industrial) within the region whilst accounting for the requirements of the relevant Water Allocation Plan.
- Establishing viable & efficient wastewater management systems as part of the leading infrastructure for all new development, including the anticipated significant regional development around Roseworthy, which collects, treats and re-cycles water within the wider region.
- All new residential development to incorporate wastewater recycling.
- Where practicable and environmentally sustainable, all industries collect, treat and recycle their wastewater within the wider region.
- For each new water recycling initiative, undertake detailed analysis of recycle consequences and develop and implement a management plan to mitigate against any risks.

**Resource Management**

Understanding the state of the resource is critical when formulating and implementing a water security strategy. The region suffers from a lack of data currency, spread and quality. It is therefore recommended that the region:

- Develops a targeted monitoring and evaluation strategy that adapts to the altering water resource management landscape whilst maintaining sufficient baseline information for all users to make informed decisions.

- Installs robust and accurate meters for all users and implements a rigorous reporting regime.
- Actively develops opportunities to creatively constrain water demand.
- Invests in strategies that limit loss to evaporation.
- Undertakes policy development to switch SA Water users to BIL and limit future allocation of potable water for agriculture.

**Environmental Water**

With the region, which has been significantly altered due to anthropogenic influences, the ecological diversity of the region has diminished to pockets of remnant habitats of high ecological value. These areas include sections of Duck Ponds Creek, Tanunda Creek and Mt McKenzie.

It is ReVision 2045's considered view that it is these areas which should be considered in detail to determine their specific water requirements and thereby provide the necessary science to support a management process specifically designed to improve and enhance these systems.
ReVision 2045 aims to set a new strategic directive for determining environmental water requirements in the region. The intent is to challenge the traditional model and currency of thinking in determining environmental water requirements to a process which addresses objectively the specific water requirements of the individual ecosystems and sets up a management process to improve and enhance these systems. Striking out into new territory is particularly important when considering the recent prolonged drought, perhaps a snapshot of climate change impacts into the future, and the impact on remnant ecological habitats.

Thus it is recommended that the region should move on from the long standing approach of broad catchment modelling and management to a process which addresses objectively the specific water requirements of key individual small ecosystems and thereby enable the establishment of a management process to improve and enhance these systems. In order to ensure fairness and equity across the system, a systematic survey of the present resources and risk assessment of the likely impact of evolving threats including climate change should be developed to inform decisions.

Adopting a more local focus on specific ecosystems (whilst still recognising the benefits and need for some interconnectivity and migration along the system) should also enable the limited water and funding resources that are likely to be available to be targeted at the areas of greatest value and highest need. To facilitate access of environmental users to water, it is also recommended that the feasibility of  all dams at a predetermined volumetric capture capacity be required to install a low flow bypass device be investigated.

Further work could be enacted which investigates the impact dams have on the ecology of the system. This work could lead to a strategy whereby low flow bypass devices are installed on dams which impact on the ecology of the region.

# 1. Introduction

## 1.1 Multiple uses of Water

To continue the strong economic growth in the Barossa and Light region in the face of increased competition for limited water resources, and increased salinity and degradation of waterways, innovative strategies and leadership is required. Environmental and water resources management has moved towards a philosophy of treating wastewater (eg grey water, black water etc) to a high enough quality such that it is a resource which can be put to beneficial use rather than wasted. By applying this conviction to responsible water resource management strategies, coupled with the vexing problems of increasing water shortages and environmental pollution, a realistic framework has emerged for considering "multiple uses of water" via reclamation and recycling (Asano 2002).

## 1.2 Background to the Study

Australian Water Environments (AWE) was engaged to undertake a review of The Barossa Valley Strategic Water Management Study (1996), otherwise known as Vision 2045 and the development of a new strategic plan for water security for the Barossa and Light Region (the region), entitled ReVision 2045.

Vision 2045 was an initiative of the Barossa Region Economic Development Authority and the North Para Water Resources Committee, with funding and in-kind support from the Department of Manufacturing, Industry, Small Business and Regional Development, the Department of Environment and Natural Resources and the Barossa, Mid North and Riverland Regional Development Association.

The aim of the study was to “determine the most appropriate ways to increase the availability of water in the Barossa region so that agricultural, industrial, tourism and urban development activities can expand whilst maintaining the character and environmental assets of the Barossa Region”.

With a strong scientific basis, the study was a comprehensive and informed analysis for reconciling the then current and future water resource demands with the available resources. Vision 2045 outlined a range of options to provide water for future development in a sustainable manner, and was generally well received and implemented. For example, Barossa Infrastructure Limited (BIL), a grower-owned company, distributes River Murray water and treated wastewater for the supplementary irrigation of vineyards in the Barossa Valley, a successful development from Vision 2045. North Para Environment Control Pty Ltd (NPEC) also provides treated wastewater for irrigation.

It is now thirteen years since the release of the report and new realities – in particular drought and climate variability, reduced certainty of River Murray flow and allocations, combined with a faster than expected growth in the region – point to a water-constrained future unless water resources are more effectively managed and utilised.

The total regional value of output in 2007 equated to $3.08 billion. The diversified array of industries, including the wine, viticulture and tourism industries ensures the region remains critical to the economic development and social infrastructure of the state. However, ongoing growth is intrinsically linked to the availability and use of appropriate water resources.

The increased public attention on water security issues has resulted in significant investment in state and national based water security research, policies and plans. Within South Australia, two water security plans relevant to the region have been developed since Vision 2045, *Water Proofing Adelaide* (2002) and *Water for Good* (2009). Maintaining a uniform approach, ReVision 2045 sits within the framework of these plans, and the *State Strategic Plan*, to present a coherent narrative on water resource management.

*Water for Good* calls for the development – with community involvement – of detailed water demand and supply plans for every region. The development of ReVision 2045 highlights the regions initiative and presents the community at the forefront of strategic water resource management in South Australia.

ReVision 2045 is presented in three sections:

Current and Future Regional Trends;

State of the Regions Available Water Resources; and

Water Resource Security Management Options.

## 1.3 Aims of ReVision 2045

ReVision 2045 strategically reviews the region's water resources to ensure they are secure, safe, reliable and able to sustain targeted growth. The broad aim of ReVision 2045 is to:

supply water for sustainable development and vineyard operations;

provide water for the environment; and

manage the impacts of climate variability in the Barossa & Light Region.

The region's increasing population, demand for water and reduced rainfall has led to a need to diversify supplies to match that future need. A detailed analysis of the current and projected use and availability of water in the region could facilitate a coordinated approach to planning for any future scenario. Hence, the aim of ReVision 2045 was also to:

- Review and update the key assumptions underlying the Vision 2045 plan (including wine industry activity, population, climate, River Murray water availability and environmental water requirements);
- Review the hydrology of the region;
- Assess environmental and commercial, industrial, agricultural, recreational, social, utility and domestic water needs;
- Identify and quantify water uses and future demands;
- Identify potential water resources and water supply options including water trading, desalination, recycled water;

- Determine, at a regional level, potential gaps between water demand and supply;
- Develop salt and water budgets;
- Identify areas for further investigation; and
- Provide recommendations that are realistic, sustainable and supported in the documentation by strategies and actions for:
    - Improving the availability of water for all water users, including the environment;
    - Achieving specific outcomes for environmental assets of highest value;
    - Providing infrastructure; and
    - Securing funding to implement the recommendations.

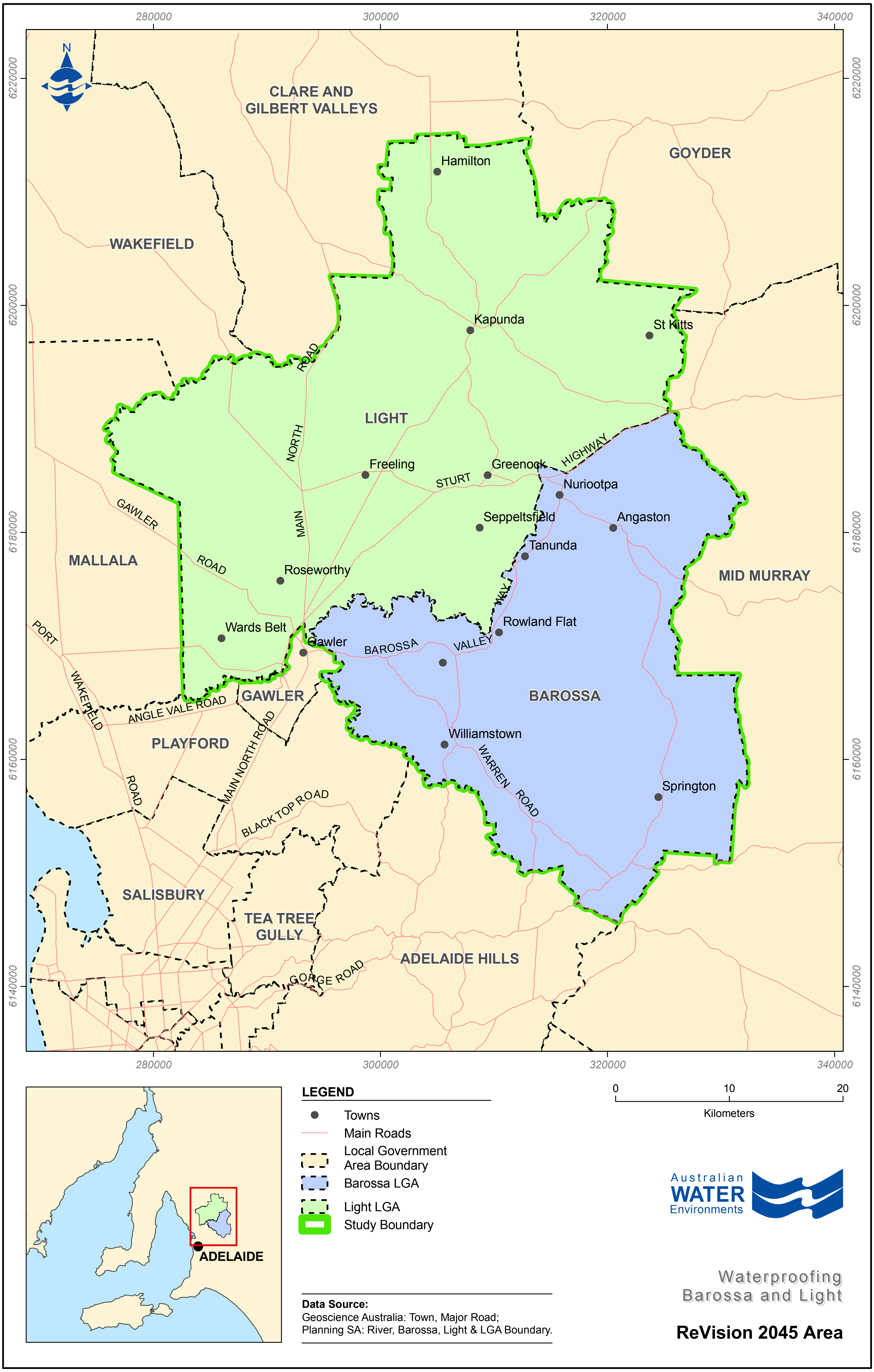
Thus, ReVision 2045 aims to ensure a sustainable approach to water resource management.

## 1.4 Barossa and Light Region

For the purposes of ReVision 2045, the Barossa and Light region is defined by the boundary of the Barossa and Light Regional Development Board (Figure 1.1). This incorporates the local government boundaries of the Light Regional Council and the Barossa Council. The region lies approximately 70 km northeast of Adelaide with a total land area of 2,186 square kilometres. It supports a population of over 35,000 people. The region has one of the fastest growing populations in South Australia, mainly due to the success of the wine industry, opportunities for employment and the high standard of living that the region enjoys.

The Barossa region is the heart of Australia's foremost winemaking State, with more than 20% of Australia's wine produced in the region. Other industries within the region include grain growing, spirit distillation, dried fruit processing and packing, tourism, forestry and broad acre agriculture. Towns in the region include Roseworthy, Freeling, Kapunda, Greenock, Nuriootpa, Tanunda, Angaston, Lyndoch, Williamstown and Mount Pleasant.

The Mediterranean-like climate within the region is typified by dry summers and mild winters. Average annual rainfall varies from less than 500 mm in the relatively flat northern zones to over 650 mm in the elevated Mount Lofty Ranges in the south of the region.




Australian WATER Environments

Waterproofing Barossa and Light

**ReVision 2045 Area**

*Job No. 47972 - 009*
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Figure 1.1

# 2. Barossa and Light Region: Current and Future Trends

## 2.1 Population

The population of the Barossa and Light region as of 30th June 2008 was estimated to be approximately 35,490 (Table 2.1). This is an increase of over 10,000 people since 1994 and Vision 2045. More than 60 per cent of the region's residents live in the Barossa local government area (22,172 people) with 13,318 people living in the local government area of Light.

Table 2.1 Current Population

| Local Government Area | 2008 Population |
|---|---|
| Barossa | 22,172 |
| Light | 13,318 |
| **Total** | **35,490** |

Source: ABS 2008c

Based on data from the 2006 Census of Population and Housing (ABS 2008a), almost 84 per cent of the region's residents were born in Australia, slightly higher than the equivalent estimate at the state level (74 per cent) (Table 2.2). The age distribution of the population is very similar to that for the state as a whole (Table 2.2) (ABS 2008a).

**Table 2.2 Population profile, Barossa and Light RDB and SA, 2006 [a]**

| | Barossa and Light RDB | South Australia |
|---|---|---|
| **Place of birth** | | |
| Australia | 83.5% | 74.0% |
| United Kingdom | 8.2% | 8.0% |
| Other | 4.2% | 12.3% |
| Country of birth not stated | 4.2% | 5.7% |
| Total | 100.0% | 100.0% |
| **Age group** | | |
| 0-14 years | 21.3% | 18.5% |
| 15-64 years | 65.4% | 66.1% |
| 65 years+ | 13.3% | 15.4% |
| Total | 100.0% | 100.0% |

[a] Based on place of usual residence.

Source: *2006 Census of Population and Housing* (ABS 2008a).

Vision 2045 predicted the population of the region by 2006 was to reach 34,000, a prediction that was exceeded. South Australia, through the State Strategic Plan, has established an aggressive population target for 2050, where the population is expected to reach 2.49 million – 60 per cent more than in 2008 (1.56 million). The population of the region has steadily increased over recent years, at a rate higher than the State average. Between 2003 and 2006 the region experienced an annual average population increase of 3.1 per cent. By comparison, South Australia recorded an annual growth rate of 0.9 per cent for the same period. Australian Bureau of Statistics 2006 Census and Planning SA Projections indicates the region's population is expected to continue to grow faster than the State over the 2006-11 and 2011-21 periods (Hugo and Smailes 2009).

The population profile of the Barossa Light region has above average proportions of school-aged children (0-14 years) and middle-aged people (45-64 years). The region has high proportions of couples, with and without children. This trend has been strengthened by the findings of Morony (2003) who investigated the nature, causes and implications of migration into the region. Demographically, those migrating into the region were mainly nuclear families, full time employees, professionals and managers, people on medium to high incomes and retirees. Conversely, those migrating out tend to be adolescent and young adults moving to Adelaide for education or employment. Not surprisingly, lifestyle reasons are the primary driver for migration in to the region with many people commuting to Adelaide daily for employment.

Planning SA has modelled population projections for the Barossa region, incorporating the Barossa, Light, Gawler and Mallala local government areas, to 2038 for the *Plan for Greater Adelaide* (2009). The net additional population in this area has been estimated at 110,000 persons, incorporating an additional 40,000 dwellings. Relatively small increases are expected around existing townships, including Freeling, Nuriootpa, Angaston and Tanunda. A large bulk of the projected increase is centred around existing transport corridors of the Light Region with Roseworthy and, to a lesser extent Concordia, at the southern end of the study area, identified for significant growth over that time. This plan incorporates proposed development in the floodplain – suggesting flood mitigation issues will need to be resolved prior to this land being developed.

The Planning SA 30 Year Plan is still in draft form. Consequently, the document and the numbers contained therein are still relatively fluid. This is highlighted when compared against the Hugo and Smailes (2009) population predictions of an additional 6,000 to 7,000 persons by 2021.

The Planning SA predictions have been extrapolated out to 2045, suggesting a Barossa and Light regional population in excess of 100,000, a marked increase from the current figure of 35,000 and 62,000 predicted in Vision 2045.

Considered development of new, or expansion of existing, urban areas should be designed to minimise impacts on water resources and high-value environmental areas, whilst creating an urban environment that demonstrates water efficiency through the application of water-sensitive urban design principles. The strategic location of dense green spaces including parklands, green recreational facilities and developing linear parks around waterways should be important considerations for all new developments. Council Development Plans will need to be reviewed so that these requirements can be embedded within them. Serious consideration of water availability should precede rezoning and development activities.

The social, economic and environmental considerations of development in the region also include the loss of prime agricultural land. Balancing the increasing demand for urban expansion whilst protecting high heritage and tourism values, including the historic towns and viticulture industry is fundamental to the region. The development, in collaboration with all stakeholders, of a region wide planning strategy is required to enable a coordinated and strategic approach to land use planning.

## 2.2 Regional Socio-Economic Indicators

The Barossa and Light Regional Development Board region is comprised of the following Statistical Local Areas (SLAs):

Barossa (DC) Angaston;

Barossa (DC) Barossa;

Barossa (DC) Tanunda; and

Light (DC).

Some general socio-economic indicators for this region have been extracted from the 2006 Census of Population and Housing (ABS 2008a and 2008b) and other sources. This data is presented below.

### 2.2.1 Labour Force

Total employment in the region in 2006/07 was estimated to be 15,748 jobs or 14,993 full-time equivalents (fte). This represented 2.2 per cent of South Australia's total employment at that time (755,713) (DEWR 2007). The average rate of unemployment in the Barossa and

Light RDB region in 2006/07 was 2.9 per cent. This was significantly less than the rate of unemployment for SA over this period (5.0 per cent) (DEWR 2007). Based on the 2006 Census of Population and Housing (ABS 2008b) there was little difference in the employment status of those employed in the region and those employed state-wide (Table 2.3).

**Table 2.3 Employment status, Barossa and Light RDB and SA, 2006 [a]**

| | Barossa and Light RDB | South Australia |
|---|---|---|
| Full-time | 64.8% | 62.6% |
| Part-time | 29.9% | 31.8% |
| Away from work | 3.8% | 3.8% |
| Not stated | 1.5% | 1.7% |

[a] Based on a person's place of work.

Source: *2006 Census of Population and Housing* (ABS 2008b).

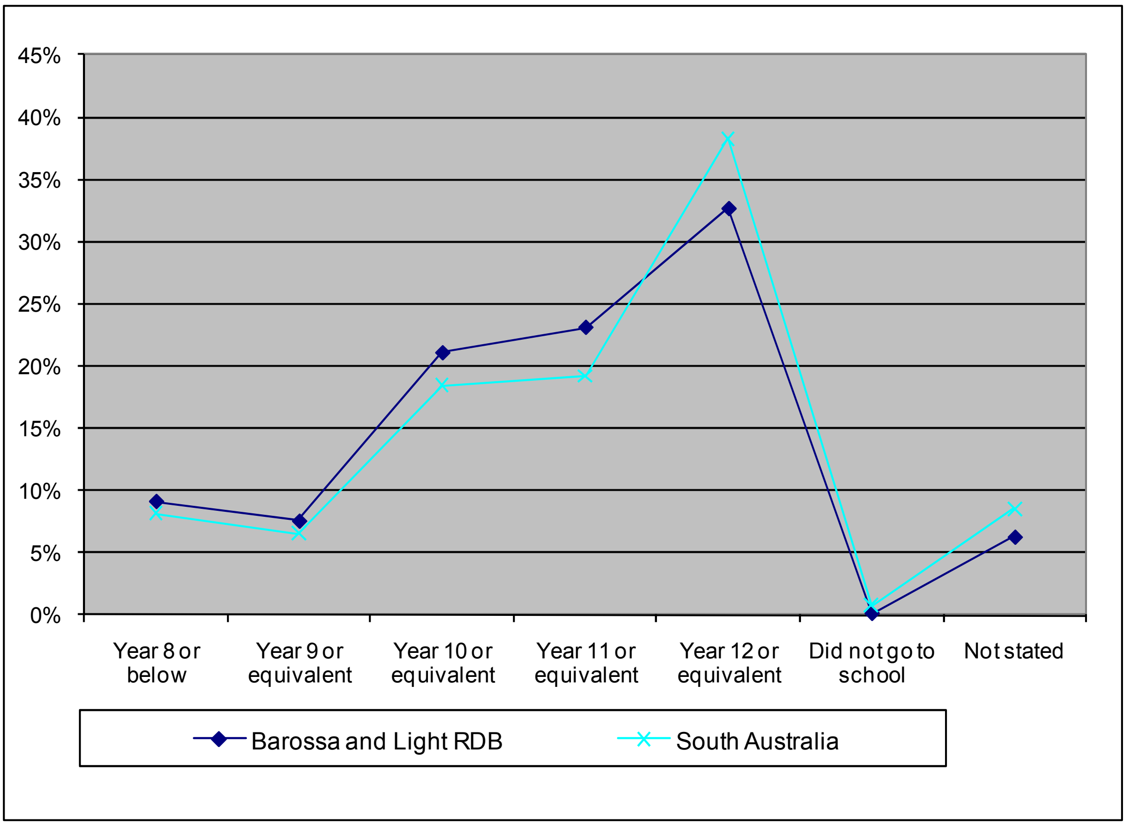
At the time of the most recent population census it was estimated that approximately 76 per cent of the jobs in the region were held by local residents, the balance by residents of other areas of SA, particularly those from the metropolitan area (15 per cent of total jobs). Approximately 68 per cent of employed residents were employed locally, with 28 per cent travelling to the metropolitan area for work.

## 2.2.2 Education Levels

There are small differences between the education levels of residents in the Barossa and Light RDB region when compared with those for South Australia as a whole. For example, at the time of the 2006 Census of Population and Housing:

- approximately 33 per cent of residents in the Barossa and Light RDB region had achieved year 12 or equivalent as the highest level of schooling compared with 38 per cent for SA (Figure 2.1); and
- approximately 20 per cent of residents in the Barossa and Light RDB region had been awarded a bachelor degree, graduate diploma or certificate or postgraduate degree compared with 27 per cent for SA (Figure 2.2).

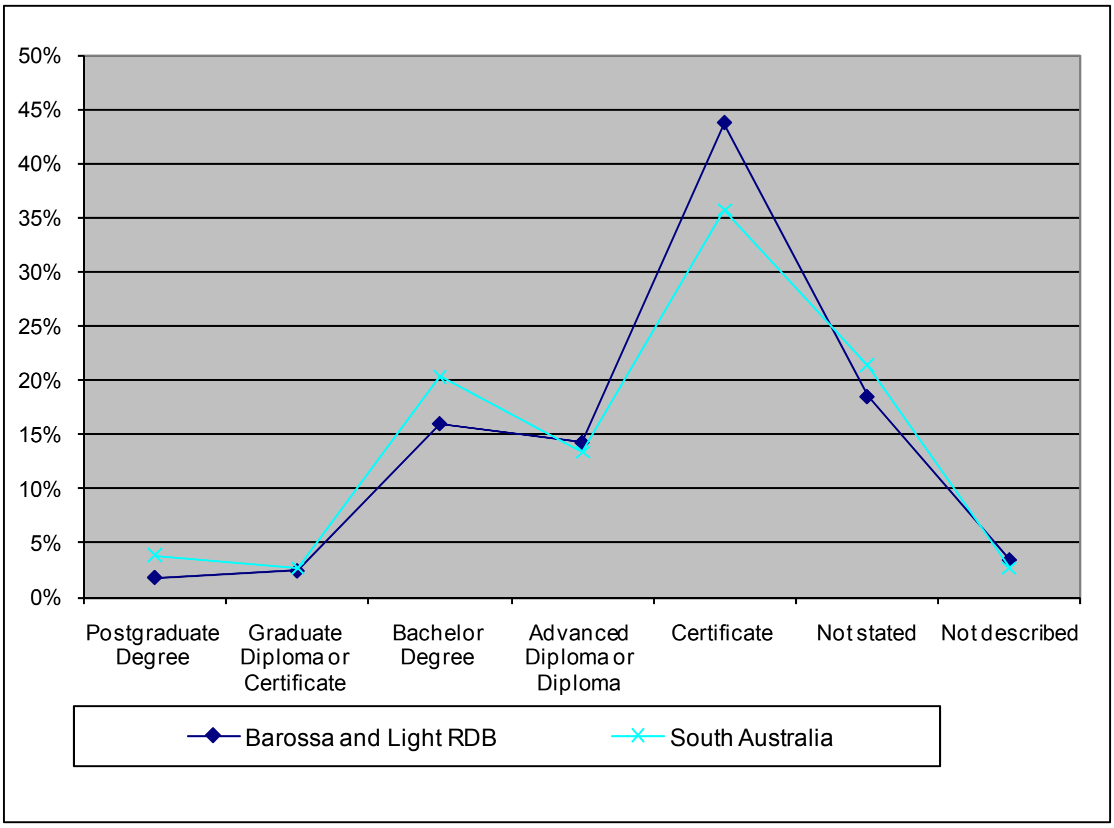
**Figure 2-1 Highest level of schooling completed, Barossa and Light RDB and SA, 2006 [a]**




[a] Based on place of usual residence. Persons aged 15 years and over.

Source: *2006 Census of Population and Housing* (ABS 2008a).

**Figure 2-2 Non-school qualification, Barossa and Light RDB and SA, 2006 [a]**




[a] Based on place of usual residence. Persons aged 15 years and over. Excludes persons with a qualification out of the scope of the Australian Standard Classification of Education.

Source: *2006 Census of Population and Housing* (ABS 2008a).

## 2.2.3 Employment and Income

An analysis of employment by occupation at the regional and state levels reveals some substantial differences. For example, the proportion of machinery drivers and labourers in the Barossa and Light RDB region (30 per cent) was substantially greater than for South Australia as a whole (19 per cent) in 2006 (Table 2.3). This is not, however, reflected in income levels, with the distribution of weekly individual incomes very similar for the region and South Australia (Figure 2.4).

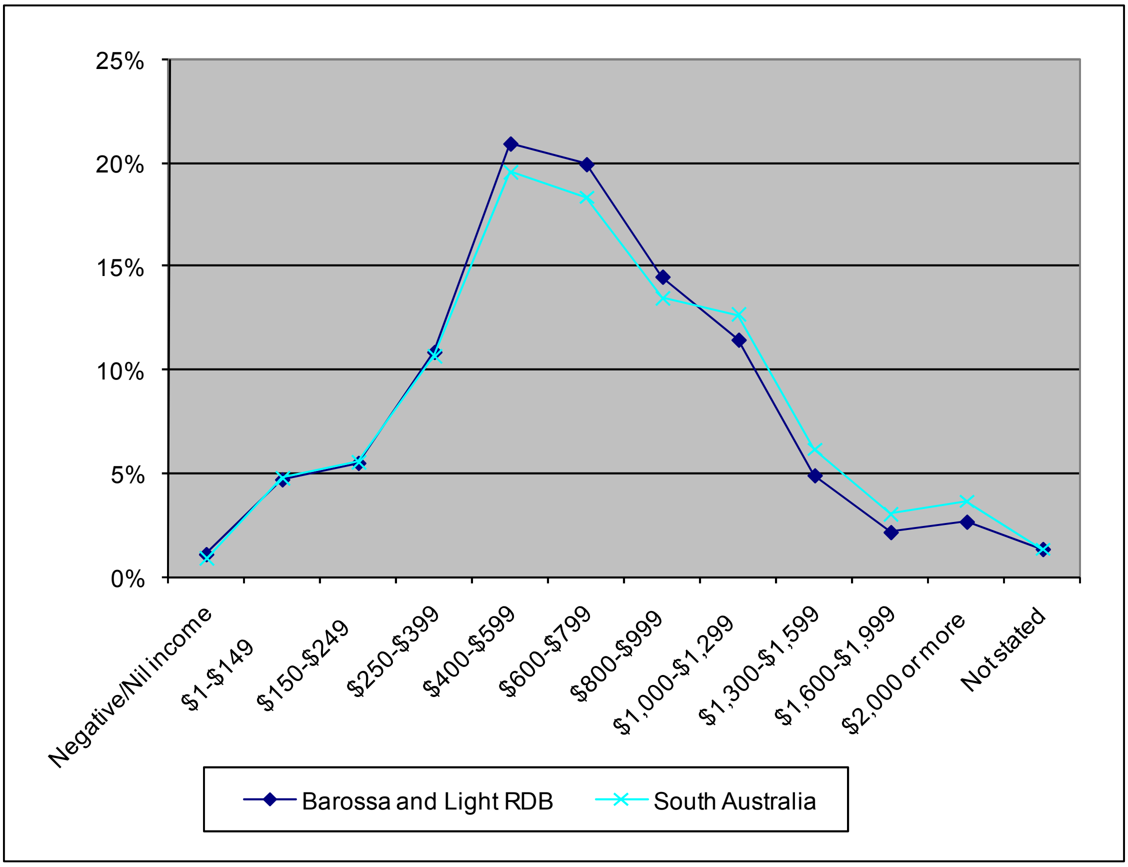
**Table 2.4 Employment by occupation, Barossa and Light RDB and SA, 2006 [a]**

| | Barossa and Light RDB | South Australia |
|---|---|---|
| Managers | 18.2% | 13.7% |
| Professionals | 12.9% | 18.9% |
| Technicians and Trade Workers | 14.0% | 14.1% |
| Community and Personal Service Workers | 7.0% | 9.4% |
| Clerical and Administrative | 11.1% | 14.9% |
| Sales Workers | 6.6% | 9.7% |
| Machinery Operators and Drivers | 7.8% | 6.3% |
| Labourers | 21.8% | 12.2% |
| Inadequately Described/Not Stated | 0.6% | 0.8% |

[a] Based on a person's place of work.

Source: *2006 Census of Population and Housing* (ABS 2008b).

**Figure 2-3 Weekly individual income, Barossa and Light RDB and SA, 2006 [a]**




[a] Based on a person's place of work.

Source: *2006 Census of Population and Housing* (ABS 2008b).

## 2.3 Detailed Profile of the Economic Structure of the Regional Economy

The detailed profile of the economic structure of the Barossa and Light economy for 2006/07 provided below is consistent with the method and data sources in a recent modelling exercise for the Department of Trade and Economic Development (EconSearch 2009a and 2009b). The profile has been prepared in terms of a 60-sector industry classification. Economic activity in the region and SA in 2006/07 is presented in terms of the following indicators:

- employment;
- output;
- household income;
- other value added;
- gross regional product (GRP);
- imports;
- tourism expenditure; and
- exports.

Employment is a measure of the number of working proprietors, managers, directors and other employees, in terms of the number of full-time equivalents and total (i.e. full-time and part-time) jobs. Employment is measured by place of remuneration rather than place of residence.

(Value of) Output is a measure of the gross revenue of goods and services produced by commercial organisations (e.g. farm-gate value of production) and gross expenditure by government agencies. Total output needs to be used with care as it includes elements of double counting (e.g. the value of winery output includes the farm-gate value of grapes) and overstates the real contribution to economic activity.

Household income is a component of Gross Regional Product (GRP) and is a measure of wages and salaries paid in cash and in kind, drawings by owner operators and other payments to labour including overtime payments, employer's superannuation contributions and income tax, but excluding payroll tax.

'Other value added' is another component of GRP and includes gross operating surplus (excluding the drawings of working proprietors) and all taxes, less subsidies.

Gross regional product is a measure of the net contribution of an activity to the regional economy. Gross regional product is measured as value of output less the cost of goods and services (including imports) used in producing the output. In other words, it can be measured as household income plus other value added (gross operating surplus and all taxes, less subsidies). It represents payments to the primary inputs of production (labour, capital and land).

Imports are a measure of the value of goods and services purchased by intermediate sectors and by components of final demand in the region/state of interest from other regions, interstate and overseas.

Tourism expenditure is a measure of the value of sales of goods and services to visitors to the state or region.

Exports (other) are a measure of the value of goods and services sold from the region/state of interest to consumers in other regions, interstate and overseas, net of sales to visitors to the region.

A breakdown of employment and value of output by sector for the Barossa and Light RDB region in 2006/07 is provided in Table 2.5.

The top five contributors to total employment in the region in 2006/07 were:

- wine (16.9 per cent);
- retail trade (10.8 per cent);
- health and community services (8.2 per cent);
- education trade (7.2 per cent); and
- viticulture (6.1 per cent).

The top five contributors to value of output in the region, $3.08b in 2006/07, were:

- wine (30.7 per cent);
- wholesale trade (5.2 per cent);
- ownership of dwellings (5.1 per cent);
- food products (3.8 per cent); and
- retail trade (3.7 per cent).

## Table 2.5 Employment and output, Barossa and Light RDB region and SA, 2006/07

| Sector | Total Employment | | Employment | | Value of Output | |
|---|---|---|---|---|---|---|
| | no. of jobs | % | fte | % | $m | % |
| Sheep | 228 | 1.4% | 252 | 1.7% | 20.6 | 0.7% |
| Grains | 261 | 1.7% | 275 | 1.8% | 17.4 | 0.6% |
| Beef cattle | 95 | 0.6% | 102 | 0.7% | 5.4 | 0.2% |
| Dairy cattle | 45 | 0.3% | 54 | 0.4% | 6.6 | 0.2% |
| Pigs | 96 | 0.6% | 100 | 0.7% | 33.5 | 1.1% |
| Poultry (meat) | 30 | 0.2% | 27 | 0.2% | 7.2 | 0.2% |
| Poultry (eggs) | 40 | 0.3% | 32 | 0.2% | 3.2 | 0.1% |
| Viticulture [a] | 956 | 6.1% | 967 | 6.5% | 95.0 | 3.1% |
| Vegetables | 48 | 0.3% | 51 | 0.3% | 11.2 | 0.4% |
| Fruit and nuts | 7 | 0.0% | 7 | 0.0% | 1.2 | 0.0% |
| Other agriculture | 126 | 0.8% | 142 | 0.9% | 16.4 | 0.5% |
| Services to agriculture | 146 | 0.9% | 148 | 1.0% | 24.1 | 0.8% |
| Forestry | 17 | 0.1% | 19 | 0.1% | 2.6 | 0.1% |
| Commercial fishing | 0 | 0.0% | 0 | 0.0% | 0.0 | 0.0% |
| Aquaculture | 0 | 0.0% | 0 | 0.0% | 0.0 | 0.0% |
| Coal, oil and gas | 0 | 0.0% | 0 | 0.0% | 0.0 | 0.0% |
| Iron ores | 0 | 0.0% | 0 | 0.0% | 0.0 | 0.0% |
| Non-ferrous metal ores | 6 | 0.0% | 9 | 0.1% | 5.2 | 0.2% |
| Other mining | 68 | 0.4% | 84 | 0.6% | 19.9 | 0.6% |
| Services to mining | 0 | 0.0% | 0 | 0.0% | 0.0 | 0.0% |
| Food products | 382 | 2.4% | 374 | 2.5% | 116.6 | 3.8% |
| Wine | 2,665 | 16.9% | 2,763 | 18.4% | 944.5 | 30.7% |
| Other beverages | 16 | 0.1% | 18 | 0.1% | 8.0 | 0.3% |
| Textiles, clothing and footwear | 4 | 0.0% | 3 | 0.0% | 0.2 | 0.0% |
| Sawmill and other wood products | 143 | 0.9% | 143 | 1.0% | 21.6 | 0.7% |
| Pulp, paper and paper products | 0 | 0.0% | 0 | 0.0% | 0.0 | 0.0% |
| Printing & services to printing | 87 | 0.5% | 84 | 0.6% | 17.3 | 0.6% |
| Publishing, recorded media, etc. | 54 | 0.3% | 36 | 0.2% | 5.8 | 0.2% |
| Petrochemical and other chemical | 151 | 1.0% | 161 | 1.1% | 56.3 | 1.8% |
| Non-metallic mineral products | 211 | 1.3% | 228 | 1.5% | 64.6 | 2.1% |
| Iron and steel | 55 | 0.4% | 57 | 0.4% | 19.2 | 0.6% |
| Basic non-ferrous metals and products | 157 | 1.0% | 160 | 1.1% | 95.5 | 3.1% |
| Metal products | 105 | 0.7% | 113 | 0.8% | 22.5 | 0.7% |
| Machinery and equipment | 286 | 1.8% | 297 | 2.0% | 60.8 | 2.0% |
| Other manufacturing | 68 | 0.4% | 65 | 0.4% | 11.2 | 0.4% |
| Electricity supply | 24 | 0.2% | 26 | 0.2% | 14.7 | 0.5% |
| Gas supply | 0 | 0.0% | 0 | 0.0% | 0.0 | 0.0% |
| Water supply, sewerage and drainage | 42 | 0.3% | 49 | 0.3% | 19.0 | 0.6% |
| Residential building | 169 | 1.1% | 174 | 1.2% | 81.7 | 2.7% |
| Other construction | 122 | 0.8% | 136 | 0.9% | 67.4 | 2.2% |
| Construction trade services | 509 | 3.2% | 527 | 3.5% | 75.1 | 2.4% |
| Wholesale trade | 860 | 5.5% | 895 | 6.0% | 160.3 | 5.2% |
| Retail trade | 1,700 | 10.8% | 1,418 | 9.5% | 114.9 | 3.7% |
| Accommodation, cafes & restaurants | 857 | 5.4% | 647 | 4.3% | 85.2 | 2.8% |
| Road transport | 543 | 3.4% | 616 | 4.1% | 109.2 | 3.5% |
| Other transport | 17 | 0.1% | 18 | 0.1% | 5.9 | 0.2% |
| Services to transport; storage | 79 | 0.5% | 85 | 0.6% | 29.5 | 1.0% |
| Communication services | 107 | 0.7% | 89 | 0.6% | 25.1 | 0.8% |
| Finance and insurance | 184 | 1.2% | 158 | 1.1% | 37.1 | 1.2% |
| Ownership of dwellings [b] | 0 | 0.0% | 0 | 0.0% | 155.7 | 5.1% |
| Other property services | 121 | 0.8% | 123 | 0.8% | 55.9 | 1.8% |
| Scientific research, technical and computer | 172 | 1.1% | 165 | 1.1% | 24.1 | 0.8% |
| Legal, accounting, marketing and business | 187 | 1.2% | 170 | 1.1% | 29.8 | 1.0% |

Table 2.5 continued over

| Sector | Total Employment | | Employment | | Value of Output | |
|---|---|---|---|---|---|---|
| | no. of jobs | % | fte | % | $m | % |
| Other business services | 318 | 2.0% | 240 | 1.6% | 36.3 | 1.2% |
| Government administration | 278 | 1.8% | 252 | 1.7% | 27.7 | 0.9% |
| Defence | 0 | 0.0% | 0 | 0.0% | 0.0 | 0.0% |
| Education | 1,139 | 7.2% | 1,070 | 7.1% | 80.2 | 2.6% |
| Health and community services | 1,284 | 8.2% | 964 | 6.4% | 73.0 | 2.4% |
| Cultural and recreational services | 177 | 1.1% | 149 | 1.0% | 35.7 | 1.2% |
| Personal services | 307 | 2.0% | 251 | 1.7% | 19.9 | 0.6% |
| Regional Total | 15,748 | 100.0% | 14,993 | 100.0% | 3,076.8 | 100.0% |
| SA [c] | 755,713 | | 694,966 | | 129,061.7 | |
| Proportion of SA | 2.1% | | 2.2% | | 2.4% | |

[a] The value of output estimate for the viticulture sector is a 5 year average for the period 2003/04 to 2007/08 in constant 2006/07 dollars. It was based on PGIBSA (2008 and previous issues). A five year average was used because the vintage of 2006/07 was severely impacted by a range of factors including drought, frost and water restrictions.

[b] The ownership of dwellings sector is a notional sector designed to impute a return to the region's housing stock. Total value of output in this sector is an estimate of rent earned on leased dwellings and imputed rent on the balance of owner-occupied dwellings.

[c] Sourced from DEWR (2007) and EconSearch (2009a).

A breakdown of gross regional product (GRP) by sector for the Barossa and Light RDB region in 2006/07 is summarised in Table 2.6. The top five contributors to GRP were:

- wine (23.6 per cent);
- ownership of dwellings (9.1 per cent);
- wholesale trade (4.7 per cent);
- viticulture (4.1 per cent); and
- education (4.1 per cent).

Total GRP ($1.53b) comprised 2.2 per cent of South Australia's GSP in 2006/07 ($68.33b) (Table 2.6).

**Table 2.6 Contribution to gross regional product, Barossa and Light RDB region and SA, 2006/07 [a]**

| Sector | Household Income | | Other Value Added | | Contribution to GRP | |
|---|---|---|---|---|---|---|
| | $m | % | $m | % | $m | % |
| Sheep | 7.4 | 1.0% | 4.3 | 0.7% | 11.7 | 0.8% |
| Grains | 8.1 | 1.1% | 2.7 | 0.4% | 10.8 | 0.7% |
| Beef cattle | 3.1 | 0.4% | 0.3 | 0.0% | 3.4 | 0.2% |
| Dairy cattle | 1.7 | 0.2% | 2.1 | 0.3% | 3.8 | 0.2% |
| Pigs | 2.0 | 0.3% | 15.1 | 2.3% | 17.1 | 1.1% |
| Poultry (meat) | 0.8 | 0.1% | 3.1 | 0.5% | 3.9 | 0.3% |
| Poultry (eggs) | 0.9 | 0.1% | 1.2 | 0.2% | 2.2 | 0.1% |
| Viticulture | 25.3 | 3.4% | 37.7 | 5.7% | 63.0 | 4.1% |
| Vegetables | 1.3 | 0.2% | 5.1 | 0.8% | 6.4 | 0.4% |
| Fruit and nuts | 0.2 | 0.0% | 0.5 | 0.1% | 0.7 | 0.0% |
| Other agriculture | 3.6 | 0.5% | 6.8 | 1.0% | 10.4 | 0.7% |
| Services to agriculture | 6.8 | 0.9% | 7.9 | 1.2% | 14.7 | 1.0% |
| Forestry | 0.8 | 0.1% | 0.6 | 0.1% | 1.4 | 0.1% |
| Commercial fishing | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Aquaculture | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Coal, oil and gas | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Iron ores | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Non-ferrous metal ores | 0.4 | 0.1% | 2.0 | 0.3% | 2.4 | 0.2% |
| Other mining | 4.0 | 0.5% | 8.0 | 1.2% | 12.0 | 0.8% |
| Services to mining | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Food products | 23.0 | 3.1% | 9.7 | 1.5% | 32.7 | 2.1% |
| Wine | 156.0 | 21.2% | 204.6 | 31.0% | 360.5 | 23.6% |
| Other beverages | 1.1 | 0.2% | 1.7 | 0.3% | 2.9 | 0.2% |
| Textiles, clothing and footwear | 0.1 | 0.0% | 0.0 | 0.0% | 0.1 | 0.0% |
| Sawmill and other wood products | 7.8 | 1.1% | 1.3 | 0.2% | 9.2 | 0.6% |
| Pulp, paper and paper products | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Printing & services to printing | 4.8 | 0.7% | 2.4 | 0.4% | 7.2 | 0.5% |
| Publishing, recorded media, etc. | 2.6 | 0.3% | 0.9 | 0.1% | 3.4 | 0.2% |
| Petrochemical and other chemical | 9.5 | 1.3% | 6.4 | 1.0% | 15.9 | 1.0% |
| Non-metallic mineral products | 14.4 | 2.0% | 6.4 | 1.0% | 20.7 | 1.4% |
| Iron and steel | 4.1 | 0.6% | 1.8 | 0.3% | 5.9 | 0.4% |
| Basic non-ferrous metals and products | 9.9 | 1.3% | 8.9 | 1.3% | 18.8 | 1.2% |
| Metal products | 6.7 | 0.9% | 1.7 | 0.3% | 8.4 | 0.6% |
| Machinery and equipment | 18.7 | 2.5% | 3.9 | 0.6% | 22.7 | 1.5% |
| Other manufacturing | 3.2 | 0.4% | 0.5 | 0.1% | 3.6 | 0.2% |
| Electricity supply | 2.1 | 0.3% | 5.1 | 0.8% | 7.2 | 0.5% |
| Gas supply | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Water supply, sewerage and drainage | 4.7 | 0.6% | 6.8 | 1.0% | 11.5 | 0.7% |
| Residential building | 13.0 | 1.8% | 9.6 | 1.4% | 22.5 | 1.5% |
| Other construction | 5.7 | 0.8% | 9.1 | 1.4% | 14.8 | 1.0% |
| Construction trade services | 26.6 | 3.6% | 4.1 | 0.6% | 30.7 | 2.0% |
| Wholesale trade | 46.8 | 6.4% | 24.9 | 3.8% | 71.8 | 4.7% |
| Retail trade | 42.8 | 5.8% | 15.8 | 2.4% | 58.6 | 3.8% |
| Accommodation, cafes & restaurants | 22.1 | 3.0% | 14.7 | 2.2% | 36.8 | 2.4% |
| Road transport | 31.4 | 4.3% | 16.1 | 2.4% | 47.5 | 3.1% |
| Other transport | 1.2 | 0.2% | 1.3 | 0.2% | 2.5 | 0.2% |
| Services to transport; storage | 5.0 | 0.7% | 7.1 | 1.1% | 12.1 | 0.8% |
| Communication services | 6.1 | 0.8% | 6.8 | 1.0% | 12.8 | 0.8% |
| Finance and insurance | 10.8 | 1.5% | 15.1 | 2.3% | 25.9 | 1.7% |
| Ownership of dwellings | 0.0 | 0.0% | 139.2 | 21.1% | 139.2 | 9.1% |
| Other property services | 9.7 | 1.3% | 15.2 | 2.3% | 24.9 | 1.6% |
| Scientific research, technical and computer | 11.4 | 1.6% | 1.5 | 0.2% | 12.9 | 0.8% |
| Legal, accounting, marketing and business | 14.0 | 1.9% | 1.1 | 0.2% | 15.1 | 1.0% |

| Sector | Household Income | | Other Value Added | | Contribution to GRP | |
|---|---|---|---|---|---|---|
| | $m | % | $m | % | $m | % |
| Other business services | 13.6 | 1.9% | 2.1 | 0.3% | 15.8 | 1.0% |
| Government administration | 13.1 | 1.8% | 2.1 | 0.3% | 15.2 | 1.0% |
| Defence | 0.0 | 0.0% | 0.0 | 0.0% | 0.0 | 0.0% |
| Education | 58.6 | 8.0% | 3.6 | 0.5% | 62.2 | 4.1% |
| Health and community services | 49.8 | 6.8% | 5.6 | 0.8% | 55.4 | 3.6% |
| Cultural and recreational services | 9.1 | 1.2% | 4.0 | 0.6% | 13.1 | 0.9% |
| Personal services | 11.2 | 1.5% | 1.0 | 0.1% | 12.1 | 0.8% |
| Intermediate total | 736.9 | 100.0% | 659.7 | 100.0% | 1,396.5 | 91.3% |
| Net Taxes in Final Demand [b] | - | - | - | - | 132.8 | 8.7% |
| Regional Total | 736.9 | 100.0% | 659.7 | 100.0% | 1,529.3 | 100.0% |
| SA [c] | 37,592.8 | | 24,892.5 | | 68,327.0 | |
| Proportion of SA | 2.0% | | 2.7% | | 2.2% | |

[a] Using the income method to derive gross regional product (GRP) enables GRP to be estimated on a sector-by-sector basis (household income and other value added are the two components of GRP).

[b] Includes net taxes (i.e. indirect taxes less subsidies) paid by households and other components of final demand.

[c] Gross state product was sourced from ABS (2008d). Household income and OVA were calculated by EconSearch (2009a).

A breakdown of the value of imports and exports by industry sector for the Barossa and Light RDB region in 2006/07 is provided in Tables 2.7 and 2.8, respectively. These data were derived from an input-output (I-O) model for the region, developed specifically for this project. Some of the key points to note from these data include:

- Expenditure by households accounted for approximately 27 per cent of the total value of goods and services imported into the region in 2006/07 from intrastate (i.e. other regions within SA), interstate and overseas (Table 2.7).
- Among the intermediate sectors, the top importers in the region in 2006/07 were the manufacturing (30 per cent), building and construction (5 per cent), wholesale trade (3 per cent) and transport and storage (3 per cent) sectors (Table 2.7).

**Table 2.7 Value of imports by industry, Barossa and Light RDB region, 2006/07 [a]**

| Sector | Imports | |
|---|---|---|
| | $m | % |
| Agriculture, forestry and fishing | 46 | 2.7% |
| Mining | 6 | 0.4% |
| Manufacturing | 516 | 30.3% |
| Electricity, gas and water | 10 | 0.6% |
| Building and construction | 79 | 4.7% |
| Wholesale trade | 55 | 3.2% |
| Retail trade | 32 | 1.9% |
| Accommodation, cafes & restaurants | 24 | 1.4% |
| Transport and storage | 52 | 3.1% |
| Communication services | 7 | 0.4% |
| Finance and insurance | 9 | 0.5% |
| Ownership of dwellings | 2 | 0.1% |
| Property and business services | 48 | 2.8% |
| Public administration and defence | 8 | 0.5% |
| Education | 11 | 0.6% |
| Health and community services | 12 | 0.7% |
| Cultural and recreational services | 14 | 0.8% |
| Personal services | 5 | 0.3% |
| Intermediate total | 936 | 54.9% |
| Household expenditure | 452 | 26.5% |
| Government expenditure | 110 | 6.4% |
| Gross fixed capital formation | 106 | 6.2% |
| Tourism expenditure | 53 | 3.1% |
| Re-exports | 50 | 2.9% |
| Total | 1,706 | 100.0% |

[a] Includes intrastate (i.e. interregional), interstate and international imports of goods and services.

Source: EconSearch analysis

Expenditure by tourists ($179m) contributed approximately 11 per cent of the total value of exports from the region in 2006/07. The balance (i.e. 'other exports'), $1.4b, represents the value of goods and services purchased by consumers (i.e. households, businesses, governments, etc.) in other regions within SA, interstate and internationally (Table 2.8).

Total regional expenditure by tourists ($179m) comprised 4.4 per cent of the SA total in 2006/07 ($4.01b) (EconSearch 2009a).

The top contributors to the value of 'other exports' from the region in 2006/07 were the manufacturing sector (84 per cent) and agriculture, forestry and fishing (6 per cent) sectors (Table 2.8).

The trade balance (i.e. exports less imports) in the Barossa and Light RDB region in 2006/07 was approximately -$131m.

On the basis that intrastate exports as a proportion of total exports for the Barossa and Light RDB region approximates that for all SA regions (i.e. 41 per cent in 2006/07 (EconSearch 2009a)) total interstate and international exports from the region in 2006/07 were approximately $645m. This comprised 2.4 per cent of the SA total ($27.4b) (EconSearch 2009a).

**Table 2.8 Value of exports by industry, Barossa and Light RDB region, 2006/07 [a]**

| Sector | Tourism expenditure | | Other exports | | Total exports | |
|---|---|---|---|---|---|---|
| | $m | % | $m | % | $m | % |
| Agriculture, forestry and fishing | 0 | 0.0% | 78 | 5.6% | 78 | 5.0% |
| Mining | 0 | 0.0% | 17 | 1.2% | 17 | 1.1% |
| Manufacturing | 22 | 12.2% | 1,170 | 83.8% | 1,192 | 75.7% |
| Electricity, gas and water | 0 | 0.0% | 4 | 0.3% | 4 | 0.3% |
| Building and construction | 0 | 0.0% | 10 | 0.7% | 10 | 0.6% |
| Wholesale trade | 7 | 3.8% | 0 | 0.0% | 7 | 0.4% |
| Retail trade | 30 | 16.6% | 0 | 0.0% | 30 | 1.9% |
| Accommodation, cafes & restaurants | 22 | 12.1% | 0 | 0.0% | 22 | 1.4% |
| Transport and storage | 7 | 4.0% | 28 | 2.0% | 36 | 2.3% |
| Communication services | 0 | 0.0% | 6 | 0.4% | 6 | 0.4% |
| Finance and insurance | 0 | 0.0% | 4 | 0.3% | 4 | 0.3% |
| Ownership of dwellings | 6 | 3.6% | 0 | 0.0% | 6 | 0.4% |
| Property and business services | 1 | 0.6% | 22 | 1.6% | 23 | 1.5% |
| Public administration and defence | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Education | 0 | 0.1% | 0 | 0.0% | 0 | 0.0% |
| Health and community services | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Cultural and recreational services | 7 | 4.0% | 0 | 0.0% | 7 | 0.5% |
| Personal services | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Intermediate total | 102 | 57.1% | 1,341 | 96.1% | 1,443 | 91.6% |
| Net taxes in final demand [b] | 24 | 13.5% | 5 | 0.4% | 30 | 1.9% |
| Re-exports | 53 | 29.5% | 50 | 3.6% | 102 | 6.5% |
| Regional Total | 179 | 100.0% | 1,396 | 100.0% | 1,575 | 100.0% |

[a] Includes intrastate (i.e. interregional), interstate and international exports of goods and services.

[b] Taxes less subsidies on products and production paid by tourists and other exporters.

Source: EconSearch analysis.

## 2.4 Wine and Viticulture Industries

The Barossa and Light Region has a number of well established industries that are fundamental to South Australian economic performance. Principal amongst them is the wine and viticulture industries, a nationally and world renowned brand.

### 2.4.1 Economic Contribution of the Wine Industry to the Regional Economy

It is clear that the wine industry makes a significant economic contribution to the Barossa and Light RDB region. However, estimates of employment, value of output and gross regional product for the regional wine and viticulture sectors, as presented in the previous section of the report, do not take account of the flow-on or indirect effects of these activities.

To illustrate this, consider the example of a vineyard that, in the course of its operation, purchases goods and services from other sectors. These goods and services would include fuel, chemicals and, of course, labour. Suppliers and employees, in turn, engage in further expenditure, and so on. These flow-on or indirect effects are part of the impact of the vineyard on the regional economy. They must be added to the direct effects (which are expenditures made in immediate support of the vineyard itself) in order to arrive at a measure of the total impact of the vineyard.

The flow-on effects of the wine industry in the Barossa and Light RDB region have been estimated using Input-Output (I-O) analysis. A regional I-O model for the region for 2006/07 was prepared specifically for this project, consistent with the method and data sources in EconSearch (2009a and 2009b).

Estimates of regional economic impact or economic contribution of the wine industry are presented in terms of

- direct impacts;
- flow-on (or indirect) impacts; and
- total impacts.

Direct impacts are the initial round of output, employment and household income generated by an economic activity. Estimates of the direct economic impact of the wine industry in the Barossa and Light RDB region are consistent with the method employed in PIRSA's Regional Scorecards value-chain analysis, 2006/07. The following stages in the marketing chain have, therefore, been included in the quantifiable economic impact:

- the direct value of output of the viticulture and wine sectors; and
- downstream impacts, including the net value of local retail and food service (e.g. hotels & restaurants) trade.

Estimates of the net value of local retail and food service trade margins were derived from PIRSA's Regional Scorecards value-chain analysis (PIRSA Corporate Strategy, pers. comm.).

Flow-on (or indirect) impacts are the sum of production-induced effects and consumption-induced effects. Production-induced effects are additional output, employment and household income resulting from re-spending by firms (e.g. spraying contractors) that receive payments from the sale of goods and services to firms undertaking, for example, wine grape production. Consumption-induced effects are additional output, employment and household income resulting from re-spending by households that receive income from employment in direct and indirect activities.

Total impacts are the sum of direct and flow-on impacts.

Estimates of the total (direct plus flow-on) regional economic impact of the wine industry on the Barossa and Light RDB regional economy in 2006/07 are provided in Table 2.9. The direct impact measures wine industry (i.e. viticulture and wine) and downstream activities (i.e. retail/food services). The flow-on impact measures the economic effects in other sectors of the economy (trade, transport, manufacturing, etc.) generated by the wine industry activity, that is, the multiplier effect.

### (a) Value of output

The value of output generated directly in the regional economy from wine industry activities (i.e. viticulture and wine) was estimated to be approximately $1,040 million in 2006/07 (Table 2.8), while output generated in the region by associated downstream activities (i.e. retail/food services) summed to $11 million.

It is important to note that, given the vintage of 2006/07 was severely impacted by a range of factors (e.g. drought, frost and water restrictions), the value of output estimate calculated for the viticulture sector is a 5 year average for the period 2003/04 to 2007/08 in constant 2006/07 dollars (PGIBSA (2008) and previous issues).

### (b) Gross regional product.

As noted above, GRP is measured as value of output less the cost of goods and services (including imports) used in producing the output. In 2006/07, total GRP in the Barossa and Light RDB region attributable to the wine industry was approximately $631 million, $63 million generated by viticulture directly, $361 million generated by the wine sector directly, $5 million generated by downstream activities and $202 million generated in other sectors of the regional economy. Total GRP attributable to the wine industry represented 41 per cent of the regional total.

### (c) Employment

The wine industry (i.e. viticulture and wine) was responsible for the direct employment of around 3,730 full-time equivalents (fte) and downstream activities created employment for a further 113 fte in the region in 2006/07. Flow-on business activity was estimated to generate a further 2,253 fte jobs. These jobs were concentrated in the trade (709 fte), other manufacturing (250), business services (233), transport (202) and accommodation, restaurants and cafes sectors (170). The total employment impact generated by wine industry activities in the Barossa and Light RDB region in 2006/07 was estimated to be almost 6,100 fte jobs, which represented 41 per cent of the regional total.

**Table 2.9 The direct and indirect impact of the wine industry on the Barossa and Light RDB regional economy, 2006/07**

| | Value of Output [a] | GRP | Employment | Household Income |
|---|---|---|---|---|
| | $m | $m | fte | $m |
| **Direct Impact** | | | | |
| Viticulture [b] | 95 | 63 | 967 | 25 |
| Wine | 945 | 361 | 2,763 | 156 |
| Retail | 6 | 3 | 75 | 2 |
| Food Services | 5 | 2 | 37 | 1 |
| **Total Direct Impact** | **1,051** | **429** | **3,843** | **185** |
| **Flow-on Impact** | | | | |
| Trade | | 42 | 709 | 28 |
| Transport | | 18 | 202 | 11 |
| Business services | | 20 | 233 | 16 |
| Other manufacturing | | 22 | 250 | 15 |
| Accommodation, restaurants and cafes | | 18 | 170 | 11 |
| Ownership of dwellings | | 41 | - | - |
| Other sectors | | 42 | 689 | 26 |
| **Total Flow-on Impact** | | **202** | **2,253** | **107** |
| **Total Impact** | | **631** | **6,096** | **292** |
| Regional total [c] | | 1,529 | 14,993 | 737 |
| Proportion of regional total | | 41% | 41% | 40% |

[a] Flow-on (indirect) and total output impacts are not reported as there are problems with double counting which can give a misleading impression of the significance of individual industries. For example, the value of wine grapes processed locally is included in both the wine and viticulture sectors. If the two values were added together the farm-gate value of wine grapes would be included twice.

[b] The value of output estimate for the viticulture sector is a 5 year average for the period 2003/04 to 2007/08 in constant 2006/07 dollars. It was based on PGIBSA (2008 and previous issues). The vintage of 2006/07 was severely impacted by a range of factors (e.g. drought, frost and water restrictions).

[c] See Tables 2.5 and 2.6.

Source: EconSearch analysis.

### (d) Household income

Household income of approximately $25 million was earned in the viticulture sector (wages of employees and estimated drawings by owner/operators), $156 million in the wine sector and approximately $4 million in downstream activities in the Barossa and Light RDB region in 2006/07. An additional $107 million was earned by wage earners in other businesses in the region as a result of wine industry and associated downstream activities. The total household income impact was approximately $740 million in 2006/07, which represented 40 per cent of the regional total.

## 2.4.2 Growth Projections for the Wine Industry

The Barossa and Light Wine Industry Impact Review (2004) demonstrated that in 2001, 341,100 tonnes of grapes were crushed or processed in the region, with just 55,920 tonnes of these grown locally. More than 156,000 tonnes of juice and 128,544 tonnes of grapes from other regions were brought into the Barossa for processing. It was predicted that by 2011, 601,600 tonnes of grapes will be crushed or processed in the region, an increase of 76% over 10 years. Locally grown grapes were anticipated to account for over 80,000 tonnes, while approximately 500,000 tonnes of grapes and juice from other regions will be brought into the Barossa for processing.

In 2006 the Barossa produced 92,351 tonnes with a farm gate value of $89.8M. In the 10 year period 1997-2006, Barossa grape production grew 60% from 57,983 to 92,351 tonnes. This level of production accounted for 11% of total South Australian production and around 4% of total Australian production.

For the Barossa Valley region it is anticipated that the estimated supply of wine grapes will increase by 0.2 per cent between the 2009 and 2013 vintages. The local wineries' committed intake, however, is anticipated to decrease by almost 21 per cent over this period. At the state level, winery demand (i.e. required intake) is expected to increase by approximately 8 per cent over the period 2009 to 2013.

An estimated 74 per cent of wine grape growers in the Barossa region expect no considerable change in their level of involvement in the industry (ABS 2008). The proportion of those who were expecting to spend more time earning non-agricultural income or planning semi-retirement is each estimated to have been around 9 per cent. The estimated proportion planning to be involved in the industry to a greater extent was just 4 per cent. An estimated 3 per cent expected to retire in the next five years.

In summary, little if any growth is expected in the wine industry in the Barossa and Light RDB region in the short to medium term. Wine grape supply is likely to remain relatively constant (subject to the vagaries of weather, etc.) whilst significant uncertainty is associated with regional winery intake volumes. Future growth in the industry could be constrained by a number of factors including:

- access to good quality, reliable supplies of irrigation water;
- the availability of suitable land for viticulture; and
- domestic and export market considerations.

Vision 2045 asserted the difficulty in predicting the growth in grape production. A prediction was based on market share, equating to a 72% increase for each 15 year period between 1996 and 2045. Applying similar principles and growth figures for the last 10 years supplied by Wine Barossa and the Phylloxera and Grape Industry Board, growth predictions for grape production in the area equate to a 60% increase every 10 years, a total production at 2045 of approximately 252,000 tonnes. This figure seems too optimistically high based on the short to medium term predictions of growth, the increasing move towards premium wine varieties, diversification of industry types within the region and land availability.

The shift towards pursuing increased share of the premium wine sector may curtail growth significantly below that estimated above. A 0.2% increase is anticipated between 2009 and 2013 (Barossa and Light regional Development Board 2007). Extrapolating that growth projection out to 2045, the total production at 2045 would equate to approximately up to 100,000 tonnes.

## 2.5 Tourism Industry

The tourism industry plays a large role in the economic activities of the region. Expenditure by tourists totalling $179million contributed approximately 11 per cent of the total value of exports from the region in 2006/07. This is a significant increase from the $40million indicated in Vision 2045. In 2007, the Barossa region attracted an estimated 246,000 overnight visitors that stayed 754,000 nights in the region. The Barossa attracted a higher proportion of its visitor nights (48%) from interstate than any other region in the state. On average, overnight visitors to the region stayed 3.1 nights (Tourism Research Australia 2008a). Length of stay varied from two nights for intrastate visitors to four nights for interstate visitors and 8.2 nights for international visitors. Domestic same-day visitors contributed 927,000 additional visits to the region (Tourism Research Australia 2008a). The majority (72%) were Adelaide residents. Spending by domestic overnight visitors in 2007 was estimated to be $105 million; an average of $165 per visitor night. Domestic day trip visitors spent an estimated $72 million; an average of $78 per visit (Tourism Research Australia 2008a).

The 2008 Barossa Tourism Profile demonstrates that forty-one percent of visitors to the Barossa visited a winery which is the highest proportion of any SA region in this sector, reflecting the region's strong branding as a premier food and wine tourism destination. The bi-annual Barossa Vintage Festival injects an additional 100,000 people into the region. There is also a growing trend towards the provision of food at cellar doors, a growth industry that will contribute to the increasing numbers of tourists that are attracted to the region.

# 3. Water Resource Description

## 3.1 Surface Water Resources

The Barossa and Light region is physically diverse, with the highly elevated Mount Lofty and Barossa Ranges dominating the South-East of the region and the gently sloping plains of the North West. The mean annual rainfall is approximately 520 mm but rainfall varies significantly across the region, with the upper reaches of the Light catchment experiencing less than 480 mm per annum and the highland region near Mt Adam above 680 mm per annum. The elevated Ranges are generally seen as being the principle source of water in the region, with the Valley Floor and Light areas relatively less (Pikusa 2002).

The Light River, North Para and South Para catchments are the principal hydrological surface water regions within the Barossa and Light (Figure 3.1). The area has been extensively cleared, significantly altering the hydrology and water balance with increased runoff and recharge. Moreover, significant development of water storages have contributed to this altered hydrological regime. There are three major reservoirs within the study region, the South Para (capacity 45,000 ML), Barossa (capacity 4,500 ML) and Warren (capacity 4, 800 ML) Reservoirs. The Warren provides contingency supply to the South Para. The South Para supplies water to the Barossa Reservoir via a diversion weir. Owned and operated by SA Water, the reservoirs supply reticulated water to metropolitan Adelaide, the Barossa and Light region and Yorke Peninsula.

The development of storages escalated in the 1970's, with the growth of the viticulture industry. There was an estimated 10 fold increase in the number of farm dams used for irrigation in the twenty years from 1970 (Philpott *et al* 1999). Cresswell (1991) found that surface water flows within the North Para River above Yaldara had decreased by approximately 20% as a result of increased water use associated with farm dams.

To redress this situation, the Barossa Prescribed Water Resources Area (1998) and the Greenock Creek Catchment (2005), which includes all the watercourses and surface waters within these defined areas were prescribed under the *Water Resources Act 1997*, now the *Natural Resources Management Act 2004*. Water resources in the Western Mount Lofty Ranges, incorporating the South Para catchment, were recently prescribed (2009). As a result, the Adelaide and Mount Lofty Natural Resources Management Board is now working with the community to develop a water allocation plan for this region.

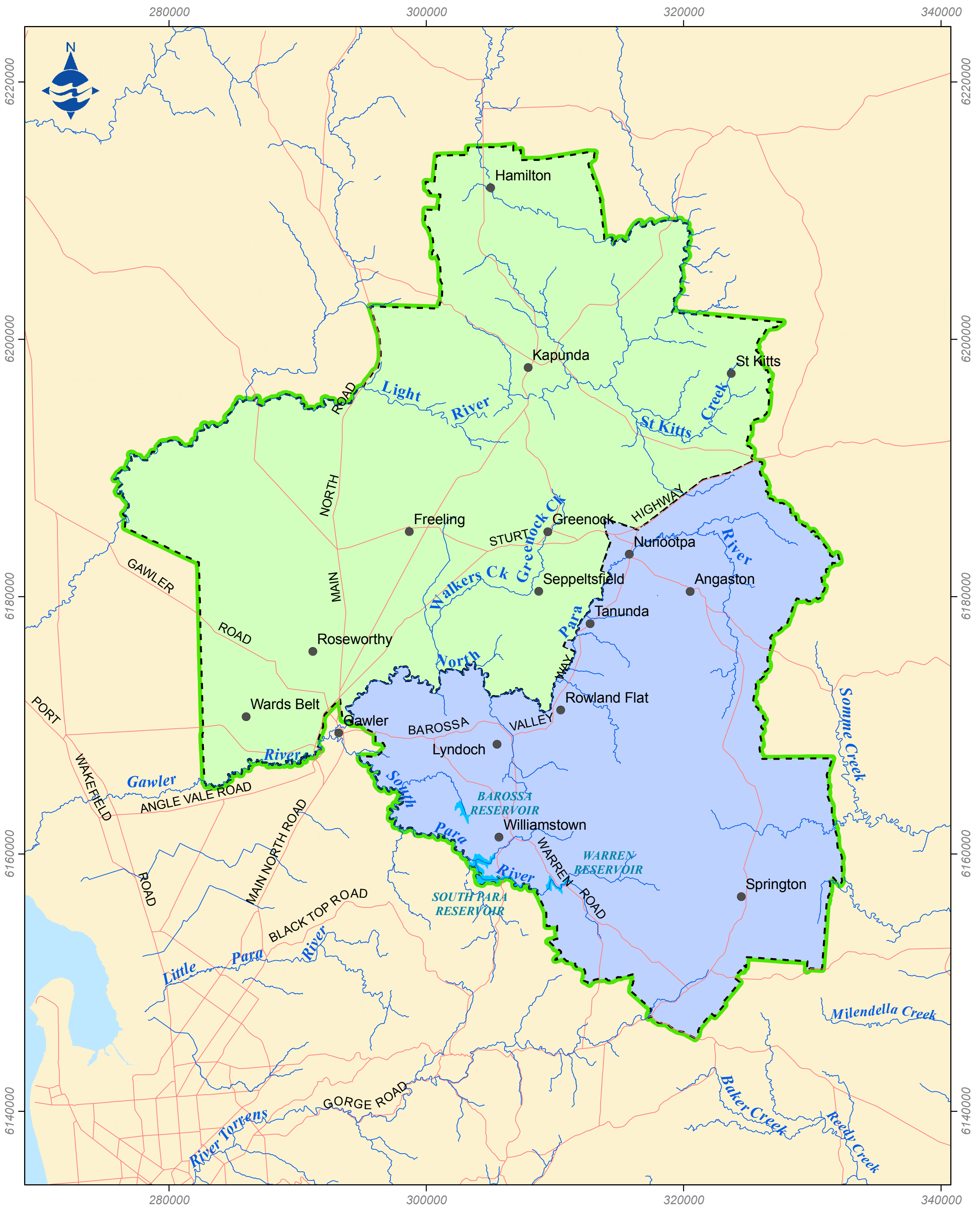
For the purpose of reviewing current and future water use, the region was split into six management zones, corresponding with defined hydrological catchments and incorporating the four surface and watercourse management zones detailed within the Barossa Prescribed Water Resources Area Water Allocation Plan (2009) (Figure 3.2). The mean annual flow for each water management zone was calculated based on the stream flow gauging stations operated by the Department of Water, Land and Biodiversity Conservation (DWLBC) and accounted for the flow captured by farm dams (Table 3.1).

**Table 3.1 Water Management Zones for the Barossa and Light region (all available record).**

| Management Zone | Mean Annual Discharge (ML/annum) | Median Annual Discharge (ML/annum) |
|---|---|---|
| Greenock Creek | 220 | 95 |
| Valley Floor | 11,580 | 7,360 |
| Jacob and Tanunda Creek | 8,100 | 6,800 |
| Flaxman Valley | 2,425 | 1,870 |
| South Para | 14,670 | N/A |
| Light River | 7,000 | 3,800 |

When considering the available (entire) flow record, the South Para, Jacob Creek, Tanunda Creek and the Flaxman Valley are the highest contributors of surface water in the region on a per area basis. This relates to the higher average rainfall in those regions and corresponds with those findings of Pikusa (2002). There has been a significant decrease in the annual discharge at all gauging stations over the period 2002 – 2007 in comparison to the entire record. Whilst previous studies have indicated elevated annual volumes in comparison to Table 3.1, they have generally incorporated data only until the late 1990's. In contrast, Table 3.1 incorporates data during the prolonged drought period of the last few years. The decrease in flow has placed stress on all users of the system.

The data itself needs to be treated with caution as the data quality varied dramatically within and between gauging sites. Appendix A presents the water management zone volume analysis in detail.





**LEGEND**

- Towns
- Main Roads
- Major Watercourse (Stream order 4 or more)
- Barossa LGA
- Light LGA
- Study Boundary
- Reservoir

0 10 20
Kilometers

Australian WATER Environments

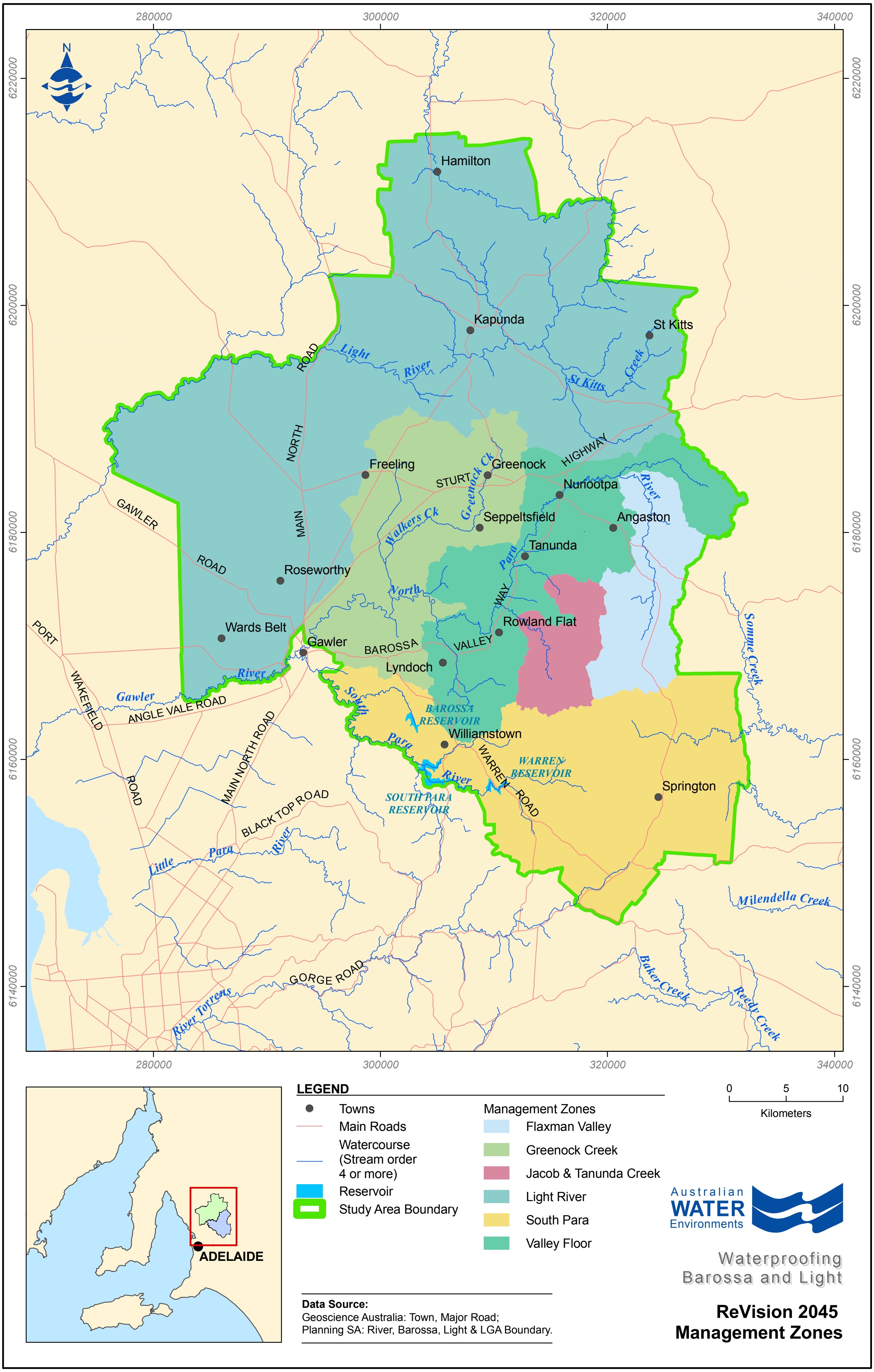
Waterproofing Barossa and Light

**Data Source:**
Geoscience Australia: Town, Major Road;
Planning SA: River, Barossa, Light & LGA Boundary.

**ReVision 2045**
**Surface Water Resources**

Job No. 47972 - 010
090911

Figure 3.1




Waterproofing Barossa and Light

**ReVision 2045 Management Zones**

Job No. 47972 - 012
090911

Figure 3.2

# 3.2 Surface Water Quality

Salinity is viewed as the principal water quality issue within the Barossa and Light region for a range of environmental values. Principal amongst these is the impact on ecological health and use for irrigation purposes. A number of other water quality analytes are of concern, including nutrients and turbidity derived from diffuse sources of pollution, *Cryptosporidium* and *Giardia* from wastewater recycle, pesticides and herbicides from agricultural use and stock access to watercourses and potassium derived from winery effluent recycle.

**Table 3.2 Mean Salinity (EC) for each Water Management Zone**

| Management Zone | Mean Salinity (EC uS/cm) | Median Salinity (EC uS/cm) |
|---|---|---|
| Greenock Creek | 5074 | 4606 |
| Valley Floor | 3706 | 3900 |
| Jacob and Tanunda Creek | 1266 | 1204 |
| Flaxman Valley | 2826 | 2869 |
| South Para | 1010 | N/A |
| Light River | 10485 | 11003 |

Salinity concentrations and loads is dependent upon a range of climatic, physical and chemical parameters including rainfall, evaporation, flow, groundwater/surface water interactions, amongst others. Salinity within each management zone differs markedly at various spatial and temporal extents. The flow weighted salinity data (where available) indicates that the Light River management zones present marginal water quality at the times of the year when low flow occurs (Table 3.2). Similarly, Greenock Creek has elevated salinity levels that could prevent long term irrigation on high value crops. Testing conducted by private enterprise within Jacobs Creek and Tanunda Creek indicates a better salinity profile – supporting the case for more frequent and rigorous sampling.

With respect to ongoing use of the water resource, the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (2000) advises that to assess the salinity and sodicity of water for irrigation use, a number of interactive factors must be considered. These include irrigation water quality, soil properties, plant salt tolerance, climate, landscape (including geological and hydrological features), and water and soil management. Consequently a more detailed investigation is required to determine flow weighted salinity outcomes for more discrete spatial zones within the region linked to key environmental values of the region (including irrigation, ecosystem etc).

The data itself needs to be treated with caution as the data quality varied dramatically within and between gauging sites. Appendix B presents the outcomes of the water quality data analysis, including data quality in detail.

## 3.3 Ground Water

The dominant groundwater aquifers within the Barossa Valley region can be grouped as the Fractured Rock aquifer (composed predominantly of Pre-Cambrian and Paleozoic sandstones, siltstones and schist), Lower Aquifer (composed of Tertiary carbonaceous clays, gravels, sands and silts) and the Upper Aquifer (composed of all the sediments overlying the Lower Aquifer which include Tertiary non-carbonaceous sands, Quaternary non-continuous sands and gravels and Holocene gravels and sands) (Figure 3.3).

The water level and salinity trends within each of three aquifers are regularly monitored via a network of government observation bores. Currently 94 bores throughout the region are monitored for water level and 67 bores are monitored for salinity.

A review of the current groundwater trends of the three aquifers was undertaken in 2002 by the Department of Water Land and Biodiversity Conservation (DWLBC 2002).

For the Fractured Rock Aquifer there is a general regional downward trend in groundwater level. This is consistent with below average rainfall over the monitored period from 1990 to 2002. An exception to this trend is in the region around Tanunda where a slight increasing trend is observed and is possibly related to a reduction in groundwater extraction due to the introduction of external water sources.

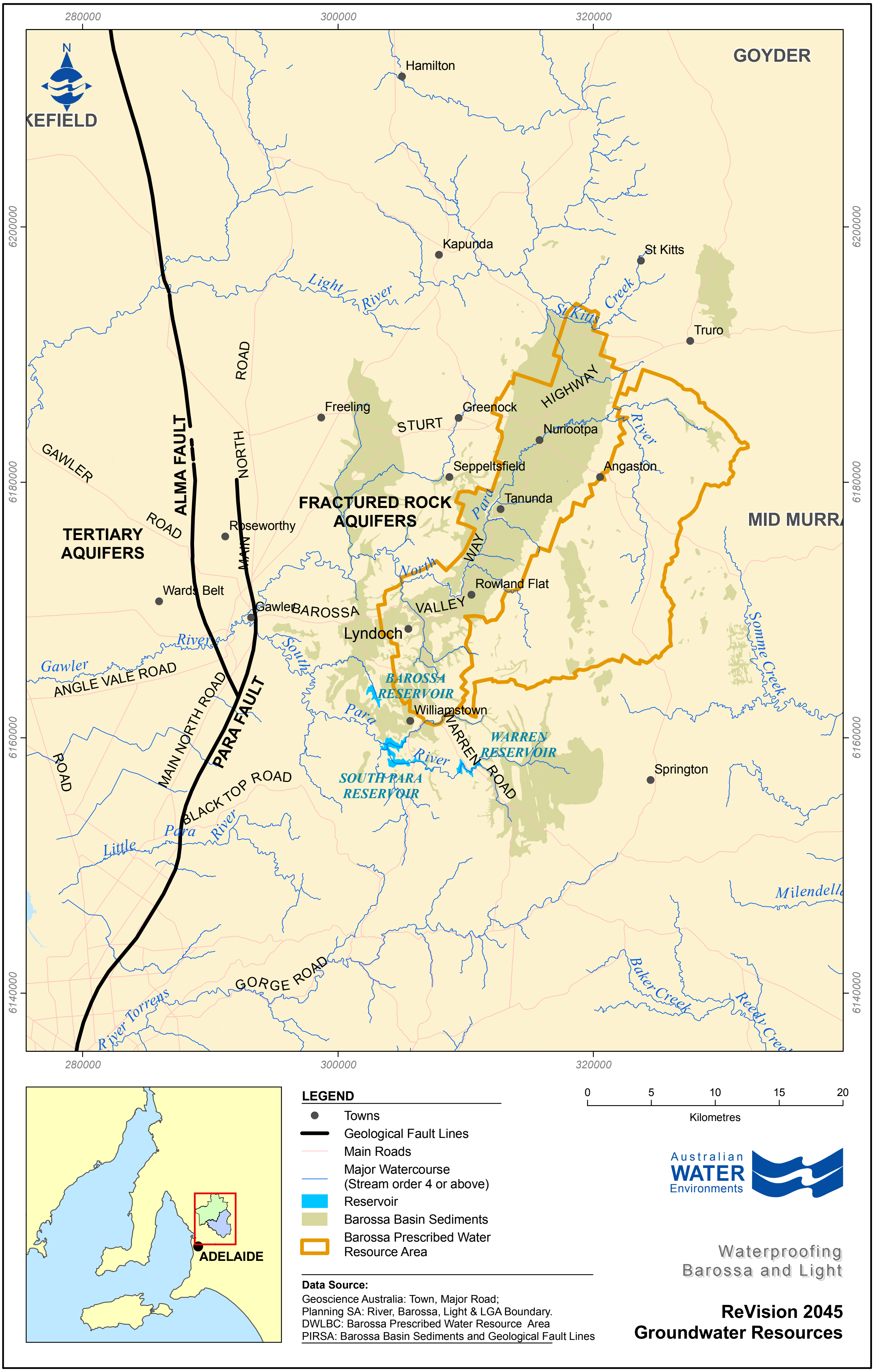
The long term monitoring of the Lower Aquifer also displays a decreasing trend in groundwater levels similar to that observed in the Fractured Rock aquifer. Seasonal fluctuations are observed in the Lower Aquifer most likely associated with the narrowness of the basin.

Decreasing trends in groundwater levels are also observed in the Upper Aquifer, however seasonal fluctuations are not as strong.

Salinity trends in the Fractured Rock Aquifer are variable due to recharge patterns and groundwater flow direction. Salinities can range from 250 mg/L to 3500 mg/L. Generally there is very little change in the overall salinity trends of the Fractured Rock Aquifer with only a few bores (for example 6628-4788 and 6628-15183) showing an increase in salinity.

While the average salinity is generally higher in the Upper Aquifer, the salinity trends in both the Upper and Lower Aquifer are generally stable.

It is generally considered that Eden Valley has a greater water stress than that within the Barossa Valley Floor, given that there is no BIL or supplementary sources other than bores.




Job No. 47972 - 014
090914

Figure 3.3

# 3.4 Basin Transfers

The natural water resources of the region are supplemented by importing water through reticulated water supply networks. There are three potable supplies owned and operated by SA Water and a non-potable irrigation supply owned by BIL. The majority (95%) of the imported water originates from the River Murray. Supplies are outlined below.

The SA Water networks are integrated systems covering much of SA and the supplies that service Barossa and Light also feed other regions. The majority of potable water imported to the Barossa and Light region comes from the River Murray with some 85% supplied via a pipeline from Swan Reach. There is a pumping station and treatment on the River Murray some 10 km north of Swan Reach. A pipeline runs due west to storages tanks at Moculta, in the Mount Lofty Ranges east of the Barossa Valley. The pipeline skirts the northern edge of the Barossa Valley and continues westward to supply the Yorke Peninsula. BIL generally receives its water from the Mannum pipeline, although in 2009 it was from Swan Reach.

A small treatment plant at Mount Pleasant treats water from the Mannum-Adelaide pipeline and supplies water into Barossa and Light through a pipeline that goes north from Mount Pleasant to Springton and Eden Valley. This supply accounts for some 3% of the imported potable water.

The Morgan –Whyalla Pipeline and associated treatment plant at Morgan primarily supply the mid-north and Upper Spencer Gulf regions, to the north of the Barossa and Light. In 2005 a new branch main was constructed from the Morgan-Whyalla pipeline to service the Clare Valley and was extended past Auburn to connect with the pipeline from Swan Reach to augment supply to Yorke Peninsula. The new connection relieved some of the demand on the Swan Reach pipeline and made more capacity available for use in the Barossa Valley.

The southern part of the region is supplied via a branch from the Barossa Trunk main which primarily services Gawler and the northern parts of the greater Adelaide metropolitan area. Water is sourced from the South Para River, a local catchment in the Mount Lofty ranges. This source accounts for some 12% of the imported potable water.

The availability of supply from the reticulated systems are influenced by three key factors:

- Water resource availability. In the case of Barossa/Light most of the imported water comes from the River Murray. Demand and licence allocation throughout the whole Murray Darling Basin exceeds available capacity, especially during periods of drought as is currently being experienced. A water market for licences does exist, however the reliability of the River Murray to provide the capacity for which a license exists is an issue. The South Para River is a major supply for the northern areas of Metropolitan Adelaide and yield capacity from the system cannot be economically increased. The Northern Areas of Adelaide are also supplied via the Mannum-Adelaide pipeline which is near capacity.
- Treatment Plant Capacity. Treatment plants are sized to meet peak summer demands. With the peak summer daily demand being some 2.7 times the annual average supply requirement. The nominal annual capacity shown in Table 3.3 has been calculated on this basis. Annual capacity can be more than doubled by supplying large volumes of network storage.

- Network Capacity is the capacity of the pipeline systems to supply water from the treatment plant to customers and, especially in the case of Barossa/Light, to regions further from the supply source. Nominal network capacity is usually supplied to match the treatment plant capacity and can be increased by providing storage as described above.

**Table 3.3 Potable Supply to Barossa Light**

| Potable Water Supply Source | Nominal Capacity | | Current Supply to Region |
|---|---|---|---|
| | Peak Day | Annual | Annual |
| Swan Reach | 90 ML | 12,000 ML | 5,500 ML |
| Mount Pleasant Pipeline | 2.5 ML | 300 ML | 300 ML |
| Barossa Reservoir via Barossa-to-Adelaide Pipeline | 160 ML | 21,600 ML | 800 ML |
| Total | | | 6,600 ML |

Vision 2045 identified a range of strategies, including *Strategy 3: Determine the availability of water from other sources and arrange for its transport into the Barossa Region*. Driven by variable rainfall, water quality (salinity) issues of the available groundwater and surface water resources, yields and ongoing sustainability of the Barossa and Light regional water resources, Barossa Infrastructure Limited was formed to supply water for irrigation in the region.

The Barossa Infrastructure Limited supply comes from the Warren Reservoir catchment, which is supplemented by the River Murray, and is transported during off peak season via the SA Water owned Mannum-Adelaide Pipeline and stored in Warren Reservoir on the southern edge of the Barossa Valley. Water is then reticulated to customers through BIL owned infrastructure, a water pipeline distribution system constructed by Barossa Infrastructure Limited capital and borrowings using a public company structure. This water is supplied via, and subject to, a Water Transport Agreement allowing for 7,000 ML per annum initially, rising to 10,000 ML per annum. This contract requires Barossa Infrastructure Limited to hold the equivalent volume of River Murray water rights to the volume of water supplied. Barossa Infrastructure Limited has had to stand in the market place and buy permanent water rights or lease water rights to meet this obligation.

The distribution system covers 450 square kilometres, consisting of 189 kilometres of buried pipeline ranging in size from the trunk main of up to 960 millimetres in diameter down to distribution mains of 150 millimetres in diameter. There are 260 customers and shareholders with 370 separate connections to their properties. Each connection is provided with a meter.

Barossa Infrastructure Limited has a total annual water licence of 7,000 ML. The annual volume utilised in any one year is governed principally by climatic and legislative conditions.

# 3.5 Wastewater Recycling and Recycle

## 3.5.1 Community Waste Management Systems

Within the Barossa and Light region, the following SA Water and Council Community Waste Management Systems (CWMS) operate (Table 3.4).

**Table 3.4 Community Waste Management Systems operated in the Barossa and Light**

| SA Water | Barossa Council | Light Regional Council |
|---|---|---|
| ▪ Angaston | ▪ Lyndoch<br>▪ Mt. Pleasant<br>▪ Tanunda<br>▪ Williamstown<br>▪ Nuriootpa<br>▪ Springton | ▪ Kapunda<br>▪ Freeling<br>▪ Greenock<br>▪ Roseworthy |

The Angaston wastewater treatment plant consists of a primary treatment facility (Imhoff Tank) and a secondary treatment facility of an aerated lagoon combined with an additional two lagoons. The annual flow volumes equate to approximately 100 megalitres.

The Department of Health requires all calculations for wastewater be based on 150 litres per day per person (lpd/person) unless data indicates otherwise. The Kapunda data provided by Light Regional Council indicates 125 lpd/person. It is clear that recent water restrictions throughout SA have led to a fall in water use in general. Consequently a general figure of 130 lpd/person for this review will be used. Comparison will be made using the Department of Health 150 lpd/person (nominally 13% higher).

**Table 3.5 Wastewater Volumes associated with Barossa Council operated CWMS**

| Flows (ML/Year) | Lyndoch | Mt. Pleasant | Tanunda | Williamstown | Nuriootpa | Springton |
|---|---|---|---|---|---|---|
| Annual Flow assumed for report (ML) | 60 | 25 | 250 | 80 | 280 | 15 |
| Monthly Flows (ML) | 5 | 2 | 20 | 6.5 | 23.5 | 1.25 |

**Table 3.6 Wastewater Volumes associated with Light Regional Council operated CWMS**

| Flows (ML) | Kapunda | Freeling | Greenock | Roseworthy |
|---|---|---|---|---|
| Annual Flow assumed for report (ML) | 110 | 30 | 15 | 20 |
| Monthly Flows (ML) | 9 | 2.5 | 1.3 | 1.7 |

Within the respective supply agreements between the Council and irrigators, both councils have the ability to recall up to 20% of the wastewater supplied and recycled for local irrigation purposes.

### 3.5.2 Industry Wastewater

There is significant industry wastewater recycle within the region. Historically, industry wastewater had been discharged to a watercourse. Community concern and legislative change ensured the shift towards partial or complete capture and recycle of all wastewater streams, including effluent and stormwater. Indeed, by 1993, all winery wastewater discharges to a watercourse had ceased. Initiatives in the area include the North Para Environment Control (NPEC), a dedicated winery waste water treatment facility that wine companies set up in the Barossa Valley in 1975 with the aim of managing the effluent generated from wine industry businesses including: Tarac Technologies, Penfolds, Kaiser Stuhl and Tolley Scott and Tolley. NPEC converts liquid winery effluent into A Class irrigation quality water for agricultural use. In the 2007/08 irrigation season, 95ML of NPEC treated water was recycled, predominantly for viticulture.

The region is attempting to reduce the amount of winery effluent to an industry low of 0.6 litres per one litre of wine produced. This ratio varies from winery to winery and from season to season dependent upon methods employed and technology driving the process. The ratio can reach upwards of two litres of winery effluent for every one litre of wine produced. Data indicates that approximately 800 ML per annum of winery effluent is produced in the region. Long term water quality consequences regarding winery effluent recycle continue to cause concern. Potassium is critical amongst this, with soil potassium concentrations critical in long term management planning. As the ratio of wastewater produced is lowered, treatment of the concentrated waste becomes more problematic.

Kumar and Kookana (2006) demonstrated that small and medium sized wineries showed highly variable data and poorer wastewater quality than larger wineries. There were major differences in pH, EC, total organic carbon loading, SAR and Biological Oxygen Demand among wineries, due to the differences in wine processing and in treatment processes employed. Winery wastewater produced during vintage always had higher biological oxygen demand, total nutrients, and electrical conductivity and was found to be more acidic in nature. McCarthy (2009) demonstrated similar results and highlighted the need for long term monitoring of soil physical/chemical parameters.

Less rainfall will put further pressure on water resources as growers may need to apply leaching irrigation to move salt out of the root zone in view of reduced winter/spring rains.

# 3.6 Climate Change

From 1910 to 2005, South Australia's average temperature increased by 0.96ºC (0.10ºC per decade), with the minimum temperature increasing by 1.13 (0.12ºC per decade) and maximum temperature by 0.79ºC (0.08ºC per decade). Since 1950, South Australia's average maximum temperature has increased by 1.2ºC (0.21ºC per decade), the minimum by 1.01ºC (0.18ºC per decade) and the average temperature by 1.1ºC (0.20ºC per decade) (Suppiah *et al* 2006).

Annual and seasonal average temperature and rainfall changes for 2030 for Special Report on Emission Scenarios (SRES) and for two $CO_2$ stabilisation scenarios were calculated for the Adelaide and Mount Lofty Ranges Natural Resources Management Board Region. The lower and upper scenarios are incorporated into ReVision 2045 (Table 3.7).

**Table 3.7 Upper and Lower Temperature and Rainfall Predictions**

| | Lower | Upper |
|---|---|---|
| Annual Temperature Rise | 0.1 | 1.3 |
| Annual Rainfall Decreases | 1% | 10% |

A 10% decline in rainfall equates to approximately 30% decline in runoff. It is estimated that the increase in water demand for viticulture associated with climate change equates to approximately 4% per degree of warming, although it is likely to be higher for irrigation demand as supplementary water is not the only water applied to the crop.

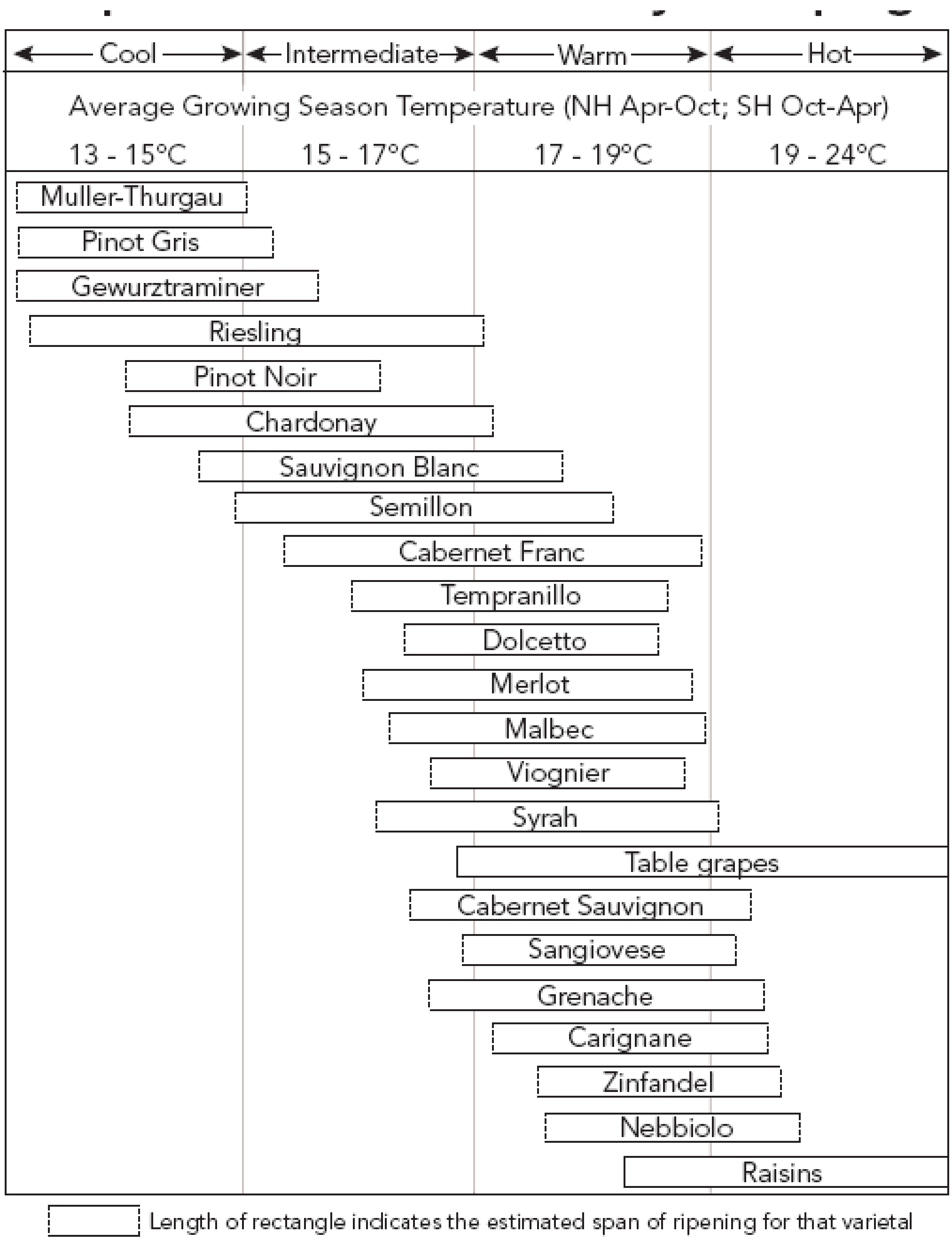
Primary Industries and Resources South Australia (2007) have identified climate change as one of the most influential and likely drivers of agricultural change in South Australia. Altered climatic conditions can have a significant impact on the production of grapes. According to Chambers (2008), drought had a significant effect on the production of grapes for 2006/2007. Rainfall in the last quarter of 2006 was less than 45% of the long-term average, and both minimum and maximum temperatures over the same period were higher than usual. The impacts of these climate conditions are described by Chambers (2008), and include fruit loss through sunburn and an early harvest. Total production of wine grapes in the Barossa zone was approximately 56kt in 2006/2007, which was about half the amount produced in the previous year (Chambers 2008; Jackson, Shaw & Dyack 2008), and about 60% of the amount projected for 2006/2007 (Gordon 2005, 2006).

Hayman (2007) identified six impacts of climate change on viticulture:

- Changes to mean temperature are likely to directly influence phenology and ripening processes (Figure 3.1). Advanced phenology is also likely to push ripening processes into the warmer period of late summer than autumn. This effect is likely to produce an effective temperature increase at the time of fruit ripening and harvest considerably greater than that directly attributable to climate change itself at that time of year.

- Changes to extreme high temperatures, such as heat waves, are likely to have a direct impact on physiological processes and water uses.
- Changes to extreme low temperatures, such as frosts, are likely to decrease in the long-term. In the short term, the frequency of extreme low temperatures will depend upon the relative influence of warming, drying and changes to weather patterns. Some regions have already observed high levels of frost risk in recent years arising from drying conditions.
- Changes to the timing and amount of rainfall will influence the water balance and have an impact on disease and quality.
- Changes to the quality and quantity of water available for irrigation.
- Changes to the atmospheric levels of green house gasses will influence vine growth.

**Figure 3.1 Average growing season temperatures for wine grapes (Haysman 2007)**



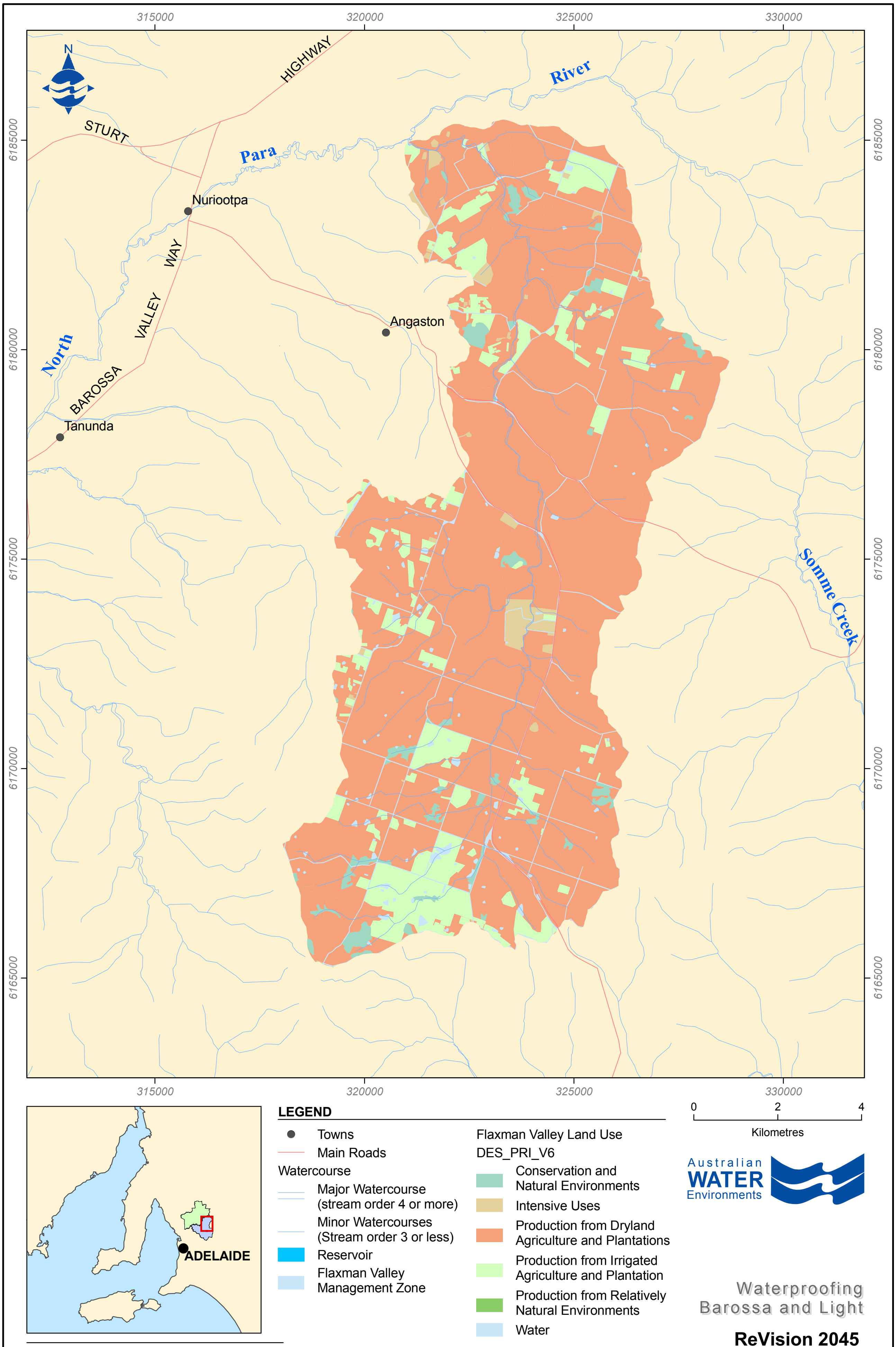
# 4. Current Water Use

During 2007/2008, 6,516 ML of water was reported to be used to irrigate land in the Barossa Prescribed Water Resource region (Adelaide and Mount Lofty Ranges Natural Resources Management Board 2009). This does not represent the full amount of water utilised in the region, nor is it necessarily a reflection of what is used by licence holders. This is due to (i) the fact that the region incorporates the Light and South Para Management Zones that are currently not prescribed or not reported (acknowledging that part of the South Para is in the Western Mount Lofty Ranges Prescribed Water Resources Area); (ii) the nature of the unverified, self reporting system in place; and (iii) under-reporting within the prescribed zones. For those management zones where prescription under the *Natural Resources Management Act 2004* has not occurred (eg Light Management Zone), reliable metered data is generally not available. Based on the 2007/08 metered data from the Barossa, accepted application rates, soil types, local knowledge and current land use data (DWLBC 2008), water use for the entire region was calculated to be 14,385 ML. The accuracy of this data is dependent upon accurate measurement and reporting mechanisms. At present, there is a relatively low confidence level on both counts. Therefore further work and initiatives are required to enable an accurate description of water use in the region. This includes a financial and resource commitment to ensure all users of water are required to possess a meter and accurately and assiduously report the water used on a regular occurrence.

A number of land owners continue to invest more resources into water saving land management techniques. This includes mulching, supplemental irrigation (including night time irrigation when evaporation is lower), improved weed control and irrigation scheduling based on monitoring of weather, soil, crop and water parameters.

The use of innovative water saving land management techniques is dependent upon the land use type. However, further and increasing use of these methods will enable water savings to be made that are commensurate with a water-constrained future.

Land use within each of the six management zones is represented in Figures 4.1 to 4.6.




Australian WATER Environments

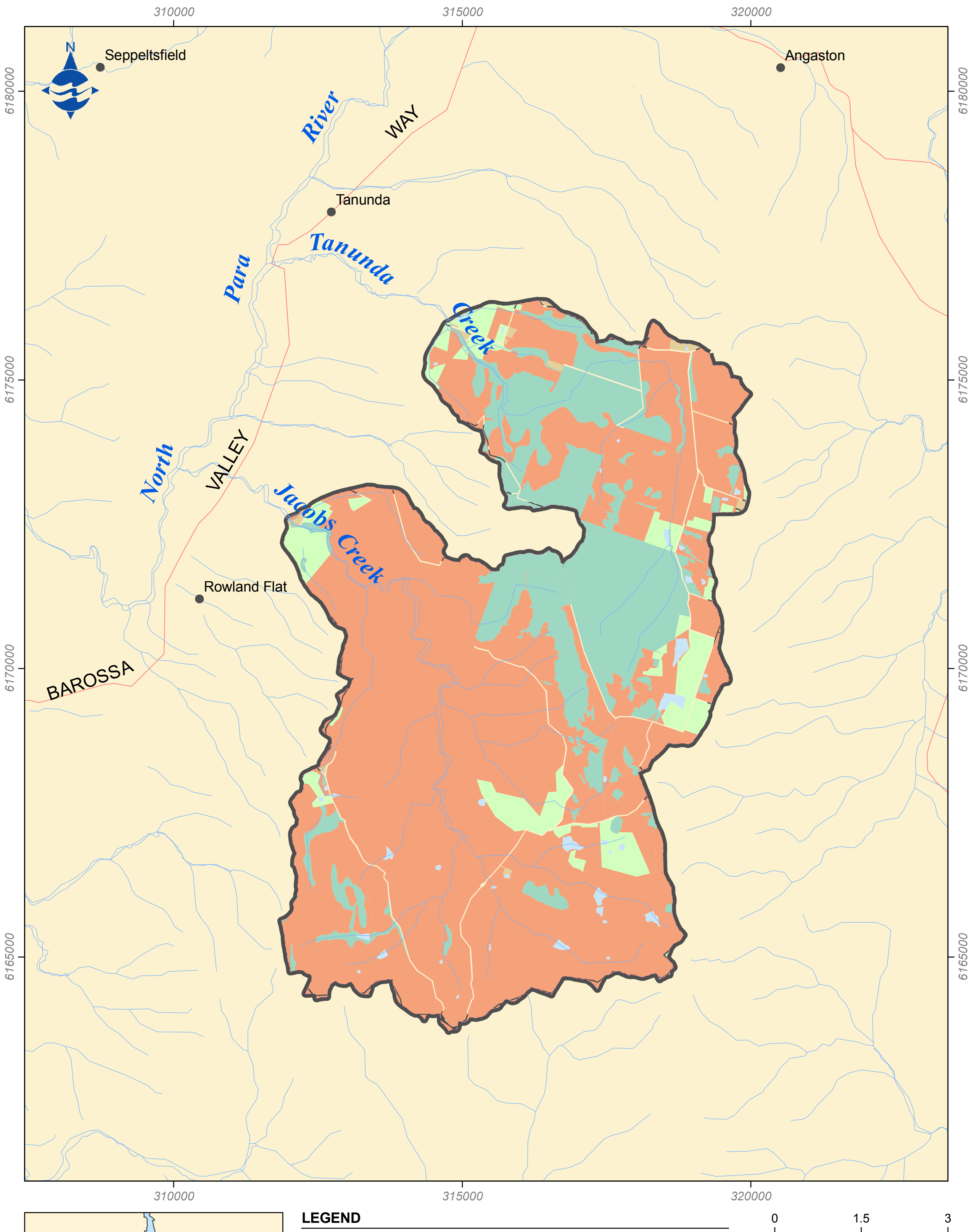
Data Source:
Geoscience Australia: Town, Major Road;
Planning SA: River, Barossa, Light & LGA Boundary.

Waterproofing Barossa and Light

**ReVision 2045**
**Flaxman Valley Management Zone**
**Land Use**

*Job No. 47972 - 020*
*090910*

Figure 4.1




**LEGEND**

- Towns
- Main Roads

Watercourse

- Major Watercourse (stream order 4 or more)
- Minor Watercourses (Stream order 3 or less)
- Reservoir
- Jacob and Tanunda Creek Management Zone

Land Use Jacob and Tanunda Creek Management Zones

- Conservation and Natural Environments
- Intensive Uses
- Production from Dryland Agriculture and Plantations
- Production from Irrigated Agriculture and Plantation
- Production from Relatively Natural Environments
- Water

0 1.5 3
Kilometres

Australian WATER Environments

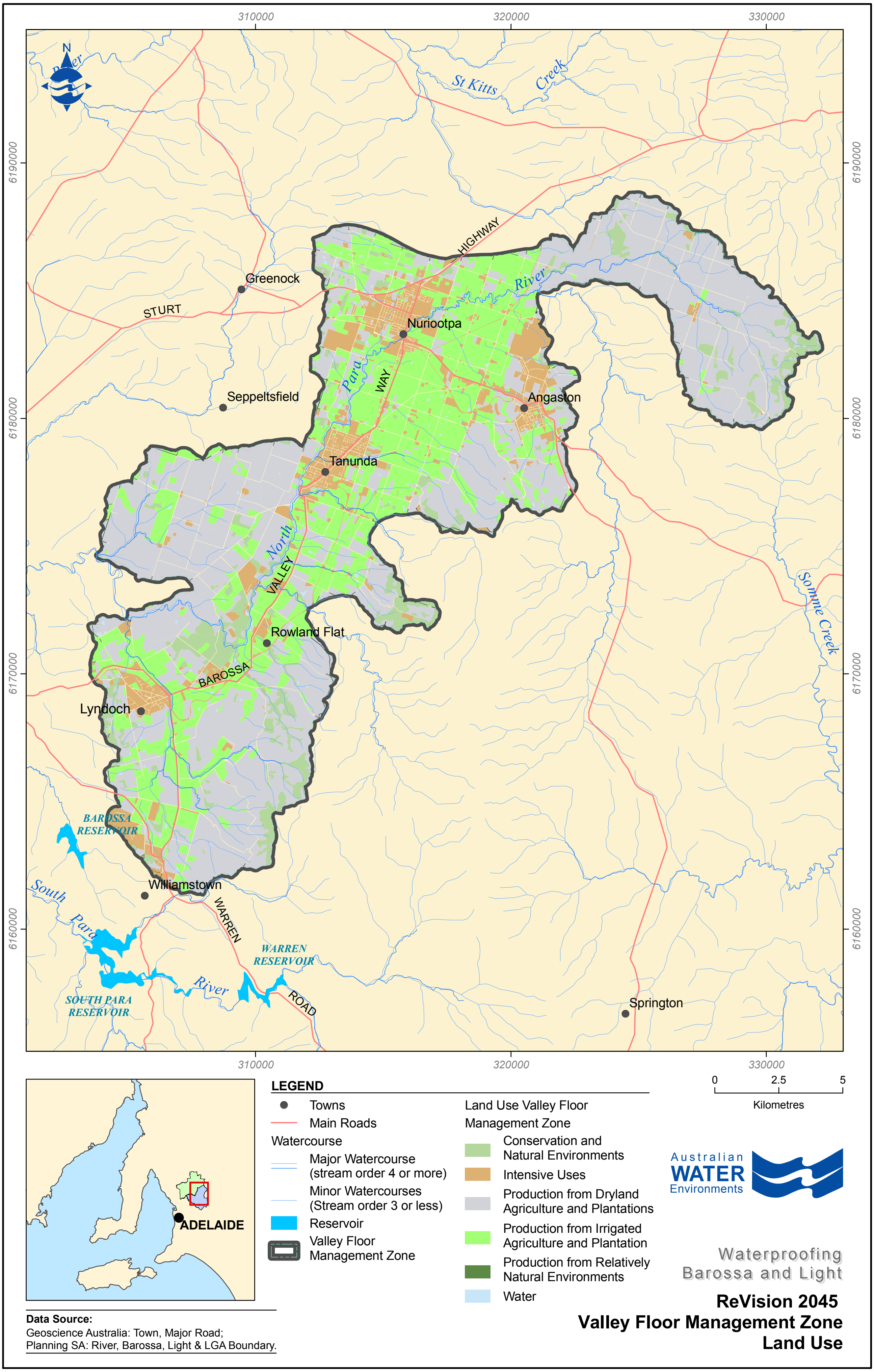
Waterproofing Barossa and Light

**Data Source:**
Geoscience Australia: Town, Major Road;
Planning SA: River, Barossa, Light & LGA Boundary.

**ReVision 2045**
**Jacob and Tanunda Creek Management Zone**
**Land Use**

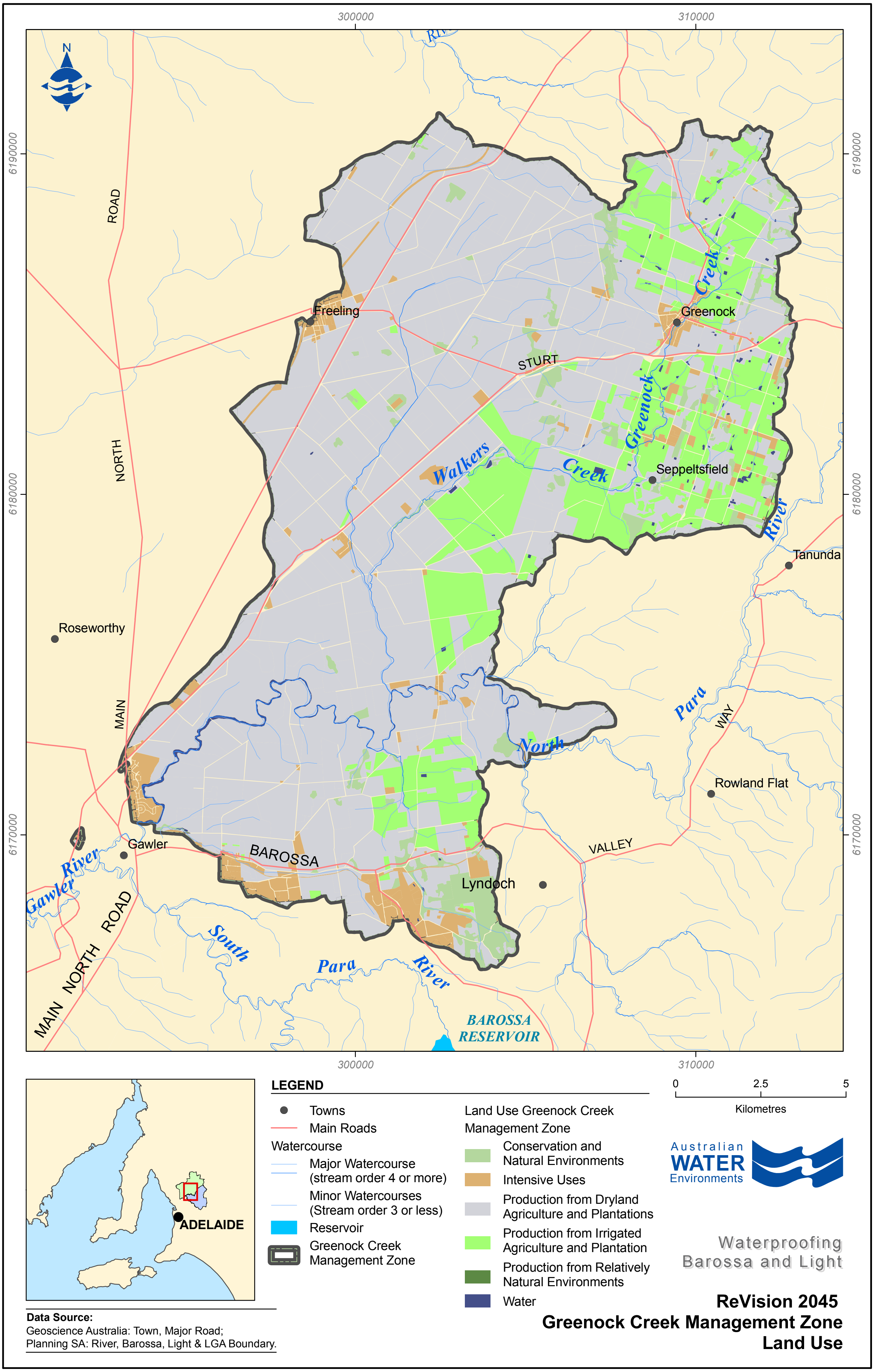
*Job No. 47972 - 021*
*090910*

Figure 4.2




Job No. 47972 - 022
090910

Figure 4.3

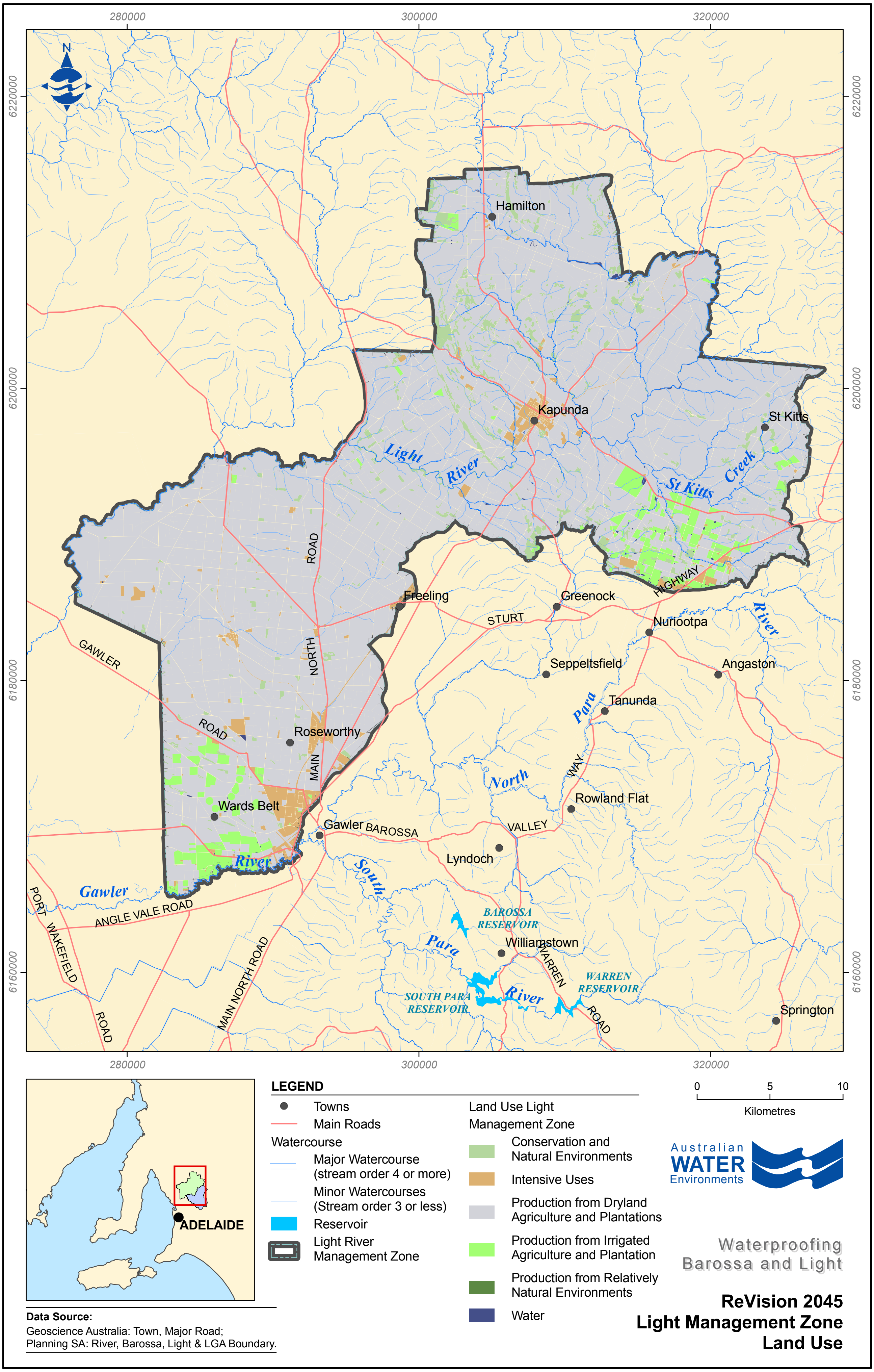



Waterproofing Barossa and Light

**ReVision 2045**
**Greenock Creek Management Zone**
**Land Use**

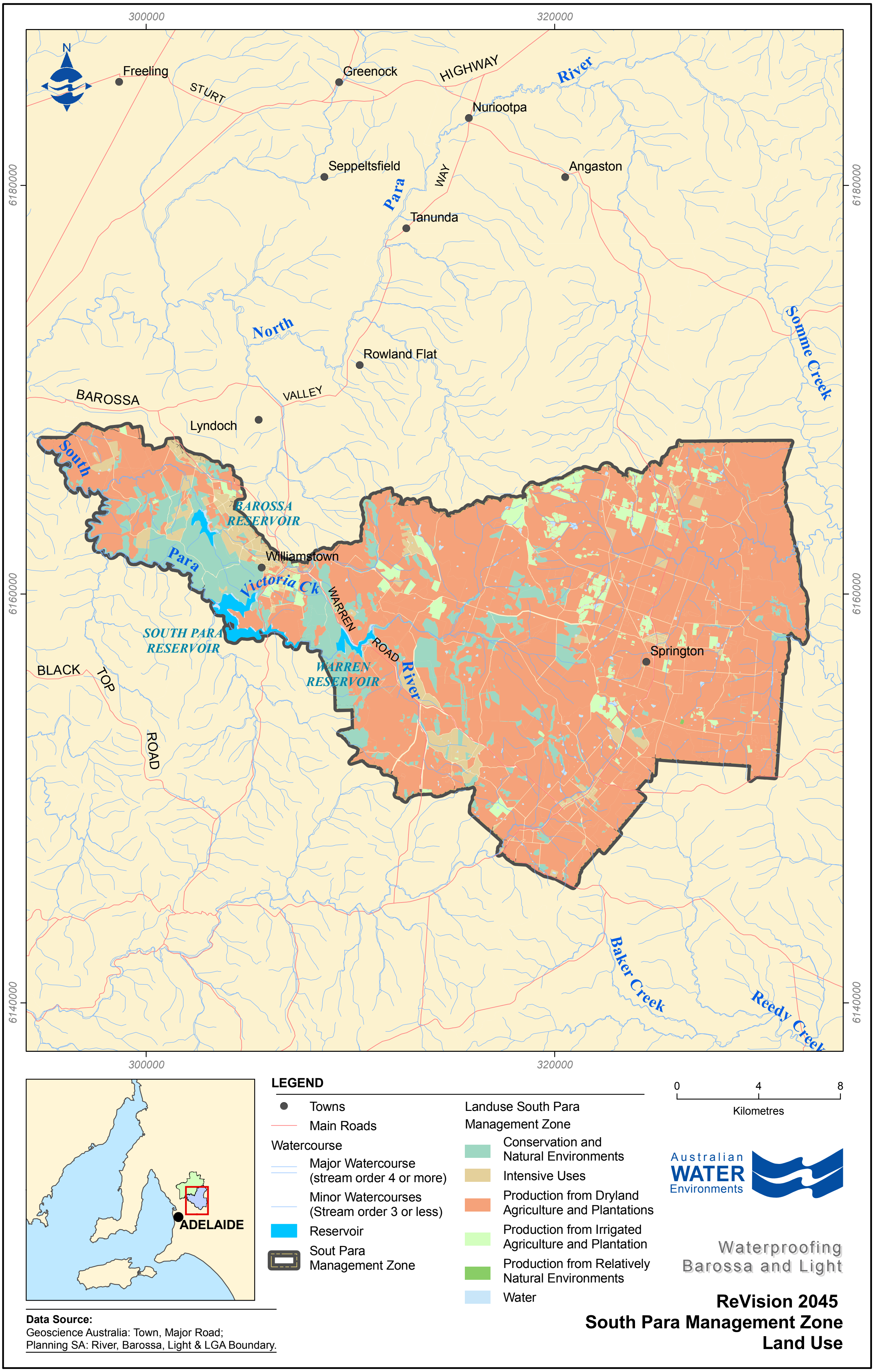
*Job No. 47972 - 023*
*090910*

Figure 4.4




Job No. 47972 - 024
090910

Figure 4.5




**ReVision 2045**
**South Para Management Zone**
**Land Use**

Job No. 47972 - 025
090910

Figure 4.6

# 4.1 Groundwater

In the Barossa Prescribed Water Resources Area, there are currently 371 volume based licences to extract groundwater equating to a volume of 5,975ML and an additional 81 area based licences which equates to an additional 1,172 ML (WAP 2009). The 2007/08 Barossa WAP District Irrigation Annual Report estimates that current groundwater use is approximately 3,900 ML which is significantly less than the allocated volume. This figure should be treated with caution however, as not every extraction is accounted for in the reporting mechanisms to the Adelaide and Mount Lofty Ranges Natural Resources Management Board. Anecdotal evidence and information presented in the 2007/08 Irrigation Annual Report indicates that irrigators often use multiple water sources in place of their groundwater allocation. It could also be due to reduced inflows to dams and groundwater recharge, therefore there may be reduced water available for use.

The current trends in groundwater levels and salinity indicate that groundwater resources are not currently under stress, which implies that reducing groundwater allocations would be unnecessary. However, close monitoring of the groundwater systems should continue to assess if groundwater allocation needs to be reviewed in the future.

Managed aquifer recharge is undertaken (at an enterprise level) within the Barossa Prescribed Wells area. The 2007/08 Irrigation Annual Report indicates that a total of 85 ML of water is injected mainly into the Upper and Lower Aquifers.

# 4.2 Farm Dams

Within the Barossa and Light region, significant changes in land use types and land management practices have occurred over the last forty years. The increased shift towards irrigated agriculture, including viticulture, along with variable water resource yields has heightened the requirement to capture and store water in the region, thereby affecting catchment hydrology. The increased numbers of small farm dams has altered the flow patterns within the region. This change in both the volume of flow and seasonal flow patterns has had an impact on the natural environment of the river system (AMLR NRM Board 2009). Whilst prescription and the development of Water Allocation Plans in the Barossa have seen farm dam development significantly decrease, farm dam development continues elsewhere in the region.

Significant work has been undertaken to determine the hydrological impact of dam development. Pikusa (2002) developed a surface water budget for the North Para system that included a determination of the impact of dams on surface water resources. That study demonstrated that farm dam development has contributed to an annual reduction of approximately 21% of flow at Yaldara. This compares favourably with the findings of Cresswell (1991).

Within the South Para, Teoh (2006) found that just fewer than 1000 dams exist in the South Para hydrological catchment (which incorporates the entire hydrological catchment, including areas outside of the Barossa and Light Region). The dams have a capacity of approximately 3,000 ML. Teoh (2006) demonstrated that the number and location of farm dams in the catchment has reduced the pre-development median flow for the whole catchment by about 7%.

The South Para incorporates the Warren, South Para and Barossa reservoirs, which have a combined capacity of 54,600 ML. As the estimated average catchment pre-development inflow for the Middle and Upper catchment was 30,200 ML/a, it is considered that approximately 88% of the upstream catchment flow in this area has been intercepted. Consequently, it is thought that the water dependent ecosystems below the Barossa Diversion Weir have become significantly ecologically stressed (Philpott *et al* 1999).

Within the Light River catchment, it is estimated that the number of farm dams in the region have a total capacity of 3,000ML and capture on average 1,900ML per year. Of that, it is estimated that 1,100 ML is used annually (Murdoch 2002). This represents an average annual decrease in flow of 7.9% (due to farm dams) in relation to the annual flow. It is not considered, at this stage, that farm dam development as a reflection across the whole catchment has a significant impact on environmental water requirements. However it is possible that in smaller sub catchments farm dam development may be starting to impact on environmental water requirements.

Pikusa (2000) has shown that 50% of the annual volume captured in an irrigation dam in the region can be diverted on a reasonably consistent basis. The remaining 50% is accounted for as either evaporation loss or unfilled storage.

**Table 4.2 Total Dam Volume in the region**

| Management Zone | Total Dam Volume (ML) |
|---|---|
| Greenock Creek | 1,050 |
| Valley Floor | 3,200 |
| Jacob and Tanunda Creek | 1,500 |
| Flaxman Valley | 3,000 |
| South Para[1] | 3,000 |
| Light River | 3,000 |

[1] Includes the hydrological catchments of the South Para which incorporates regions outside the Barossa and Light Region

# 4.3 Environmental Water Requirements

## 4.3.1 Defining the environment?

In the context of this strategic review of Barossa and Light water resources, the environment is considered to comprise the interaction between physical form (eg geology, geomorphology) and physical processes that support water dependent ecosystems (WDE) and water dependent land uses, directly influenced by the water availability and condition of the Light and Gawler catchments.

Examples of physical processes that support WDE are those that:

1. keep a balance between those physical processes depositing/moving salt into the catchments and those processes which move the salt back to the ocean; or

2. move silt from natural erosion processes through the tributary/river system.

## 4.3.2 What is a Water Dependent Ecosystem?

Water Dependent Ecosystems have been defined as “those parts of the environment, the species composition and natural ecological processes which are determined by the permanent or temporary presence of flowing or standing water” (ARMCANZ & ANZECC, 1996). Water Dependent Ecosystems include watercourses, riparian zones, wetlands and floodplains, and may depend on surface, watercourse and/or groundwater (AMLR NRM Board 2009).

## 4.3.3 What is water for the environment?

Environmental flows can be defined as flows of a particular quantity, quality and timing necessary to ensure a healthy river system, from environmental perspectives. Recognising and accounting for specific environment-based water requirements allows for the ecosystem to receive water to support plant and animal life and to carry out processes that achieve quantifiable beneficial outcomes consistent with our definition of ‘*the environment*’ targets set out above. These processes also result in services that humans rely on, including production of economic goods such as agricultural crops, regulation of damaging events such as floods, removal of wastes and important cultural services including aesthetically acceptable rivers and indigenous values. Consequently, the provision of environmental flows can be viewed as having a range of social outcomes, including altering the way water is used and managed, whilst transitioning water from existing users back to the community, to be held in trust for the environment.

Providing environmental water maintains natural processes in water dependent ecosystems, thereby supporting the intrinsic biodiversity values of these systems. In addition, as outlined above, a number of other benefits arise that improve the state of water resources for all of the community, for example:

- managed salinity levels in streams and rivers – increases productivity for downstream users (lower salinity = more usable water);
- protected flora and fauna – vegetation provides erosion control, wind breaks and water quality improvements;
- improved water quality – e.g. lower water temperatures, good oxygen levels and reduced frequency of algal blooms); and
- export of salt.

### 4.3.4 Approaches to Determining Environmental Water Requirements

Agreement on the values of the individual ecosystems within a watercourse and in the adjacent land is considered important when determining environmental water requirements. Whilst the primary aim is to provide flows sufficient to sustain these systems in the long term, the degree of 'good health' at which they will be sustained is a judgement that will vary according to the environmental imperatives of each region. What is considered to be an appropriate environmental flow for a particular watercourse or even stretch of a watercourse will largely depend on the values for which the system is to be managed. This is particularly so in the Barossa and Light region where significant modification to the environment has occurred.

To provide adequate water for the environment, there is a need to understand how underground water, rivers, wetlands, catchments and floodplains interact. Water Dependent Ecosystems depend on a pattern or regime of water flow, level or quality. This regime can be described in terms of seasonality, timing, frequency, duration, magnitude, depth and rate of change. Changes in important elements of the water regime are likely to lead to changes in condition and composition of WDE's.

Environmental flows are facilitated via water allocation policies for consumptive use which regulate the times and quantities of water that may be taken. The environmentally sustainable level of extraction is also referred to as the sustainable yield and is defined in the National Water Initiative as the level of water extraction from a particular system which, if exceeded would compromise key environmental assets or ecosystem functions and the productive base of the resource.

The Barossa Prescribed Water Resources Area Water Allocation Plan (adopted by the Minister for Environment on 18 June 2009) supports this approach in the determination of environmental water requirements for the existing water dependent ecosystems (WDE's).

In the current approach to determining environmental water requirements, river habitat types, geomorphology, macroinvertebrates, fish species and vegetation composition are considered when estimating water requirements for the environment. The assessment of the geomorphology of the region and associated processes allows a determination of process zones (eg Incised, Mobile, Pool and Transition). Ecological assets are identified and for each process zone, flow bands and their associated environmental water requirements calculated.

This method takes a large catchment scale approach in determining environmental water requirements for the region.

However, there is concern regarding the determination of environmental water requirements for the region in this way. This concern resides with the actual impact of environmental water allocations on ecological health in a region that has been significantly altered due to anthropogenic influences with only small pockets of remnant high value habitats remaining.

The abstractions which are currently taken from the natural flows have been accounted for in the responses made by small remnant ecosystems. In the current water management regime, further abstractions are now limited as the North Para surface and ground waters are prescribed.

ReVision 2045 aims to set a new strategic directive for determining environmental water requirements in the region. The intent is to challenge the traditional model and currency of thinking in determining environmental water requirements to a process which addresses objectively the specific water requirements of the individual ecosystems and sets up a management process to improve and enhance these systems. Striking out into new territory is particularly important when considering the recent prolonged drought, perhaps a snapshot of climate change impacts into the future, and the impact on remnant ecological habitats.

This review proposes that Environmental Water Allocations be made through a process of considering objectively where local water management actions can actually improve outcomes for:

(i) salinity management;

(ii) biodiversity improvement;

(iii) erosion and siltation;

(iv) in-stream fishes, micro-invertebrates and macro-invertebrates; and

(v) “over-bank” flood flow dependant biological and physical systems.

### 4.3.5 Current Approach to EWR – time to move on?

For the purpose of developing the Barossa Prescribed Water Resources Area Water Allocation Plan, a catchment water balance model was developed to help understand water movement through the catchment and simulate the current level of dam development (AMLR NRM Board 2009).

A variety of investigations have also been undertaken that were used for the development of the Water Allocation Plan, to ascertain the nature of the water resources in the Barossa Prescribed Water Resources Area (PWRA) and to determine water demands for consumptive and environmental uses (EPA 1999 and Pikusa 2002).

Moreover, unpublished investigations have been undertaken in the Light River and Western Mount Lofty Ranges which relate to the Barossa and Light region (eg Murdoch 2002), to ascertain environmental water requirements for their respective catchments.

These studies use a long standing approach which models the catchment as a whole ecosystem rather than a collection of small ecosystems (many interacting). These smaller ecosystems have been modified over time as a result of natural variation, impacts of human land use practices and, in recent times, variation as a result of climate change. This approach results in a set of target flows for different flow bands and zones across the catchment.

For the purpose of developing a regional and management zone water balance for ReVision 2045 that was consistent with current approaches by regulatory authorities, investigations were carried out to determine flow requirements in the Gawler and Light River systems to provide water for the environment (Light River System (Table 4.3) and the Gawler River System (Table 4.4)). The volumes are derived from inventory studies conducted in the region and are considered to set the bar on volumes required for the environment quite high.

The water regime needed to sustain the ecological values of aquatic ecosystems, including their processes and biological diversity, at a low level of risk is termed the environmental water requirement (DWLBC, 2006). Those parts of environmental water requirements that can be provided at any time with consideration of existing users' rights, social and economic impacts is termed the environmental water provisions.

**Table 4.3 Light River System DWLBC Environmental Water Requirements**

| Zone | Band | Duration (Days) | Seasonality | Annual Volume (ML) |
|---|---|---|---|---|
| 2 | Low | 45 | Late Winter/Spring | 3800 |
| | Mid | 6 | Late Winter/Spring | 5460 |
| | Bank Full | 2 | Spring/Summer | 1170 |
| 6 | Base Flow | 30 | Autumn/Spring | 195 |
| | Low | 30 | Late Winter/Spring | 760 |
| | Bank Full | 3 | Late Winter/Spring | 590 |
| 7 | Base Flow | 21 | Late Winter/Spring | 45 |
| | Mid | 4 | Late Winter/Spring | 260 |
| | High | 2 | Spring/Summer | 220 |
| | Bank Full | 2 | Spring/Summer | 350 |
| 8b | Base Flow | 21 | Late Winter/Spring | 40 |
| | Mid | 4 | Late Winter/Spring | 200 |
| | Bank Full | 3 | Late Winter/Spring | 160 |

*Note: Overbank flow was not included in the assessment, as it was assumed that it is beyond harvest and will naturally occur.*

**Table 4.4 Gawler River System DWLBC Environmental Water Requirements (From EPA 1999)**

| Zone | Band | Duration (Days) | Seasonality | Annual Volume (ML) |
|---|---|---|---|---|
| 2 | Base Flow | 365 | Continuous | 24,820 |
| | Pool Connection | 270 | Autumn/Spring | 53,730 |
| | Mid | 2 | Any | 1280 |
| | Bank Full | 3 | Any | 1140 |
| 4 | Base Flow | 180 | Autumn/Spring | 12,240 |
| | Freshets | 3 | Autumn/Spring | 204 |
| | Pool Connection | 75 | Autumn/Spring | 25,550 |
| | Mid | 2 | Any | 1980 |
| | Bank Full | 1 | Any | 450 |
| 5 | Base Flow | 365 | Continuous | 24,820 |
| | Freshets | 78 | Autumn/Spring | 10,530 |
| | Pool Connection | 75 | Any | 24,750 |
| | Mid | 1.5 | Any | 2280 |
| | Bank Full | 0.5 | Any | 465 |
| 6 | Base Flow | 78 | Autumn/Spring | 4840 |
| | Freshets | 75 | Autumn/Spring | 5100 |
| | Bank Full | 0.5 | Any | 44 |
| 7 | Base Flow | 365 | Continuous | 22,630 |
| | Freshets | 165 | Autumn/Spring | 11,220 |
| | Bank Full | 0.5 | Any | 44 |

*Note: Overbank flow was not included in the assessment, as it was assumed that it is beyond harvest and will naturally occur.*

*Updated information will be available shortly on the Gawler River as part of the Western Mount Lofty Ranges Water Allocation Plan*

## 4.3.6 Flow Band and Salinity

Further investigations were undertaken to determine the salinity consequences of different flow bands (quartiles) within the management zones and their potential impact on environmental water users.

**Table 4.5 Light Management Zone Annual Flow Bands and Associated Salinity**

| Flow Quartile | Flow (ML/day) | Mean EC (uS/cm) | Median EC (uS/cm) |
|---|---|---|---|
| 1st | <0.642 | 10933 | 10875 |
| 2nd | 0.643 – 1.292 | 10487 | 10701 |
| 3rd | 1.293 – 4.305 | 10061 | 10456 |
| 4th | >4.306 | 7920 | 8462 |

**Table 4.6 Valley Floor Management Zone Annual Flow Bands and Associated Salinity**

| Flow Quartile | Flow (ML/day) | Mean EC (uS/cm) | Median EC (uS/cm) |
|---|---|---|---|
| 1st | <0.394 | 5586 | 5485 |
| 2nd | 0.395 – 2.683 | 4878 | 4764 |
| 3rd | 2.684 – 9.605 | 3376 | 3382 |
| 4th | > 9.606 | 1699 | 1450 |

**Table 4.7 Jacob and Tanunda Creek Management Zone Annual Flow Bands and Associated Salinity**

| Flow Quartile | Flow (ML/day) | Mean EC (uS/cm) | Median EC (uS/cm) |
|---|---|---|---|
| 1st | <0.1 | 2106 | 1997 |
| 2nd | 0.1 – 0.258 | 1887 | 1769 |
| 3rd | 0.259 – 1.659 | 1471 | 1393 |
| 4th | > 1.659 | 793 | 753 |

It was not possible to undertake this analysis for Greenock Creek, South Para and Flaxman Valley because there is insufficient salinity data available. The paucity of water quality data available to calculate the flow/salinity consequences on the ecology of the region is symptomatic of data collection in the region. The lack of data is exacerbated by the relative lack of stream flow associated with drought during the periods when most of the water quality data has been collected. With negligible stream flow in areas of the Barossa and Light associated with drought conditions, the measurements of salinity has at times been undertaken in stagnant pools as opposed to flowing watercourses. Consequently caution should be used when assessing the analysis from these data sets based on the data's limitations.

Based on the available data, the Light and Valley Floor Management Zones can be categorised as being slightly saline to brackish (Light) across all flow bands. The Jacob and Tanunda Creek Management Zone demonstrates relatively fresh to slightly saline water quality across the flow bands. Not surprisingly, conductivity decreases with increasing flows, although significant decreases do not occur until relatively elevated flows occur. The elevated conductivity is consistent with the typical freshwater fish species located in the region, some of which tolerate high salinities, degraded habitat condition and low flows. These include the native *Galaxius olidus* (Mountain Galaxias) and the non native *Gambusia holbrooki* (Mosquito Fish).

It would appear that salinity is largely not a limiting factor on river health within the region because the species that predominate are largely salt tolerant.

### 4.3.7 Environmental Water Requirements – An Alternative, More Effective Approach

Within the Barossa and Light region, there have been a number of studies and investigations which have reviewed the natural environment to determine the anthropogenic influence since development. A number of sites, at a variety of spatial scales have been classified ranging from heavily degraded and severely modified to areas of higher ecological value. A significant body of work to survey the region was undertaken in the late 1990's, including the Environment Protection Agency's Watercourse Survey and Riparian Zone Management Project (1999) and the Determination of Environmental Water Requirements for the Gawler River System (1999). There are, however, areas within the region where the level of detailed understanding of ecological value is limited, including in the Light Catchment. Further and ongoing work is required to capture contemporary information that enables this new strategic approach to determining environmental water requirements to be enacted.

Within the Barossa PWRA, the majority of impacts in all zones relate to the base flows and pool connection flows. It is anticipated that the impacts of altered flow regimes in the Barossa PWRA, and the development of frequencies and seasonality that more closely resemble what would have occurred naturally, can be addressed by increasing the duration of base flow and pool connection flow (AMLR NRM Board 2009).

This can be achieved in several ways, including:

- limiting the total volume of water captured and stored in dams to provide water for environmental flow; and
- allowing low flows to bypass dam storage.

In addition, the maintenance of base flows in the third, fourth and fifth order watercourse can be achieved through minimising underground water extraction near these high order watercourses.

The existence of healthy permanent pools has been identified as important. These permanent pools are fed by groundwater during summer. Little is known about current extractions of the groundwater in these areas and its quality. Based on the limited information that is available, it would appear that the salinity levels of the groundwater currently do not make it attractive for irrigation.

Within the Light River Management Zone, there may be potential threats to environmental water requirements from the over use of contour banking and from direct water extractions from the streams. Although salinity levels currently do not make it attractive for irrigation, future users may not be constrained by these levels. In some areas, this threat exists due to rapidly changing stream profiles because of incision and deposition (Murdoch 2002). However, these conclusions are based on one gauging station in the Light River Catchment which is not sufficient to assess environmental water requirements or the impact that development may have on flows.

Furthermore, the catchment has largely been altered from its natural condition and it is possible that contour banks and minimal tillage practices may simply be returning the hydrological regime back towards its pre-cleared conditions.

Figure 4.1 outlines the key areas of ecological importance as currently recorded within the State's spatial database. Based on this data, there are significant reach lengths with little or no vegetation, erosion heads, poor bank stability, presence of exotic species and/or little native vegetation. In contrast, there are few areas where there are intact riparian systems.

The region is also categorised by water dependent ecosystems that are generally tolerant of low flow and relatively high salinity levels.

With the region significantly altered due to anthropogenic influences, the ecological diversity of the region has diminished to pockets of remnant habitats of high ecological value. These areas generally include sections of Duck Ponds Creek, Tanunda Creek and Mt McKenzie.

It is ReVision 2045's contention that it is these areas which should be considered in detail to determine their specific water requirements and thereby provide the necessary science to support a management process specifically designed to improve and enhance these systems.

The above approach has come about because of ReVision 2045's recognition that Australia is rapidly losing its remnant ecosystems in a relentless process of exploitation and human intervention. Many of these losses are the result of the long-standing approach of considering the catchment in too great a scale, rather than considering the fine detail.

The folly of applying the conventional approach to the Barossa is highlighted by the large volumes of water that the catchment wide assessment process would deem necessary to achieve healthy ecosystems. Simply put these volumes are unlikely to be available in the short term and whilst they may be desirable aspirational targets - and should remain within our vision - we are at risk of losing the remnants that are left because of lack of attention to detail whilst we engage in a debate endeavouring to secure volumes of water that simply are not practically available in the short term.

The opportunity now exists to move on from the long standing approach of broad catchment modelling and management to a process which addresses objectively the specific water requirements of key individual small ecosystems and thereby enable the establishment of a management process to improve and enhance these systems.

Adopting a more local focus on specific ecosystems (whilst still recognising the benefits and need for some interconnectivity and migration along the system) should also enable the limited water and funding resources that are likely to be available to be targeted to the areas of greatest value and highest need.

### 4.3.8 Low Flow Bypass

The options for environmental releases from dams include low flow bypass mechanisms, mechanisms to allow the first seasonal flood to go to the environment, or the release of flows to mimic or enhance a natural flood. In light of the findings of the EPA (1999), Pikusa (2002), Murdoch (2002) and Teoh (2005) and the recommendations outlined in the Barossa PWRA Water Allocation Plan, including *Policy Direction 2: Design Criteria for new dams - allowing low flows to bypass dam storage*, it is prudent to determine the effectiveness of low flow bypass devices in the region.

As treated water discharge into the river system reduces, further negative impacts on flows within the river system may be experienced.

A low flow bypass is a device used to prevent a water storage (eg dam) from harvesting low flows. Low flow bypass structures on dams have both a strong resource sharing focus, as well as presenting a beneficial impact on the downstream environment. There are a variety of means by which a low flow bypass device can work. The basic system collects low flows using a small weir. During low flows water collects behind the weir where it is forced into a bypass system (usually a pipe) rather than flowing into the dam. As flow rates increase the water level behind the weir increases. At flows above the threshold flow rate the capacity of the weir and diversion pipe is exceeded, the weir overtops, and water enters the dam. Low flow bypass systems are one means by which the duration of flow in a stream can be maintained and help to ensure that harvesting of water in dams occurs when flows are plentiful. Reinstatement of a more natural flow regime could potentially provide downstream benefits for the environment as well as help to ensure that landholders' riparian rights are also protected. The mobilisation and transference of salt downstream within the watercourse and catchment is another significant benefit derived from the installation of low flow bypass devices. Installing these systems on new dams can be reasonably straight forward but retro-fitting adds another layer of complexity. However, this hould not discount a policy of retro-fitting low flow bypass devices onto existing dams.

The effectiveness of low flow bypass devices was demonstrated by Lee (2008) who investigated the effectiveness of installing a low flow bypass on each of three farm dams in the upper sub-catchments of the Marne Catchment. The study entailed determining the downstream ecosystem responses associated with a low flow bypass device that did not disadvantage the dam's capacity to provide for other values. The low flow bypass devices were installed to prevent flows up to a 2 litres per second threshold from entering the dams. Utilising a low flow bypass, these flows were diverted around the dams and returned to the stream channel downstream of the dams. The health of the environment downstream of these dams was measured via a determination of the diversity and abundance of macroinvertebrates present.

Comparisons were made between each of the bypassed dams (treatment dams) and their paired dams (control dams) in the catchment. The most notable change following the installation of the bypasses was that a temporal approximation of the natural flow regime was restored at the sites downstream of the bypassed dams. This reduced the artificially-increased period of zero-flow that is normally experienced downstream of dams, leading to a subsequent improvement in the macrophyte cover as well as an increase in the abundance and diversity of macroinvertebrate taxa at these sites. Furthermore, a greater number of lotic macroinvertebrates (i.e. those that prefer flowing water, including Ephemeroptera and Plecoptera) were found downstream of the bypassed dams, and a corresponding decrease in lentic macroinvertebrates (i.e. those that prefer still water, including several Coleoptera, Hemiptera and Diptera) was observed.

Lee's results suggest that low flow bypasses can be effective at restoring the crucial low flow part of the natural flow regime. Rather than low flow bypass devices being installed only on new dams in the Barossa and Light region, ReVision 2045 recommends consideration of a requirement that all catchment dams at a pre-determined volumetric capture capacity be required to install a low flow bypass device.

### 4.3.9 Knowledge Gaps

The National Principles for the Provision of Water for Ecosystems (1996) details the primary goal of providing water for the environment. That is, to sustain and where necessary restore ecological processes and biodiversity of water dependent ecosystems. The principles associated with this goal include ensuring that the provision of water for ecosystems should be on the basis of the best scientific information available on the water regimes necessary to sustain the ecological values of water dependent ecosystems. Consequently, ongoing strategic and applied research to improve understanding of environmental water requirements is essential.

Determining how much water that can be sustainably extracted requires an understanding of groundwater and surface water systems, making special arrangements for high conservation value watercourses, reaches and groundwater areas; conducting periodic independent audits of environmental achievements; and publicly reporting the results. The various reports associated with determining environmental water requirements for the Barossa and Light region systematically detail the knowledge gaps associated with these key areas and the associated difficulty in establishing an appropriate and targeted approach to water for the environment regime. Principally, this is manifested by the paucity of flow, water quality and targeted ecological data available. The number and spatial spread of monitoring sites, the quality of the data collected, especially during periods of flow around and at the top of the hydrograph (peak flow) and an understanding of the relationships between all elements of the region, including hydrology, land use and ecology are all areas of concern. Despite this, it is important to recognise the current commitment of resources by various tiers of Government to improving this situation, including the decision to invest in improving data acquisition and management systems such as WILMA and GIS platforms.

The current methodology for determining environmental water requirements appears to have a narrow consideration of species that are part of water dependent ecosystems in the region.

Whilst the Barossa Prescribed Water Resources Area Water Allocation Plan presents the most complete information available on water dependent ecosystems of the region, including aquatic and terrestrial species in the riparian area the level of understanding is still relatively limited. Obtaining clearer understanding of suitable flow rates for each ecologically healthy site/habitat in the region is required. The determined flow rates should support the key management objectives for this site. These in turn will support the designated environmental values derived for each site. Whilst management objectives for sites can vary, they would incorporate aspects of habitat provisions regarding water availability, flow duration and timing, water quality (salinity), silt movement, shading, food sources, soil moisture amongst others.

There are also uncertainties regarding data coverage and quality, including flooding of gauging stations, failures (mechanical), vandalism and/or missing regular maintenance graduation process.

Decision making, data and knowledge gaps for determining environmental water requirements in the Barossa and Light region include:

- maintaining an updated database on the extent, diversity and health of high value, remnant ecological sites such that environmental water needs can be determined;
- understanding of regional dam capacity and capture volumes – the discrepancy between actual and estimated;
- holistic understanding of water used across the entire region (no uniform metering);
- water dependent ecosystem state, extent and health;
- level of dependence of water dependent ecosystem on water sources (flow and duration);
- impact of water quality on water dependent ecosystems;
- threshold limits for changing hydrology associated with drought and climate change;
- impacts of land use on runoff and water dependent ecosystems;
- stream-flow (number and integrity of recording locations);
- extent and impact of shallow dams on water resource efficiency
- water quality (number and integrity of recording locations);
- approach to installing low flow bypass devices within a catchment (blanket installation on every dam versus targeted approach currently employed in the Western Mount Lofty Ranges) and the impact on the water resource; and
- impacts on water dependent ecosystems likely to stem from localised effects of extraction.

It is recommended that a targeted and coordinated approach to reducing the knowledge gaps be developed by the Barossa and Light Regional Development Board in consultation with the Department of Water, Land and Biodiversity Conservation, the Adelaide and Mount Lofty Ranges Natural Resources Management Board and relevant stakeholders.

### 4.3.10 Recommendations

Currently, the Murray-Darling Basin Sustainable Yields Project being conducted by the CSIRO is providing detailed assessments of the water available in all catchments in the Murray-Darling Basin. Whilst the initiative is well intentioned, the Barossa and Light region has moved towards a point where more detailed analysis on the key ecologically healthy sites is warranted. Rather than fostering the current, broader approach to developing environmental water requirements, ReVision 2045 recommends detailed, high investment investigations to strengthen environmental water requirement determinations. This recommendation recognises the conceptual link between key flow components and ecological processes, integrating assessments of hydrology, geomorphology, macroinvertebrate and fish ecology, whilst identifying the critical parts of the flow regime as well as the ecological and geomorphological roles of these flow components for each site. Furthermore, it allows ongoing assessment of the implementation of water for the environment allocations by utilisation of indicator species such as indicator fish species, whose habitats are sensitive to alterations in flow.

The proposed approach is intended to focus assessments and resource allocations (both water and financial) to specific higher value sites, rather than adapting a broad generic management/allocation response. The learnings and outcomes of these assessments can be transferred to the other areas in the region.

The State Government has made an undertaking under the National Water Initiative to meter non-domestic applications for areas that are prescribed. This initiative, the installation of a meter, should be mandatory for all users accessing water resources within the Barossa and Light Region.

The assessment or the capacity of the water resources within the current Barossa Water Resources Area Water Allocation Plan was based on the 2004/05 water use year data. This does not include a complete assessment of the impact of the current prolonged drought period, and the potential for the ecology of the area. A short term analysis is not valid for any determination on environmental water requirements. Consequently, it is recommended that a targeted monitoring strategy be implemented which includes the upgrade of the existing gauging stations in the region. Moreover, it is recommended that they be managed in a way that ensures the data base does not suffer from the breakdowns associated with the stations in the past, including those periods of high flows. Additionally, long and short term monitoring sites are required to improve the understanding of the catchment hydrology. These have been divided into three categories and follow the recommendations made by Murdoch (2002) and Pikusa (2002):

- Long term - high quality, monitoring sites measuring to a high resolution continuous level flow, EC, temperature and possibly rainfall (or stand alone rainfall sites).
- Short Term - (operating for a minimum of 5 years, subject to meeting their requirements) lower quality, monitoring sites measuring to a lower resolution continuous level flow, EC, temperature and possibly rainfall (or stand alone rainfall sites).
- Environmental Water Requirement (EWR) monitoring sites located at points of environmental interest or significance. They are simpler sites in that a control is not required to be constructed and interest is in level timing, duration and frequency. It is anticipated that within a five year time frame a correlation between these sites and

long term sites in the catchment can be made for the level timing duration and frequency to check various environmental water requirement hypotheses.

Further investigations on the impact of the installation on low flow bypass devices at a local, reach and catchment scale are required to inform policy makers. This includes the impact on flushing salt and sediment through the system.

## 4.4 Treated Wastewater

Within the Barossa and Light region, significant volumes of treated effluent are provided to third party landholders for irrigation. The SA Water operated scheme at Angaston supplies the bulk of its reclaimed water to local irrigators.

### 4.4.1 Barossa Council

A majority of the Barossa Council's Community Wastewater Management Systems (CWMS) effluent is currently supplied to third party irrigators within and around the immediate vicinity of the respective schemes. The exception is that of Williamstown, where an agreement is currently being developed for a pipeline to be constructed for supply to local irrigators. Commencing in August 2009, an agreement has been reached to utilise 260ML of treated wastewater from Barossa Council through BIL infrastructure.

### 4.4.2 Light Regional Council

Almost all of the reclaimed water captured by CWMS operated by the Light Regional Council is recycled for irrigation.

**Kapunda CWMS**

Whilst approximately 60 ML per annum is lost via evaporation and seepage, final disposal of the remaining treated effluent (nominally 60 ML per annum) is achieved by a combination of irrigation of the Dutton Park oval, golf course and Memorial Gardens. The majority of reclaimed water is used for irrigation of the golf course.

**Freeling CWMS**

Irrigation of vineyards (nominally 15 ML per annum). A new Waste Water Treatment Plant (WWTP) is soon to become operational. This will allow for greater re-use of treated water for local vignerons as well as local parks and gardens.

**Greenock**

As of 1997, Council has agreed for an adjacent vigneron, located on Sections 118 and 151, Hundred of Nuriootpa, to draw treated effluent from the evaporation lagoon. In accordance with the South Australian Reclaimed Water Guidelines (April 1999), this water (to irrigate wine making grapes) must meet Class "C" standard. The vigneron draws water from the evaporation lagoon by syphoning from the evaporation lagoon to his dam on an "as needs" basis (nominally 15ML per annum).

**Roseworthy**

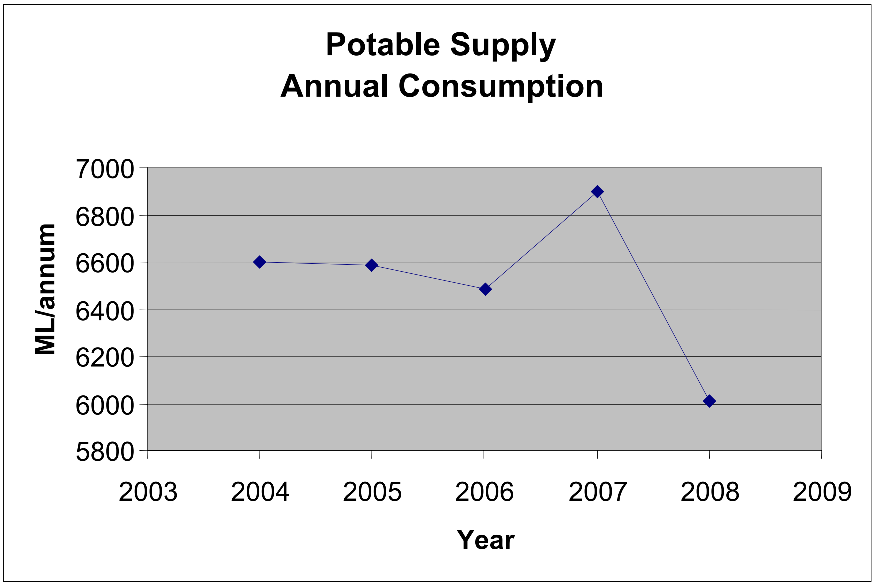
This system requires review and implementation of a recycle plan. The present disposal is to aland-disposal area which is not adequate for the purpose.

It is estimated, the upgrade of the Kapunda, Freeling and Greenock schemes will allow for an additional recycle of 100 ML per annum of treated water and will also allow for the production of higher quality water.

# 4.5 Reticulated Water

All supply points from the SA Water network are metered. Most meters are read twice yearly. SA Water has provided metered consumption data for the Barossa and Light region for the last five years. The total potable supply over the last five years is shown in Figure 4.7. The low consumption in 2008 is most likely due the water restrictions currently in place so, if this figure is ignored, the average over the preceding four years was 6640 megalitres per annum.

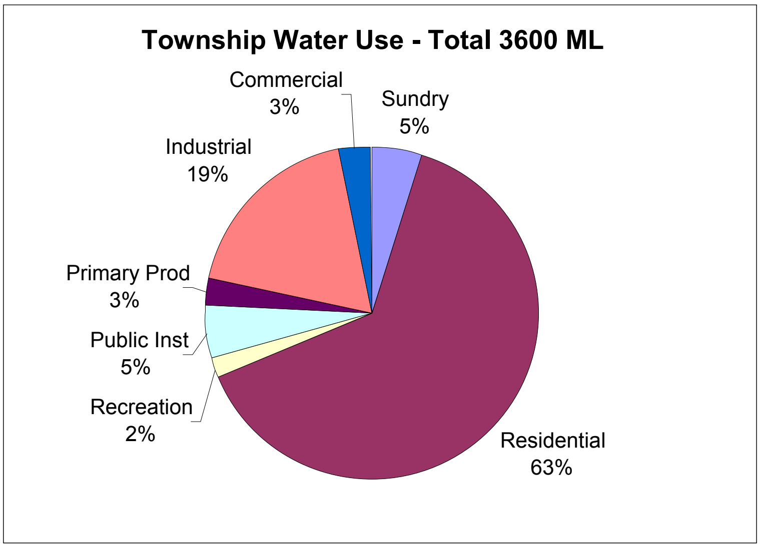
**Figure 4.7 Barossa and Light – Annual Potable Consumption**




Of the average annual consumption of 6,640 ML, just over 50% (3,600 ML) is used within townships. The use on Recreation and Public Institutions is low, in percentage terms, compared with many other rural areas and reflects the relatively good rainfall the area receives and the availability of alternative supplies, including bore water, for irrigation of sporting facilities and other open space areas.

The other SA Water network usage, 3,000 ML, is supplied to rural areas from the country mains distribution network and would provide water for domestic purposes, stock water and some irrigation. The actual end use is unable to be discriminated from the data.

**Figure 4.8 Country Lands Usage**



# 5. Future Demand to 2045

The demands on water in the Barossa and Light are expected to grow substantially as the region experiences significant development and growth in the viticultural, wine, tourism and horticultural industries, as well as in residential areas. Ongoing, or possibly permanently reduced River Murray allocations, combined with the impact of drought on surface and groundwater supplies, continue to impact on the region's water supplies. In 2008/09 the allocation to BIL of 1260 ML (18% of the 7000 ML annual supply) saw growers accessing alternative sources of water, with some concerns raised. For example, reverting to increasingly saline groundwater potentially impacts on sustainable growth of the resource. The general under-utilisation of groundwater allocations is understood to result from a combination of factors including low yielding bores and marginal underground water quality in some areas. It is worth noting that despite the reduced allocations, some growers continue to purchase water on the market via BIL, thereby maintaining high quality water to their crops

Restrictions imposed by SA Water on mains water use in February 2008, at 62% of the previous 12 months water use, will have a significant impact on a large number of growers in the 2008/09 growing season.

Climate change impacts on surface water capture and associated runoff into dams are manifested in decreasing reliability and higher evaporation as temperatures increase. Similarly less watercourse flow and groundwater recharge are predicted in future, interspersed with extreme events.

The anticipated future demands by 2045 for water cannot be met by any significant increase beyond current levels of water allocation and use from native water resources within the region. The demand may be met by the use of a range of strategies including, but not limited to, inter- and intra-basin transfers, recycle of wastewater and MAR.

## 5.1 Wine and Viticulture Industries

Growth predictions for grape production in the area equate to a prediction of 0.2% increase every five years, equating to approximately 100,000 tonnes in 2045. It is also predicted that several hundred thousand tonnes of grapes will be crushed or processed in the region in 2045.

### 5.1.1 Current pattern of Water Use

For those management zones where prescription under the *Natural Resources Management Act 2004* has not occurred (eg Light Management Zone) and/or reliable metered data is not available, the 2007/08 metered data from the Barossa, accepted application rates, soil types, local knowledge and current land use data (DWLBC 2008) were all used to calculate viticultural water use for the entire region (Table 5.1).

In 2007/08, the total recorded volume of water used for irrigation of grapes in the region was approximately 7,413 ML. This data should be treated with caution due to the lack of a comprehensive metering and reporting strategy for the entire region. Table 5.1 outlines the estimated water used for viticulture within the six management zones.

**Table 5.1 Volume of Water Used for Viticulture (2007/08)**

| Management Zone | Volume of Water (ML) |
|---|---|
| Greenock Creek | 1000 |
| Valley Floor | 7000 |
| Jacob and Tanunda Creek | 1500 |
| Flaxman Valley | 1000 |
| South Para | 500 |
| Light River | 1800 |
| **Total** | **12,800** |

Irrigation application rates for each management zone varied heavily dependent upon crop type, crop age, soil type and rainfall. Average irrigation rates varied between 40 mm/Ha/year in the upper reaches of the Valley Floor and Greenock Creek Management Zones, to over 100 mm/Ha/year in Jacobs and Tanunda Creek Management Zone. Irrigation efficiencies within the region have improved significantly to the extent that the viticultural irrigators are considered market leaders.

### 5.1.2 Future Viticulture Irrigation Requirements

The growth predictions for grape growth production equates to a forecast of 100,000 tonnes per annum. Based on the assumption that irrigation efficiency rates remain at their current level, the water demand to meet the grape growth predictions has been estimated. It is estimated that water use will remain relatively stable at approximately 13,000 ML per annum, dependent upon climatic conditions, soil types, grape varieties grown amongst other factors. The change in pattern of water use associated with climate change, including the need to maintain crops, flush salt and account for increased evaporation and evapotranspiration may lead to an increased annual water volume that is statistically different from the figure presented above. Detailed modelling incorporating climate change scenarios are required to ascertain a volumetric prediction, incorporating a variety of spatial and temporal scales.

### 5.1.3 Climate Change Impacts on Future Viticulture Irrigation Requirements

Taking into account climate change impacts, which are estimated to be an increase in water demand equating to approximately 4% per degree of warming (Hayman *et al* 2007), the upper and lower climate change scenarios and their anticipated viticultural water requirement impact have been calculated for the grape growth prediction (Table 5.2).

**Table 5.2 Viticultural Water Demand in 2045: Climate Change Scenarios**

| | Lower | Upper |
|---|---|---|
| Water Demand | 13,050 | 13,700 |
| Volume Increase (ML) | 250 | 900 |

Consequently, it is estimated the region could potentially need to source up to an additional 1000 ML of water per annum for viticulture by 2045 as a result of climate change. More sophisticated modelling is required in order to determine the impact of all parameters on viticultural water use, including soil type, grape type, irrigation efficiencies, spatial, temporal and rainfall variability. It is believed that these figures underestimate water needed for viticulture into the future.

### 5.1.4 Winery Effluent

It is assumed that by 2045, the commercial, social, environmental and legislative imperative regarding winery effluent will be for minimising volumes, whilst capturing and reusing any effluent that is produced. Hence it is assumed that all winery effluent produced in the region by 2045 will be made available for recycle.

Using a figure of 600,000 tonnes of grapes crushed or processed in the region by 2045 and a market leading winery effluent production rate of 0.6 litres for every litre of wine produced, the volume of winery effluent produced annually in 2045 is expected to be approximately 400 ML. This is a 50% decline from the current volume produced, estimated to be in the vicinity of 800 ML per annum. As stated above, the water quality consequences of reusing this water needs to be carefully managed.

## 5.2 Population Growth

As the population targets included within the *State Strategic Plan* and *Prosperity through People: a Population Policy for South Australia (2004)* are government policy, it is necessary to determine water resource requirements for those targets. Utilising the predictions contained within the *Plan for Greater Adelaide* (2009), it is estimated that the Barossa Statistical region (which includes Gawler and Mallala) may have a population in excess of 150,000 people by 2045. Roseworthy is identified as the centrepiece of this strategy with population targets in the vicinity of 60,000 - 100,000 people. Using the industry standard of 2.4 persons per household, this could lead to an additional 40,000 additional dwellings in Roseworthy alone.

### 5.2.1 Reticulated Water

Barossa and Light is on the northern fringe of the greater Adelaide Metropolitan area and residential expansion of Adelaide will be a key driver of growth in the Barossa and Light. It is anticipated that by 2045 the population in the region will increase from the current 35,000 to 150,000. The increased residential water demand for the area equates to some 12,000 ML each year and with a 25% allowance for associated commercial, recreational and public institution requirements the increased demand is likely to be 15,000 ML.

Two major growth centres identified are Roseworthy, which is some 7 km north of Gawler, and Concordia, which is 3.4 km east of Gawler. Both of these major growth centres currently receive potable water supply from the Barossa trunk main system and utilise water resources of the South Para River. Concordia is immediately north of the trunk water main from Barossa Reservoir to Gawler. Roseworthy is currently served by a spur main from this trunk main which will need to be upgraded as growth occurs.

Accompanying the residential growth will be industrial growth. Assessing supply of water to industry can be problematic as it depends significantly on the type of industry and the associated demand for water. Much of the area available for industrial growth north of Gawler is currently on the limit of the supply network capacity and thus not conducive to industry with high water use. With the source of most water ultimately being the River Murray, transport costs are high. High water use industries are best established adjacent the major trunk main system or will need to consider alternative water supply such as reclaimed wastewater, stormwater or off peak supplies with significant local storage.

The demand for water for irrigation of horticulture in the region is likely to grow. As Adelaide grows overall demand for fruit and vegetables will increase and residential development in the Virginia Irrigation Area will force some existing growers to move north to the Light River area. Thus the region will be a target area not only to meet new demand but also due to the relocation of existing capacity. Further expansion of the wine industry will also be anticipated over the planning period.

#### (a) Supply Side Strategies

The following are possible strategies which would enable supply to be increased to meet the growth in demand. The final solution will be a combination of measures that needs to be assessed while also meeting the demand for the whole water sector in SA.

Major residential growth due to the expansion of Adelaide will need to be met by SA Water. This is likely to be achieved through using the existing Barossa Trunk main system to serve growth in the north and switching areas further south, currently supplied from the Barossa systems to alternative supplies. For Adelaide as a whole, the spare bulk supply capacity is generally in the South via the Murray Bridge-Onkaparinga pipeline and will be further increased with the construction of a desalination plant at Lonsdale. Developers will most likely need to contribute to the additional network capacity.

The current SA Water system is sized to meet peak summer demands and has limited spare peak capacity. The demand on peak summer days is some 2.7 times the annual average demand and thus additional water can be supplied during off-peak periods. For non-potable use the storage of off-peak water for use during summer provides a real opportunity to increase apparent network capacity. Off-peak water is currently being used in some systems, primarily in areas which have high value non-potable demand, a network that is experiencing pressure problems during summer and that is expensive to duplicate. To make use of the additional apparent capacity this strategy still requires obtaining additional source water, through purchase of additional River Murray water licenses. This is problematic, given the current inability of the Murray Darling Basin Authority (MDBA) to supply water for current licenses.

Expansion of residential and industrial developments brings with it a wastewater volume that should be viewed as an additional resource. The need for an additional 15,000 ML to meet residential and associated demand will provide a wastewater resource in the order 6,500 ML which need to be put towards meeting other demands in the area, both recreational and horticultural. With a large local demand for non-potable water it is expected that the most economic method of re-use will be collection, centralised treatment and re-use. Wastewater from Gawler is currently transported south some 26 km to Bolivar WWTP for treatment. A significant portion of the Bolivar effluent is treated to a standard suitable for re-use on horticulture at Virginia, which is 13 km north of Bolivar. With expansion at Roseworthy the distance to Bolivar becomes 33km with the return pipeline also being 7km longer. Treated wastewater from Bolivar has a relatively high salinity due to inflow of saline groundwater in the catchment near sea level (eg Gillman) and the high salinity limits crop choice and reduces yields. The localised treatment of wastewater north of Gawler has the potential to provide a low salinity re-use resource.

### 5.2.2 Urban Stormwater Runoff

Within the Barossa and Light region there is currently an estimated 6,000 ML of stormwater runoff from the intensive land use areas, principally the region's townships. A MUSIC Model (eWater CRC 2009) was constructed to determine indicative stormwater runoff volumes for the region in 2045 and MAR yields. It was assumed that 100,000 people would reside in Roseworthy, 10,000 in Concordia, with the remaining townships experiencing relatively smaller growth. Information supplied by the Light Regional Council and Barossa Council on Development Planning strategies pertaining to allotment sizes (300m$^2$ to 800 m$^2$) and site coverage (50 – 70%), enabled the runoff volumes for the upper and lower bound climate change scenarios to be determined (Table 5.3). Yields were calculated based on multiple bores being used with injection rates of between 10 – 75 litres per second considered.

**Table 5.3 Estimated Stormwater Runoff and Yield for two Climate Change Scenarios**

| | Lower | Upper |
|---|---|---|
| Estimated Stormwater Runoff (ML/annum) | 8,000 | 10,500 |
| Yield (ML/annum) (Injection Rate 10 L/s) | 80 | 105 |
| Yield (ML/annum) (Injection Rate 75 L/s) | 4,000 | 5,750 |

Detailed rainfall runoff modelling would need to occur for each new development to determine more accurate predicted volumes. A significant proportion of this additional stormwater runoff would occur within Roseworthy. A review of the hydrogeology of the region indicates that there are high yielding bores to the west of Roseworthy. The construction of a wetland and MAR bore scheme in this location would be the preferred location for a water treatment and harvesting system. Stormwater is currently considered in the existing water balance modelling for the Barossa Prescribed Water Resources Area.

Significantly, the planning and design constraints placed upon any large scale development such as Roseworthy would only be able to maximise capture and storage capacity by embedding Water Sensitive Urban Design (WSUD) principles within the relevant Development Plan. Retrofitting solutions will be expensive and disallow meeting capture efficiencies that would be established with a comprehensive WSUD development. The infrastructure challenges for delivering water under both developmental and retrofit stormwater strategies is considered a significant impediment to fully utilising not only captured stormwater but all other forms of water. The development of a coordinated water related infrastructure strategy is necessary to enable complete spatial coverage of the region. Eden Valley is one area where the implication of infrastructure shortages is actually a reality. Whilst this nominally relates to Water Allocation Plan related water delivery, a holistic water delivery framework would currently be limited in this region.

Stormwater management planning is required within the region, and has a significant bearing on general water management in the region as it may enable supplementation of existing supplies for amenity horticulture and other uses. The development of stormwater management plans needs to take into account rural watercourse flow management - that being rural runoff, stormwater runoff, wastewater recycle and groundwater connectivity issues are managed in an integrated manner. It is recommended that such stormwater management plans are developed for each town within the region. Whilst all of the plans will have the same base level of information, each will be required to have individual aspects captured, all the while meeting the Stormwater Management Authority's principles.

### 5.2.3 Amenity Horticulture

Whilst the Barossa and Light region anticipates significant population and developmental growth to 2045, the values of the region need to be enunciated and a coordinated plan needs to be developed to account for these values, whilst at the same time allowing for this growth. With the tourism industry providing an increasing economic return to the region, appropriate planning strategies are required to ensure the cultural and amenity values of the region are maintained, if not enhanced. Current water use for amenity horticulture in the region is relatively low.

The region also needs to look towards supporting facilities which encourage residents to reside in the area long term. This is increasingly important as the concern with the use of energy resources, fossil fuels and greenhouse emissions and the associated increased costs of commuting outside of the area may also impact on the area's attractiveness for residents.

The strategic location of dense green spaces including parklands, green recreational facilities and developing waterway linear parks should be required for all new developments. It is recommended that Council Development Plans should have these requirements embedded within them.

Planning law currently legislates for a minimum of 12.5% open space for new developments. In order to demonstrate leadership in this area, the strategic plan will advocate a minimum of 15% open space. With this, Roseworthy alone could have potentially over 300 ha of open/green space required to be irrigated. Based on current reported irrigation rates for landscapes such as ovals and significant green spaces, this could equate to 600 ML per annum required to maintain these open/green spaces. For the region, this is estimated to be 800 ML per annum. 15% open space could be considered conservative and it is recommended that a consultative community discussion is enabled to determine an aesthetic vision for the region.

### 5.2.4 Recycled Wastewater

It is anticipated that all Community Wastewater Management Systems (CWMS) in the region would be required to be upgraded to meet the demand on the systems via population increases, as well as technology improvements as they become cost effective. For the proposed expansion of residential and industrial developments in Roseworthy, this brings with it a wastewater volume that should be viewed as an additional resource. With the large local demand for non-potable water it is expected that the most economic method of re-use will be collection, centralised treatment and re-use. A facility constructed for Roseworthy, to be utilised within the region will allow an additional 6500 ML of recycled wastewater per annum by 2045. Regionally, an additional 9000 ML per annum of recycled wastewater could become available.

The combined re-use volume due to the additional residential development (11,500 ML) is some 75% of the additional residentially associated demand. It is considered that the most economically efficient use of the re-use water is in large non-residential demands rather than 3rd pipe systems to each household. If implemented as part of the overall planning strategy, the re-use will be a significant contributor to meeting other increased water demand.

**Current water use demands and projections for 2045 are summarised in figure 5.1**

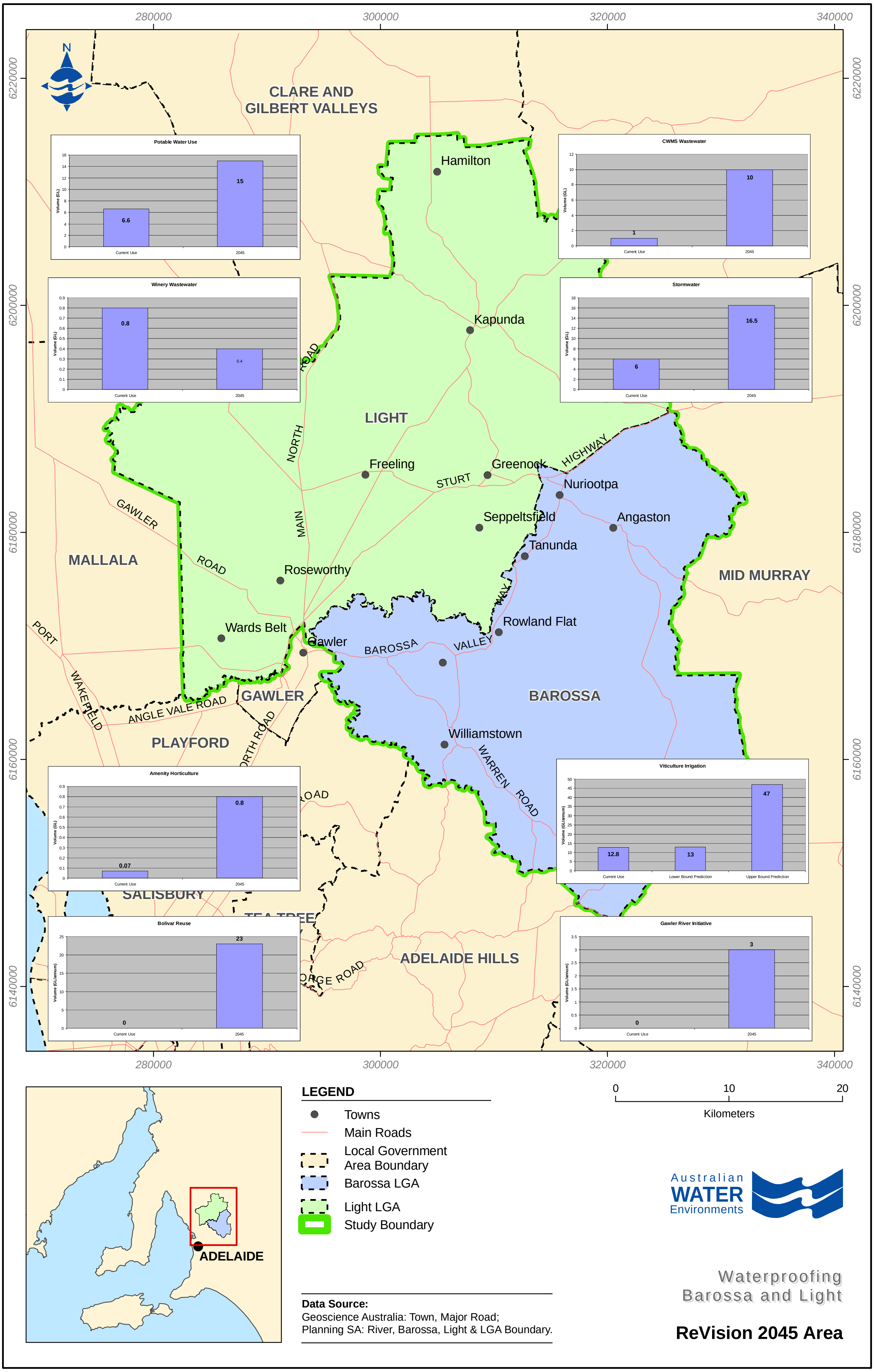



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Figure 5.1

# 5.3 Climate Change Impacts on Natural Resources

The impact of upper and lower band climate change scenarios have been made by utilising the annual and seasonal average temperature and rainfall changes for 2030 calculated for the Adelaide and Mount Lofty Ranges Natural Resources Management Board Region, based on the Special Report on Emissions Scenarios (SRES) and for two CO2 stabilisation scenarios (Suppiah *et al* 2006).

**Table 5.4 Upper and Lower Climate Change Temperature and Rainfall Predictions**

| | Lower | Upper |
|---|---|---|
| Annual Temperature Rise | 0.1 | 1.3 |
| Annual Rainfall Decreases | 1% | 10% |

Modelling was conducted using the assumptions that a 10% decline in rainfall equates to approximately 30% decline in runoff.

**Table 5.5 Annual Discharge under two climate change scenarios for the Barossa and Light region.**

| Management Zone | Mean Annual Discharge (ML/annum) | |
|---|---|---|
| | Lower | Upper |
| Greenock Creek | 212 | 153 |
| Valley Floor | 11,233 | 8,106 |
| Jacob and Tanunda Creek | 7,857 | 5,670 |
| Flaxman Valley | 2,352 | 1,698 |
| South Para | 14,229 | 10,268 |
| Light River | 6,790 | 4,900 |

Climate change impacts on the viticulture and tourism industries have already been described above. With respect to the water resources of the Barossa and Light region, the consequence of both the lower and upper band scenarios results in a significant reduction in mean annual stream flow. This will have multiple impacts on all users of the water resources of the region, including reduced recharge of the groundwater resources, reduced inflows to potable water supply storages, in particular, the South Para and Warren Reservoirs, and reduced inflow into dams for irrigation and stock and domestic uses. Coupled with these impacts will be the anticipated alterations in environmental water requirements as the ecology of the region adapts to the shifting hydrological and climatic landscape.

Whilst there may be reduced storm events, the intensity of storm events may increase, thereby potentially increasing flood risks and erosion issues. The water quality consequences of this new landscape will undoubtedly include increased turbidity and possibly algal issues.

It is recommended that more sophisticated modelling is required to be undertaken to determine the altered flow and water quality regime for the region to 2045 under the lower and upper climate change scenarios. This will need to incorporate generation and analysis of stochastic rainfall and evaporation data, transmission of water and constituents through dams, incorporating groundwater/surface water interactions and pathways for flow and constituents, including salt. See Section 8 for recommendations relating to water resource management data and modelling requirements, gaps and opportunities.

# 6. Managing Water in the Barossa and Light to 2045

## 6.1 Managing Water in the Future

Managing all water resources into the future will be increasingly challenging, particularly with the uncertainties associated with the extent and impacts of climate change. Maximising water efficiencies whilst accounting for the economic, social and environmental values of the region will require a range of options at a multitude of temporal and spatial scales. The Barossa and Light region has demonstrated leadership with Vision 2045 and the updated ReVision 2045 to determine water resource management options in the future. However, with the expansion of metropolitan Adelaide northwards and the increase in residential development within the Barossa and Light region itself, amenity horticulture requirements for elevated tourism into the region and an expected increase in viticulture and irrigated horticulture, each water resource management option will be required to be investigated and implemented at different regional scales – not necessarily limited to the Barossa and Light region. This is particularly important in a water constrained environment where the increasing cost of water could limit future growth.

ReVision 2045 has relied heavily upon community, industry and government stakeholder consultation to determine future regional values and ascertain strategies for managing water resources and water demand to 2045. There has been recognition that a range of strategies, including a water pricing review, is an area of strategic water management that requires a State or Federal level initiative. However, the key finding from this consultation has been to foster innovative strategies and to have a diverse array of water resource management options rather than relying on a few sources. Linking closely to the strategic planning of the State (*Water for Good* 2009) was also seen as a requirement to ensure a coordinated approach. The following section details the key strategies identified as part of this consultation and reflects the collective thinking on potential options for detailed investigations.

### 6.1.1 Leading Water Security Management in the Region

| **Initiative**: *Leadership in Water Security Management in the Barossa and Light* | | | |
|---|---|---|---|
| **Recommendation** | **Organisations** | **Volume (ML)** | **Timeframe** |
| • The Barossa and Light Regional Development Board (BLD) take the leadership role in delivering water security for the region to 2045.<br><br>• Explore mechanisms under the Local Government Act to form an independent Authority to oversee water security management in the region. | *Lead*<br>BLD<br><br>*Participatory*<br>All Stakeholders | 0 | To 2045 |

Leadership is required to deliver water security to the region. The water security management options to 2045 will encompass different spatial and temporal scales and require involvement from a broad array of stakeholders. Consequently, there is only one existing organisation that can provide the leadership and the mandate to drive the various water security strategies to implementation. The Barossa and Light Regional Development Board (BLD) is a partnership between The Barossa Council, Light Regional Council, the State Government of South Australia and regional industry. BLD's mission is to facilitate economic growth and activity for the Barossa and Light region. Increasing growth in the region associated with the viticulture, wine and tourism industries amongst others, coupled with anticipated significant residential development (up to an additional 100,000 people) is intrinsically linked to the availability and use of appropriate water resources. Consequently, it is incumbent for the organisation that drives economic growth and activity for the region to oversee the review, consultation, development and implementation of the water security projects in the region. Currently, the Barossa and Light Regional Development Board is best placed to undertake this role, in close consultation with the Office for Water Security.

Key Recommendation(s):

1. Barossa and Light Regional Development Board (BLD) take the leadership role in the competing demands facing water security for the region to 2045.

2. Establishment of an alternative management body and an appropriately constituted management group. It is also recommended that BLD continues to provide leadership in water security in the region once this management body is established.

### 6.1.2 Managed Aquifer Recovery (MAR)

| **Initiative**: *Managed Aquifer Recovery (MAR)* | | | |
|---|---|---|---|
| **Recommendation** | **Organisations** | **Volume (ML)** | **Timeframe** |
| • Undertake detailed investigation for the implementation of Managed Aquifer Recharge in the region | *Lead*<br>BLD<br><br>*Participatory*<br>AMLRNRM Board, DWLBC, EPA, Barossa Council and Light Regional Council | 0[1] | December 2010 |
| • Managed Aquifer Recharge initiatives be incorporated into all major residential developments in the region where feasible | *Lead*<br>Barossa Council and Light Regional Council<br>*Participatory*<br>BLD, AMLRNRM Board, DWLBC, EPA, Planning SA | 0[1] | June 2011 |

[1] Additional water is accounted for in other initiatives (eg stormwater recycling, wastewater recycling)

There are several areas throughout the study region that would be conducive to further Managed Aquifer Recovery (MAR) investigations and development.

#### (a) Barossa Region

Managed aquifer recharge is undertaken within the Barossa Prescribed Wells area. The 2007/08 Irrigation Annual Report indicates that a total of 85 ML of water is injected mainly into the Upper and Lower Aquifers. These are privately managed MAR's. This suggests that the region would be conducive to further MAR expiations. Potential options for further MAR development would include expanding current MAR schemes to include additional bores and/or investigate new MAR bore fields, though there is limited scope for this under the current regional Water Allocation Plan.

The Water Allocation Plan for the Barossa region states that 100% of the injected area may be extracted if the water has come from external/imported sources while only 80% may be extracted if injected water is sourced within the prescribed area (i.e. watercourse and surface water captured within the prescribed area).

Such conditions may influence the target aquifer (i.e. Upper or Lower Aquifer) and source water. For example, in areas where ambient groundwater salinity is higher and recovery efficiencies (NB: recovery efficiencies refer to the percentage of water extracted with acceptable salinity levels) are likely to be less than 100%, non-imported water would be recommended for injection. This would also have the benefit of gradually lowering the ambient groundwater salinity in such locations.

#### (b) Light Region

The region west of the township of Roseworthy presents an attractive opportunity for further MAR investigations. The Alma fault line runs approximately 5 km west of the township of Roseworthy in a north-westerly direction. The hydrogeology west of the Alma faults is characterised by the Quaternary sediments underlain by the Tertiary Aquifers of the Northern Adelaide Plains. The First and Second Tertiary aquifers (T1 and T2 Aquifers) have been widely targeted for MAR over the past 10 years. MAR schemes developed west of Roseworthy would also have the benefit of being within reasonably close proximity to "imported" water supplies such as Bolivar reclaimed water and urban run-off from the Northern Expressway.

Key Recommendation(s):

1. Undertake detailed investigation for the implementation of Managed Aquifer Recharge in the region.

2. Legislate for Managed Aquifer Recharge initiatives to be incorporated into all major residential developments in the region.

### 6.1.3 Stormwater Recycling

| **Initiative**: *Stormwater Recycling* | | | |
|---|---|---|---|
| **Recommendation** | **Organisations** | **Volume (ML)** | **Timeframe** |
| • Develop Stormwater Management Plans for each township within the region while accounting for the requirements of the relevant water allocation plan. | *Lead*<br>Barossa Council and Light Regional Council<br>*Participatory*<br>BLD, AMLRNRM Board, DWLBC, SMA, EPA, LGA | 0 | June 2011 |
| • All new large scale developments (residential and industrial) to capture and recycle stormwater within the region whilst accounting for the requirements of the relevant Water Allocation Plan. | *Lead*<br>Barossa Council and Light Regional Council<br>*Participatory*<br>BLD, AMLRNRM Board, DWLBC, SMA, EPA , DPLG | 6,000 | June 2011 |

A number of targets for stormwater recycling, linked in part to Managed Aquifer Recovery have been established in previous strategy documents. For example, Water Proofing Adelaide (2005) estimated, in an average year, approximately 160,000 ML per annum of storm water could be reclaimed and used for irrigation in the Adelaide region. Water for Good (2009) establishes a target of 15,000 ML per annum of stormwater harvesting potential in South Australia's regional areas by 2050. Preliminary MUSIC modelling as part of this investigation has predicted an additional 8,000 to 10,500 ML of stormwater would runoff from the increased residential developments in the Barossa and Light region by 2045. Up to 6,000 ML could be stored for recycle subject to policies in the relevant water allocation plan.

Key Recommendation(s):

1. Develop Stormwater Management Plans for each township within the region while accounting for the requirements of the relevant water allocation plan.

2. Legislate for all new large scale developments (residential and industrial) to capture and recycle stormwater within the region whilst accounting for the requirements of the relevant Water Allocation Plan.

### 6.1.4 Wastewater Recycling

**Initiative**: *Wastewater Recycling*

| Recommendation | Organisations | Volume (ML) | Timeframe |
|---|---|---|---|
| • Establish a centralised wastewater management system which accounts for the anticipated significant regional development around Roseworthy, and which collects, treats and re-uses the recycled water within the region. | *Lead*<br>BLD, Barossa Council and Light Regional Council<br><br>*Participatory*<br>AMLRNRM Board, EPA, LGA, DoH, Other Relevant Councils | 6,500 | June 2025 |
| • All new large scale residential development to investigate the suitability of incorporating greywater recycling. | *Lead*<br>Barossa Council and Light Regional Council<br>*Participatory*<br>BLD, EPA, LGA, DoH | Unknown | June 2011 |
| • All industries collect, treat and recycle their wastewater within the region where suitable recycle options exist. | *Lead*<br>Barossa Council and Light Regional Council<br>*Participatory*<br>BLD, EPA, DoH | Unknown[2] | June 2011 |
| • For each new wastewater recycle initiative, undertake detailed analysis of recycle consequences and develop and implement a management plan to mitigate against any risks | *Lead*<br>BLD, Industry Organisation<br><br>*Participatory*<br>Relevant Industry Group, EPA, DoH, Barossa Council and Light Regional Council | 0 | Ongoing |

[2] For the viticulture and wine industry, this is estimated to be 400 ML per annum by 2045

It is anticipated that within the next five years, all wastewater from residential allotments captured within the Councils Community Wastewater Management System (CWMS) will be recycled in the region. Expansion of residential and industrial developments in the region will result in a wastewater volume that should be viewed as an additional resource. The additional wastewater resource in the region will equate to 6,500 ML per annum which could be put towards meeting other demands in the area, both recreational and horticultural. With a large local demand for non-potable water it is expected that the most economic method of re-use will be collection, centralised treatment and re-use. Establishing a centralised plant near Roseworthy that can service the expansion of Roseworthy and the greater region (including an expanding Gawler) is one strategy that could minimise infrastructure costs and reduce the environmental impact on the Gulf.

New residential allotments should incorporate greywater recycling where appropriate. An understanding of site characteristics, including soil type and other factors, are important considerations for permanent greywater systems. It is not possible to adequately control the quality of greywater, and therefore rules governing permanent system installations need to take account of site-specific factors.

Waste water from wineries is now being recycled at the North Para Environmental Control Waste Water Treatment Plant and piped to seven Barossa vineyards for recycle in irrigation. It is anticipated that by 2045 all industries, including wineries, will have the facility to capture, treat and recycle all streams of wastewater. Long-term changes in soil and sustainability of the resource must be quantified and managed.

Key Recommendation(s):

1. Establish a centralised wastewater management system, which accounts for the anticipated significant regional development around Roseworthy, and which collects, treats and re-uses the recycled water within the region.

2. Legislate for all new large scale residential development to investigate the suitability of incorporating greywater recycling.

3. Legislate that all industries collect, treat and recycle their wastewater within the region where suitable recycle options exist.

4. For each new wastewater recycle initiative, undertake detailed analysis of recycle consequences and develop and implement a management plan to mitigate against any risks.

### 6.1.5 Considered Developmental Planning

| **Initiative**: *Considered Developmental Planning* | | | |
|---|---|---|---|
| **Recommendation** | **Organisations** | **Volume (ML)** | **Timeframe** |
| • Seek community and stakeholder input into current and future regional values and integrate within Council Development Plans ensuring development planning accounts for those values. | *Lead*<br>BLD, Barossa Council and Light Regional Council<br><br>*Participatory*<br>LGA, Planning SA | 0 | June 2011 |
| • Incorporate Water Sensitive Urban Design principles into Council Development Plans and ensure all new residential developments comply with those principles | *Lead*<br>Barossa Council and Light Regional Council<br>*Participatory*<br>BLD, Planning SA | 0 | June 2011 |

Associated with the projected significant increase in population in the region, are significant increases in water demand. The region's stakeholders strongly believe that the Barossa Council and Light Regional Council have a duty to ensure development is managed appropriately. This incorporates embedding Water Sensitive Urban Design (WSUD) principles in their respective Development Plans, allowing for sufficient green and open spaces to facilitate a sense of community and maintaining the cultural, social and environmental values of the region. The region's stakeholders have clearly stated throughout the consultation period that ensuring planning principles satisfy these requirements will reduce requirements (and costs) to retro-fit solutions between now and 2045. Moreover, sufficient provision for amenity horticulture and tourism requirements will be enunciated.

#### (a) Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) is an approach which integrates the management of all water resources and the total water cycle into the urban development process.

WSUD includes:

- utilising water saving measures within and outside domestic, commercial, industrial and institutional premises to minimise requirements for drinking and non-drinking water supplies;
- storage, treatment and beneficial use of runoff (at building and street level, including stormwater);
- treatment and recycle of wastewater; and
- using vegetation for treatment purposes, water efficient landscaping and enhancing biodiversity and amenity.

Incorporating WSUD principles into the respective Council's Development Plans will mandate any future developments to consider its water resource footprint and have input into all aspects of land use planning and development to improve water use efficiency.

Key Recommendation(s):

1. Seek community and stakeholder input into current and future regional social values and integrate within Council Development Plans, thereby ensuring development planning accounts for those values.

2. Incorporate Water Sensitive Urban Design principles into Council Development Plans and ensure all new residential developments comply with those principles.

### 6.1.6 Premium Wine Production

| **Initiative**: *Premium Wine Production* | | | |
|---|---|---|---|
| **Recommendation** | **Organisations** | **Volume (ML)** | **Timeframe** |
| • Undertake a regional review on strategic directions for viticulture and wine industries with respect to water use and grape quality. | *Lead*<br>BLD, Wine Barossa, BIL<br><br>*Participatory*<br>Industry Organisations | 0 | June 2012 |

Consultation with all stakeholders for ReVision 2045 has delivered a strong message regarding water use efficiencies, including irrigation efficiencies and the move towards a larger proportion of premium wine grapes grown and premium wine produced in the region. Premium wine grapes generally do not require large volumes of water, although the timing is critical. The Barossa and Light region is well regarded with respect to current and continuing improvements in water use efficiencies. The mix of viticulture and wine production in the region, coupled with the significant differences across the landscape (eg climate, soil, rainfall etc), ensures minimum water requirements for grape production varies significantly. Whilst it is not a linear relationship, it is considered that larger irrigation volumes can lead to reduced grape quality. The issue with minimising irrigation volumes is that salt can accumulate in the root zone, especially of drip irrigated vines in premium wine growing areas. The effect of salt on vine performance is dependent on winter rainfall. This may be mitigated by establishing soil management strategies for drip irrigated vineyards in the Barossa Valley. This will need to occur for the full suite of soil types and irrigation water quality. Moreover, innovative strategies can be fostered, including implementing vineyard salinity mapping using electro-magnetic induction and other technologies that will enable real time monitoring of soil salinity & nutrients.

Key Recommendation(s):

1. Undertake a regional review on strategic directions for viticulture and wine industries with respect to water use and grape quality.

### 6.1.7 Inter Basin Transfers

| **Initiative**: *Inter Basin Transfers* | | | |
|---|---|---|---|
| **Recommendation** | **Organisations** | **Volume (ML)** | **Timeframe** |
| • Undertake a detailed investigation of the social, economic and environmental consequences of each inter-basin transfer option. Where suitable, enter into a long term agreement for water to be supplied from that inter basin transfer option (Certainty). | *Lead*<br>BLD<br><br>*Participatory*<br>SA Water, BIL, , Wakefield Group, OWS, DoH, EPA, DWLBC, AMLRNRMB, Barossa Council and Light Regional Council | 3,000 (GRI)<br><br>23,000 (Bolivar) | June 2011 |

With the River Murray currently under significant stress, the prevailing view amongst the Barossa and Light stakeholders regarding inter- and intra-basin transfers was that it should be limited to reclaimed water unless purchased on the open water market. There are currently four inter-basin transfers identified for further investigation regarding their economic, social and environmental considerations.

#### (a) Gawler River and Northern Expressway Initiative

The Gawler River Initiative is a proposed stormwater recycle scheme which integrates the developments planned for Greater Gawler and the regional towns including Roseworthy to initially provide about 3,000 ML for non-potable urban uses.

The collection system integrates all existing and proposed urban stormwater system developments from Gawler Urban Rivers Project (GURP), as well as development of Evanston South, Gawler East, Concordia and Roseworthy. The scheme concept to date would involve controlled releases from the North and South Para Rivers. The main harvest location is proposed at the Northern Expressway crossing (see below) near Wingate Road where flood detention works are required. The scheme incorporates MAR which would be in the T2 aquifer west of the Alma fault and require up to 20 bores.

Water is proposed to be distributed through about 30 km of main forming a ring through the town and including 3.5 km in Evanston South and 4 km in Roseworthy, as well as 3 km in Kingsford Estate, all of which may be subject to developer's contributions.

The Northern Expressway Project consists of two components, the new Northern Expressway and the Port Wakefield Road Upgrade. The Northern Expressway will be a new 23 kilometre road with a pedestrian and cycle pathway linking the Gawler Bypass with Port Wakefield Road at a point about three kilometres north of the Waterloo Corner Road intersection. Modelling indicates that a 22,000 ML dam would fill every ten years and that the average annual volume of water captured will equate to approximately 3,000 ML.

Access to this water is dependent upon storage facilities, principally suitable Managed Aquifer Recovery sites and infrastructure to deliver the water to the region.

It is important to note that the Gawler River is a prescribed watercourse. Water will need to be secured through an application for an allocation when the Western Mount Lofty Ranges Water Allocation Plan is adopted, if there is water available under the plan.

### (b) Sewer Mining – Bolivar

The Bolivar Wastewater Treatment Plant receives wastewater from a significant proportion of metropolitan Adelaide. Whilst the water is treated and disposed to the Gulf, some of the treated wastewater is transported to the surrounding areas, principally within the District Council of Mallala for agricultural and horticultural use. The Adelaide Plains currently use 12,000 ML of recycle from Bolivar. It is estimated that another 23,000 ML is, and will become, available from Bolivar in coming years.

Any access to this water will require appropriate infrastructure and contractual agreement. Sewer mining is defined as the process of tapping into a sewer (before or after it reaches the sewage-treatment plant) and extracting the sewage so that it can be treated in a separate treatment facility and put to another use as recycled water (Sydney Water, How to Establish a Sewer Mining Operation, May 2006). Although the production and supply of recycled water could be undertaken by the sewerage service provider, sewer mining is normally associated with third-party access by persons who either use the recycled water for their own purposes or supply it to others. In that sense, sewer miners are a subset of a wider class, known as third-party access seekers. Sewer miners engage in sewer mining by virtue of a contractual agreement with the public water infrastructure owner.

Treated wastewater from Bolivar has a relatively high salinity due to inflow of saline groundwater in the areas of the catchment near sea level (eg Gilman) and the high salinity limits crop choice and reduces yields. Appropriate management plans would need to be devised for any irrigation undertaken using this water resource, including potentially shandying the recycle water.

### (c) Desalinisation Plant

The Adelaide Desalination Project, located at Port Stanvac, is estimated to deliver up to 100,000 ML of water each year - about half of Adelaide's water supply. A transfer pipeline system to deliver water from Port Stanvac to the Happy Valley water treatment supply will enable water to enter the distribution network. Any potential additional Desalinisation plants to service the State's potable water needs would utilise similar water transfer solutions. Considering the current SA Water system is sized to meet peak summer demands and has limited spare peak capacity, an alternative integrated delivery solution may need to be found.

Key Recommendation(s):

1. Undertake a detailed investigation on the social, economic and environmental consequences of each inter-basin transfer option. Where suitable, enter into a long term agreement for water to be supplied from that inter-basin transfer option (Certainty).

2. Further investigate localised desalination (and brine disposal) of saline underground water resources for domestic use, as well as viticulture and horticulture.

### 6.1.8 Shared Water Supply Infrastructure Network

| **Initiative**: *Shared Water Supply Infrastructure Network* | | | |
|---|---|---|---|
| **Recommendation** | **Organisations** | **Volume (GL)** | **Timeframe** |
| • Review the water supply infrastructure network ownership arrangements, for the purpose of establishing a coordinated regional third party access agreement for all water supply infrastructure. This review will need to consider supply capabilities, legislative consequences and commercial opportunities and liabilities. | *Lead*<br>BLD<br><br>*Participatory*<br>SA Water, BIL, Barossa Council, Light Regional Council, BC, Wakefield Group, OWS, DoH, EPA, DWLBC, AMLRNRMB | 0 | June 2010 |

Intra- and inter-basin transfers, including those listed above, require significant investment in appropriate infrastructure to deliver water to the region. Barossa Infrastructure Limited (BIL) enabled such a development for supply of irrigation water to its constituents however, generally, costs are prohibitive for any commercial entity to develop it's own supply infrastructure network to satisfy either it's own demands and/or customers' demands. Fostering the innovative solutions, the Barossa and Light region's stakeholders have identified the need to provide new third-party (and usually private-sector) access to public and/or private sector infrastructure in order to make better use of these valuable water resources.

Providing a range of private-sector entities with access to water supply infrastructure, and facilitating private-sector wastewater services will require sophisticated levels of science and technology. It may also require the development of an appropriate legislative framework to regulate private-sector access and services. The issues of how to maintain quality standards and societal protections in the face of private-sector involvement in the supply of water resources also presents a legislative challenge. There are currently a number of third party access agreements to SA Water's infrastructure. Barossa Infrastructure Limited is one such example. Water for Good (2009) describes the requirement for water and wastewater service providers to be licensed under these third party access arrangements.

Key Recommendation(s):

1. Review the water supply infrastructure network ownership arrangements, supply side capabilities, legislative consequences and commercial opportunities and liabilities associated with establishing a coordinated, regional third party access agreement for all water supply infrastructure.

### 6.1.9 Small Scale Desalinisation

| **Initiative**: *Small Scale Desalinisation* | | | |
|---|---|---|---|
| **Recommendation** | **Organisations** | **Volume (ML)** | **Timeframe** |
| • Consult extensively with the relevant community and stakeholder groups regarding proposed small scale desalinisation schemes. | *Lead*<br>BLD<br><br>*Participatory* | Unknown | As required |
| • Ensure any small scale desalinisation scheme satisfies the legislative requirements and does not diminish the social, economic and environmental values of the region. | *Lead*<br>BLD<br><br>*Participatory* | 0 | As required |

Water for Good (2009) describes desalination as that which can be used to process treated wastewater and brackish groundwater for use in industry processing. Small scale desalination or community based desalinisation projects utilising the saline groundwater reserves has been identified as an area for further investigation within the Barossa and Light region. Issues associated with the implementation of such schemes include maintaining the groundwater ecosystem values, the establishment, running and maintenance costs, the environmental impact of brine disposal and the significant energy demands. By 2010, there is expected to be a State desalination policy which will guide future desalination plant proposals. It is assumed that any such small scale desalinisation scheme would be funded by the operators of the scheme. Eden Valley is one such area to explore the possibility of small scale desalinisation given the lack of BIL or supplementary water sources and the reliance on existing groundwater sources that are relatively saline.

Extraction and desalination of saline groundwater would appear at first glance to be an attractive (albeit possibly costly) solution. There are however a range of potential resource management issues that will still require careful consideration. For example, localised lowering of groundwater levels may result in a reduction of brackish base flows in streams which may then have detrimental environmental impacts. Similarly, lowering of groundwater levels in saline areas may alter the pattern of regional groundwater flows and recharge and thereby have impacts on groundwater resources beyond the immediate zone of influence. It is possible that neither of these issues will be significant, but they are plausible and serve to highlight that the groundwater and surface water resources are intrinsically linked with the natural resources of the region and will required careful management (even though they are salty) to ensure unexpected impacts do not occur. The energy requirements and brine disposal associated with small scale desalinisation plants are significant areas of concern that need to be assessed carefully.

Key Recommendation(s):

1. Consult extensively with the relevant community and stakeholder groups regarding proposed small scale desalinisation schemes.

2. Ensure any small scale desalinisation scheme satisfies the legislative requirements and does not diminish the social, economic and environmental values of the region.

# 7. Conclusions

## 7.1 Current Regional Trends

### 7.1.1 Social, Demographic and Economic Data

- The value of output of the region for 2006/07 was $3.08 billion. The top five contributors to that were:
    - wine (30.7 per cent);
    - wholesale trade (5.2 per cent);
    - ownership of dwellings (5.1 per cent);
    - food products (3.8 per cent); and
    - retail trade (3.7 per cent);
- The population of the Barossa and Light region as of 30th June 2008 was estimated to be approximately 35,490;
- The tourism industry plays an increasingly large role in the economic activities of the region. Expenditure by tourists totalling $179 million contributed approximately 11 per cent of the total value of exports from the region in 2006/07. This is much larger than predicted in Vision 2045.

### 7.1.2 Water Resources

- The mean annual rainfall is approximately 520 mm but rainfall varies significantly across the region, with the upper reaches of the Light catchment experiencing less than 480 mm per annum and the highland region near Mt Adam above 680 mm per annum.
- Prescription has occurred in the Barossa Prescribed Water Resources Area (1998) and the Greenock Creek Catchment (2005). Water resources in the Western Mount Lofty Ranges, incorporating the South Para catchment were recently prescribed (2009).
- The South Para, Jacob Creek, Tanunda Creek and the Flaxman Valley are the highest contributors of surface water in the region on a per area basis.
- There has been a significant decrease in the annual discharge at all gauging stations over the period 2002 – 2007 in comparison to the entire record.
- Salinity continues to be relatively high in the region with the Light River (Mean EC 10,485 uS/cm), Valley Floor (Mean EC 3,706 uS/cm) and Greenock Creek (Mean EC 5,074 uS/cm) presenting marginal water quality for a range of environmental and commercial uses.
- There is a general regional downward trend in groundwater level for the Fractured Rock, Lower Aquifer and Upper Aquifer over the past two years.
- The average salinity is generally higher in the Upper Aquifer, while the salinity trends in both the Upper and Lower Aquifers are generally stable.
- There are three potable supplies owned and operated by SA Water and a non-potable irrigation supply owned by BIL. The majority (95%) of the imported water originates from the River Murray.

- On average, 6,640 ML per annum of potable water is used within the region. 63% is utilised by residential users, 19% by industrial users, with the remainder split between commercial enterprises, primary producers, public institutions and recreational needs.
- BIL has an existing Water Transport Agreement allowing for 7,000 ML per annum to be conveyed into the region initially, rising to 10,000 ML per annum.
- Eleven (11) Community Waste Management Systems (CWMS) operate in the region overseen independently by the relevant council and SA Water (Angaston). Approximately 1,000 ML per annum of wastewater is treated in the region, with a majority of this water utilised by local irrigators. Community concern still exists with respect to water quality and health related aspects of wastewater recycle.
- There is significant industry wastewater recycle within the region. Data indicates that approximately 800 ML per annum of winery effluent is produced in the region. In the 2007/08 irrigation season, 95ML of NPEC treated water was recycled. Long term water quality consequences regarding winery effluent recycle continue to cause concern, with soil potassium concentrations critical in long term management planning.
- Based on the 2007/08 metered data from the Barossa Prescribed Water Resources Area, accepted application rates, soil types, local knowledge and current land use data (DWLBC 2008), water use for the entire region was calculated to be 14,385 ML.
- Currently there are 371 volume based licences to extract groundwater equating to a volume of 5,975ML and an additional 81 area-based licences which equates to an additional 1172 ML. The 2007/08 Barossa WAP District Irrigation Annual Report estimates that current groundwater use is approximately 3,900 ML which is significantly less than the allocated volume. This is considered a conservative estimate on groundwater extraction based on the anticipated percentage of extractions that are metered/reported remaining relatively low. It could also be due to reduced inflows to dams and groundwater recharge, therefore there may be reduced water available for use.
- Managed Aquifer Recharge is undertaken within the Barossa Prescribed Wells area. The 2007/08 Irrigation Annual Report indicates that a total of 85 ML of water is injected mainly into the Upper and Lower Aquifers.
- Within the Barossa and Light region there is currently an estimated 6,000 ML of stormwater runoff from the intensive land use areas, principally the region's townships.
- Farm dams in the region have the capacity to capture up to 14,750 ML of water. The increased numbers of small farm dams has altered the flow patterns within the region. This change in both the volume of flow and seasonal flow patterns has had an impact on the natural environment of the river system.
- The heavily altered landscape has resulted in water dependent ecosystems consisting generally of highly tolerant species and communities. Communities exist in those watercourses where there is a level of permanence with respect to water supply. It would appear that salinity is not a limiting factor extant on river health because species remaining are largely salt tolerant.
- Significant knowledge gaps exist with respect to determining environmental water requirements. These include water dependent ecosystem (WDE) state, extent and health, the level of dependence of WDE on water sources and the spatial and temporal extent and integrity of recording stations.
- The approach to determining environmental water requirements (EWR) should shift towards focused assessments and resource allocations (both water and financial) to

specific higher value sites, rather than adapting a broad generic management/allocation response.

- In 2007/08, the total recorded volume of water used for irrigation of grapes in the prescribed areas was approximately 7,413 ML.
- The 2007/08 metered data from the Barossa, accepted application rates, soil types, local knowledge and current land use data (DWLBC 2008) were used to calculate viticultural water use for the entire region which is estimated to be 12,800 ML per annum.

# 7.2 Future Regional Trends

## 7.2.1 Social, Demographic and Economic Data

- The population could increase to beyond 150,000 people by 2045 if the Greater Adelaide 30 year plan, released in 2009, comes to fruition.
- Growth predictions for grape production in the region to 2045 indicate that there is a range of potential outcomes from very little expansion to an upper estimate of 100,000 tonnes per annum. The reason for the wide range in projection is that the shift towards pursuing increased share of the premium wine sector will potentially limit the increase in tonnages whilst still increasing economic productivity for the industry.
- It is estimated that up to 1,000,000 tonnes of grapes, sourced from both within and outside of the region, will be crushed in the Barossa and Light by 2045.

## 7.2.2 Water Resources

- Climate change impacts in the region by 2045 are expected to entail an annual temperature rise between 0.1 and 1.3 degrees Celsius and an annual rainfall decrease between 1% and 10%. A 10% decline in rainfall equates to approximately 30% decline in runoff.
- The region is attempting to reduce the amount of winery effluent to an industry low of 0.6 litres per one litre of wine produced.
- The volume of winery effluent produced annually in 2045 is expected to be approximately 400 ML. This is a 50% decline from the current volume produce, estimated to be in the vicinity of 800 ML per annum.
- It is anticipated that by 2045 the population in the region will increase from the current 35,000 to 150,000. The increased residential water demand for the area equates to some 12,000 ML each year and with a 25% allowance for associated commercial, recreational and public institution requirements the increased demand is likely to be 15,000 ML.
- Expansion of residential and industrial developments brings with it a wastewater volume resource in the order of 6,500 ML which will need to be put towards meeting other demands in the area, both recreational and horticultural.
- Assuming an increasing population to 150,000, this could equate to an additional 10,500 ML per annum of stormwater runoff. This could equate to a yield of up to 6,000 ML per annum.

- Amenity horticulture is considered crucial when considering the proposed residential development in the region. Assuming 15% open space (eg recreational, linear parks) for all new developments, it is estimated 800 ML per annum would be required to irrigate these open space areas.
- For the lower limit of grape growth prediction, it is estimated that water use will remain relatively stable (13,000 ML per annum), dependent upon climatic conditions, soil types, grape varieties grown, amongst other factors.
- For the upper limit of grape growth prediction, it is estimated that approximately 47,000 ML per annum would be required to produce the anticipated grape production.
- Under the upper limit of climate change predictions for the region, it is estimated the region could potentially need to source up to an additional 36,700 ML of water per annum for viticulture by 2045.

# 8. Recommendations

The following recommendations have been made to foster greater understanding of the state, use and future of the water resources in the region.

### 8.1.1 Leadership

- Barossa and Light Regional Development Board (BLD) take the leadership role in the competing demands facing water security for the region to 2045.
- Establishment of an alternative management body and an appropriately constituted management group. It is also recommended that BLD continues to provide leadership in water security in the region once this management body is established.
- Financial management of the water cost is incorporated into forward planning for all land holders.

### 8.1.2 Managed Aquifer Recharge

- Undertake detailed investigation for the implementation of Managed Aquifer Recharge in the region.
- Managed Aquifer Recharge initiatives to be incorporated into all major residential developments in the region where feasible while accounting for the requirements of the relevant water allocation plan.

### 8.1.3 Stormwater Recycling

- Develop Urban Stormwater Management Plans for each township within the region, while accounting for the requirements of the relevant water allocation plan.
- All new large scale developments (residential and industrial) to capture and recycle stormwater within the region whilst accounting for the requirements of the relevant Water Allocation Plan.

### 8.1.4 Wastewater Recycling

- Establish a centralised wastewater management system, which accounts for the anticipated significant regional development around Roseworthy, and which collects, treats and re-uses the recycled water within the region.
- All new large scale residential development to investigate the suitability of incorporating greywater recycling.
- All industries collect, treat and recycle their wastewater within the region where suitable recycle options exist.

- For each new wastewater recycle initiative, undertake detailed analysis of recycle consequences and develop and implement a management plan to mitigate against any risks.

### 8.1.5 Considered Developmental Planning

- Seek community and stakeholder input into current and future regional values and integrate within Council Development Plans ensuring development planning accounts for those values.
- Incorporate Water Sensitive Urban Design principles into Council Development Plans and ensure all new residential developments comply with those principles.

### 8.1.6 Premium Wine Production

- Undertake a regional review on strategic directions for viticulture and wine industries with respect to water use and grape quality.

### 8.1.7 Inter Basin Transfers

- Undertake a detailed investigation on the social, economic and environmental consequences of each inter-basin transfer option. Where suitable, enter into a long term agreement for water to be supplied from that inter-basin transfer option (Certainty).

### 8.1.8 Shared Water Supply Infrastructure Network

- Review the water supply infrastructure network ownership arrangements, supply side capabilities, legislative consequences and commercial opportunities and liabilities associated with establishing a coordinated, regional third party access agreement for all water supply infrastructure.

### 8.1.9 Small Scale Desalinisation

- Consult extensively with the relevant community and stakeholder groups regarding proposed small scale desalinisation schemes.
- Ensure any small scale desalinisation scheme satisfies the legislative requirements and does not diminish the social, economic and environmental values of the region.

### 8.1.10 Prescription

- The State Government ensures prescription extends across the entire region, thus allowing for sustainable use and recording of all water resources in the region. Urban stormwater to be exempt from the prescription process to facilitate recycle (including via MAR).

- Investigate further the possibility of exempting urban stormwater from prescription to allow development of innovation in water resource management in the region. Stormwater is considered surface water under the NRM Act. The definition of stormwater and options for its management are currently being considered by State Government agencies. The advantage of prescription of stormwater is security of access to the stormwater. Without that security, investors may not wish to take significant financial risks to invest in stormwater projects.

### 8.1.11 Metering

- The State Government has made an undertaking under the National Water Initiative to meter non-stock and domestic applications in prescribed areas. This initiative, the installation of a meter, should be mandatory (a legislative mechanism is required) for all users accessing water resources within the Barossa and Light region.

### 8.1.12Environmental Water Requirements

- The approach to determining EWR should shift towards focused assessments and resource allocations (both water and financial) to specific higher value sites, rather than adapting a broad generic management/allocation response.

### 8.1.13 Low Flow Bypass

- All dams at a predetermined volumetric capture capacity or those which offer strategic environmental benefit be required to install a low flow bypass device.

### 8.1.14 Monitoring

- Long term - high quality monitoring sites measuring to a high resolution continuous level, flow, EC, temperature and possibly rainfall (or stand alone rainfall sites).
- Short Term (operating for a minimum of 5 years, subject to meeting their requirements) - lower quality monitoring sites measuring to a lower resolution continuous level, flow, EC, temperature and possibly rainfall (or stand alone rainfall sites).
- Environmental Water Requirement (EWR) monitoring sites located at points of environmental interest or significance. They are simpler sites in that a control is not required to be constructed and interest is in level timing, duration and frequency. It is anticipated that within a five year time frame that a correlation between these sites and long term sites in the catchment can be made for the level timing duration and frequency to check various environmental water requirement hypotheses (as per Murdoch 2002).

### 8.1.15 Catchment and Climate Change Modelling

- A catchment model be developed to more accurately predict the climate change impacts on the water resources in the region.

# Appendix A

Management Zone Volume Descriptions

# 1. Light Management Zone

The Light River Management Zone is characterised by relatively few recording stations. There are two streamflow gauging stations that have or are currently operated in the region, including A5050512 Light River Kapunda (1973 to 1989) and AW5050532 Light River Mingays Waterhole (currently in use). The latter station was used to determine indicative flow volumes for the Light River Management Zone. Despite the relative lack of spatial coverage associated with the data, the quality of the flow data captured at A5050532 Light River Mingays Waterhole is considered good. This assessment is based on the period of data captured and the relative lack of data gaps within that data set.

The annual flow since 2002 has been well below the average and is indicative of the prolonged drought experienced in that time. The seasonal pattern of low flow during the summer/autumn periods, slowly rising in the winter months prior to peaking in the spring period is consistent with the rainfall runoff patterns of the region. The elevated records for January are associated with a few significant storm events.

Table A1. Summary of Annual Flow statistics at A5050532 Light River Mingays Waterhole

| Annual Flow (ML) | |
|---|---|
| Mean | 6997.40 |
| Standard Error | 2423.02 |
| Median | 3797.98 |
| Standard Deviation | 11364.95 |
| Range | 53840.80 |
| Minimum | 255.34 |
| Maximum | 54096.14 |
| Sum | 153942.72 |
| Count | 22.00 |
| 10th Percentile | 467.08 |
| 25th Percentile | 1549.37 |
| 75th Percentile | 6540.47 |
| 90th Percentile | 13796.49 |

Table A2. Annual Flow Volumes at A5050532 Light River Mingays Waterhole (1986 to 2007)

| Year | Flow (ML) |
|---|---|
| *1986* | 6820.384 |
| *1987* | 3175.674 |
| *1988* | 3720.726 |
| *1989* | 3943.323 |
| *1990* | 5167.785 |
| *1991* | 10619.59 |
| *1992* | 54096.14 |
| *1993* | 15854.7 |
| *1994* | 1086.817 |
| *1995* | 2937.011 |
| *1996* | 9285.834 |
| *1997* | 3875.228 |
| *1998* | 678.792 |
| *1999* | 3068.351 |
| *2000* | 5700.743 |
| *2001* | 14149.48 |
| *2002* | 443.554 |
| *2003* | 4702.028 |
| *2004* | 975.621 |
| *2005* | 3048.032 |
| *2006* | 337.57 |
| *2007* | 255.34 |

Figure A1. Annual Flow Volumes at A5050532 Light River Mingays Waterhole (1986 to 2007)

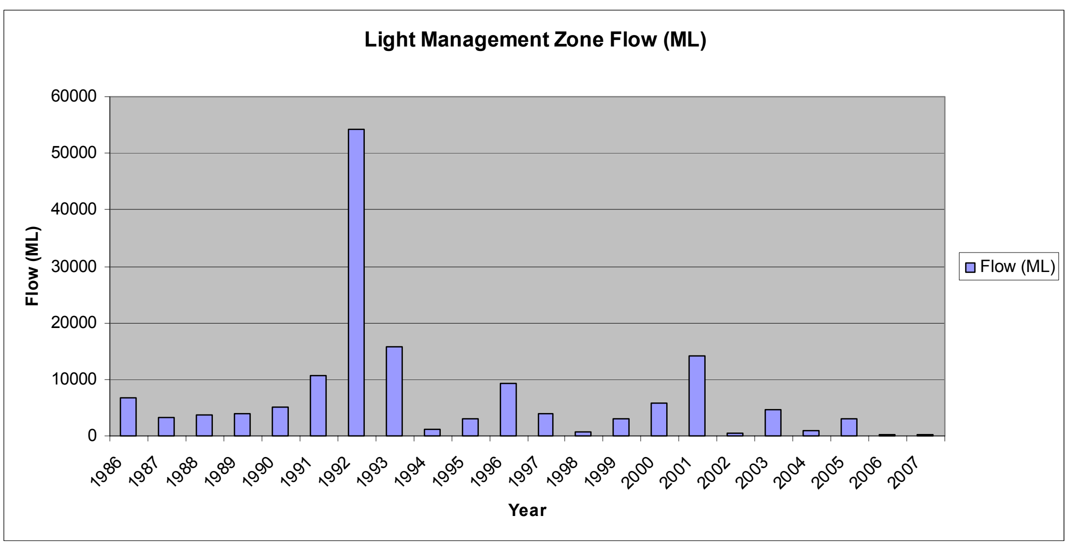
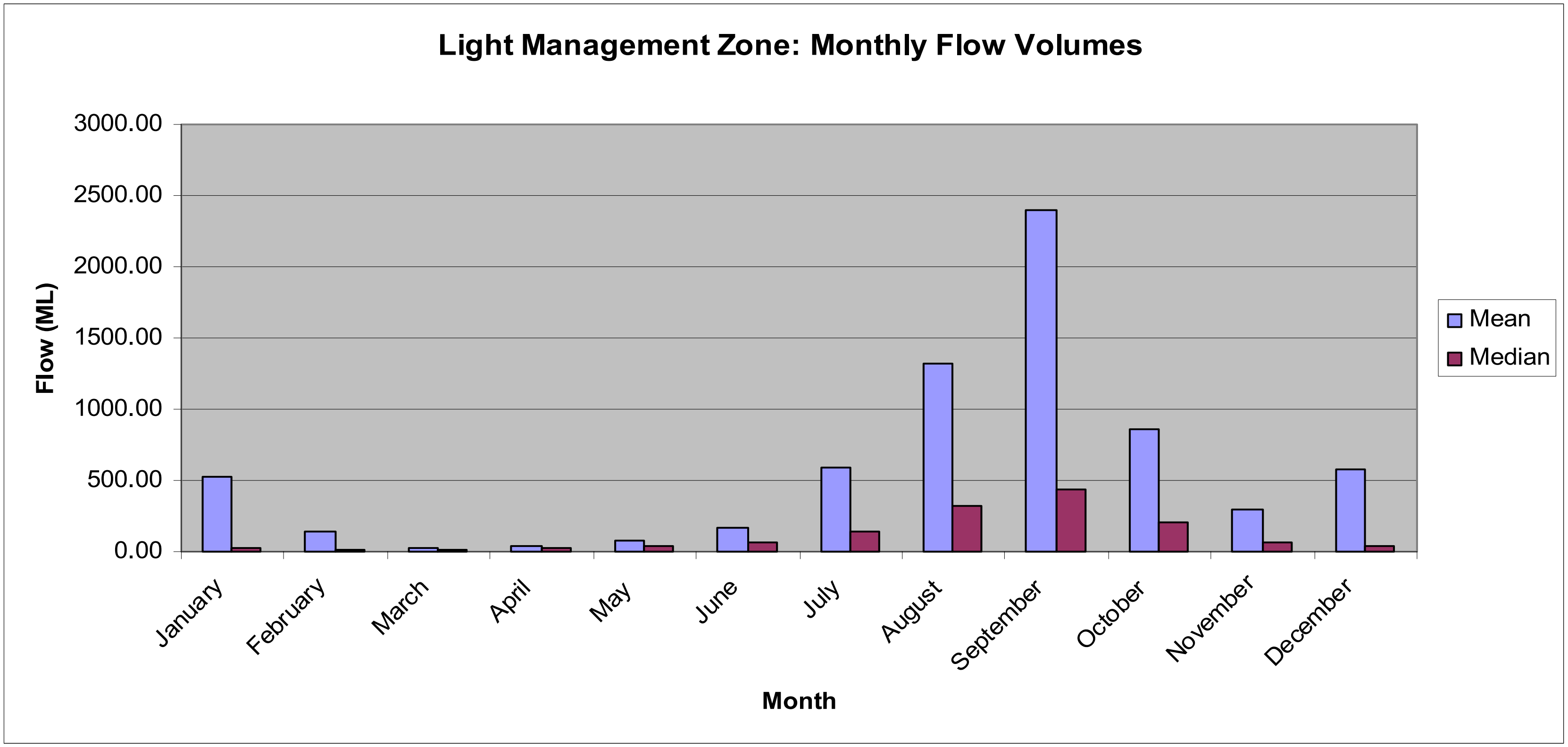


Table A3. Summary of Monthly Flow statistics at A5050532 Light River Mingays Waterhole

| Month | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 531.67 | 138.97 | 28.02 | 40.17 | 71.87 | 170.43 | 585.98 | 1317.47 | 2395.20 | 858.70 | 292.11 | 582.16 |
| Standard Error | 509.66 | 102.74 | 9.95 | 7.89 | 17.19 | 65.71 | 146.79 | 488.47 | 1094.14 | 539.74 | 153.76 | 432.06 |
| Median | 19.88 | 15.58 | 17.72 | 28.36 | 40.33 | 59.73 | 137.93 | 325.22 | 432.91 | 199.66 | 69.32 | 34.03 |
| Standard Deviation | 2390.50 | 481.89 | 46.66 | 37.01 | 80.62 | 308.22 | 688.50 | 2291.15 | 5131.95 | 2531.60 | 721.18 | 2026.53 |
| Range | 11234.17 | 2236.91 | 230.38 | 143.96 | 305.46 | 1448.09 | 2189.69 | 10024.02 | 21326.20 | 11770.28 | 3265.54 | 9267.35 |
| Minimum | 0.00 | 0.00 | 1.90 | 3.25 | 13.06 | 18.02 | 26.57 | 29.46 | 34.44 | 21.82 | 3.37 | 0.00 |
| Maximum | 11234.17 | 2236.91 | 232.27 | 147.21 | 318.53 | 1466.11 | 2216.26 | 10053.49 | 21360.63 | 11792.10 | 3268.91 | 9267.35 |
| Sum | 11696.69 | 3057.34 | 616.47 | 883.64 | 1581.20 | 3749.36 | 12891.53 | 28984.24 | 52694.43 | 18891.48 | 6426.35 | 12807.62 |
| Count | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 | 22.00 |
| 10th Percentile | 4.98 | 2.82 | 7.96 | 14.45 | 29.78 | 31.45 | 40.77 | 60.13 | 55.36 | 37.65 | 17.17 | 8.34 |
| 25th Percentile | 13.14 | 6.74 | 11.31 | 19.67 | 32.80 | 35.03 | 79.81 | 139.80 | 135.52 | 64.62 | 26.59 | 12.69 |
| 75th Percentile | 26.79 | 19.50 | 26.77 | 43.77 | 54.92 | 208.03 | 1060.73 | 1589.23 | 1586.49 | 296.88 | 112.78 | 50.07 |
| 90th Percentile | 50.65 | 33.11 | 35.22 | 71.15 | 172.71 | 332.00 | 1418.62 | 3745.62 | 4570.82 | 540.77 | 722.21 | 211.11 |

Figure A2. Monthly Flow at A5050532 Light River Mingays Waterhole



# 2. Valley Floor

The Valley Floor Management Zone is characterised by a number of recording stations. There are five streamflow gauging stations that have or are currently operated in the region, including:

- A5050502 North Para River at Yaldara;
- A5050541 Lyndoch Creek at Lyndoch;
- A5050536 Upstream Tanunda Creek Junction;
- A5050527 Downstream Nuriootpa HS; and
- A5050517 North Para River at Penrice.

All stations were assessed for flow volumes (where relevant). A5050502 North Para River at Yaldara was used to determine indicative flow volumes for the Valley Floor Management Zone. Typically, the quality of the flow data captured at A5050502 North Para River at Yaldara is considered good, however, in recent times, there appears to be an increasing amount of data gaps and an associated dip in data quality.

Table A4. Summary of Annual Flow statistics at A5050502 North Para River at Yaldara

| Annual Flow (ML) | |
|---|---|
| Mean | 11581.38 |
| Standard Error | 3387.86 |
| Median | 7361.52 |
| Standard Deviation | 14767.36 |
| Range | 62645.59 |
| Minimum | 895.45 |
| Maximum | 63541.03 |
| Sum | 220046.29 |
| Count | 19.00 |
| 10th Percentile | 1546.84 |
| 25th Percentile | 24330.97 |
| 75th Percentile | 2200.47 |
| 90th Percentile | 14596.99 |

Table A5 Annual Flow at A5050502 North Para River at Yaldara (1990 – 2008)

| Year | Flow (ML) |
|---|---|
| *1990* | 12049.11 |
| *1991* | 16521.71 |
| *1992* | 63541.03 |
| *1993* | 4203.247 |
| *1994* | 895.446 |
| *1995* | 7361.518 |
| *1996* | 24031.21 |
| *1997* | 1962.694 |
| *1998* | 2264.718 |
| *1999* | 2136.22 |
| *2000* | 8744.66 |
| *2001* | 13515.19 |
| *2002* | 1565.3 |
| *2003* | 14661.01 |
| *2004* | 14532.97 |
| *2005* | 25529.98 |
| *2006* | 1472.995 |
| *2007* | 2499.047 |
| *2008* | 2558.244 |

Figure A3 Annual Flow at A5050502 North Para River at Yaldara (1990 – 2008)

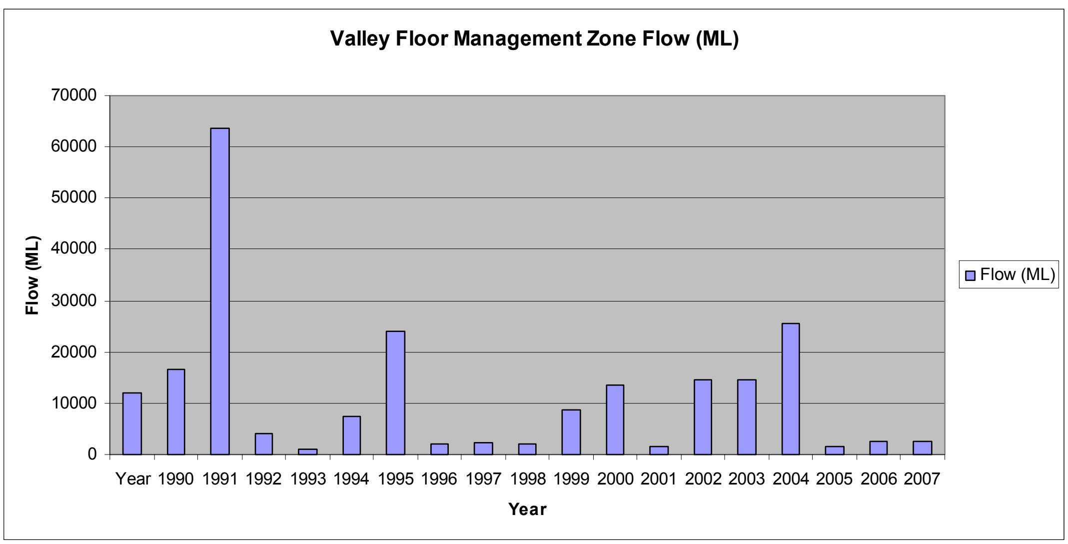
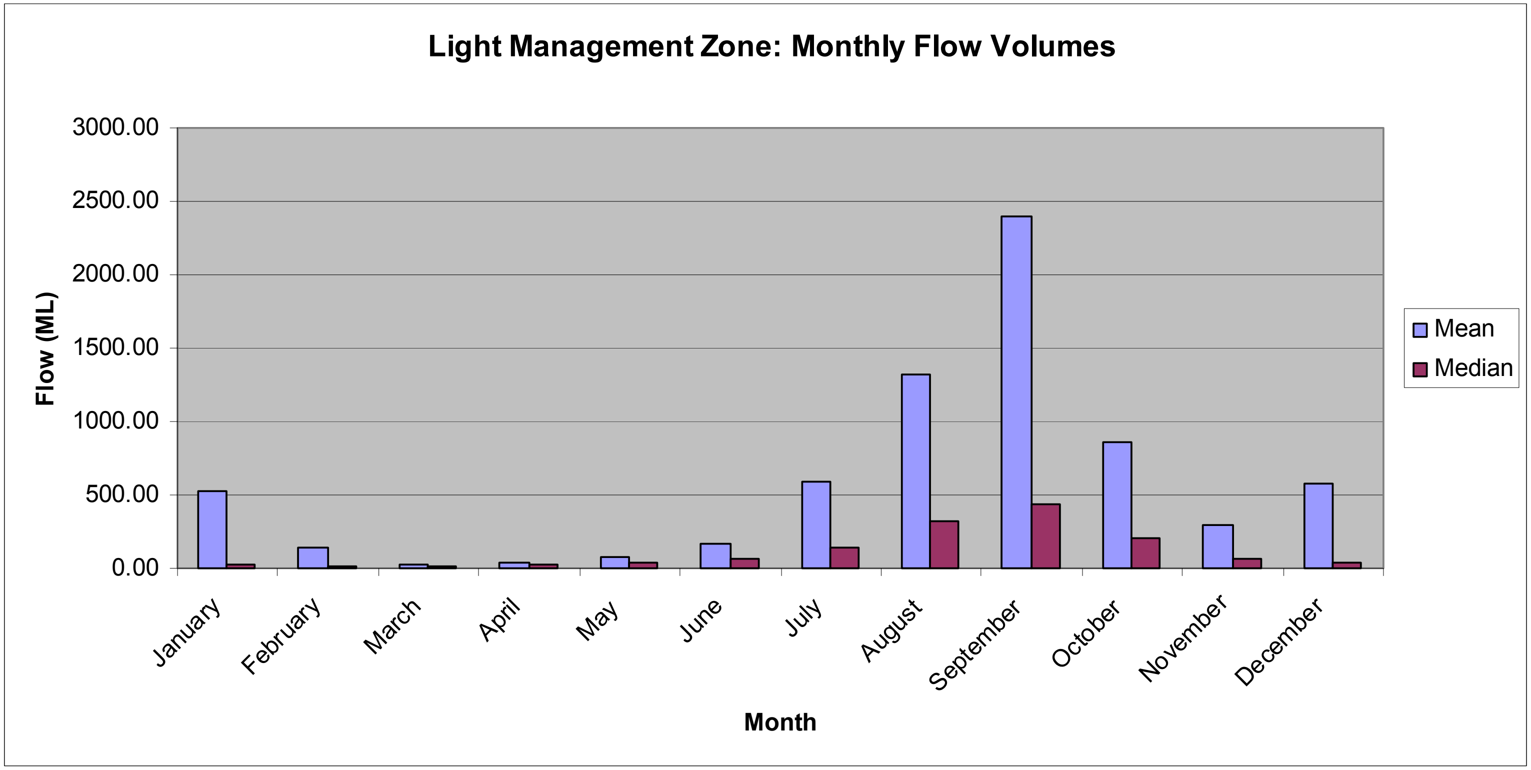


Table A6. Summary of Monthly Flow statistics at A5050502 North Para River at Yaldara

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 66.06 | 19.39 | 17.37 | 37.25 | 92.19 | 257.19 | 1128.31 | 3049.77 | 3443.44 | 1905.30 | 963.17 | 646.20 |
| Standard Error | 48.93 | 9.03 | 8.61 | 11.36 | 12.53 | 40.40 | 276.74 | 744.76 | 1199.88 | 938.48 | 616.48 | 583.97 |
| Median | 7.76 | 5.50 | 3.87 | 20.44 | 77.99 | 214.03 | 546.78 | 2056.44 | 1161.94 | 339.09 | 121.89 | 48.67 |
| Standard Deviation | 213.30 | 39.35 | 37.54 | 49.50 | 54.63 | 176.10 | 1206.27 | 3246.34 | 5230.18 | 4090.75 | 2687.18 | 2545.44 |
| Range | 941.88 | 170.33 | 137.95 | 190.34 | 163.50 | 663.81 | 4465.91 | 8482.53 | 22075.10 | 16865.46 | 11001.12 | 11150.87 |
| Minimum | 0.00 | 0.00 | 0.00 | 0.00 | 20.81 | 73.15 | 57.47 | 145.23 | 69.73 | 40.25 | 13.19 | 2.66 |
| Maximum | 941.88 | 170.33 | 137.95 | 190.34 | 184.30 | 736.96 | 4523.38 | 8627.76 | 22144.83 | 16905.70 | 11014.31 | 11153.53 |
| Sum | 1255.21 | 368.40 | 329.98 | 707.72 | 1751.66 | 4886.60 | 21437.86 | 57945.58 | 65425.32 | 36200.74 | 18300.31 | 12277.84 |
| Count | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 10th Percentile | 0.12 | 0.00 | 0.00 | 0.00 | 29.00 | 116.65 | 324.90 | 176.35 | 199.27 | 93.44 | 32.71 | 8.25 |
| 25th Percentile | 57.42 | 39.85 | 39.97 | 93.53 | 158.81 | 504.16 | 2729.74 | 7832.23 | 6770.99 | 5207.29 | 1273.53 | 238.12 |
| 75th Percentile | 2.08 | 0.15 | 0.00 | 2.35 | 42.98 | 150.01 | 438.74 | 430.33 | 328.99 | 188.37 | 66.13 | 16.78 |
| 90th Percentile | 31.50 | 21.14 | 11.82 | 66.19 | 144.80 | 282.71 | 1262.25 | 6416.71 | 5560.05 | 739.90 | 203.70 | 73.06 |

Figure A4 Monthly Flow at A5050502 North Para River at Yaldara



# 3. Greenock Creek

The Greenock Creek Management Zone is serviced by a single recording station, A5050542 Greenock Creek at Lienert Rd (She-Oak Log).This station was used to determine indicative flow volumes for the Greenock Creek Management Zone. Typically, the quality of the flow data captured at A5050542 Greenock Creek at Lienert Rd (She-Oak Log) is considered poor, with significant data gaps, and a short collection timeframe.

Table A7. Summary of Annual Flow statistics at A5050542 Greenock Creek at Lienert Rd

| | |
|---|---|
| Mean | 219.92 |
| Standard Error | 145.04 |
| Median | 94.95 |
| Standard Deviation | 324.31 |
| Range | 785.69 |
| Minimum | 0.00 |
| Maximum | 785.69 |
| Sum | 1099.60 |
| 10th Percentile | 12.50 |
| 25th Percentile | 31.25 |
| 75th Percentile | 187.71 |
| 90th Percentile | 546.50 |

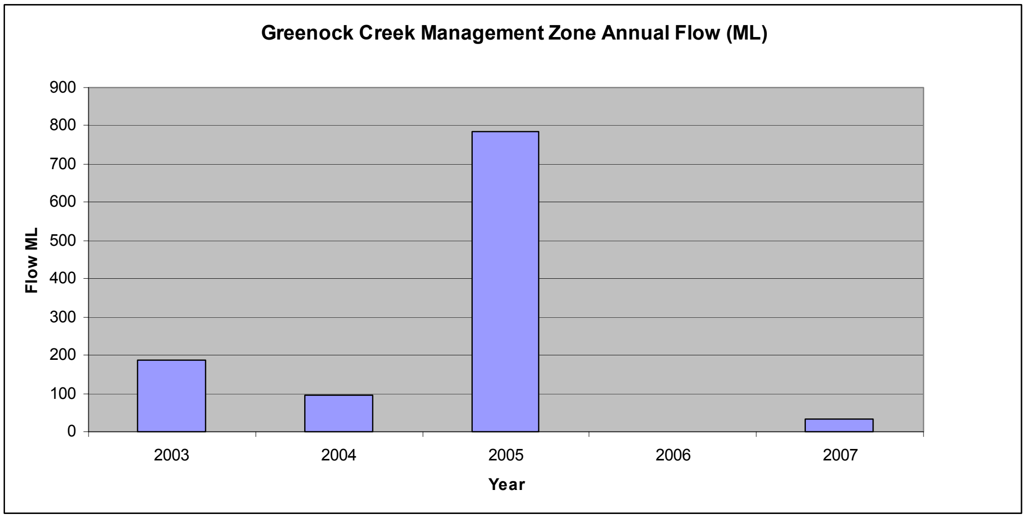
Table A8. Annual Flow at A5050542 Greenock Creek at Lienert Rd (2003 – 2007)

| Year | Flow (ML) |
|---|---|
| *2003* | 187.707 |
| *2004* | 94.948 |
| *2005* | 785.694 |
| *2006* | 0 |
| *2007* | 31.246 |

Table A9. Monthly Flow at A5050542 Greenock Creek at Lienert Rd (2003 – 2007)

| Year | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 164.25 | 23.457 | 0 | 0 | 0 |
| 2004 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 62.671 | 32.277 | 0 | 0 | 0 |
| 2005 | 0 | 0 | 0 | 0 | 0 | 10.73 | 0 | 0 | 38.426 | 310.242 | 426.296 | 0 |
| 2006 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2007 | 0 | 0 | 0 | 31.139 | 0.107 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Figure A5. Annual Flow at A5050542 Greenock Creek at Lienert Rd (2003 – 2007)



# 4. Flaxman Valley Management Zone

The Flaxman Valley Management Zone is serviced by a single recording station, A5050533 North Para River at Mt McKenzie. This station was used to determine indicative flow volumes for the Flaxman Valley Management Zone. Typically, the quality of the flow data captured at A5050533 North Para River at Mt McKenzie is considered moderate, with significant data gaps in recent years, despite the relatively lengthy collection timeframe.

Table A10. Summary of Annual Flow statistics at A5050533 North Para River at Mt McKenzie

| **Annual Flow (ML)** | |
|---|---|
| Mean | 2425.70 |
| Standard Error | 666.25 |
| Median | 1870.52 |
| Standard Deviation | 2826.65 |
| Range | 10662.85 |
| Minimum | 44.29 |
| Maximum | 10707.14 |
| Sum | 43662.59 |
| Count | 18.00 |
| 10th Percentile | 62.28 |
| 25th Percentile | 180.11 |
| 75th Percentile | 3574.61 |
| 90th Percentile | 5558.71 |

Table A11. Annual Flow at A5050533 North Para River at Mt McKenzie (1990 – 2007)

| Year | Flow (ML) |
|---|---|
| *1990* | 3589.792 |
| *1991* | 3687.374 |
| *1992* | 10707.14 |
| *1993* | 175.981 |
| *1994* | 44.285 |
| *1995* | 1647.782 |
| *1996* | 6382.607 |
| *1997* | 159.612 |
| *1998* | 329.968 |
| *1999* | 192.486 |
| *2000* | 2093.259 |
| *2001* | 3529.045 |
| *2002* | 847.319 |
| *2003* | 2368.776 |
| *2004* | 2586.137 |
| *2005* | 5205.611 |
| *2006* | 69.141 |
| *2007* | 46.278 |

Figure A6. Annual Flow at A5050533 North Para River at Mt McKenzie (1990 – 2007)

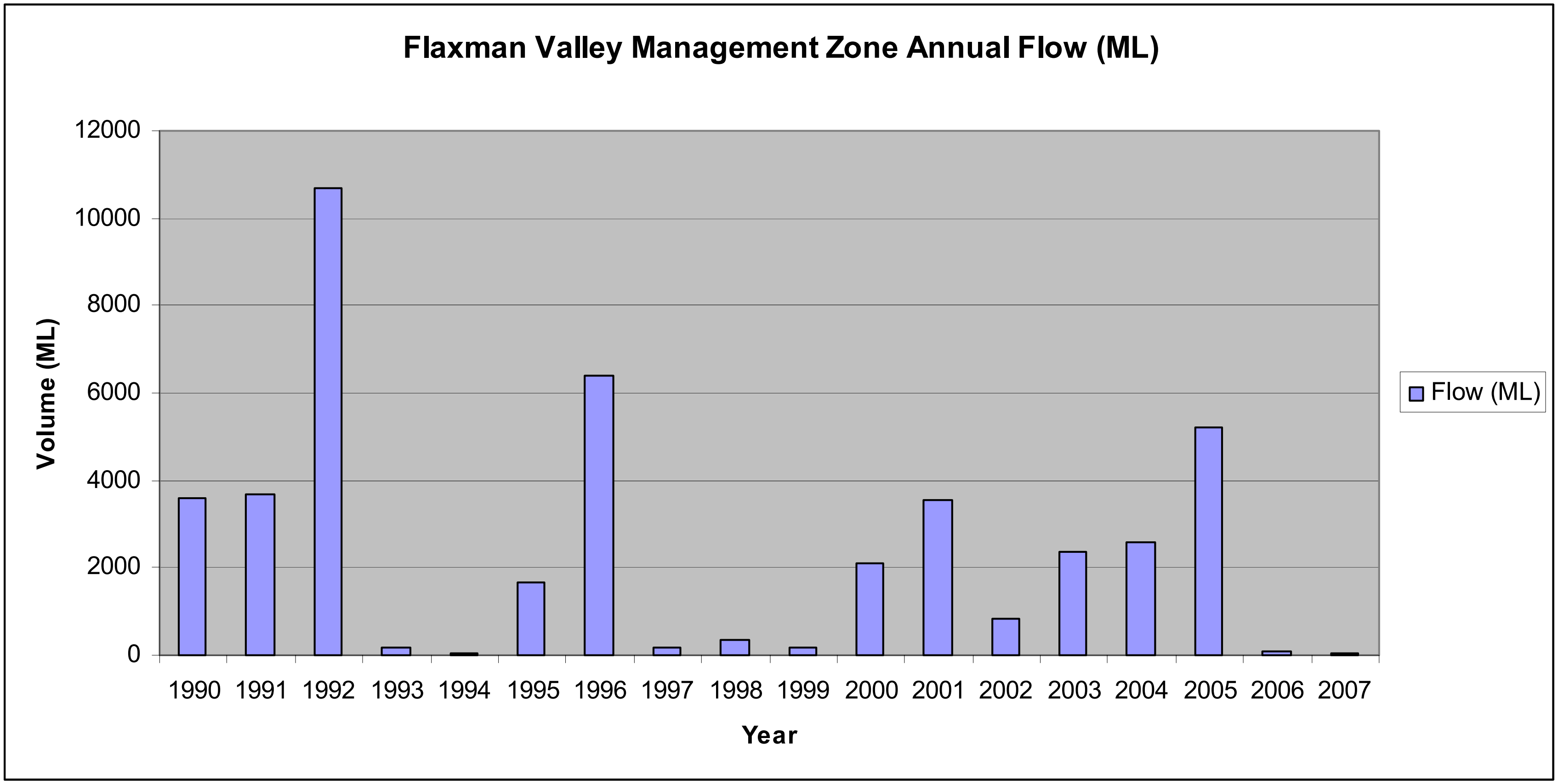
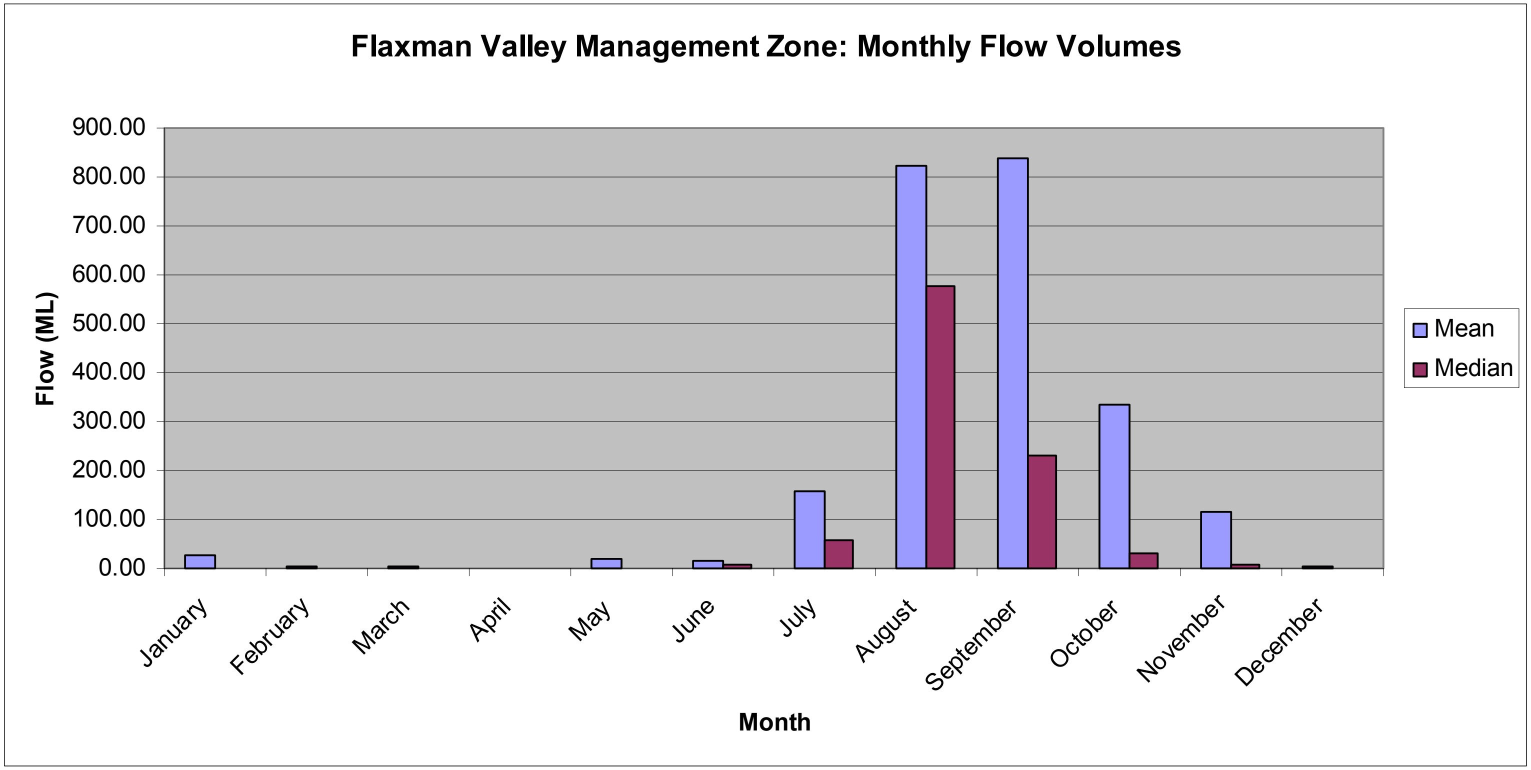


Table A12. Summary of Monthly Flow statistics at A5050533 North Para River at Mt McKenzie

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 26.00 | 2.69 | 3.26 | 0.65 | 18.93 | 17.11 | 156.52 | 822.24 | 837.52 | 335.00 | 116.24 | 5.32 |
| Standard Error | 22.82 | 1.21 | 2.70 | 0.27 | 17.31 | 6.28 | 61.21 | 222.62 | 282.36 | 162.14 | 101.83 | 3.36 |
| Median | 0.07 | 0.00 | 0.00 | 0.02 | 1.50 | 6.33 | 57.00 | 576.87 | 232.57 | 31.33 | 8.76 | 1.09 |
| Standard Deviation | 96.81 | 5.15 | 11.47 | 1.14 | 73.44 | 26.65 | 259.71 | 944.50 | 1197.94 | 687.92 | 432.05 | 14.24 |
| Range | 411.85 | 15.47 | 49.02 | 3.95 | 313.17 | 100.93 | 1049.17 | 2731.02 | 4558.03 | 2541.91 | 1843.79 | 61.33 |
| Minimum | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.95 | 1.12 | 7.38 | 2.34 | 0.39 | 0.18 | 0.00 |
| Maximum | 411.85 | 15.47 | 49.02 | 3.95 | 313.17 | 101.88 | 1050.29 | 2738.40 | 4560.36 | 2542.30 | 1843.96 | 61.33 |
| Sum | 468.04 | 48.46 | 58.62 | 11.69 | 340.75 | 308.00 | 2817.35 | 14800.37 | 15075.35 | 6029.96 | 2092.24 | 95.76 |
| Count | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 |
| 10th Percentile | 0.00 | 0.00 | 0.00 | 0.00 | 0.20 | 1.14 | 5.48 | 12.87 | 5.98 | 2.21 | 0.36 | 0.00 |
| 25th Percentile | 0.00 | 0.00 | 0.00 | 0.00 | 0.72 | 2.44 | 22.48 | 19.42 | 23.30 | 5.23 | 2.67 | 0.04 |
| 75th Percentile | 1.76 | 2.12 | 0.88 | 0.74 | 2.29 | 17.27 | 152.59 | 1500.20 | 1266.79 | 100.32 | 14.54 | 3.13 |
| 90th Percentile | 15.79 | 12.33 | 2.27 | 2.41 | 4.15 | 38.06 | 413.02 | 2139.60 | 2167.18 | 1101.52 | 59.94 | 8.34 |

Figure A7 Monthly Flow at A5050533 North Para River at Mt McKenzie



# 5. Jacobs and Tanunda Creek Management Zone

The Jacobs and Tanunda Creek Management Zone is characterised by two recording stations.

- A5050535 Tanunda Creek at Bethany;
- A5050518 Jacob Creek at Kaiser Stuhl.

The former station was used to determine indicative flow volumes for the Jacobs and Tanunda Creek Management Zone. Despite the relative lack of spatial coverage associated with the data, the quality of the flow data captured is considered good at A5050535 and moderate at A5050518. For the latter, this assessment is based on the period of data captured and the increasing number of data gaps within that data set.

Table A13. Summary of Annual Flow statistics at A5050535 Tanunda Creek at Bethany

| Annual Flow (ML) | |
|---|---|
| Mean | 1888.84 |
| Standard Error | 536.45 |
| Median | 1189.45 |
| Standard Deviation | 2145.79 |
| Range | 8271.14 |
| Minimum | 106.78 |
| Maximum | 8377.92 |
| Sum | 30221.52 |
| Count | 16.00 |
| 10th Percentile | 168.53 |
| 25th Percentile | 418.23 |
| 75th Percentile | 2706.16 |
| 90th Percentile | 3583.51 |

Table A14. Annual Flow at A5050535 Tanunda Creek at Bethany (1992 – 2007)

| Year | Flow (ML) |
|---|---|
| *1992* | 8377.917 |
| *1993* | 640.806 |
| *1994* | 106.775 |
| *1995* | 1738.089 |
| *1996* | 3182.423 |
| *1997* | 572.389 |
| *1998* | 434.257 |
| *1999* | 370.145 |
| *2000* | 1889.414 |
| *2001* | 2464.753 |
| *2002* | 197.697 |
| *2003* | 2600.07 |
| *2004* | 3024.447 |
| *2005* | 3984.589 |
| *2006* | 139.372 |
| *2007* | 498.373 |

Figure A8 Annual Flow at A5050535 Tanunda Creek at Bethany (1992 – 2007)

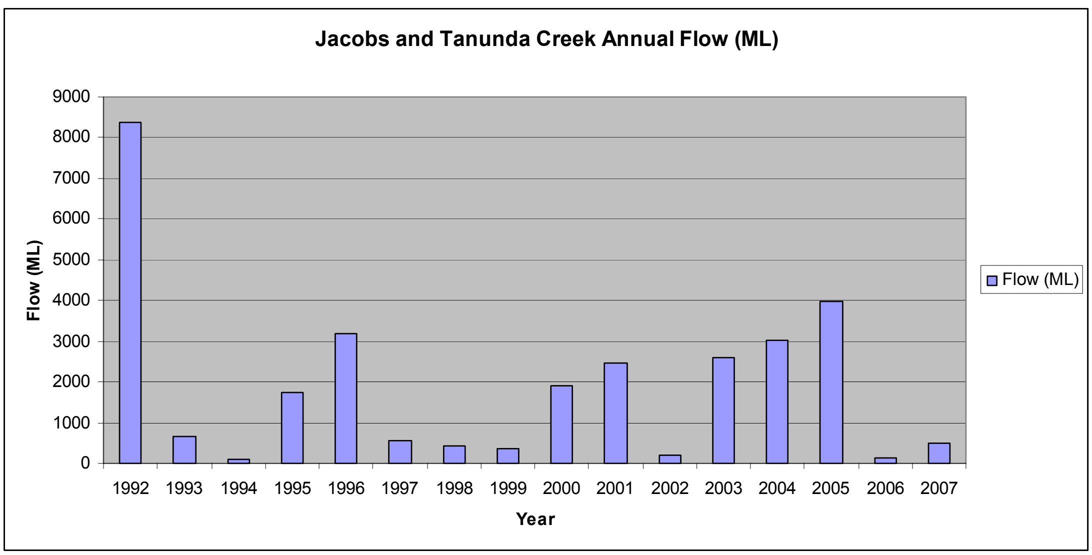
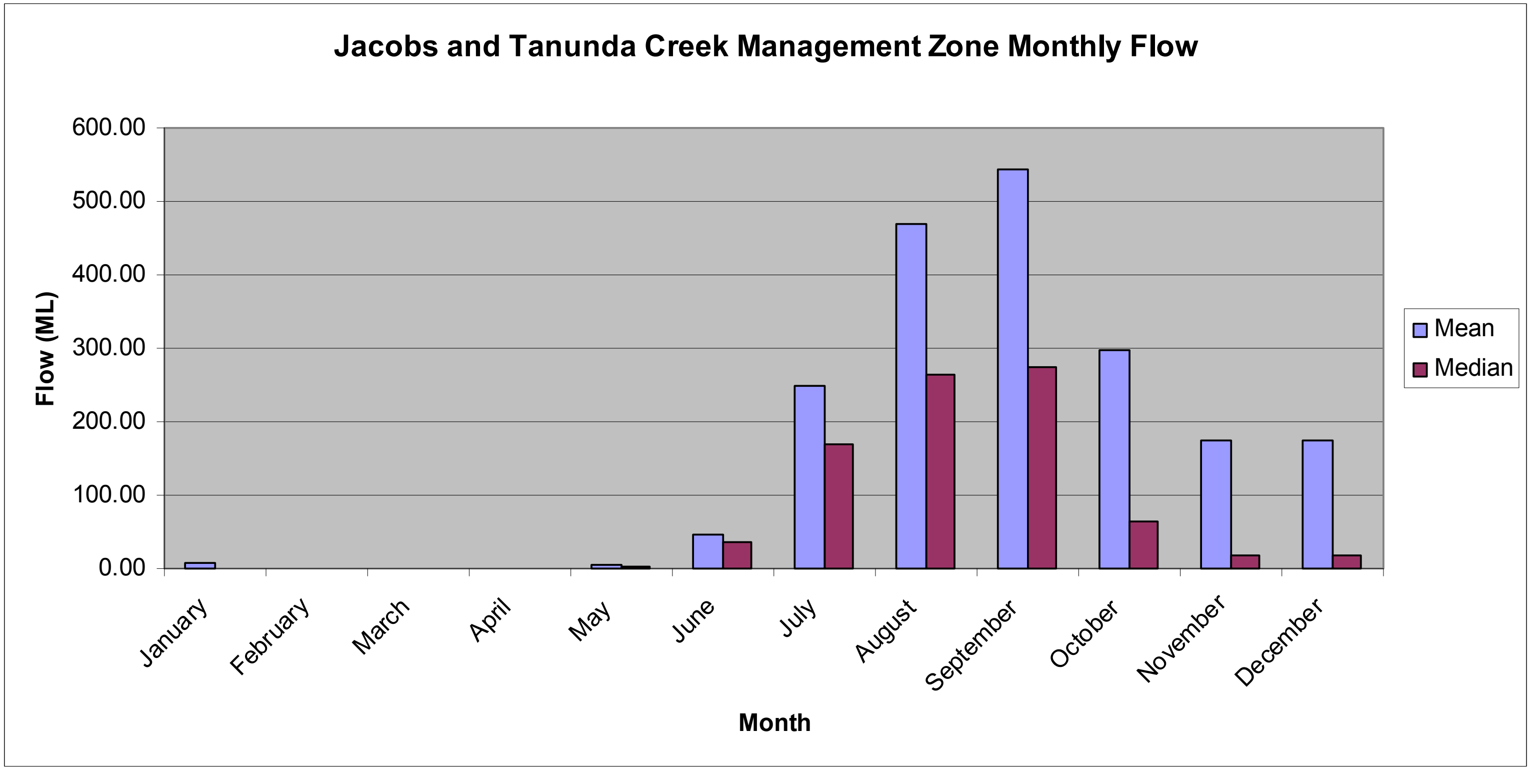


Table A15 Summary of Monthly Flow statistics at A5050535 Tanunda Creek at Bethany

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 6.82 | 0.69 | 0.57 | 0.21 | 6.24 | 46.06 | 248.12 | 469.61 | 544.84 | 298.30 | 174.73 | 174.73 |
| Standard Error | 5.93 | 0.60 | 0.56 | 0.21 | 2.11 | 8.35 | 72.53 | 133.53 | 172.99 | 134.99 | 108.55 | 108.55 |
| Median | 0.00 | 0.00 | 0.00 | 0.00 | 2.35 | 36.96 | 167.95 | 264.93 | 274.46 | 63.94 | 17.30 | 17.30 |
| Standard Deviation | 23.71 | 2.40 | 2.25 | 0.83 | 8.45 | 33.39 | 290.12 | 534.13 | 691.95 | 539.95 | 434.20 | 434.20 |
| Range | 95.13 | 9.60 | 9.00 | 3.34 | 25.43 | 111.39 | 1188.99 | 1839.70 | 2579.19 | 1911.28 | 1503.37 | 1503.37 |
| Minimum | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.43 | 9.41 | 19.02 | 7.58 | 1.09 | 0.16 | 0.16 |
| Maximum | 95.13 | 9.60 | 9.00 | 3.34 | 25.43 | 120.83 | 1198.41 | 1858.72 | 2586.77 | 1912.36 | 1503.53 | 1503.53 |
| Sum | 109.07 | 11.07 | 9.08 | 3.34 | 99.79 | 737.02 | 3969.98 | 7513.80 | 8717.37 | 4772.80 | 2795.63 | 2795.63 |
| Count | 16.00 | 16.00 | 16.00 | 16.00 | 16.00 | 16.00 | 16.00 | 16.00 | 16.00 | 16.00 | 16.00 | 16.00 |
| 10th Percentile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 13.29 | 40.12 | 34.92 | 18.26 | 9.10 | 2.36 | 0.00 |
| 25th Percentile | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 18.73 | 95.19 | 70.34 | 49.59 | 22.21 | 8.34 | 0.31 |
| 75th Percentile | 0.38 | 0.00 | 0.00 | 0.00 | 9.57 | 75.11 | 253.15 | 651.40 | 892.13 | 247.01 | 33.65 | 6.45 |
| 90th Percentile | 6.46 | 0.74 | 0.04 | 0.00 | 18.50 | 84.32 | 461.11 | 1095.09 | 1151.97 | 879.77 | 542.79 | 15.96 |

Figure A9 Monthly Flow at A5050535 Tanunda Creek at Bethany



# Appendix B

Management Zone Water Quality Descriptions

# 1. Light River Management Zone

Continuous salinity (EC) monitoring in the Light River Management Zone has only occurred since 2003. The data quality for that period is relatively poor, with data gaps, coupled with assumed sampling during periods of no flow, resulting in a poor data set.

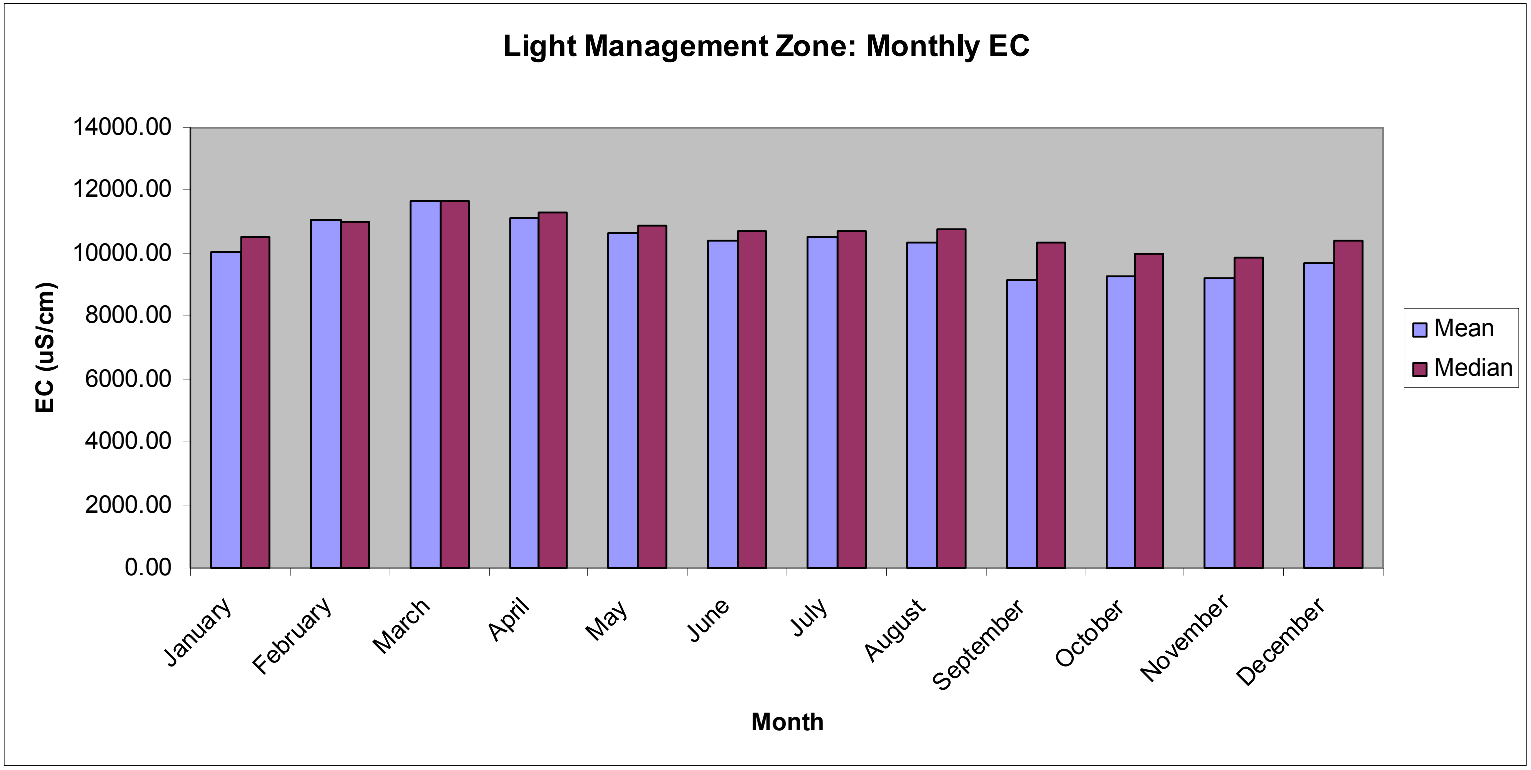
Table B1. Summary of Annual EC statistics at A5050532 Light River Mingays Waterhole (2003 – 2004)

| Year | 2003 | 2004 |
|---|---|---|
| Mean | 10422.90 | 10547.53 |
| Standard Error | 137.08 | 90.51 |
| Median | 11357.63 | 10788.07 |
| Standard Deviation | 2618.94 | 1731.49 |
| Range | 11263.16 | 8580.36 |
| Minimum | 2408.59 | 4481.11 |
| Maximum | 13671.74 | 13061.47 |
| Count | 365.00 | 366.00 |
| 10th Percentile | 6106.71 | 7898.62 |
| 25th Percentile | 9280.76 | 10001.02 |
| 75th Percentile | 12283.19 | 11721.87 |
| 90th Percentile | 12673.04 | 12465.56 |

Table B2. Summary of Monthly EC statistics at A5050532 Light River Mingays Waterhole

| Month | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 10077.89 | 11078.70 | 11685.04 | 11126.66 | 10625.65 | 10388.20 | 10536.92 | 10330.46 | 9129.04 | 9260.75 | 9192.37 | 9671.51 |
| Standard Error | 127.76 | 85.50 | 101.35 | 68.14 | 104.25 | 148.38 | 89.55 | 118.29 | 186.21 | 137.07 | 137.86 | 147.03 |
| Median | 10546.25 | 10994.24 | 11657.40 | 11322.75 | 10914.90 | 10697.21 | 10681.87 | 10794.63 | 10369.11 | 10014.04 | 9879.22 | 10427.42 |
| Standard Deviation | 1364.10 | 824.54 | 1137.66 | 914.19 | 1421.74 | 1923.18 | 1224.63 | 1613.33 | 2391.97 | 1689.92 | 1688.40 | 1689.19 |
| Range | 6251.59 | 3297.39 | 3777.26 | 3619.39 | 5701.48 | 11429.93 | 8818.20 | 9388.11 | 9212.49 | 9275.90 | 8852.72 | 6422.43 |
| Minimum | 6013.25 | 9377.12 | 9894.48 | 9115.95 | 7621.35 | 1708.04 | 3468.75 | 2413.18 | 2408.59 | 1632.89 | 1715.83 | 5090.34 |
| Maximum | 12264.84 | 12674.50 | 13671.74 | 12735.34 | 13322.82 | 13137.97 | 12286.95 | 11801.29 | 11621.07 | 10908.79 | 10568.55 | 11512.77 |
| Count | 114.00 | 93.00 | 126.00 | 180.00 | 186.00 | 168.00 | 187.00 | 186.00 | 165.00 | 152.00 | 150.00 | 132.00 |
| 10th Percentile | 8117.79 | 10033.10 | 10188.93 | 9720.86 | 8491.73 | 7610.23 | 9286.67 | 9738.26 | 5064.78 | 6813.96 | 6971.62 | 6565.92 |
| 25th Percentile | 9235.05 | 10512.40 | 10644.41 | 10571.13 | 9699.12 | 9632.66 | 10206.48 | 10169.13 | 7712.52 | 8472.98 | 8974.72 | 9628.79 |
| 75th Percentile | 11128.01 | 11632.35 | 12781.68 | 11785.87 | 11337.26 | 11866.49 | 11025.75 | 11038.25 | 10774.59 | 10214.11 | 10242.45 | 10836.66 |
| 90th Percentile | 11334.83 | 12367.28 | 12969.76 | 12260.93 | 12610.30 | 12306.02 | 11967.14 | 11476.29 | 10848.80 | 10817.92 | 10384.43 | 10970.72 |

Figure B1. Monthly EC at A5050532 Light River Mingays Waterhole



# 2. Valley Floor Management Zone

Surface water salinity monitoring in the Valley Floor is undertaken at A5050502 North Para River at Yaldara and A5050517 North Para River at Penrice. The respective stations data sets can be classified as moderate, with data gaps existing throughout the record.

Table B3. Summary of Annual EC statistics at A5050502 North Para River at Yaldara

| | |
|---|---|
| Mean | 3706.96 |
| Standard Error | 27.58 |
| Median | 3900.63 |
| Standard Deviation | 1713.59 |
| Range | 9401.16 |
| Minimum | 182.41 |
| Maximum | 9583.57 |
| Count | 3861.00 |
| 10th Percentile | 3235.86 |
| 25th Percentile | 6900.22 |
| 75th Percentile | 12575.58 |
| 90th Percentile | 13172.39 |

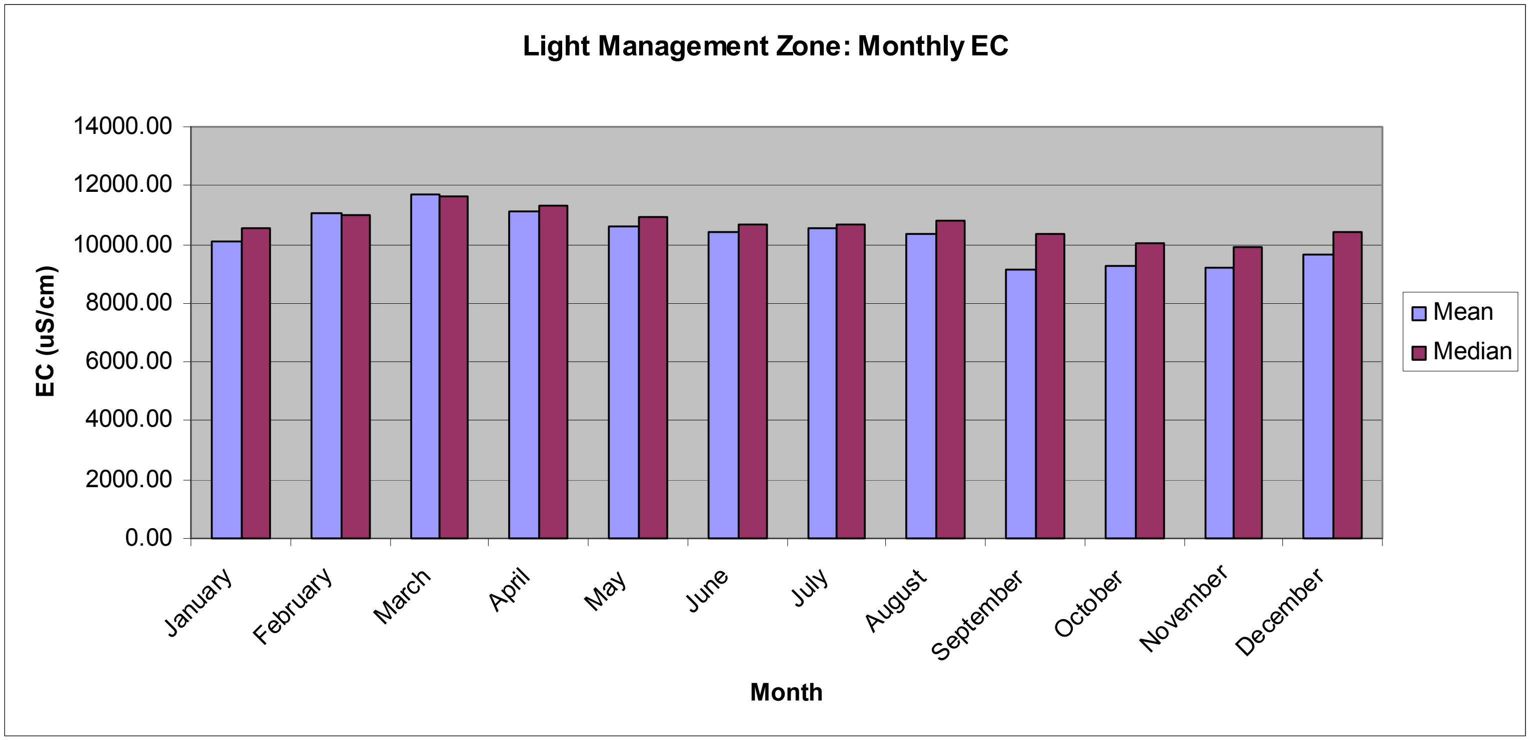
Table B4. Summary of Annual EC statistics at A5050502 North Para River at Yaldara (1995 – 2007)

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 3956.13 | 3622.75 | 5592.72 | 3626.63 | 5168.42 | 3393.84 | 2199.70 | 3535.54 | 3263.49 | 2974.19 | 3068.89 | 4186.12 | 3748.33 |
| Standard Error | 90.49 | 125.15 | 68.42 | 82.24 | 136.69 | 86.07 | 90.71 | 62.82 | 158.52 | 110.87 | 99.29 | 61.43 | 106.86 |
| Median | 4120.44 | 4211.82 | 5458.90 | 3607.28 | 5225.13 | 3197.63 | 1706.51 | 3371.86 | 2221.50 | 2319.14 | 3056.92 | 4012.88 | 3897.99 |
| Standard Deviation | 1497.81 | 2217.58 | 952.97 | 1395.65 | 1453.06 | 1598.59 | 1384.56 | 1165.10 | 2179.29 | 1760.03 | 1806.46 | 994.38 | 1484.52 |
| Range | 8913.20 | 9081.32 | 3939.27 | 6057.58 | 4357.74 | 5879.59 | 6237.95 | 5356.59 | 6008.23 | 7161.82 | 6440.92 | 3589.52 | 4932.33 |
| Minimum | 670.37 | 365.52 | 4181.82 | 893.42 | 2958.79 | 504.21 | 454.34 | 569.52 | 427.25 | 344.19 | 182.41 | 2289.49 | 1111.42 |
| Maximum | 9583.57 | 9446.84 | 8121.08 | 6951.00 | 7316.52 | 6383.80 | 6692.29 | 5926.12 | 6435.48 | 7506.01 | 6623.33 | 5879.01 | 6043.75 |
| Count | 274.00 | 314.00 | 194.00 | 288.00 | 113.00 | 345.00 | 233.00 | 344.00 | 189.00 | 252.00 | 331.00 | 262.00 | 193.00 |
| 10th Percentile | 1258.29 | 880.25 | 4541.45 | 1896.21 | 3208.45 | 1253.89 | 783.61 | 1979.14 | 891.39 | 905.19 | 912.56 | 2810.04 | 1557.27 |
| 25th Percentile | 3483.26 | 1221.36 | 4800.95 | 2350.70 | 3566.50 | 2121.66 | 1259.96 | 2586.61 | 1104.87 | 1612.44 | 1311.24 | 3449.67 | 2288.83 |
| 75th Percentile | 4851.12 | 5150.64 | 6153.48 | 4581.65 | 6688.77 | 4470.74 | 3819.27 | 4543.86 | 5395.70 | 4018.76 | 4959.99 | 5011.72 | 5165.84 |
| 90th Percentile | 5467.35 | 6324.22 | 6289.57 | 5243.18 | 6750.71 | 5729.87 | 4511.68 | 5050.77 | 5968.35 | 5792.21 | 5350.72 | 5563.98 | 5637.74 |

Table B5. Summary of Monthly EC statistics at A5050502 North Para River at Yaldara (1995 – 2007)

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 4912.77 | 5270.55 | 5411.98 | 5716.27 | 4708.76 | 3749.37 | 2216.31 | 1624.21 | 2093.20 | 2480.56 | 3318.74 | 4389.95 |
| Standard Error | 51.14 | 51.43 | 68.80 | 82.02 | 63.53 | 47.83 | 51.47 | 43.00 | 66.03 | 63.91 | 77.42 | 60.97 |
| Median | 5130.97 | 5084.49 | 5517.51 | 5751.11 | 4775.20 | 3751.51 | 1939.21 | 1450.93 | 1691.68 | 2357.78 | 3545.77 | 4666.79 |
| Standard Deviation | 878.41 | 725.47 | 1006.43 | 1335.22 | 1143.46 | 905.03 | 998.03 | 829.44 | 1233.56 | 1117.98 | 1228.93 | 1073.49 |
| Range | 3660.15 | 2787.80 | 6747.00 | 7507.73 | 5772.69 | 4743.81 | 3987.94 | 3902.54 | 4375.15 | 4465.22 | 5149.53 | 4204.33 |
| Minimum | 2927.38 | 4041.67 | 569.52 | 2075.84 | 2240.44 | 1284.42 | 610.06 | 344.19 | 426.68 | 365.52 | 182.41 | 1740.88 |
| Maximum | 6587.54 | 6829.47 | 7316.52 | 9583.57 | 8013.13 | 6028.23 | 4598.00 | 4246.73 | 4801.82 | 4830.74 | 5331.95 | 5945.20 |
| Count | 295.00 | 199.00 | 214.00 | 265.00 | 324.00 | 358.00 | 376.00 | 372.00 | 349.00 | 306.00 | 252.00 | 310.00 |
| 10th Percentile | 3684.10 | 4459.80 | 4650.03 | 4038.70 | 3230.51 | 2672.04 | 1065.11 | 777.57 | 775.94 | 916.36 | 1448.33 | 2674.40 |
| 25th Percentile | 4229.12 | 4699.46 | 5010.45 | 5181.30 | 3967.56 | 3187.26 | 1487.50 | 1009.43 | 1081.68 | 1573.46 | 2592.82 | 3603.00 |
| 75th Percentile | 5607.32 | 5788.15 | 6088.91 | 6505.75 | 5292.53 | 4341.85 | 3021.59 | 2022.68 | 3019.58 | 3452.17 | 4390.70 | 5319.87 |
| 90th Percentile | 5957.75 | 6391.61 | 6203.70 | 7467.54 | 6202.43 | 4904.81 | 3643.85 | 2665.88 | 4083.55 | 3991.01 | 4631.30 | 5667.30 |

Figure B2. Monthly EC at A5050502 North Para River at Yaldara (1995 – 2007)



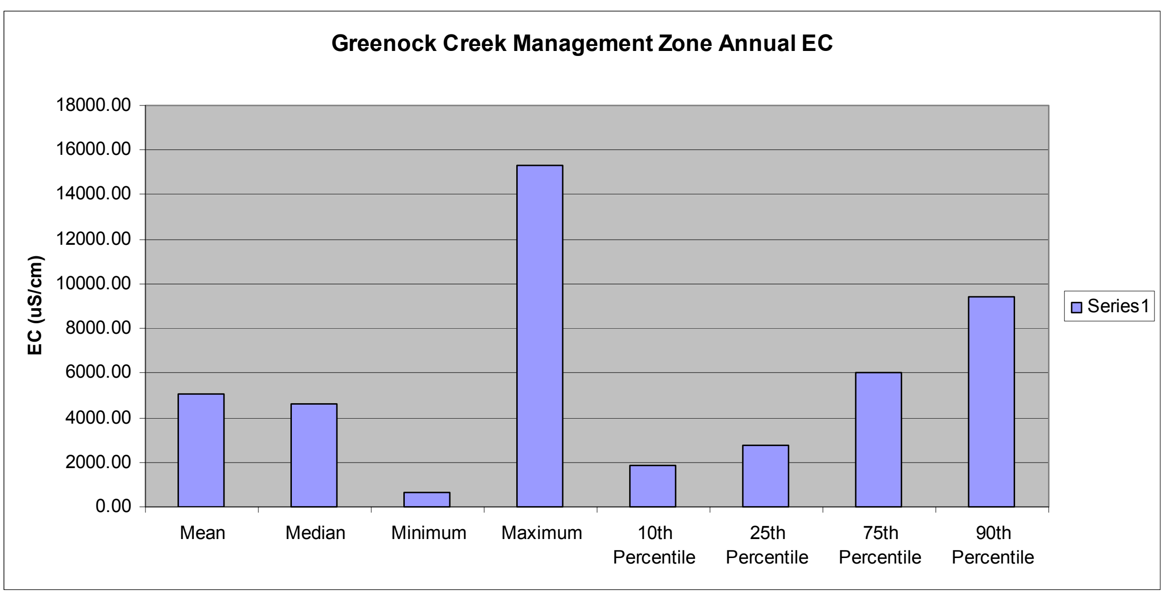
# 3. Greenock Creek Management Zone

With the relative lack of flow in Greenock Creek, continuous salinity monitoring is relatively difficult. A5050542 Greenock Creek at Lienert Rd (She-Oak Log).Irrespective, the quality of the flow data captured at A5050542 Greenock Creek at Lienert Rd (She-Oak Log) is considered poor, with significant data gaps, and a short collection timeframe.

Table B6. Summary of Annual EC statistics at A5050542 Greenock Creek at Lienert Rd

| | |
|---|---|
| Mean | 5074.36 |
| Standard Error | 329.39 |
| Median | 4606.27 |
| Standard Deviation | 3227.34 |
| Range | 14701.60 |
| Minimum | 620.75 |
| Maximum | 15322.35 |
| Count | 96.00 |
| 10th Percentile | 1884.96 |
| 25th Percentile | 2763.48 |
| 75th Percentile | 6037.51 |
| 90th Percentile | 9445.92 |

Figure B3 Annual EC statistics at A5050542 Greenock Creek at Lienert Rd



# 4. Flaxman Valley Management Zone

Continuous surface water salinity sampling in the Flaxman Valley is conducted at the recording station, A5050533 North Para River at Mt McKenzie. Based on the significant data gaps and length of collection period, the data set can be considered poor.

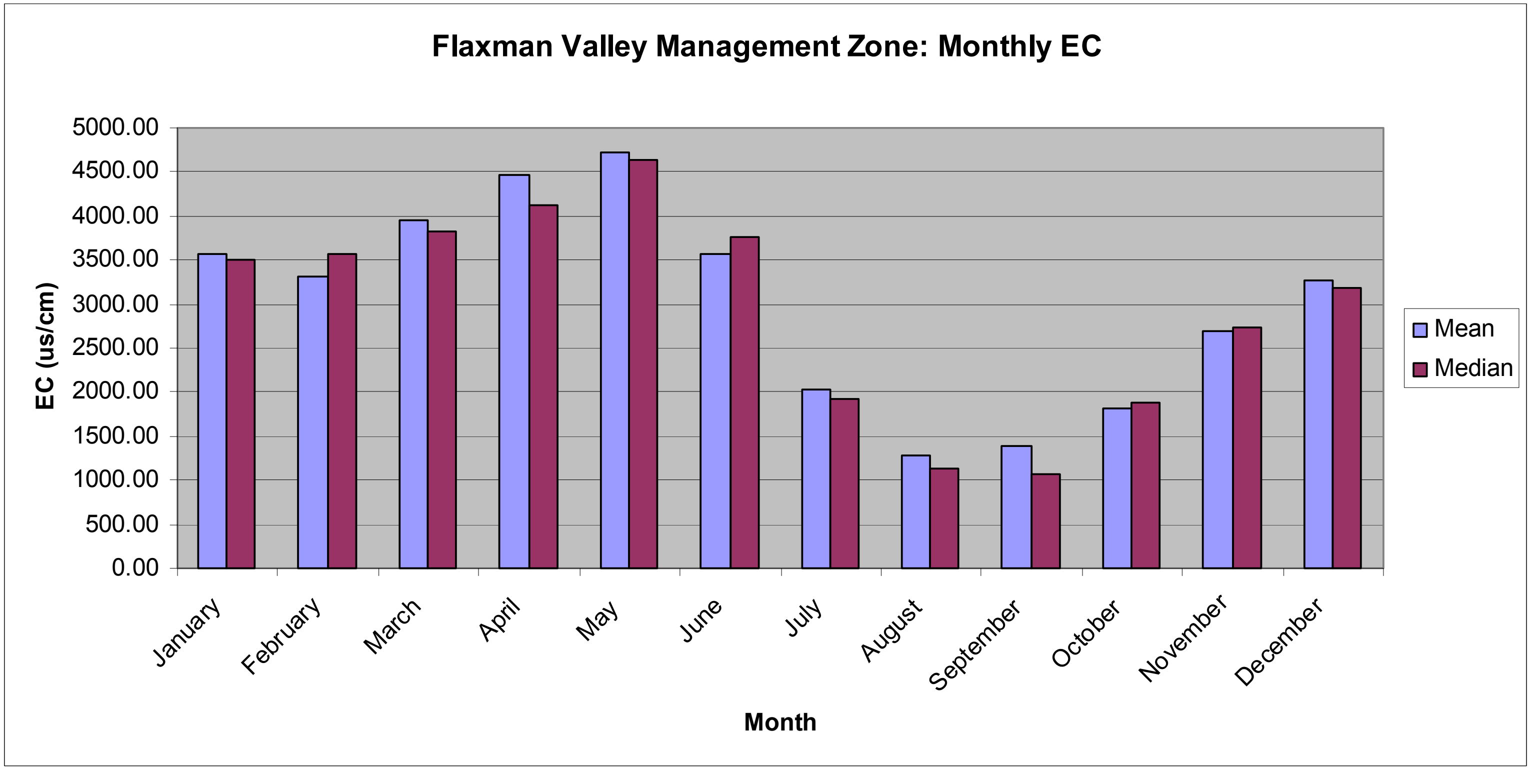
Table B7 Summary of Annual EC statistics at A5050533 North Para River at Mt McKenzie

| | |
|---|---|
| Mean | 2826.24 |
| Standard Error | 26.81 |
| Median | 2869.65 |
| Standard Deviation | 1359.07 |
| Range | 6303.02 |
| Minimum | 160.28 |
| Maximum | 6463.29 |
| Count | 7263428.19 |
| 10th Percentile | 877.85 |
| 25th Percentile | 1822.70 |
| 75th Percentile | 3760.95 |
| 90th Percentile | 4594.50 |

Table B8 Summary of Monthly EC statistics at A5050533 North Para River at Mt McKenzie

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 3576.37 | 3321.80 | 3951.69 | 4455.62 | 4723.08 | 3560.87 | 2031.47 | 1292.63 | 1388.05 | 1825.59 | 2699.28 | 3264.06 |
| Standard Error | 58.51 | 50.71 | 71.53 | 79.49 | 48.93 | 71.92 | 57.20 | 48.52 | 63.82 | 59.82 | 47.81 | 43.97 |
| Median | 3502.95 | 3564.71 | 3830.29 | 4129.28 | 4640.43 | 3767.93 | 1926.32 | 1128.99 | 1064.92 | 1872.50 | 2726.97 | 3189.88 |
| Standard Deviation | 808.69 | 564.70 | 674.82 | 885.20 | 733.94 | 1078.83 | 887.94 | 759.52 | 957.28 | 930.56 | 728.22 | 695.18 |
| Range | 3803.30 | 1937.92 | 2565.38 | 3051.37 | 3340.80 | 4604.95 | 3779.74 | 2892.97 | 3303.24 | 3465.60 | 3244.74 | 3364.31 |
| Minimum | 1893.17 | 2193.72 | 2736.08 | 2937.72 | 3122.49 | 729.96 | 392.81 | 203.69 | 160.28 | 222.85 | 965.89 | 2319.95 |
| Maximum | 5696.47 | 4131.64 | 5301.46 | 5989.10 | 6463.29 | 5334.91 | 4172.55 | 3096.66 | 3463.52 | 3688.45 | 4210.63 | 5684.26 |
| Count | 191.00 | 124.00 | 89.00 | 124.00 | 225.00 | 225.00 | 241.00 | 245.00 | 225.00 | 242.00 | 232.00 | 250.00 |
| 10th Percentile | 2729.22 | 2451.33 | 2882.14 | 3072.59 | 4001.54 | 1631.06 | 827.91 | 477.83 | 355.59 | 687.52 | 1763.05 | 2480.66 |
| 25th Percentile | 3056.02 | 2723.85 | 3647.21 | 4018.85 | 4231.62 | 3428.15 | 1401.57 | 732.87 | 631.89 | 949.33 | 2356.90 | 2735.00 |
| 75th Percentile | 3995.25 | 3681.15 | 4181.77 | 5243.45 | 5256.25 | 4170.78 | 2602.46 | 1572.32 | 2084.22 | 2415.81 | 3054.98 | 3515.33 |
| 90th Percentile | 4688.67 | 3940.83 | 5081.33 | 5751.23 | 5764.69 | 4871.75 | 2602.46 | 2718.94 | 3190.85 | 3472.43 | 3784.45 | 4283.00 |

Figure B4 Monthly EC at A5050533 North Para River at Mt McKenzie



# 5. Jacobs and Tanunda Creek Management Zone

Salinity is monitored in the Jacobs and Tanunda Creek Management Zone at A5050535 Tanunda Creek at Bethany. The data set is considered moderate based on the data gaps inherent within the data set.

Table B9 Summary of Annual EC statistics at A5050535 Tanunda Creek at Bethany

| | |
|---|---|
| Mean | 1266.52 |
| Standard Error | 11.85 |
| Median | 1204.99 |
| Standard Deviation | 615.50 |
| Range | 180.48 |
| Minimum | 3361.83 |
| Maximum | 2698.00 |
| Count | 23.24 |
| 10th Percentile | 464.61 |
| 25th Percentile | 831.62 |
| 75th Percentile | 1654.52 |
| 90th Percentile | 2117.22 |

Table B10 Summary of Monthly EC statistics at A5050535 Tanunda Creek at Bethany

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 1851.58 | 2566.27 | N/A | N/A | 2061.73 | 1672.56 | 1229.54 | 967.19 | 923.05 | 1028.91 | 1330.02 | 1429.06 |
| Standard Error | 89.73 | 119.05 | N/A | N/A | 49.55 | 22.75 | 20.58 | 23.76 | 26.84 | 30.84 | 33.14 | 32.67 |
| Median | 1656.11 | 2429.23 | N/A | N/A | 2200.24 | 1691.41 | 1170.44 | 900.80 | 877.93 | 905.83 | 1232.84 | 1417.31 |
| Standard Deviation | 671.49 | 461.06 | N/A | N/A | 602.74 | 437.07 | 428.79 | 495.06 | 535.44 | 583.52 | 583.42 | 432.21 |
| Range | 2211.12 | 1100.78 | N/A | N/A | 2252.00 | 2354.80 | 2023.17 | 2184.76 | 1989.77 | 2456.40 | 2586.03 | 2322.65 |
| Minimum | 1133.61 | 2050.99 | N/A | N/A | 1109.82 | 743.15 | 259.13 | 180.48 | 226.55 | 233.52 | 225.79 | 588.64 |
| Maximum | 3344.73 | 3151.77 | N/A | N/A | 3361.83 | 3097.95 | 2282.30 | 2365.24 | 2216.32 | 2689.92 | 2811.83 | 2911.28 |
| Count | 56.00 | 15.00 | N/A | N/A | 148.00 | 369.00 | 434.00 | 434.00 | 398.00 | 358.00 | 310.00 | 175.00 |
| 10th Percentile | 1199.97 | 2104.63 | N/A | N/A | 1320.00 | 1165.57 | 701.64 | 391.65 | 368.67 | 434.18 | 654.20 | 904.49 |
| 25th Percentile | 1422.58 | 2130.31 | N/A | N/A | 1421.45 | 1323.52 | 925.38 | 505.96 | 458.75 | 565.50 | 913.71 | 1084.02 |
| 75th Percentile | 2108.38 | 3066.28 | N/A | N/A | 2550.70 | 2005.83 | 1497.03 | 1300.15 | 1291.05 | 1264.70 | 1588.64 | 1694.73 |
| 90th Percentile | 3112.31 | 3121.15 | N/A | N/A | 2766.57 | 2238.89 | 1829.51 | 1779.02 | 1700.26 | 1914.03 | 2296.84 | 1941.80 |

Table B5 Monthly EC at A5050535 Tanunda Creek at Bethany