

# Wimmera Water Quality Strategy



Wimmera  
Catchment Management  
Authority

*Waterways for Life.*



# Acknowledgments

The Wimmera Catchment Management Authority has developed its Water Quality Strategy with the assistance of the Wimmera Waters Functional Committee and Wimmera Nutrient Management Working Groups. These committees consisted of:

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John Martin	Wimmera Mallee Water
John Griffiths	Rural City of Horsham
Reg McMillan	Grampians Water
Peter Taylor	Landholder
Geoff Miller	Natural Resources and Environment

The Victorian Nutrient Management Program provided funding to produce this Strategy. Additional thanks must also go to the many people who assisted in the collection of information including government representatives, many members of the community and the Oliver and Domaschenz families for the use of personal images.

For further information regarding the Strategy, or to obtain a copy please contact the water quality coordinator at Wimmera CMA on (03) 5382 1544.

## DISCLAIMER

Specific reference to funding levels in this Strategy are for indicative purposes only. The level of government investment in this Strategy is contingent on budgets and government priorities.

All information contained in this Strategy is based on the best available knowledge. The Wimmera Catchment Management Authority claims no responsibility for any errors or opinions that are contained in the Strategy.

\* Front page and facing page - blue-green algae blown against a fence in Lake Bringalbert.



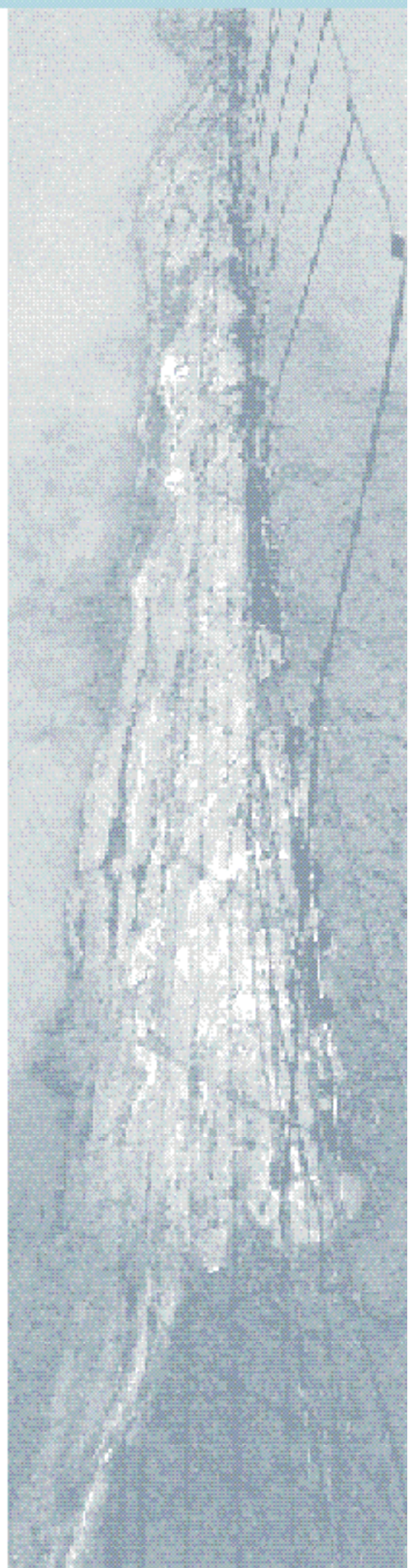
# Wimmera Water Quality Strategy

October 2002



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Catchment Management  
Authority

*Waterways for Life.*





# Foreword

Water quality is identified as a very high priority in the Wimmera Regional Catchment Strategy released in 1997. The Wimmera community assisted in the development of the Wimmera CMA Regional Catchment Strategy, which recommended producing this Strategy. This Strategy encompasses two water basins, the Wimmera River Basin and the Victorian section of the Millicent Coast Basin.

The Wimmera community recognises the importance of water quality in the Region. In 1982 the Victorian Environment Protection Appeals Board ruled in favour of land disposal of sewage treatment plant effluent in Horsham. This ruling was the result of community demands to improve water quality. The community also supports the Northern Mallee pipeline project that increases the amount of water available for environmental flows, thus improving water quality.

In the Millicent Coast Basin, the community values their unique wetland systems. These wetlands provide economic, tourism and recreation opportunities for the Region as well as homes for native plants and animals. Current work to restore and protect natural wetlands has become a local priority. Further to this, ensuring viable groundwater resources in the Region is vital in maintaining economic productivity and environmental health in the Region.

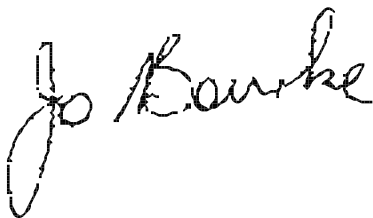
There have been a number of water quality studies completed in the Wimmera over the last ten years. These studies dealt with specific water quality issues in particular areas in the Region. Findings from these reports and new information were used to produce an integrated water quality strategy. It is the first time that the Millicent Coast Basin has been included in a detailed water quality strategy along with the Wimmera River Basin.

In order to maintain areas of high quality water and improve areas of low quality, an integrated approach is needed. Actions are prioritised so that cost effective improvements can happen. This includes work to reduce nutrient loads in our waterways.

This Strategy will guide community and government efforts in addressing the water quality issues in our Region. It is vital that the whole community is aware and involved in the management of our most vital resource.

It is essential that the Wimmera Catchment Management Authority support all projects and actions to improve water quality. It is also essential that activities that have a detrimental effect on the water quality and waterways be discouraged.

We all have a role to play in protecting water quality.

A handwritten signature in black ink, reading 'Jo Bourke'. The signature is written in a cursive, flowing style.

**Jo Bourke**  
**Chairman**  
**Wimmera Catchment Management Authority Board**

# Minister's Foreword

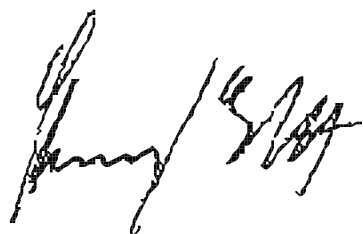
The Bracks Government is committed to protecting and enhancing Victoria's water resources. Good water quality is fundamental to supporting not only our agriculture and industries, but also for human consumption and for the environment.

The Government's ongoing commitment to improving water quality is demonstrated through the support of catchment-based plans such as the Wimmera Water Quality Strategy. Produced as part of the Victorian Nutrient Management Plan, the plan aims to address blue-green algae blooms through the management of nutrients, especially phosphorus and nitrogen.

The Victorian Government is committed to working in the partnership with the people of Victoria to ensure the sustainable use of our natural resources. The plan has been developed with extensive stakeholder and community input at every step and draws on the extensive technical and local knowledge of the people in the Wimmera.

This plan recognises the complexity resulting from Government investment decisions in natural resource management by acknowledging the wide range of benefits flowing to landholders, commercial enterprises and recreational users. Many of the benefits are not easily measurable but are none the less important to the social well being of the Wimmera community. The plan will not be integrates as part of the Regional Catchment Strategy, the blueprint for natural resource management in the Wimmera.

I commend the efforts of those involved and I am sure this will be a positive step forward in the management of nutrients in the Wimmera.

A handwritten signature in black ink, appearing to read 'Sherryl Garbutt', written in a cursive style.

**Sherryl Garbutt MP**  
**Minister for Environment and Conservation**

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# Executive Summary

The Wimmera Water Quality Strategy applies to the Wimmera Catchment Management Authority Region, which includes the Wimmera River Basin and Victorian section of the Millicent Coast Basin.

"Waterways for Life" is the catch-cry of the Wimmera Catchment Management Authority (Wimmera CMA). This vision is also adopted for the Wimmera Water Quality Strategy. The implementation of the Strategy aims to reduce total phosphorus entering the Regions' water from 127 tonnes per year to 85 tonnes per year. This will reduce the frequency of algal blooms by 62%, which has many economical, social and environmental benefits to the whole community.

Waters that have a high nutrient level are more likely to experience algal blooms, under certain conditions. Two important nutrients when discussing algal blooms are nitrogen and phosphorus.

Since 1989, there have been over 50 blue green algal blooms reported in the Wimmera Region (Appendix A and B). It is probable that more blooms have occurred in the Region over this time period, as many would go undetected or unreported, especially when occurring on private property.

Algal blooms have disrupted urban and rural water supplies, killed livestock and reduced recreational usage of waterbodies in the Region, resulting in costs to the community and the environment. The cost benefit analysis estimates that without intervention algal blooms could cost the Wimmera Region up to \$4.4 million annually<sup>(3)</sup> within the next 30 years.

The value of wetlands and waterways in the Region is estimated to be over \$140 million dollars<sup>(3)</sup>. This was established through allocating a conservation value to each wetland depending on its significance. Protection of environmental values is an essential component of this Strategy.

Groundwater quality is a very important aspect of this Strategy and will be positively affected by its implementation. The groundwater resource was not included in the CMSS model due to the lack of water quality information available and information gaps regarding the interrelationship between it and surface water. Therefore, the groundwater resource could not have specific actions and benefit cost ratios allocated. The need to fill information gaps is highlighted in the Strategy through Program 5: Monitoring, Evaluation and Research.

## Water Quality in the Wimmera Region

There are a number of different water quality parameters that indicate the quality of water in a waterway or wetland. These parameters are physical, chemical and biological. Some of the commonly monitored physical aspects of water include temperature and turbidity (murkiness of the water), while some of chemical aspects include salinity, pesticides and nutrient content. Biological monitoring includes parameters such as macroinvertebrates and fish.

This Strategy focuses on nutrients due to:

- The social, environmental and economic cost that the Wimmera community will incur if no action occurs.
- Control of nutrients will impact on other water quality parameters. For example controlling nutrients through implementing best management practices in primary production areas will reduce sediment entering the waterways.
- Some of the parameters are being addressed in other strategies, for example salinity is being addressed in the Wimmera Salinity Management Plan.

Reductions in total phosphorus are considered to be the most important nutrient in regards to controlling algal blooms as blue green algae can fix atmospheric nitrogen. Moreover, the majority of data on the likely effectiveness of management actions in Australia is associated with estimates of total phosphorus reductions rather than total nitrogen reductions. Therefore, the nutrient reduction target for the strategy is presented in terms of total phosphorus reduction.

The Wimmera community believes that attainment of naturally occurring levels of nutrients is unachievable, as the system has been significantly altered by development since European settlement.

The State Environment Protection Policy (SEPP) guidelines<sup>(11)</sup> for total phosphorus at the lower Wimmera River states that the total phosphorus should be less than 0.2 mg/L for 90% of the time. There are no SEPP guidelines<sup>(11)</sup> for total nitrogen in the Wimmera Region, therefore Environmental Protection Authority Preliminary Nutrient Guidelines for Victorian Inland Streams<sup>(39)</sup> apply. These guidelines state that the maximum total nitrogen level should not exceed 0.9mg/L.

Due to nutrient levels exceeding guidelines at certain times and locations it is essential that this Strategy be implemented to reduce nutrient levels and subsequently the intensity and frequency of algal blooms.



# Executive Summary

There are intensified consequences of nutrients entering Wimmera surface waters due to the prevalent amount of wetlands in the system i.e. the Wimmera River ends with a terminal lake and the Millicent Coast Basin has over 3000 wetlands. The continual input of nutrients into the system can compound in wetlands and are difficult to remove and manage.

The past number of reported algal blooms indicates substantial amount of insoluble nutrients in the system. These nutrients may become soluble under certain conditions. These soluble forms of nutrients are able to be used by aquatic plants and may result in problematic plant growth i.e. algal blooms.

It has been estimated that there are 127 tonnes of phosphorus and 1159 tonnes of nitrogen entering the Regions' waterways and wetlands each year. Nutrient contributions include both the soluble and insoluble forms. The contribution of nutrients to waterways and wetlands varies with different land uses, as shown in Figure 1 and 2 following.

## Algal blooms

Nutrients are elements essential for plant growth and occur naturally in soils. High nutrient levels, especially soluble phosphorus, with favorable conditions (e.g. warm, still, shallow water) can promote accelerated growth of aquatic plants. Algae can grow at accelerated rates, which may result in algal blooms.

Blue green algae are not a true algae but cyanobacteria. Cyanobacteria are primitive organisms that lack internal organelles. They photosynthesise with the by-product of oxygen. They may grow to prolific numbers and release toxins into the water. These toxins can affect humans, native and domestic animals. Algal blooms decrease the value of the water through reducing its ability to be used for consumption, production and recreational purposes. They also degrade the aquatic ecosystem.

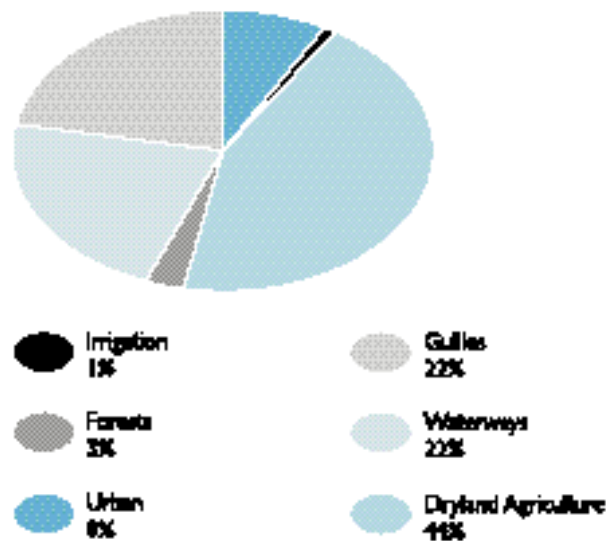


Figure 1 Estimate contribution of total phosphorus of landuse. Source Appendix C, D and E.

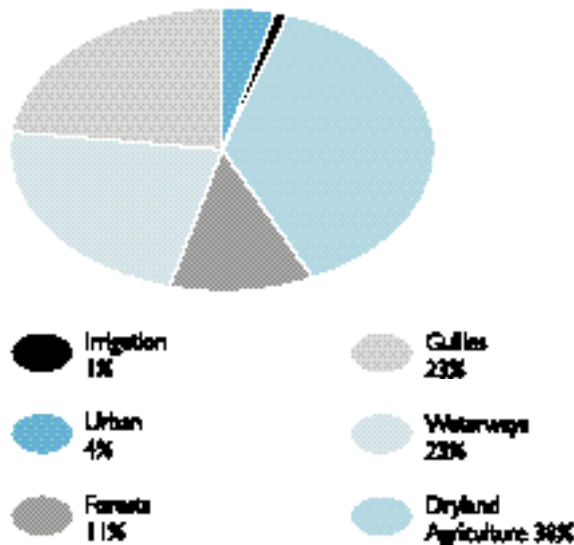


Figure 2 Estimated contribution of total nitrogen by landuse. Source Appendix C, D and E.

# Executive Summary

## Impacts of Algal Blooms

Without intervention it is estimated that blue green algal blooms will cost the Wimmera community up to \$4.4 million annually over the next 30 years. Some of the costed impacts of algal blooms in the Strategy include <sup>(3)</sup>:

- Management Authorities: managing blooms
- Amenity: reduced amenity to foreshore residents
- Urban Supplies: treating water
- Recreation: reduced visitors visiting
- Stock and Domestic: unable to utilise water
- Irrigation: private diversion

The proportion of these costs to different facets of the community is shown in Figure 3.

## Wimmera Water Quality Strategy

### Vision

"Waterways for Life" is the catch-cri of Wimmera CMA. The vision was adopted for the Wimmera Water Quality Strategy as it encompasses the ultimate aim that the Regions' water must be healthy to sustain all types of life.

### Aim

The aim of the Wimmera Water Quality Strategy is to improve the quality of water in the Regions' water, which will result in economic, social and environmental benefits.

### Total Phosphorus Target

The aim of implementing this Strategy is to reduce phosphorus entering surface waters from approximately 127 tonnes per year to 85 tonnes per year. This has the potential to reduce the amount of algal blooms by 62%, which reduces the costs of algal blooms to the Region.

Nutrient reduction estimates or targets are based on the best available information and modelling, at the time of development. Targets will be refined as more information becomes available.

Assumptions associated with nutrient reduction estimates are highlighted in Appendix K. Targets will be revisited and assessed at the 5 year Strategy review.

## Strategy

The Wimmera Water Quality Strategy has been developed through community consultation, nutrient monitoring and modelling and an assessment of environmental, economical and social benefits including a cost benefit analysis. It aims to reduce nutrient levels and the occurrence of algal blooms.

Implementation of the Strategy will protect the waters uses. These include:

- aquatic ecosystems and associated wildlife
- potable water supply
- tourism assets
- agricultural water supply
- streambank and foreshore native vegetation
- urban non-potable water supply
- scientific and educational uses
- recreation
- migratory bird habitat
- production of edible fish and crustacea
- watering of parks and gardens

This Strategy will cost \$534 000 per year to implement. The implementation will in turn reduce the amount of algal blooms by 62%, resulting in a calculated benefit of \$730 000. Therefore the Strategy has a benefit cost ratio of 1.4.

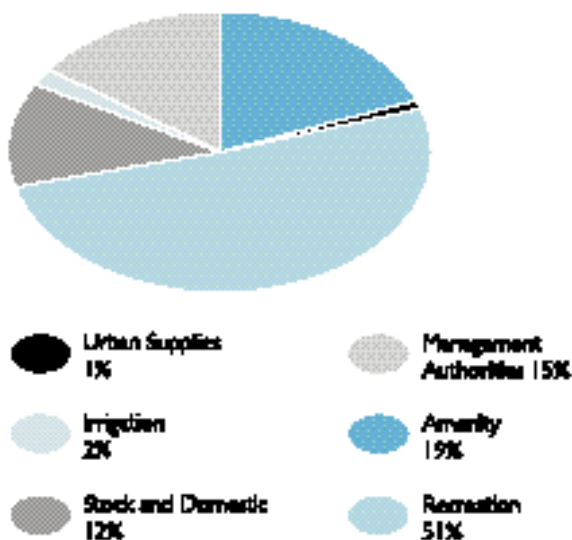
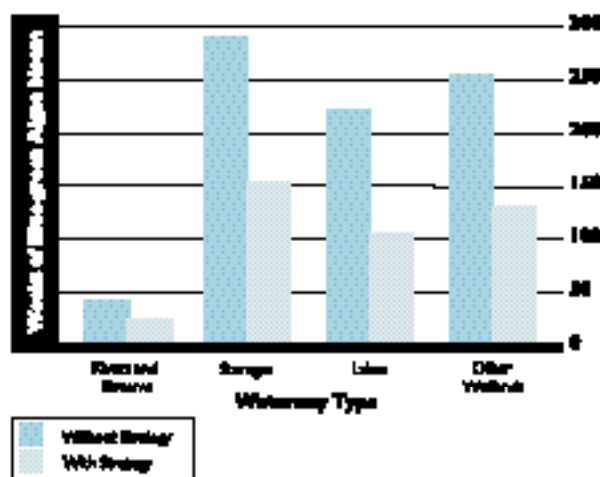


Figure 3 Proportional cost to the community without the implementation of the Strategy (over 30 years)

# Executive Summary



Graph 1 Weeks of Blue Green Algae with and without implementing the Strategy over the next 10 years

Graph 1 highlights the difference in algal bloom occurrence over the next ten years in relation to Strategy implementation and "doing nothing". From the graph it is evident that there is a large reduction in the amount and time of algal blooms from implementing the Strategy. This reduction directly equates to environmental, social and economical benefits. More information regarding the reduction in blooms in the different waterbodies, and the method for calculation, is highlighted in Appendix F.

Environmental, social and economic benefits of reducing the amount of nutrients in the Regions' water are numerous and some of these benefits, especially in regards to the environment and society, are difficult to estimate. To give a better understanding of the actual benefits of implementing the 7 programs in the Strategy, the benefits, costs and target reductions are shown in Table 1 below.

Appendix H also highlights some of the environmental assets in the Region that will be protected by this Strategy.



Lake Albacutya is an internationally significant wetland that requires good water quality.



Water quality in waterways is affected by the catchment.

# Executive Summary

**Table 1 Benefits, costs and reduction in total phosphorus from implementing the Strategy**

Program	Benefit Cost ratio	Non Costed Economic Benefits	Non Costed Social Benefits	Non Costed Environmental Benefits	Equivalent Annual Cost \$	Total Phosphorus reduction (tonnes per year)
Coordination, communication, education and awareness	Not calculated	Improved environmental values Improved land values Improved usage of water Protection of assets and infrastructure Improved tourism values	Preservation of natural values for the future Increased enterprise viability, improving town sustainability Increase in skills Community working together Increased aesthetics and recreational values	Improved water quality Improved habitats Improved biological diversity Decreased pollution Protection of the unique Wimmera Region environmental assets including the Wimmera River and Millicent Coast basin wetlands	89 000	Not calculated
Urban waters	3.52	Reduction in reactive work, which generally costs more Improved utilisation of resources Improved effective and efficient management Improved land values Protection of assets and infrastructure Improved tourism values	Preservation of natural values for the future Prevention of litter, sediment and chemicals Increased community health Improved aesthetics Improved recreational values Improved town sustainability	Improved water quality Improved habitats Improved biological diversity Decreased pollution	120 000	5.764

# Executive Summary

**Table 1 Benefits, costs and reduction in total phosphorus from implementing the Strategy**

Program	Benefit Cost ratio	Non Costed Economic Benefits	Non Costed Social Benefits	Non Costed Environmental Benefits	Equivalent Annual Cost \$	Total Phosphorus reduction (tonnes per year)
Minimising the impacts of rural drainage	1.79	<p>Improved understanding and management</p> <p>Improved uses of resources</p> <p>Strategic management and planning</p> <p>Improved tourism values</p> <p>Protection of private land</p>	<p>Preservation of natural values for the future</p> <p>More viable enterprises and sustainable communities</p> <p>Increased skills</p> <p>Equality in drain management</p> <p>Improved recreational and aesthetic values</p> <p>Protection of private land and waters</p>	<p>Improved water quality</p> <p>Improved habitats</p> <p>Improved biological diversity</p> <p>Decreased pollution</p>	56 000	3.691
Minimising the impact of agriculture and forestry	1.00	<p>Retained nutrient on land reducing the need for fertiliser</p> <p>Protection of private land</p> <p>Improve efficiency of herbicides</p> <p>Improved animal production</p> <p>Improved soil structure and ecology</p>	<p>Preservation of natural values for the future</p> <p>More viable enterprises and communities</p> <p>Increased skills</p> <p>Improved aesthetics and recreation</p>	<p>Improved water quality</p> <p>Improved habitats</p> <p>Improved biological diversity</p> <p>Decreased pollution</p> <p>Improved soil structure and ecology</p> <p>Protection of remnant and native vegetation</p> <p>Protection of wildlife corridors</p>	212 000	8.174
Monitoring, Evaluation and Research	Not calculated	Better understanding and management decisions	Better understanding and management decisions	<p>Better understanding and management decisions</p> <p>Decreased pollution</p>	Not calculated	Not calculated



# Executive Summary

**Table 1 Benefits, costs and reduction in total phosphorus from implementing the Strategy**

Program	Benefit Cost ratio	Non Costed Economic Benefits	Non Costed Social Benefits	Non Costed Environmental Benefits	Equivalent Annual Cost \$	Total Phosphorus reduction (tonnes per year)
Planning	Not calculated	Improved strategic planning  Improved landuse allocation  Better understanding of associated development risks and therefore management plans  Decreased effects of pollution events	Equality in development  Preservation of natural values for the future  Improved usage of water  Improved recreational and aesthetic value	Improved water quality  Improved habitats  Improved biological diversity  Decreased pollution	21 000	Not calculated
Catchment and river health management	Not calculated	Protection of private land  Protection of infrastructure  Increased land values	Preservation of natural values for the future  Protection of private land  Improved recreational and aesthetic values	Improved water quality  Improved habitats  Improved biological diversity  Decreased pollution  Improved soil structure and ecology  Improved native vegetation corridors  Protection of native vegetation	36 000	24.105

## Review and Evaluation

This Strategy has been devised on best available information. As information gaps get filled and monitoring data becomes available it would be beneficial to review the Strategy. The review will address aspects that were not addressed in the original cost benefit analysis such as the Wimmera fisheries resources. This review should occur every five years.

# Introduction

"Waterways for Life" is the catch-cry of the Wimmera Catchment Management Authority (Wimmera CMA). This vision is adopted for the Wimmera Water Quality Strategy, as it encompasses the ultimate aim that Wimmera waters must be of a high quality to support all types of life. The implementation of the Strategy aims to reduce the nutrient levels of the Regions' water by 42 tonnes of total phosphorus per year.

Under certain conditions, high total phosphorus and total nitrogen levels can induce algal blooms. These nutrients can be either soluble or insoluble. Insoluble forms do not contribute to algal blooms, as they are unable to be used by plants for growth. However, under certain conditions insoluble forms of nutrients may become soluble and therefore able to be used by plants and algae. Due to the ability to change form, both soluble and insoluble nutrients are addressed in this Strategy.

Since 1989, there have been over 50 blue green algal blooms recorded in the Wimmera Region (Appendix A and B). It is probable that more blooms have occurred in the Region over this time period, as many would go undetected or unreported, especially when occurring on private property. These blooms have disrupted urban and rural water supplies, killed livestock and reduced recreational usage of waterbodies in the Region. This costs the community and the environment<sup>(1)</sup>.

Poor water quality has led to significant investment funds to treat water to reduce its impacts. Water and wastewater treatment represents an economic burden to the community. In Horsham and Stawell, the sewerage treatment plants were changed to have land reuse, while in Edenhope, a \$1.8 million water treatment plant has been installed. Grampians Water has also completed a significant infrastructure upgrade to improve urban water quality and wastewater quality at Murtoa, Dimboola and Rainbow (other significant water treatment facilities in progress at Edenhope, Halls Gap, Stawell and Warracknabeal). For the five-year period ending 2001-2002, Grampians Water will have spent over \$14 million on works to improve urban water and wastewater quality.

Without intervention, there is likely to be an increase in nuisance plant growth and algal blooms, due to a build up of insoluble nutrients in the terminal lakes of the Region. These nutrients are contained in the organic matter (plant and animal material) and sediments. Nutrients in the organic matter are released through the decaying process. Nutrients in sediment are released

under favorable conditions i.e. in anaerobic conditions, environment where there is no oxygen. Ongoing nutrient contributions will further increase the occurrence, frequency and severity of algal blooms.

The Strategy supports other programs to ensure that the most beneficial outcomes are achieved. An example is the "Piping the System" project that will reduce the amount of water that is lost through evaporation and recharge. This in turn will allow the water to become available for environmental flows, which is beneficial to water quality.

Implementation of the Strategy also has a number of non costed economic, environmental and social benefits. These benefits are aimed at protecting the environmental assets of the Region. It has been estimated that the environmental assets of the Region are over \$140 million<sup>(3)</sup>. This was estimated through allocating a conservation value to each wetland depending on its significance. Appendix H shows environmental assets of the Region

The estimated cost of algal blooms to the community is up to \$4.4 million annually over the next 30 years<sup>(3)</sup>. Implementing the Strategy will cost \$534,000 per year. This will reduce the occurrence of algal blooms by as much as 62% resulting in economical, social and environmental benefits to the Region.

Implementation of the Strategy will reduce nutrient levels in the Regions' water. Implementation will also impact on some other water quality parameters including salinity and dissolved oxygen. It is anticipated to take up to 30 years to achieve desirable reductions in nutrient levels.

Groundwater quality is a very important aspect of this Strategy and will be positively affected by its implementation. The groundwater resource was not included in the CMSS model due to the lack of water quality information available and information gaps regarding the interrelationship between it and surface water. Therefore, the groundwater resource could not have specific actions and benefit cost ratios allocated. The need to fill information gaps is highlighted in the Strategy through Program 5: Monitoring, Evaluation and Research.

The Wimmera Water Quality Strategy will provide a strategic plan for activities to reduce nutrient inputs in surface, groundwater and wetlands. Through undertaking monitoring, modelling and a cost benefit analysis with continual community consultation the Strategy has developed 7 programs.

# Background

## CATCHMENT DESCRIPTION

This Strategy applies to two basin areas Figure 4<sup>(4)</sup>, the Wimmera River Basin and the Victorian section of the Millicent Coast Basin (Millicent Coast Basin). The Wimmera CMA Region is an area of 23 400km<sup>2</sup> with a population of approximately 48 000<sup>(5)</sup>.

## WIMMERA RIVER BASIN

### Area, Population, Towns<sup>(5)</sup>

The Wimmera River Basin covers an area of 13 400 km<sup>2</sup> and has a population of 43 000. The major centres are Horsham, Stawell, Warracknabeal, Nhill and Dimboola.

Major landuse is broad acre cropping, grazing and increasing areas of irrigation (upper catchment).

### Land and Water Systems

The Wimmera River is the major system in the basin. It begins in the Grampians and Mt Cole/Pyrenees Ranges flowing west then north across the Wimmera Plains before terminating in a series of lakes. The Wimmera River flows into Lake Hindmarsh, Victoria's largest freshwater lake. Outlet Creek then carries water to Lake Albacutya, an internationally protected wetland<sup>(12)</sup>.

The Wimmera River system is highly modified and stressed. Stressed rivers typically suffer from poor water quality, loss of native vegetation and over extraction of water. Water extractions for stock and domestic use frequently leave the system with less than 20% of the natural flow. There is currently Water Resource Management Plans being developed to address flow management.

The Wimmera River between Polkemmet Bridge and Wyperfeld National Park is listed as a Heritage River. A Heritage River is a river that has a substantial part of its system with outstanding nature, conservation, recreational, scenic and/or cultural heritage values. There are two major distributaries from the Wimmera River, the Deakin and the Murrumbidgee.

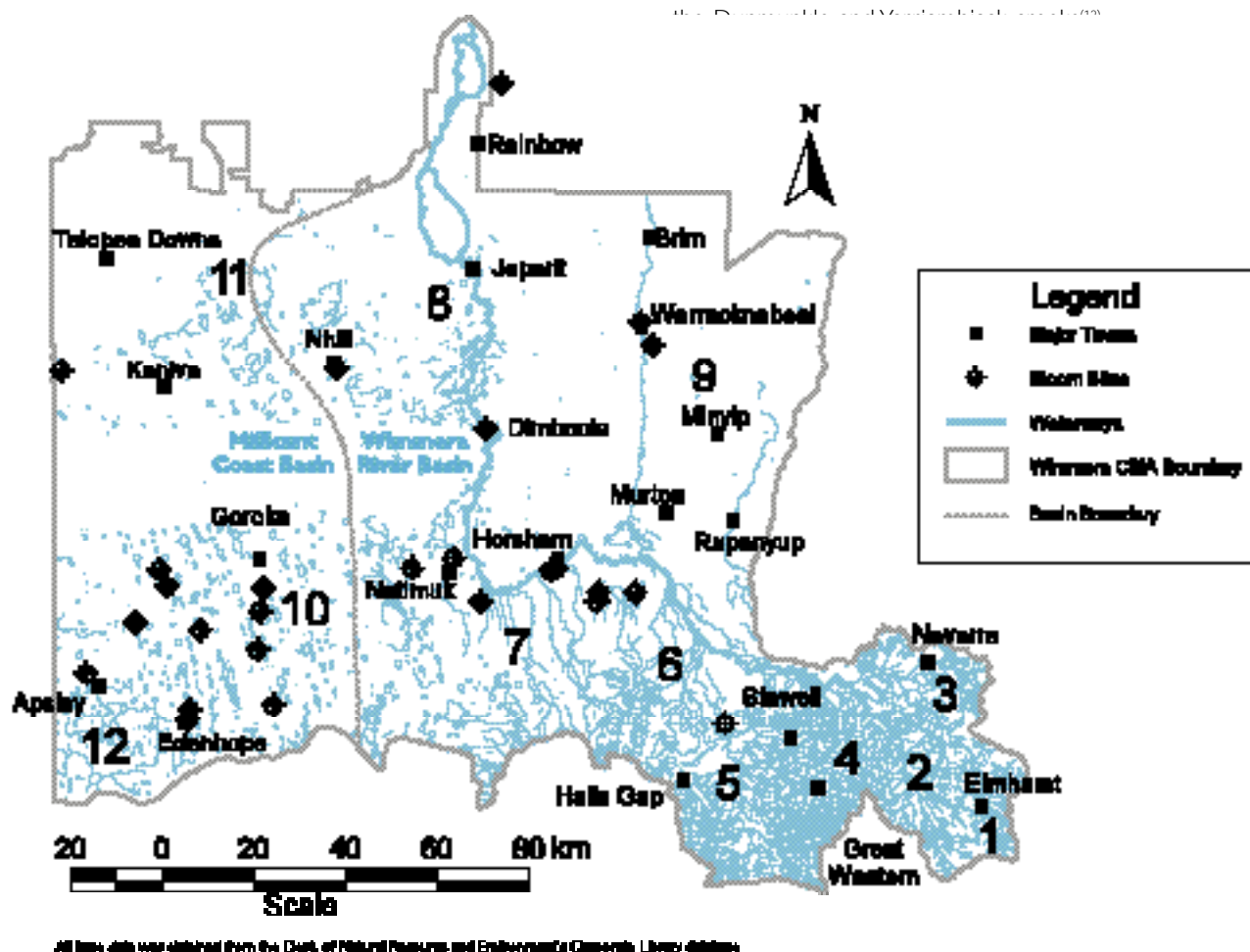


Figure 4 Map of the Millicent Coast and Wimmera River Basins<sup>(4)</sup>

There are minimal groundwater systems with usable water, which means that most of the water is supplied from reservoirs via overland channels <sup>(30)</sup>.

Environmental assets in the Wimmera River Basin are contained in Appendix H. High nutrient levels and potentially increased occurrence and intensity of algal blooms reduce the economical, environmental and social value of these resources.

**Rainfall <sup>(6)</sup>**

Rainfall for the Wimmera River Basin varies from 700-1000 mm/year in the south to 300 mm/year on the northern plains.

**Geology <sup>(6)</sup>**

The Wimmera River Basin is predominantly fluvial and marine in the north, with some intrusive and extrusive geology. This influences the hydrology and can result in salty groundwater entering the surface water.

In the south the geology is predominantly aeolian, with some marine and fluvial. This results in highly erosive soils, which can influence the turbidity of the surface water.

**Vegetation <sup>(35)</sup>**

Approximately 87% of the native vegetation has been cleared in the Wimmera River Basin. This affects the stability of the soil and streambank, potentially increasing the turbidity and nutrient levels of the Regions' water. The vegetation also affects the recharge into the groundwater system and therefore groundwater heights. This in turn can affect the salinity of the Regions' water. Native vegetation in the Wimmera River Basin is variable.

The Wimmera plains contain woodlands of Yellow Gum, Buloke, Black Box and Grey Box interspaced with large areas of natural grassland. The northern section of the plains has distinct tall mallee vegetation. Grampians National Park has a wide diversity of native vegetation including tall wet forest with tree-fern understorey, dry forests, healthy and grassy woodlands, wet and dry scrubs, and heaths.

The eucalyptus Red Ironbark, Grey Box and Yellow Gum, are also located in the Wimmera River Basin. In the southeast corner of the area, the rocky slopes of the large public land blocks have Red Stringybark and Box open forests. Taller Messmate Stringybark, Peppermint and Gum forests occur on the Mt Cole-Ben Nevis Plateau, with Gum and Peppermint associations on the South East slopes of Mount Cole.

Ecological vegetation classes (ECV's) are currently being developed in the Wimmera River Basin. These classes will assist in determining significant conservation areas.

**Fauna**

There are a number of significant fauna species in the Wimmera River Basin. Some examples of significant species include Leadbeater's Possum, Common Dunnart, Greater Long-eared Bat, Bullant, Striped Worm-Lizard and Barking Owl. Appendix L is a list of significant fauna that inhabit the Wimmera River Basin <sup>(41)</sup>.

Fish species are important in the Wimmera Region, from environmental, social and economical perspectives. Fishing is a valuable tourism and recreational resource in the Region. Fisheries Victoria has a restocking program for fish in the Wimmera Region (in 2000 Fisheries Victoria had anticipated to spend \$70 000 on restocking) <sup>(33)</sup>.

The fish species are diverse for the basin and are listed in table 2.

**Table 2 Fish species in the Wimmera River Basin**

Indigenous native fish	Non-indigenous native fish	Exotic fish
River blackfish	Silver perch	Goldfish
Mountain galaxias	Common galaxias	Carp
Western carp gudgeon	Murray cod	Eastern gumbusia
Southern pigmy perch	Golden perch	Rainbow trout
Flat-headed gudgeon	Freshwater catfish	Redfin
Australian smelt		Brown trout
		Tench

## MILLICENT COAST BASIN

### Area, Population, Towns <sup>(5)</sup>

The Millicent Coast Basin covers an area of 9 200 km<sup>2</sup> and has a population of 5000. The major population centres are Edenhope, Kaniva, Goroke, and Apsley.

Broad acre cropping and public land dominate in the north, with land in the south mainly used for grazing. Irrigated agriculture is also increasing in this area.

### Land and Water Systems

Surface water in the Millicent Coast Basin is contained in wetlands and creeks that flow north and /or west into South Australia.

There are over 3 000 wetlands in the Millicent Coast Basin, of which 90% are privately owned. These wetlands are important ecosystems and are used for water storage and recreation. These wetlands have been identified as being highly biologically diverse in macroinvertebrates <sup>(19)</sup>. Significant wetlands are highlighted in Appendix H.

The Millicent Coast Basin is divided in half by the Little Desert National Park. South of the Little Desert shallow sandy ridges dominate the landscape, with strings of wetlands found in the depressions. These wetlands vary from shallow freshwater marshes to permanent open-water lakes.

North of the Little Desert drainage lines are less significant. Evaporation rates are greater than rainfall, resulting in limited available surface water.

Groundwater in the Millicent Coast Basin is used for primary production and town water supply. The major aquifers are the Murray Group Limestone aquifers <sup>(30)</sup>.

Environmental assets in the Millicent Coast Basin are contained in Appendix H. High nutrient levels and potentially increased occurrence of algal blooms reduce the economical, environmental and social value of these resources.

### Rainfall <sup>(6)</sup>

Average annual rainfall varies from between 340-450mm/year north of the Little Desert to 500-750mm/year in the south.

### Geology <sup>(6)</sup>

North of the Millicent Coast Basin aeolian, with small amounts of fluvial and marine, dominates the geology. In the south there are a combination of paludal and fluvial, with small amounts of marine.

Geology in the Millicent Coast Basin is important in influencing the wetland characteristics i.e. freshwater meadows to permanent saline wetlands.



# Background

## Vegetation <sup>(35)</sup>

Approximately 82% of the native vegetation has been cleared in the Millicent Coast Basin. This affects the stability of the soil potentially increasing the turbidity and nutrient levels of the Regions' water. The vegetation also affects the recharge into the groundwater system and therefore groundwater heights. This in turn can affect the salinity of the Regions' water <sup>(12)</sup>.

The Little Desert contains a diverse range of native flora including Desert Stringybark woodlands and open scrub, heaths, and Mallee-Broombush. Stands of Yellow Gum grow in interdune depressions. In the southwest particularly around Edenhope, there are areas of Brown Stringybark-Messmate scrub associations on light sandy soils. The southwest area has Red Gum, Yellow Gum and Buloke open woodlands.

Ecological vegetation classes (EVC's) are currently being developed in the Millicent Coast Basin. These classes will assist in determining significant conservation areas.

## Fauna

There are a number of significant fauna species in the Millicent Coast Basin. Some examples of significant species include Little Pygmy Possum, Silky Mouse, Fat-tailed Dunnart, Large Blue Ant, Rosenberg's Goanna and White-bellied Sea Eagle. Appendix L is a comprehensive list of significant fauna that inhabit the Millicent Coast Basin <sup>(41)</sup>.

Fish species are important in the Wimmera Region, from environmental, social and economical perspectives. The fishing resource is a valuable tourism and recreational resource in the Region. Fisheries Victoria has a restocking program for fish in the Wimmera Region (in 2000 Fisheries Victoria had anticipated to spend \$70 000 on restocking) <sup>(33)</sup>.

The fish species diversity is shown in the table below.

**Table 3 Fish species in the Millicent Coast Basin**

Indigenous native fish	Non indigenous fish	Exotic fish
Fly-specked hardyhead	Murray cod	Goldfish
Yarra pigmy perch	Freshwater catfish	Rainbow trout
River Blackfish	Golden perch	Redfin
Flat headed galaxias		Brown trout
Mountain galaxias		Tench
Western carp gudgeon		
Southern pigmy perch		
Flat-headed gudgeon		
Australian smelt		



**Recreation is an important beneficial use of our waterways.**

# National & State Policy

## **National Water Quality Management Strategy<sup>(48)</sup>**

The National Water Quality Management Strategy, developed by Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ), aims "to achieve the sustainable use of the nation's water resources by protecting and enhancing their quality, while maintaining economic and social development." It has subsequently produced policies and guidelines for a range of water quality issues. This is addressed through the following plans, policies and strategies.

## **National Action Plan (NAP) for Salinity and Water Quality<sup>(34)</sup>**

In November 2000, the Federal Government announced the National Action Plan for Salinity and Water Quality (NAP). The Wimmera- Avon Rivers have been highlighted as priority areas. The Wimmera Regional Catchment Strategy will be the primary document for determining the priority actions in the Region, and together with other complementary plans such as this Strategy, will direct the NAP funding.

## **State Environment Protection Policy- Waters of Victoria (SEPP-WoV)<sup>(11)</sup>**

The SEPP goal is to "attain and maintain levels of water quality that are sufficient to protect the beneficial uses of the surface waters in the policy area." Water quality targets relate to marine, estuarine and freshwater and their beneficial uses. The SEPP guidelines for water quality in the Wimmera are highlighted in "Water Quality in the Wimmera Region" section of this Strategy. The SEPP - WoV is currently being reviewed and is due to be released in 2002. It is anticipated that the new SEPP guidelines will be risk based, aligning with the ANZECC guidelines and will be included in the Strategy as part of the review process.

## **Nutrient Management Strategy for the Victorian Inlands Waters<sup>(10)</sup>**

The Victorian Blue-Green Algae Project Team developed the Nutrient Management Strategy. The aim is "to provide a policy and planning framework to assist local communities and the state government to manage nutrient levels in waterbodies to minimise the potential for the development of algal blooms, particularly bluegreen algae." This framework includes guidelines for the development for Catchment Nutrient Management Plans that were used in this Strategy for the Wimmera Region.

## **Wimmera Catchment Management Authority Regional Catchment Strategy<sup>(12)</sup>**

A high priority in the Wimmera Regional Catchment Strategy was the development of a Wimmera Water Quality Strategy for the Region. The priority stated "develop and implement an integrated water quality management program including development and implementation of a nutrient management strategy for the Wimmera Region"

This led to the employment of a water quality coordinator to develop and implement the Wimmera Water Quality Strategy.

## **Other Important Policies**

Two other policies important to water quality management are the Victorian Biodiversity Strategy<sup>(38)</sup> and the Wetland Policy<sup>(49)</sup> and are referred to in this Strategy. The Wimmera Water Quality Strategy will be complementary with the DRAFT Wimmera Vegetation Plan that aims to protect and manage native vegetation.

The interconnectedness and relationship of these Strategies and Policies are highlighted in figure 5.

# National & State Policy

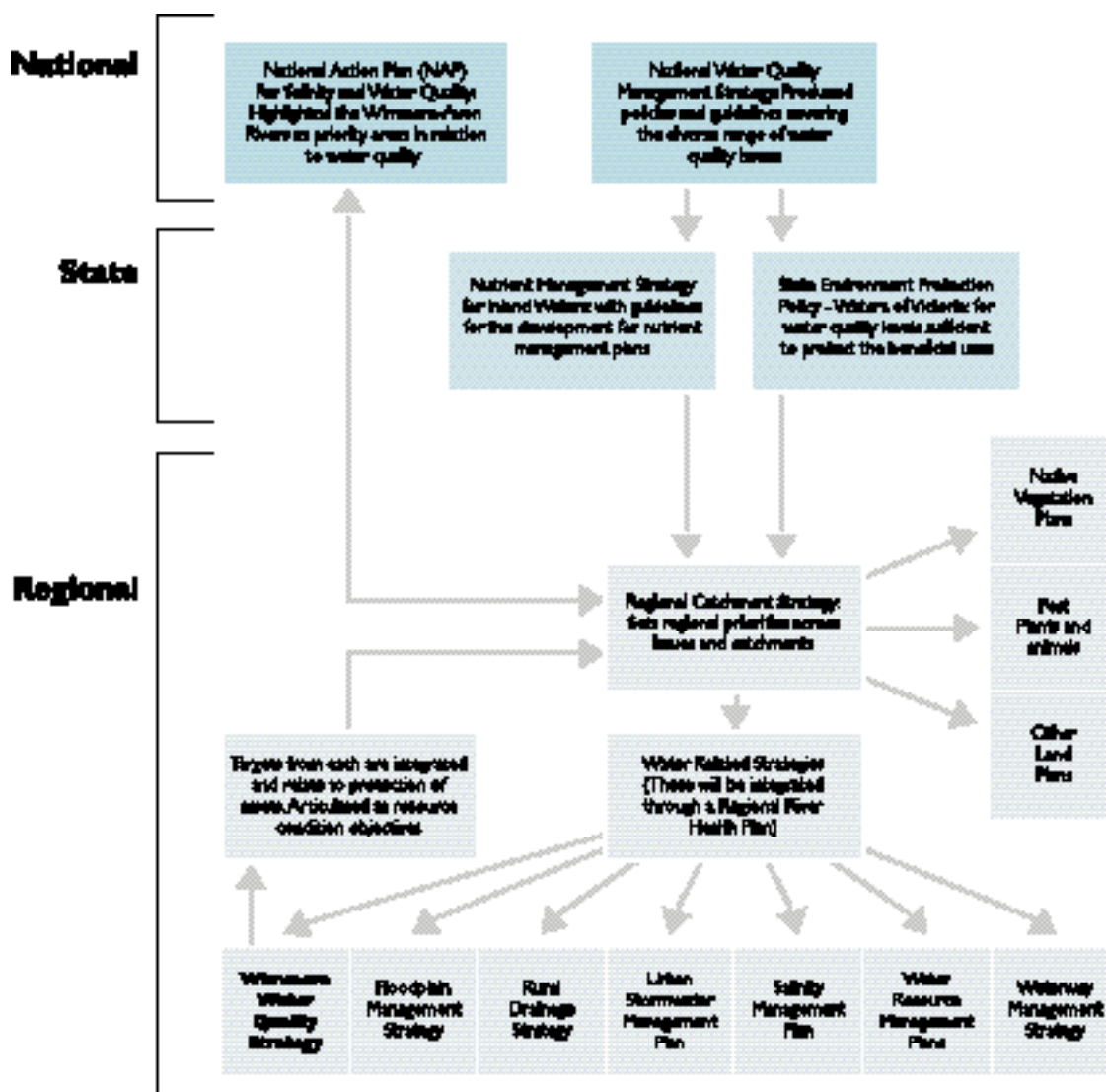


Figure 5 Diagram of policies, strategies and plans and their interconnection in relation to water quality.

# Water Quality

Water quality of a high standard is required to ensure that the beneficial uses of water can be sustained. Water quality can be measured by its physical, chemical and biological characteristics. Some of the regularly monitored parameters include:

- dissolved oxygen
- litter, pathogens, chemicals
- pH
- turbidity
- salinity
- temperature
- nutrients
- macroinvertebrates

## WATER QUALITY BENEFITS AND COSTS

This Strategy aims to maximise potential benefits through water quality improvements, thereby minimising costs associated with poor water quality. The environmental, social and economic cost or benefits depending on the quality of the water resources are summarised in table 4.

**Table 4 Potential benefits and costs and associated water quality**

Environmental benefits	Environmental costs
Increased aquatic ecosystems and associated wildlife	Increased algae bloom frequency and intensity
Improved streambank and foreshore native vegetation	Altered native species composition
Improved migratory bird habitat	Reduction in biological diversity, both water and land
Improved recharging of aquifers	Increased nuisance aquatic weed growth
	Reduced habitat availability and diversity
	Detrimental impacts on riparian habitat
Social benefit	Social costs
Increased potable water supply	Increased risk to public health
Increased scientific and educational uses	Reduced water activities and events
Increased recreation	Reduced aesthetic values
Improved watering parks and gardens usage	Reduced image of the Region and waterways
Increased landscape amenity	Reduced employment opportunities
Increased aesthetics	
Increased economy	
Improved regional economy	
Less cost of rehabilitation	
Improved natural values for future generations	
Economical benefits	Economical costs
Improved agricultural water supply	Reduced tourism
Increased land values	Reduced animal production
Improved protection of assets and infrastructure	Disruption to water supplies
Increased tourism assets	Finding and obtaining alternative water supplies
Production of edible fish and crustacea	Increased water treatment costs
Reduction in water treatment	Limited regional economic development
	Increased stock mortality

# Water Quality

## WATER QUALITY IN THE WIMMERA REGION

The Wimmera community believes that attainment of naturally occurring levels of nutrients is unachievable, as the system has been significantly altered by development since European settlement. Some physical, chemical and biological water quality parameters for the Wimmera Region are highlighted below.

### Dissolved Oxygen

Dissolved oxygen gets into the water from aquatic plants and air mixing with the water. Dissolved oxygen levels vary according to the time of day, water temperature and depth of sample. Due to this variation, it is difficult to detect dissolved oxygen issues. Adequate dissolved oxygen levels are required to ensure that aquatic plants and animals survive. For example low dissolved oxygen levels has caused fish deaths in some waterbodies in Victoria.

The Wimmera River experiences problems with low dissolved oxygen levels. These problems are greatest in deep pools, due to pool stratification. There is not enough information on dissolved oxygen in the Millicent Coast Basin to determine if there is a problem <sup>(15, 16, 17, 18, 19, 20)</sup>.

Dissolved oxygen levels will be indirectly affected by the implementation of this Strategy. When algal blooms occur they may form a layer over the surface of the water. This reduces mixing of air and water, reducing this source of dissolved oxygen. Algae covering the surface of water reduces the amount of light penetration and the ability of submerged plants to photosynthesise and produce oxygen. Once all the nutrients have been used in the algal bloom, the algae will start to die. The decomposition process will further deplete oxygen from the water body. This can lead to low oxygen levels that can result in a reduction in population and diversity of aquatic animals. The implementation of this Strategy will result in a higher amount of dissolved oxygen through reduced algal blooms.

The Wimmera Water Resource Management Plans (currently being developed by the Wimmera CMA) will also assist in addressing low dissolved oxygen levels through the management of environmental flow in the Wimmera River Basin.

### Litter, pathogens, chemicals

Litter, pathogen and chemicals can adversely affect water

quality. Litter can smother plants and animals and can become unsightly to the observer. Litter breakdown can also release chemicals to the water. Pathogens and chemicals in water can affect plant, animal and community health.

There is little monitoring of these parameters in the Region. This results in little information regarding condition and trends. There is currently no specific strategy dealing with the impacts of pesticides and pathogens. Monitoring is required to determine if any action is needed.

This Strategy involves the implementation of best management practices in relation to water quality. Best management practices would primarily involve reducing pollutants entering the system, which would subsequently reduce the amount of chemicals and pathogens in the water.

Litter is primarily associated with urban environments. An Urban Stormwater Management Plan for the region <sup>(44)</sup> is currently being developed by local governments to help reduce the effect of the urban environment on surrounding waters. This plan will assist in the reduction of chemicals and pathogens that may be entering water from the urban environment. The Rural Drainage Strategy <sup>(28)</sup> will address the effect of rural drainage on surrounding water, through implementing best management practices for rural drains.

### pH

The term pH refers to the alkalinity or acidity of water. pH of waters varies across the Wimmera Region. While some reaches are becoming more acidic, others are becoming alkaline. pH is an important parameter as it affects aquatic plants and animals survival in the environment. This parameter also affects the solubility of metals and nutrients, which can also affect the quality of water.

Information in the Millicent Coast Basins shows that pH varies between and within wetlands <sup>(16,17,18,20)</sup>.

The SEPP guidelines for pH indicate that it should vary within a range of 6-9 with pH not varying by more than 0.5 from natural background levels<sup>(11)</sup>.

As it is unclear if pH is an issue, pH is not specifically targeted in a strategy. Monitoring is required to determine if any action is needed.



# Water Quality

## Salinity

Salinity refers to the amount of free salts in the environment. Two types of salinity that affect the Australian landscape are primary and secondary salinity. Primary salinity is a natural feature of the Australian landscape, whereas, secondary salinity is the increase in the amount of salts that are in and entering the water and land, due to changes in land and water management<sup>(31)</sup>.

There are two types of secondary salinity, dryland and irrigation salinity. Irrigation salinity is caused through rising water tables due to an increase in recharge (water entering the water table) in irrigated areas. Rising water tables can have large amounts of salt in them. When water tables rise within 2 meters from the surface, water will rise to the surface through capillary action. When it reaches the surface, water evaporates off, leaving salts in the soil. This is repeated, resulting in salts becoming concentrated, causing salinity problems. Irrigation salinity can also be caused through the accumulation of salts on the surface from irrigation water. If irrigation water contains high salt levels, they are left on the surface soil when the water evaporates off. Repetition of this process results in saline topsoil<sup>(31)</sup>.

Dryland salinity is occurring due to the change in balance between water tables and rainfall. When native vegetation has been removed, the use of water is also reduced resulting in increased recharge to water tables. This increase raises the watertable, which has the same repercussion as in irrigation salinity i.e. accumulation of salts on the surface of the soil<sup>(31)</sup>.

Increasing waterway salinity can be caused by:

- Salts accumulating on the soil surface becoming dissolved in runoff or attaching to soil particles, increasing salt concentration when runoff enters the waterway.
- Waterways becoming intercepted by rising saline water tables.
- Increasing water contribution from water tables to streams naturally fed by groundwater<sup>(31)</sup>.

Electrical conductivity measures the ability of a solution to carry a current and is dependant on the presence, concentration and dissociation of salts. As salinity is defined as the concentration of these salts, electrical conductivity is often used as a measure of salinity.

Overall there is a high attainment SEPP guideline for electrical conductivity, for monitoring sites in the Wimmera River Basin although two sites, Glenorchy and the Congongella Creek at Stawell, had a low attainment of the electrical conductivity guidelines<sup>(29)</sup>. In the Millicent Coast Basin, salinity in wetlands sampled is generally low. Exceptions include Minimay Swamp and Lakes Wallace, Lake Lumeah, Caldow Lake and Mosquito Creek<sup>(19)</sup>.

Salinity will be indirectly addressed through the Wimmera Water Quality Strategy, through reducing the amount of runoff containing sediments (therefore salts and nutrients) entering the waterway.

The Wimmera Salinity Management Plan and the West Wimmera Salinity Management Plan will directly address salinity aspects of water quality that are otherwise excluded from this Strategy.

## Temperature

Temperature can affect the ability of aquatic plants and animals to survive. Warm water temperatures can promote algal blooms. Temperature also affects the amount of dissolved oxygen. Temperature is a highly variable parameter with the time of day, season, depth of water body, flows and stream bank vegetation.

Temperature will be indirectly addressed through this Strategy through the encouragement of landuse best management practices such as buffer strips along waterways and highlighting support of other strategies and plans.

The Wimmera Water Resource Management Plans will involve the release of environmental flows, which will influence water temperature. The Wimmera Waterway Management Strategy aims to increase the amount of native streamside vegetation, which will increase the streambank shade and address high water temperatures.

## Turbidity

Turbidity refers to the amount of particulate matter that is in the water (i.e. the "dirtiness"). Turbidity can be caused from point sources (nutrients enter the waterway at an identifiable point), although the largest contributor is generally erosion.

# Water Quality

Water with high turbidity levels has poor light penetration, which affects the ecological structure of waterbodies, as plants require light for photosynthesis. When particulate matters settles it reduces aquatic fauna habitat, and decreases the depth and definition of a waterway, increasing minor flooding possibilities. The potential for pollutants and nutrients entering the water is also increased, as they are often transported attached to sediment.

The SEPP guidelines for the Wimmera River, tributaries and terminal lakes state that turbidity should be less than 50 NTU, 90% of the time<sup>(11)</sup>. Turbidity levels generally increase along the Wimmera River, exceeding SEPP guidelines at Jeparit. Turbidity levels in the Region greatly increase during storm events, due to the increase in runoff, and therefore particulate matter<sup>(15,16, 17, 18, 20, 29)</sup>.

Turbidity will be addressed by some of the activities in this Strategy such as the implementation of best management practices in the landuse program, surface water management in the rural drainage program, assisting in prioritising waterway works and support of urban stormwater management plans.

The major strategies that will help reduce turbidity in the Region are:

- Wimmera Waterway Management Strategy reduces turbidity through gully stabilisation, waterway repair and maintenance and catchment management works programs.
- Urban Stormwater Management Plan reduces urban pollution entering the waters through education and construction of onground works.
- Rural Drainage Strategy reduces the effects of rural drains on surrounding water and assist in reducing turbidity.

The collation of existing actions and further analysis of turbidity outcomes will be developed as part of the Wimmera River Health Strategy.

## Macroinvertebrates

Macroinvertebrates are a biological parameter that can be used to measure the quality of water.

Macroinvertebrates are small aquatic animals that do not have a backbone. Different macroinvertebrates have different feeding and habitat needs. Water of high quality provides a greater range of feeding and habitat opportunities and correspondingly there should be a greater diversity of animals, numbers and increasing ecological structure. Macroinvertebrates are a useful

water quality monitoring tool, as they can show the impact of an event that may be missed in routine physio-chemical monitoring.

The Victorian Biodiversity Strategy objective of conserving and managing biodiversity would ultimately address the diversity of macroinvertebrates in waterways. There are no regional strategies that directly deal with macroinvertebrates, but many have indirect benefits as they are aimed at improving river and wetland health and therefore macroinvertebrate diversity.

This Strategy will indirectly improve the abundance and diversity of macroinvertebrates through improved water quality, which is in alignment with the Victorian Biodiversity Strategy<sup>(38)</sup> and Wetland Policy<sup>(49)</sup>.

## Nutrients

Nutrients are elements essential for plant growth and occur naturally in soil. Nutrients occur in different forms namely soluble and insoluble. An excess of nutrients in water, especially phosphorus and nitrogen, leads to accelerated growth of aquatic plants, weeds and algae.

Nutrients in the Wimmera Region come from a wide range of sources including<sup>(10)</sup>:

- Soil erosion
- Run-off from landuse
- Urban stormwater runoff
- Sewerage
- Irrigation drainage
- Internal loading

These can be categorised into three types of sources:

- Diffuse: nutrients from a general area e.g. run-off from farms
- Point: nutrients from a discrete source e.g. drain; and
- Internal Loading: nutrients from sediments or plants in the water.

High nutrient levels, especially soluble phosphorus, combined with favorable conditions (e.g. warm, still, shallow water) can promote accelerated growth of aquatic plants. Algae can grow at accelerated rates, which may result in algal blooms. Domination of a single or few plant species affects the ecosystem balance and biodiversity of the system, limiting its use and value.

# Water Quality

The State Environment Protection Policy (SEPP) guidelines<sup>(11)</sup> for total phosphorus at the lower Wimmera River states that the total phosphorus should be less than 0.2 mg/L for 90% of the time. There are no SEPP guidelines<sup>(11)</sup> for total nitrogen in the Wimmera Region, therefore Environmental Protection Agency Preliminary Nutrient Guidelines for Victorian Inland Streams<sup>(39)</sup> apply. These guidelines state that the maximum total nitrogen level should not exceed 0.9 mg/L.

With regards to the nutrient levels actually occurring in the surface water in the Wimmera CMA Region, there is varying amounts of information available. Two of the regularly monitored Lakes (Lake Lonsdale and Green Lake) had high levels of both total nitrogen and total phosphorus, whilst the other monitored lakes had low levels of nutrients. Monitoring sites in the upper Wimmera River had low total nitrogen levels, whereas the middle and lower part of the river system had varying and sometimes high nutrient levels, in relation to the guidelines<sup>(43)</sup>.

In regards to total phosphorus, sites located in the lower part of the Wimmera River had higher nutrient levels than upstream. The lower river had moderate attainment of the nutrient guidelines<sup>(43)</sup>. To give a better understanding of the nutrient levels from the monitoring table 5 highlights the 10th, 90th percentiles and median (definition in the glossary). A statewide project found that in the Wimmera Region there was not enough data to confidently undertake trend analysis on either total phosphorus or total nitrogen<sup>(47)</sup>.

Less information is available about nutrient levels in the Millicent Coast Basin, although most permanent lakes have experienced at least one bluegreen algae bloom over the last decade linked to high nutrient levels<sup>(19)</sup>.

Due to the varying nutrient levels, with the nutrient levels occasionally exceeding guidelines it is essential that this Strategy be implemented to reduce nutrient levels and subsequently the intensity and frequency of algal blooms.

There are intensified consequences of nutrients being inputted into the Wimmera surface waters due to the prevalent amount of wetlands in the system i.e. the Wimmera River ends with a terminal lake and the Millicent Coast Basin has over 3000 wetlands. The continual input of nutrients into the system can compound in wetlands and are difficult to remove and manage.

Nutrients in wetlands are usually in an insoluble form but may become available under favorable conditions e.g. phosphorus stored in the sediments may become available under anaerobic conditions. These nutrients are difficult to remove and manage.

It has been estimated that there are 127 tonnes of phosphorus and 1159 tonnes of nitrogen entering the Regions' water each year<sup>(3)</sup>. These nutrient contributions include both the soluble and insoluble forms. Despite insoluble nutrient being unavailable for aquatic growth, they are considered together in this Strategy. This is because insoluble forms of nutrients can become soluble, therefore biologically available, under certain conditions.

Table 5 Nutrient levels in the Wimmera River (1999)<sup>(43)</sup>

Location	Parameter	10th Percentile	Median	90th Percentile
Wimmera River at Glenorchy	TN	0.334	0.449	<b>0.922</b>
Wimmera River at Glenorchy	TP	0.016	0.022	0.040
Wimmera River at Horsham	TN	0.520	0.766	<b>1.460</b>
Wimmera River at Horsham	TP	0.026	0.045	0.119
Wimmera River at Lochiel Bridge	TN	0.548	0.641	0.806
Wimmera River at Lochiel Bridge	TP	0.011	0.021	0.03

Note: TP guidelines: 90th percentile <0.2mg/L  
Note: TN guidelines: maximum <0.9mg/L

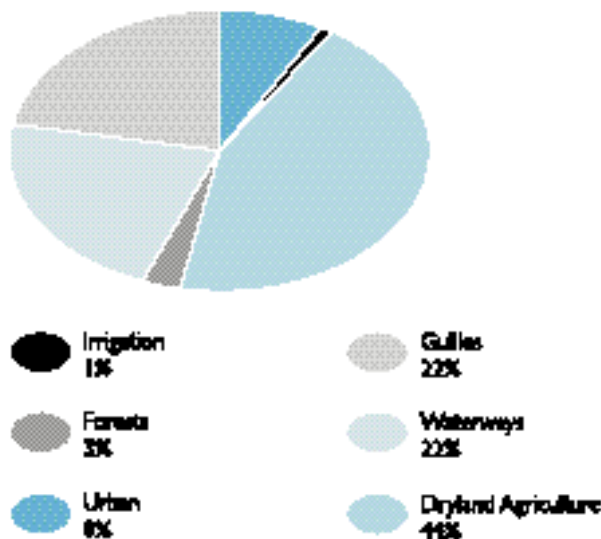


Figure 6 Estimated contribution of total phosphorus by landuse. Source Appendix C, D and E.

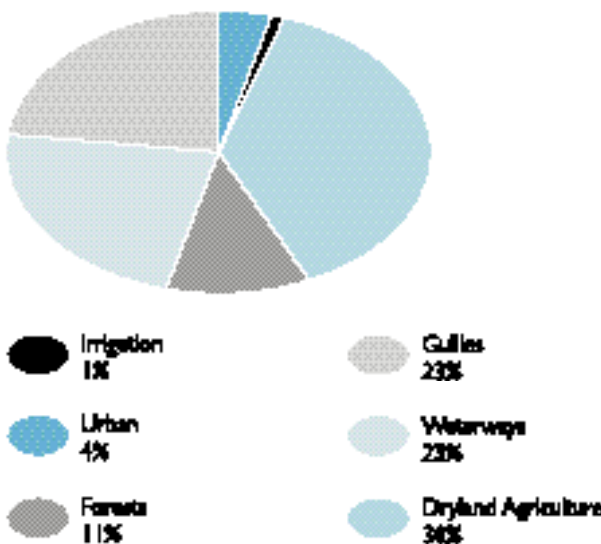


Figure 7 Estimated contribution of total nitrogen by landuse. Source Appendix C, D and E.

Nutrient contributions from different landuses is shown in figure 6 and 7. This has been calculated by determining nutrient generation rates and area occupied in the Region for each landuse. The results from each landuse have then been compared.

### Causes of Algal Blooms

Nutrient levels can cause algal blooms, but there are other contributing factors. These include <sup>(23, 24, 25, 26)</sup>:

- Calm weather conditions;
- Degraded aquatic environments;
- Low water flows;
- High light availability/low turbidity;
- High water temperatures;
- Groundwater inflows; and
- Sulfates (from groundwater or fertilisers).

**Nutrient levels and water flow can be managed to reduce the potential of blooms and/or excess plant growth. This Strategy focuses on the management of nutrients.**

### Blue Green Algae

There are many types of algae and therefore algal blooms. One commonly reported bloom is blue green algae. Blue green algae are native to Australia, but due to increases in the intensity, frequency and therefore effect of blooms they are becoming a high concern for many communities.

Blue green algae are not a true algae but cyanobacteria. Cyanobacteria are primitive organisms that lack internal organelles. They photosynthesise with the by-product of oxygen. They may grow to prolific numbers and release toxins into the water. These toxins can affect humans, native and domestic animals. Algal blooms decrease the value of the water through reducing its ability to be used for consumption, production and recreational purposes. They also degrade the aquatic ecosystem.

There are a number of different genera and species of blue green algae. Only three genera produce toxins that are collectively known as microcystins. Toxins include:

- hepatotoxins - cause liver damage and may promote tumour growth
- neurotoxins - cause staggering, muscle tremors, paralysis and respiratory arrest
- endotoxins- cause gastroenteritis, skin and eye irritations and skin rashes

As some non-toxic blooms can become toxic, all blooms are assumed to be toxic for management purposes.

# Water Quality

## History of Blue Green Algal Blooms

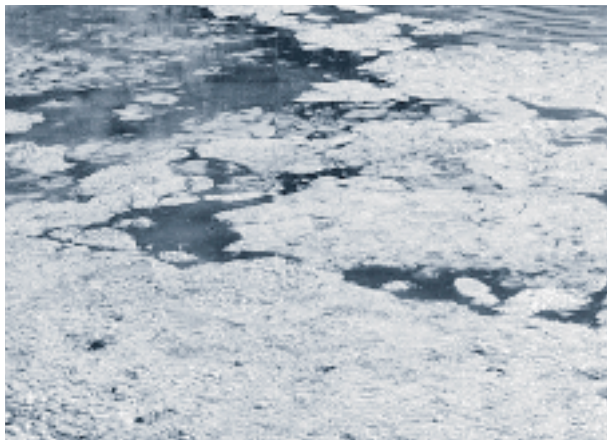
There have been 54 blue-green algal blooms recorded in 30 waterbodies in the Wimmera since 1987 (Appendix A and B)<sup>(1)</sup>. Lake Wallace has recorded the highest number, 7, and Green Lake, 5. It is probable that more blooms have occurred in the Region over this time period, as many would go undetected or unreported, especially when occurring on private property. This is also affected by the difficulties in counting algal blooms.

Domestic and native animals have been reported to die after being exposed to these toxins in the Region<sup>(8)</sup>. There are also anecdotal reports of allergic reactions and gastroenteritis from Edenhope residents after contacting water from Lake Wallace during a bloom.

## Impacts of Blue Green Algal Blooms

Without intervention it is estimated that blue green algal blooms will cost the Wimmera community up to \$4.4 million annually over the next 30 years. Some of the costed impacts of algal blooms in the Strategy include<sup>(3)</sup>:

- Management authorities: managing blooms
- Amenity: reduced amenity to foreshore residents
- Urban supplies: treating water
- Recreation: reduced visitors visiting
- Stock and Domestic: unable to utilise water
- Irrigation: private diversion



Effects of poor water quality include non-toxic algae blooms.

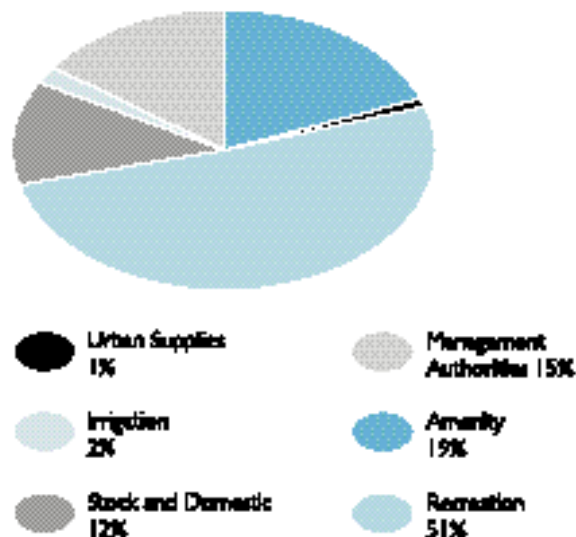


Figure 8 Proportionally distributed economic impacts of blue green algae over the next 30 years<sup>(3)</sup>

Calculated impacts borne to different sectors of the community are shown in figure 8.

Some of the non costed impacts of algal blooms in the Strategy include:

- Reduced amenity for those other than foreshore residents;
- Reduced preservation of natural values for future generations;
- Reduced biodiversity;
- Poor image for regional economy;
- Reduced animal production;
- Excessive weed growth;
- Impact on environmental assets;
- Reduced efficiency of herbicides; and
- Other health impacts.



# The Strategy

## VISION

"Waterways for Life" is the catch-cry of Wimmera CMA. The vision was adopted for the Wimmera Water Quality Strategy as it encompasses the ultimate aim that the Regions' water must be healthy to sustain all types of life.

## AIM

The aim of the Wimmera Water Quality Strategy is to improve the quality of the Regions' water that will result in environmental, social and economic benefits to the Region.

## TOTAL PHOSPHORUS TARGET

Reductions in total phosphorus are considered to be the most important nutrient in regards to controlling algal blooms as blue green algae can fix atmospheric nitrogen. Moreover, the majority of data on the likely effectiveness of management actions in Australia is associated with estimates of total phosphorus reductions rather than total nitrogen reductions. Therefore, the nutrient reduction target for the strategy is presented in terms of total phosphorus reduction.

The aim of implementing this Strategy is to reduce phosphorus entering surface water from approximately 127 tonnes per year to 85 tonnes per year. This has the potential to reduce the amount of algal blooms by 62%. This reduction reduces the costs of algal blooms to the Region.

Nutrient reduction estimates or targets are based on the best available information and modelling, at the time of development. Nutrient reduction estimates will be refined as more information becomes available. Assumptions associated with the nutrient reduction estimates are highlighted in Appendix K. Targets will be revisited and assessed at the five year Strategy review.

## STRATEGY DEVELOPMENT

Development of the Strategy involved a number of key steps including consultation, nutrient monitoring, modelling and an assessment of environmental, economic and social benefits including a cost benefit analysis.

## COMMUNITY INVOLVEMENT

The Wimmera Water Quality Strategy has been produced with assistance from three major community

based working groups. The Nutrient Management Working Group, assisted in developing the nutrient model that was used to determine annual nutrient loads in the Wimmera River in 1997<sup>(42)</sup>.

The Water Quality Steering Committee and the Wimmera Catchment Management Board have provided advice and direction into the cost benefit analysis and development of the Wimmera Water Quality Strategy. These groups represent all sectors of the community. The DRAFT Wimmera Water Quality Strategy was released in March 2001 for an extended period of time to enable community input. In this period, numerous presentations and media articles were released. Five public feedback meetings were held throughout the Region, ensuring that the community had an opportunity to raise and discuss their issues.

Through using information from these groups, the Strategy has been developed with local information, which is important when understanding and addressing social and environmental considerations associated with water quality protection.

## WATER QUALITY MONITORING

Water quality in the Wimmera is monitored through the following complementary programs. These are <sup>(27)</sup>:

- Victorian Water Quality Monitoring Network <sup>(17)</sup>
- Major Storages Operational Monitoring Program <sup>(18)</sup>
- EPA Fixed Site Monitoring Network <sup>(17)</sup>

Other water quality monitoring programs include:

- Saltwatch; and
- Waterwatch

In addition there have been several independent studies completed in the Region including:

- Nutrients, palaeolimnology and cyanobacterial blooms in Lake Wallace, Western Victoria, Greg Vinall Deakin University;
- Unpublished report examining macroinvertebrates, Rhonda Butcher, Monash University;
- Review of West Wimmera Water Quality, Wimmera Catchment Management Authority<sup>(19)</sup>;
- Watching those Watertables, Theiss Environmental Services; and
- Environmental flow studies for the Wimmera River, Victoria (Part A, B, C, and D).

In the Millicent Coast Basin, there was a lack of base line water quality information.

# The Strategy

Water quality data required for the model, was collected from these monitoring sources. Development of this Strategy relied on the best available data however, due to the variety of data sources, types and quality some discrepancies may have resulted. There were also some information gaps, which could influence the Strategy and its targets. Key data gaps have been identified in Program 5.

## NUTRIENT MANAGEMENT UNITS

To better understand where nutrients are generated, the Region was divided into 12 Nutrient Management Units (NMU). This division allowed modelling to be more accurate assisting in highlighting nutrient sources, resulting in the development of more directed actions to address nutrient issues. Nutrient management units, descriptions of the units and recorded algal blooms are depicted in the map below <sup>(4)</sup>.

## NUTRIENT MODELLING

A Catchment Management Support System (CMSS) was used to model the nutrients with a 10 year time frame in the Wimmera Region.

The CMSS was developed by the CSIRO to help resource managers assess the potential impact of management decisions on the nutrient status of catchments <sup>(42)</sup>.

NMU	Description
1	Wimmera River and tributaries upstream from Eversley
2	Wimmera River and tributaries between Eversley and Joel Joel
3	Wimmera River and north side tributaries between Joel Joel and Glenorchy
4	South side tributaries between Joel Joel and Glenorchy
5	Tributaries upstream of Lake Lonsdale
6	Wimmera River Glenorchy to Doon and tributaries downstream of Lake Lonsdale
7	Wimmera River and tributaries between Doon Swamp and O'Bree's Crossing
8	Wimmera River mainstream (north of O'Bree's Crossing)
9	North East Wimmera - Distributaries
10	West Wimmera terminal streams (South of and including Little Desert)
11	West Wimmera terminal streams (North of Little Desert)
12	West Wimmera border streams (West Flowing)

Table 6: Description of nutrient management units.

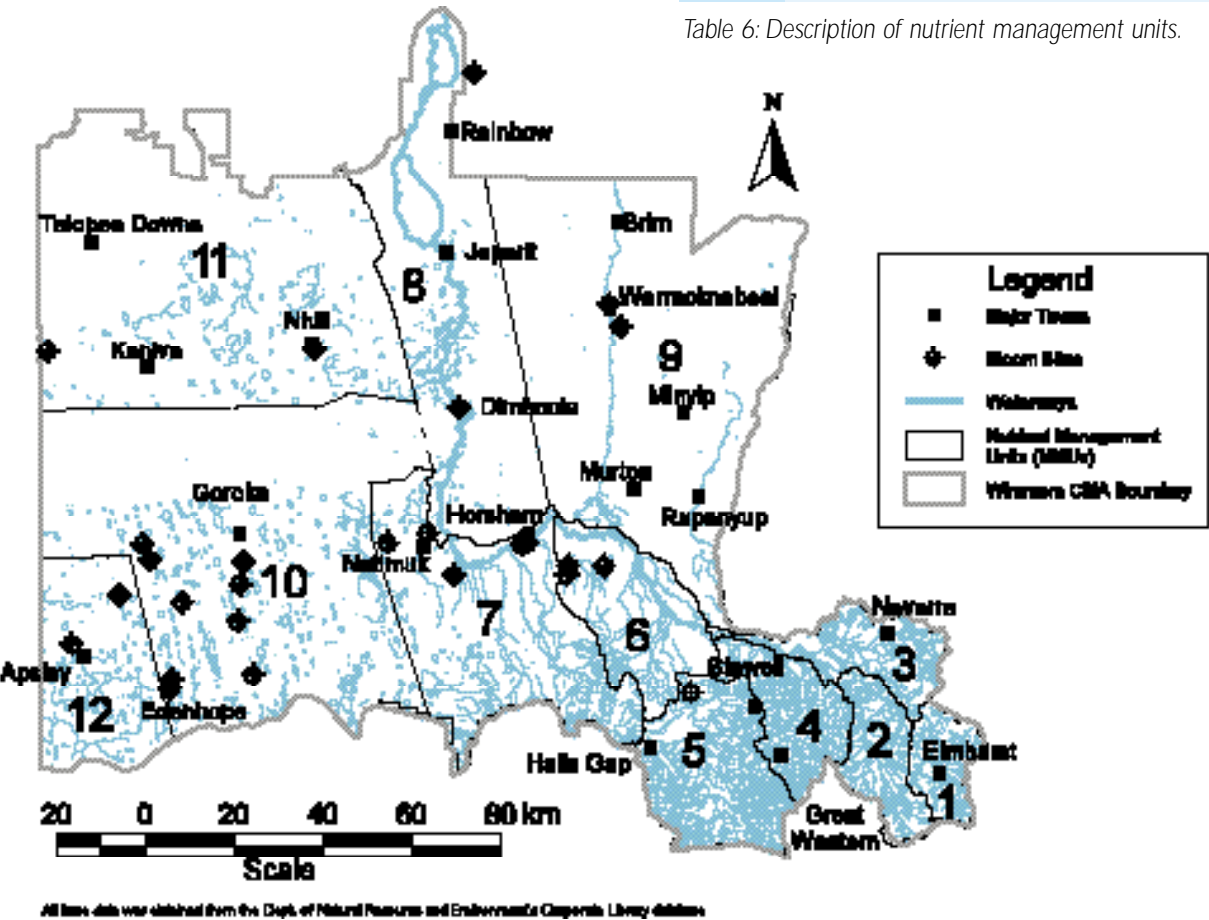


Figure 9 Nutrient Management Units and recorded algal blooms in the Wimmera Region.

# The Strategy

Nutrient modelling was firstly undertaken by Water Ecoscience in 1997, but only covered 25% of the existing Region. Read and Sturgess subsequently adjusted the model to include the rest of the Wimmera Region<sup>(3)</sup>. Nutrient generation rates were determined for each landuse, more information is highlighted in Appendix C, D, and E. The nutrient generation rates were specified for the model based on the mean results of the State Wide Review of Nutrient Management Strategies that was undertaken by AWT (2000)<sup>(46)</sup>.

The model included the following parameters<sup>(3)</sup>:

- nutrient generation rates from:
  - landuse types
  - waterway and gully erosion
- nutrient reduction through land management
- water flow and assimilation processes
- historical bloom frequency

The effect of changing management practices on nutrient loads could be determined by using this model. These reductions were used as a basis for the cost benefit analysis. A model is used to simulate a process and therefore necessarily relies on a number of assumptions. These assumptions may affect the accuracy of the output and therefore the conclusions made from the model. More information is contained in Appendix I.

## COST BENEFIT ANALYSIS

In order to undertake a cost benefit analysis, it was first necessary to complete a risk assessment to determine the potential for future algal blooms, through scoring the waterbody in relation to some of its variables that influences the occurrence of algal blooms, namely water quality, water velocity, water temperature and history of blooms.

A cost-benefit analysis was completed, by identifying the cost of implementing actions and the benefits of reducing algal blooms<sup>(3)</sup>. Benefits are based on a 1:1 ratio of percent nutrient reduction and percent bloom reduction.

Some of the costed impacts of algal blooms in the Strategy include<sup>(3)</sup>:

- Urban water supplies: treating water
- Value of recreation and tourism: reduced visitors
- Domestic and stock use: unable to utilise water
- Irrigation: private diversion
- Management authorities: managing blooms
- Foreshore residents: reduced amenity

## Results from the Cost Benefit Analysis<sup>(3)</sup>

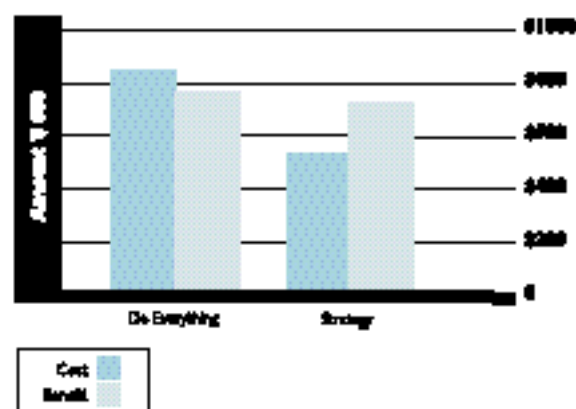
As a basis for the cost benefit analysis, three nutrient management scenarios were devised. These were:

- Do nothing- do not complete any new water quality protection activities;
- Do everything- complete all the water quality protection activities outlined in table 10;
- Preferred management option-complete water quality protection activities in priority NMUs outlined in table 10.

The "do nothing" scenario would not implement any nutrient management activities anywhere in the Region. The impact of algal blooms could cost the community up to \$4.4 million per year within the next 30 years.

The "do-everything option" would involve implementing the urban waters, rural drainage, waterway management and landuse programs in all NMUs. This would have a benefit cost ratio of 0.94, with an annual cost of \$840,000. Significant non-economic benefits would be gained from this program such as the protection of beneficial uses and the reduction in non-toxic blooms.

The "preferred management option" forms the basis for the Wimmera Water Quality Strategy. See table 10. It undertakes urban waters, rural drainage, waterway management and landuse programs in priority NMUs. The "preferred management" option was chosen because of the benefit cost ratio of 1.4 and significant non costed benefits to the community. It will have in excess of \$730 000 of benefits per year. Implementing the Strategy will cost \$534,000 per year. This equates to a total cost of \$15 983 000 for the 30 year life of the Strategy. This will reduce the occurrence and therefore cost of algal blooms by as much as 62%. It is therefore beneficial from an economic, social and environmental perspective to implement this Strategy.



Graph 2 Difference in benefits and costs between the "Do everything" scenario and the Strategy

# The Strategy

**Table 7 Difference in activities between do everything and preferred management option**

	<b>Prog 2: Urban Waters</b>		<b>Prog 3: Rural Drainage</b>		<b>Prog 4: Landuse</b>		<b>Prog 7: Waterway Manag't</b>	
NMU	Urban Stormwater Works	Urban Stormwater Education	Rural Drainage	Grazing BMP	Farm Extension	Cropping BMP's	Irrigation BMP	Waterways & Gullies
1	X   O	X   O	X	X	X	X	X	X
2	X   O	X   O	X	X	X	X	X	X
3	X   O	X   O	X	X	X   O	X	X	X
4	X   O	X   O	X	X   O	X   O	X   O	X	X
5	X   O	X   O	X	X   O	X   O	X	X	X   O
6	X	X	X	X   O	X   O	X   O	X	X
7	X   O	X   O	X	X   O	X   O	X   O	X	X   O
8	X	X	X	X	X	X	X	X
9	X   O	X   O	X	X	X   O	X	X   O	X
10	X	X   O	X   O	X   O	X   O	X	X	X   O
11	X	X	X	X	X	X	X	X
12	X   O	X	X	X	X	X	X	X

X Activities of the "Do Everything" scenario

O Activities of the "Preferred" scenario

## Priority NMUs

Selection of priority NMUs was based on nutrient contributions, benefit cost ratios, community consultation, environmental assets in the area and professional expertise. The benefit cost ratios also assist in determining action timeframes.

### Very High Priority-

urgent, the benefit cost ratio is typically >1.9 and also results in high non-costed benefits.

### High Priority-

short term, the benefit cost ratio is typically 1.0-1.9, and also results in high non-costed benefits.

### Medium Priority-

medium term, the benefit cost ratio is typically 0.6-0.9, or results in high non-costed benefits.

### Low Priority-

long term, benefit cost ratio is typically <0.5 or results in high non-costed benefits. Not included in this Strategy.

Other programs have been included in this Strategy that were inappropriate for inclusion in the cost benefit analysis as direct reduction in algal blooms could not be determined. These programs include coordination, communication, education and awareness, planning, monitoring, evaluation and research and river health management.

These programs will reduce nutrient loads and have significant non costed benefits.

## Priority Actions

There are a number of actions in each program that are required to achieve the desired nutrient reduction to surface waters. Actions in programs are prioritised. This is undertaken to assist in directing funding. Prioritisation of actions considered:

- The environmental and social assets and values of an area, the higher the environmental or social value of the area, the higher the priority.
- Whether or not it was a nutrient source. Actions are directed to key nutrient sources to enable the best reductions in nutrient levels in the Regions' water.
- Community consultation. Activities that were believed to be necessary and justifiable by the community were added and given the depicted priority.
- Professional opinions were also used in assisting in the prioritisation of actions in the relevant programs, as working knowledge of the areas was especially important where information gaps occurred.

## Programs

The programs included in the Wimmera Water Quality Strategy, nutrient targets, and non costed benefits are shown in table 7.

# The Strategy

**Table 8 Non costed benefits of implementing the Strategy**

Program	Non costed economic benefits	Non costed social benefits	Non costed environmental benefits	Equivalent annual cost \$	TP Reduction (T/year)
Coordination, communication, education and awareness	Improved environmental values	Preservation of natural values for the future	Improved water quality	89 000	Not calculated
	Improved land values	Increased enterprise viability, improving town sustainability	Improved habitats		
	Improved usage of water		Improved biological diversity		
	Protection of assets and infrastructure	Increase in skills	Decreased pollution		
	Improved tourism values	Community working together			
		Increased aesthetics and recreational values			
Urban waters	Reduction in reactive work, which generally costs more	Preservation of natural values for the future	Improved water quality	120 000	5.764
		Prevention of litter, sediment and chemicals	Improved habitats		
	Improved utilisation of resources		Improved biological diversity		
	Improved effective and efficient management	Increased community health	Decreased pollution		
		Improved aesthetics			
	Improved land values	Improved recreational values			
	Protection of assets and infrastructure	Improved town sustainability			
	Improved tourism values				
Minimising the impacts of rural drainage	Improved understanding and management	Preservation of natural values for the future	Improved water quality	56 000	3.691
	Improved uses of resources	More viable enterprises and sustainable communities	Improved habitats		
	Strategic management and planning	Increased skills	Improved biological diversity		
			Decreased pollution		
	Improved tourism values	Equality in drain management			
	Protection of private land	Improved recreational and aesthetic values			
			Protection of private land and waters		

# The Strategy

**Table 8 Non costed benefits of implementing the Strategy**

Program	Non costed economic benefits	Non costed social benefits	Non costed environmental benefits	Equivalent annual cost \$	TP Reduction (T/year)
<b>Minimising the impact of agriculture and forestry</b>	Retained nutrient on land reducing the need for fertiliser	Preservation of natural values for the future	Improved water quality	212 000	8.174
	Protection of private land	More viable enterprises and communities	Improved habitats		
	Improve efficiency of herbicides	Increased skills	Improved biological diversity		
	Improved animal production	Improved aesthetics and recreation.	Decreased pollution		
	Improved soil structure and ecology		Improved soil structure and ecology		
			Protection of remnant and native vegetation		
			Protection of wildlife corridors		
<b>Monitoring, evaluation and research</b>	Better understanding and management decisions	Better understanding and management decisions	Better understanding and management decisions	Not costed	Not calculated
			Decreased pollution		
<b>Planning</b>	Improved strategic planning	Equality in development	Improved water quality	21 000	Not calculated
	Improved landuse allocation	Preservation of natural values for the future	Improved habitats		
	Better understanding of associated development risks and therefore management plans	Improved usage of water	Improved biological diversity		
		Improved recreational and aesthetic value	Decreased pollution		
	Decreased effects of pollution events				

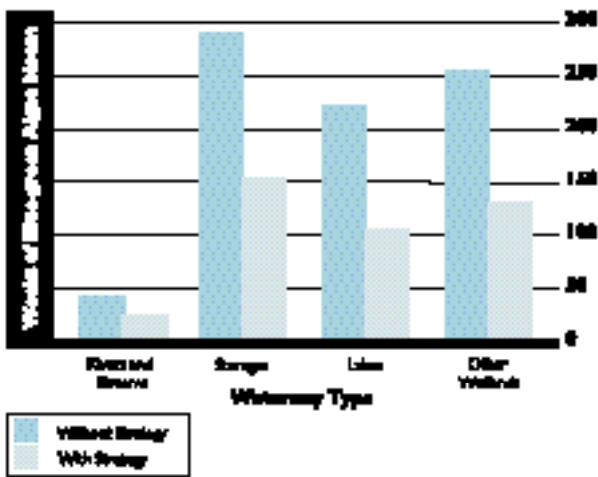


Table 8 Non costed benefits of implementing the Strategy

Program	Non costed economic benefits	Non costed social benefits	Non costed environmental benefits	Equivalent annual cost \$	TP Reduction (T/year)
Catchment and river health management	Protection of private land	Preservation of natural values for the future	Improved water quality	36 000	24.105
	Protection of infrastructure	Protection of private land	Improved habitats		
	Increased land values	Improved recreational and aesthetic values	Improved biological diversity		
			Decreased pollution		
			Improved soil structure and ecology		
			Improved native vegetation corridors		
			Protection of native vegetation		

# The Strategy

Graph 3 highlights the difference in algal bloom occurrence over the next ten years in relation to Strategy implementation and the "do nothing" option. From the graph it is evident that there is a large reduction in the amount and time of algal blooms from implementing the Strategy. This reduction directly equates to environmental, social and economic benefits, as previously highlighted through the Strategy. More information regarding the reduction in blooms in the different waterbodies and how this was calculated is highlighted in Appendix F.



Graph 3 Reduction in algal blooms (measured in the number of weeks over 10 years) through the implementation of the Wimmera Water Quality Strategy

## PROTECTED BENEFICIAL USES

Implementation of the Strategy will protect the beneficial uses of the waters. Some of the beneficial uses include (11):

- Environmental beneficial uses:
- Aquatic ecosystems and associated wildlife
  - Streambank and foreshore native vegetation
  - Migratory bird habitat
  - Recharging aquifers

- Social beneficial uses:
- Potable water supply
  - Scientific and educational uses
  - Recreation
  - Watering parks and gardens

- Economical beneficial uses:
- Agricultural water supply
  - Tourism assets
  - Production of edible fish and crustacea
  - Reduction in water treatment

## REVIEW AND EVALUATION

This Strategy has been devised on best available information. As information gaps get filled and monitoring data becomes available it would be beneficial to review the Strategy. Appropriate changes to targets, programs and/or actions will occur. The review will also address facets of water quality management that were not addressed in the original cost benefit analysis such as Wimmera fisheries resources. This review should occur every five years.

## WIMMERA CATCHMENT MANAGEMENT AUTHORITY ROLE

Wimmera Catchment Management Authority will oversee the Strategy implementation, ensure cooperation between stakeholders, review and evaluate the Strategy. Other stakeholders will have responsibility for overseeing and/or implementing programs and activities where they are identified as the lead agency. A table highlighting other agencies and their roles are contained in Appendix G.

## FUNDING

Specific references to funding levels in this Strategy are for indicative purposes only. The level of government investment into this Strategy is contingent on budgets and government priorities.

The Wimmera CMA cost shares for waterway health related activities highlighted in the programs may come from tariff replacement funding.

## COST SHARING GUIDELINES

Cost sharing guidelines are based on the guidelines developed for nutrient management by the Nutrient Management Strategy (1997). These are contained in Appendix J.

The guidelines are based on the following principles:

- The prime responsibility for paying the cost of a nutrient management activity rests with the individual, industry or authority that is responsible for the related nutrient contribution;
- Beneficiaries of nutrient management are encouraged to share in costs; and
- Government may share in the cost to facilitate the uptake of nutrient management so that broader environmental, economic and social objectives are met.

## IMPLEMENTATION TABLES

The following sections contain the 7 programs. The Program actions are highlighted in Implementation tables. These tables have a number of headings across the top:

- **Action:** is the activity required to be undertaken
- **Output:** is the result of implementing the action
- **Priority:** is the precedence of the activity for implementation. This prioritisation is based on a number of factors; these are highlighted in the Priority Action section.
- **Lead Agency:** is the organisation or individual responsible for implementing the action
- **Cost Share:** are percentages of funding from organisations or individuals. These are based on guidelines in Appendix J.
- **Cost:** is the cost of implementing the action over a certain timeframe. These costs are for indicative purposes only.
- **30 year NPV (\$):** this is the Net Present Value cost for implementing the action over the next 30 years with a 4% discount. These have been calculated as part of the cost benefit analysis<sup>(3)</sup>. These costs are for indicative purposes only.



Research and planning are essential to understanding and managing our waterways.

### OBJECTIVE

To ensure the coordinated and strategic implementation of the Wimmera Water Quality Strategy and Communication Plan. To increase stakeholder and community awareness of and commitment to addressing water quality issues in the Wimmera CMA Region.

This will be achieved through:

- Implementation of the Wimmera Water Quality Strategy and Communication Plan; and
- Delivering communication, education and awareness activities.

### BACKGROUND

The communication, education and awareness program complements recommendations from the Regional Catchment Strategy, highlighting education to be undertaken to achieve its objectives.

As a necessity to achieve onground action, communication and education are highlighted in all programs in the Strategy, resulting in a reduction in nutrients and improved water quality.

Everyday activities and management can adversely affect water quality. These activities can range from washing cars in the street to using waterways for recreational purposes. The affects can include litter, sediment, agrochemical inputs as well as altering pH, flow and temperature. Changes to these physical and chemical aspects of water quality can adversely affect fauna and flora. These affects can be reduced through knowledge about the effect of our actions on water quality.

This program addresses general water quality issues and management. Education and training activities are still highlighted in other programs where specific education and training activities need to be undertaken e.g. Program 2 Urban Waters highlights that urban stormwater best management practices needs to be delivered to the urban community.

### Information Dissemination and Education Activities

Information dissemination involves distributing research and general water quality information to the community. Established networks such as Grampians Water, Local Government and industry groups can be used. Education activities increase community awareness and skills regarding water quality. This empowers the community and increases their resource management ability. This activity will include coordinated field and community action days. Waterwatch has been an important and useful program in information dissemination and community education activities with regards to water quality. It will play an important role in undertaking some of these actions including 1.2, 1.3, 1.6 and 1.9.

### Implementation of the Wimmera Water Quality Strategy

A coordinated and strategic implementation of the Wimmera Water Quality Strategy is required to achieve reductions in nutrient levels in the Regions' water. Implementation of the Strategy will be through the employment of a water quality coordinator who will be responsible for preparing funding bids, reporting, monitoring, evaluation and implementing the actions.

### Communication Plan

The communication plan will provide targeted and timely delivery of water quality information to the Wimmera community. The plan will highlight necessary steps, communication medians and organisations to successfully deliver information on water quality and assist in implementing the Wimmera Water Quality Strategy.

### NUTRIENT TARGET

This program will help to achieve nutrient reduction through the coordination of the implementation of the Strategy. The reduction from implementing the Strategy has been highlighted in the relevant programs. Nutrient reductions will also occur due to the increase in awareness and education regarding water quality throughout the Region. The actual nutrient targets have not been calculated. Changes in perception and management will lead to changes in nutrient levels.

### IMPLEMENTATION TABLE

		Action	Output	Pri- ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
Information dissem- ination and education activities	#	Survey community knowledge, attitudes and information gaps (every 5 years).	Recorded community perceptions. Benchmarking community awareness	VH	WCMA	Up to 100% WCMA Up to 50% State	2 000 per survey	14 000
	WQ 1.1							
	#	Disseminate water quality information.	Relevant information sought and distributed to stakeholders including GW, WMW, NRE & LG	VH	WCMA	Up to 100% WCMA Up to 50% State	5 000	214 000
	WQ 1.2							
	WQ 1.3	Specific urban stormwater education activities as highlighted in actions WQ 2.1, 2.2, 2.3	HIGHLIGHTED IN PROGRAM 2 URBAN WATERS					
	WQ 1.4	Specific rural drainage education activities as highlighted in WQ 3.1, 3.2	HIGHLIGHTED IN PROGRAM 3 MINIMISING IMPACTS OF RURAL DRAINAGE					
	WQ 1.5	Specific agricultural and forestry education activities as highlighted in actions WQ 4.1, 4.2, 4.3.	HIGHLIGHTED IN PROGRAM 4 MINIMISING THE IMPACTS OF AGRICULTURAL AND FORESTRY					
	#	Support community education programs to promote water quality such as Farmbis and Waterwatch.	Water quality principles included in education programs.	H	WCMA	Up to 50% WCMA Up to 50% State Up to 25% Federal Up to 25% Local Government	7 000	301 000
	WQ 1.6							
	WQ 1.7	Incorporate best management practices for water quality into both state and regional natural resource strategies	Water quality incorporated in both state and regional natural resource strategies	H	CMA	Up to 100% WCMA Up to 50% State	2 000	85 000
	WQ 1.8	Support the development of SEPP-WoV and any other targets or water quality guidelines	Appropriate and beneficial water quality guidelines and targets for the Region	H	CMA	Up to 100% WCMA Up to 50% State	5 000	214 000

## IMPLEMENTATION TABLE

		Action	Output	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr	30 year NPV \$
	# WQ 1.9	Encourage participation by key stakeholders in water quality training programs.	Stakeholders trained in water quality monitoring and management	M	WCMA	Up to 50% WCMA Up to 50%State Up to 25% Federal Up to 25% Local Government	2 000	85 000
<b>Implementa tion of the Wimmera Water Quality Strategy Commun- ication Plan</b>	# WQ 1.10	Employment of a Water Quality Coordinator	Water Quality Coordinated employed and responsible for implementing the Wimmera Water Quality Strategy actions	VH	WCMA	100% State	32 000	1 324 000
	WQ 1.11	Development of a communication plan	Strategic communication plan	VH	WCMA	Up to 100% WCMA Up to 100% State	15 000	15 000
	# WQ 1.12	Implement the Wimmera CMA communication plan.	Implementation of high priority actions.	VH	WCMA	Up to 100% WCMA Up to 50% State	7 000	301 000
	# WQ 1.13	Establish a reference group with all stakeholders.	Network established and used to distribute information.	M	WCMA	Up to 50% WCMA Up to 50%State Up to 25% Federal Up to 25% Local Government	2 000	85 000
	WQ 1.14	Review Communication Plan every five years	Updated communication plan.	M	WCMA	Up to 100% WCMA Up to 100% State	5 000 per review	33 000
# The Water Quality Coordinator would undertake these activities as part of the position.						Total Cost		\$2 671 000
* Activities for a duration of 30 years unless otherwise stipulated.						Annual cost		\$89 000



## OBJECTIVE

To minimise the impact of urban waters on surface, groundwater and wetlands.

This will be achieved through:

- Training and Education;
- Planning;
- Works; and
- Investigations.

## BACKGROUND

Urban waters have the ability to adversely affect the quality of water by increasing sediment loads, litter contributions, nutrient levels and chemicals.

Urban waters include wastewater, stormwater, septic and sewerage.

Wastewater treatment and reuse/disposal is being progressed in accordance with Grampians Water Authorities Wastewater Management Plans. The plans provide a strategic approach to maintain and improve sustainable environmental outcomes from its wastewater activities. The works and operational improvement programs have been developed to meet various stakeholder requirements, including EPA.

Septic tanks location, operation and ongoing maintenance are continual issues that require addressing to ensure that negative impacts from these systems do not occur.

This program aligns with the Victorian Stormwater Action Program, which aims to improve environmental management of "urban stormwater" in Victoria. This program will complement the urban stormwater management plans and address areas specific to water quality that may not have been examined.

Urban stormwater best management practices are outlined in guidelines prepared for the Stormwater Committee by EPA, Melbourne Water Corporation, Department of Natural Resources and Environment and Municipal Association of Victoria (1999)<sup>(40)</sup>.

### Training and Education

This education and training program will primarily focus on the urban environment, but where applicable rural education programs will be undertaken. Where possible established networks and programs will be utilised such as Waterwatch.

### Planning

Planning aspects of this program are designed to meet the Victorian Stormwater Action Program principles and complements the urban stormwater management plans. With developments occurring throughout the Region, it is essential to have planning that is conscious of water quality impacts.

Local Government have a responsibility to ensure that urban developments meet water quality best management practice. Local Government will need to ensure that developers are informed about their responsibility to utilise current information to minimise impacts on water quality and that householders adequately operate and maintain septic tanks.

### Works

Works such as constructed wetlands, grass pollutant traps, grass swales and sediment basins reduce the impact of stormwater on waterways. Where a project targets current nutrient sources rather than impacts, state and federal government may share the cost with local government. Where treatment is proposed in low priority Regions or where impacts on nutrients is limited, then the cost may be borne by Local Government and other local supporters e.g. industry, developers, service clubs.

The works and costings for maintenance are based on information in the DRAFT Urban Stormwater Management Plan.

### Investigation

Urban waters need to be valued as a resource to avoid being disposed of in an unsustainable way. It is therefore important to examine the current situation and methods for improvement.

## NUTRIENT TARGETS

It has been estimated that average annual total phosphorus load would be reduced by 5.8 tonnes as a result of implementing this program.

There are a number of assumptions made regarding the total phosphorus target for this Program. There is an assumed reduction of 15% of total phosphorus in stormwater discharge through implementing the education and awareness aspects of this program. In regards to stormwater works, there is an assumption of a total phosphorus reduction of 60%. More assumptions are highlighted in Appendix K.

## IMPLEMENTATION TABLE

		Action	Output	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
Education and awareness	X WQ 2.1	Urban stormwater education program, in NMUs 1,2,3,4,5,7,9,10	Implementation of a targeted urban stormwater education program	VH	LG WCMA	Up to 50% WCMA Up to 50% State Up to 50% LG	28 000	1 196 000
	X WQ 2.2	Urban Stormwater BMP promotion and training as per stormwater management plan priorities	Urban stormwater BMP information disseminated and 5 training workshops undertaken with major stakeholders	H	WCMA	Up to 100% WCMA Up to 100% LG	7 000	299 000
	X WQ 2.3	Under take education activities to highlight possible effect of septic tanks including management and alternative environmentally friendly systems.	Information distributed to landholders with septic tanks through the 5 major LG	M	LG	Up to 100% WCMA Up to 100% LG	4 000	170 000
Works	O WQ 2.4	Implement urban stormwater works for NMU 1,2,3,4,7,9,12 <ul style="list-style-type: none"> <li>WR &amp; tribs u/s of Eversley</li> <li>WRWR &amp; tribs Eversley and Joel Joel</li> <li>WR &amp; north side tribs Joel Joel and Glenorchy</li> <li>Southside tribs Joel Joel to Glenorchy</li> <li>WR &amp; tribs Dooen to O'Brees Crossing</li> <li>NE Wimmera distributaries</li> <li>SW border streams (west flowing).</li> </ul>	Stormwater works implemented in Horsham, Natimuk, Warracknabeal, Murtoa and Edenhope as per stormwater management plans	VH	LG	Up to 50% WCMA Up to 50% State Up to 50% LG	128 500 (3 yrs)	713 000
	V WQ 2.5	Maintenance of stormwater works	Stormwater works maintained to maximise efficiency	VH	LG	100% LG	Varying over time From \$0 in year 1 to Year 5 \$57,225	

## IMPLEMENTATION TABLE

		Action	Output	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
	WQ 2.6	Monitor case study works sites	Annual report on the effect of works determined for 5 case sites	H	LG	Up to 75% WCMA Up to 100% LG	10 000 (10yrs)	119 000
	O WQ 2.7	Implement urban stormwater works for NMUs 5, 8 <ul style="list-style-type: none"> <li>• Tribs upstream of Lonsdale</li> <li>• WR north of O'Bree's Crossing</li> </ul>	Stormwater works completed in Dimboola, Rainbow, Jeparit, Stawell and Halls Gap as per stormwater management plan.	H	LG	Up to 50% WCMA Up to 50% State Up to 50% LG	106 000 (5 yrs)	588 000
<b>Planning</b>	WQ 2.8	Developers to incorporate BMP for water quality in planning designs.	100% developers to incorporate urban BMP for water quality for urban developments.	H	LG	100% D	10 000 (10 yrs)	119 000
<b>Investigations</b>	WQ 2.9	Investigate viable capture and/or usages of stormwater in several case study areas	Report on practical uses of stormwater for case 3 study	H	LG	Up to 100% LG Up to 50% State	30 000 (5 yrs)	166 000
	WQ 2.10	Review emergency discharge licenses	Applicability and necessary action undertaken regarding use of discharge licenses	H	EPA	100% State	10 000 (1 yr)	10 000
	WQ 2.11	Work with appropriate organisations to gain a better understanding of the implications of unsealed roads on water quality and disseminate appropriate information	Better understanding of effect of unsealed roads in the Region. 50% of road workers aware of environmental guidelines for road construction and maintenance.	M	LG	50% LG 50% WCMA	5 000	214 000
Total Cost								\$3 594 000
Annual cost								\$120 000

X An officer could undertake these activities and could utilise established and proven community programs such as Waterwatch

V This could not be accurately determined due to the maintenance costs varying on structures and time of construction. Estimates have been given. This information is from the DRAFT Urban Stormwater Management Plan<sup>(44)</sup>.

O Costs have been estimated from the DRAFT Urban Stormwater Management Plan.

\*Activities for a duration of 30 years unless otherwise stipulated.

## OBJECTIVE

To minimise the impact of rural drainage on surface, groundwater and wetland water quality.

To be achieved through:

- Education and awareness;
- Information gap filling;
- Action plans; and
- Technical assessment guidelines.

## BACKGROUND

Rural drainage relates to surface water management, covering all activities that alter or impact on water movement. Some aspects include excavated drains, alterations to natural streams, channels, roads, railways and land forming. Rural drainage has the ability to affect water quality of waterways, wetlands and groundwater systems. It has the ability to affect the nutrient, salinity, agrochemical, pH and heavy metal composition of the water, which can adversely affect the diversity of aquatic fauna and flora.

The Wimmera Rural Drainage Strategy aims to provide coordinated planning and management of drainage works in a fair and sustainable manner. It will be achieved through community education and awareness, organisational support, environmental identification, coordinated drainage and drainage monitoring programs. This Strategy is currently being implemented in the Region, and it should be noted that for all rural drainage issues first refer to the Wimmera Rural Drainage Strategy<sup>(28)</sup>.

The Minimising the Impact of Rural Drainage Program complements the Rural Drainage Strategy through addressing issues of rural drainage that directly affect water quality and may not have been previously highlighted e.g. determining the effect of rural drainage on surface water and wetlands.

Some actions are also contained in the Rural Drainage Strategy but due to their importance in achieving nutrient reductions they have also been included in this Strategy. This will ensure that the actions are undertaken and optimum results achieved. These actions are WQ 3.3, 3.7 and 3.8.

**WQ 3.3** This action supports Rural Drainage Strategy action 3.1. Knowledge of the location and extent of drainage lines will show the interconnectedness. This will allow potential effects of drains on water quality to be determined. This is a very high priority activity.

**WQ 3.7** This action supports the Rural Drainage Strategy Coordinated Drainage program. It is necessary that water quality issues and management be addressed in these plans. This will ensure that future planning and onground action aim to improve water quality in the catchment. This is a high priority activity.

**WQ 3.8** This action supports Rural Drainage Strategy activity 4.6, to further develop Technical Guidelines for assessing drainage works. It is necessary that this activity occurs to reduce poor drainage. It is also highly important that water quality is incorporated into this process, to ensure that it is considered when future drainage works are being proposed. This is a medium priority.

### Education and Awareness

Education and awareness regarding rural drainage in the Region is proposed to assist changes on the ground. This involves a training session and collating and distributing information to the community.

### Information Gap Filling

It is essential to have a good understanding of the rural drainage systems and their effects on water quality. This can help in the development of appropriate management practices for rural drains.

### Catchment Plans

Catchment plans will be developed with the community to assist in minimising the impact of rural drainage. These are being developed under the Rural Drainage Strategy program but it is essential that water quality issues be considered. Catchment plans will use basic principles of rural drainage management to address water quality issues. These principles are shown in table 8.

Table 9 Management Principles for Rural Drainage <sup>(28)</sup>

Farm Activity	Landholder Benefit	Environmental Benefit
<b>Productive area</b>		
Minimal tillage practices	Improve soil structure	Less sediment runoff
	Reduce costs	Restore natural rate of runoff
Contour ploughing	Retention of soil moisture	Restore natural rate of runoff
	Retention of topsoil	Less sediment runoff
Gypsum and deep ripping	Improved profitability	Reduced runoff
	Improved soil structure	
Controlled grazing on hills	Protect soil structure	Reduced sediment runoff
	Retain topsoil	
Efficient use of fertilisers	Improved profitability	Reduced nutrient runoff
<b>Buffer Zones</b>		
Grass filter strips along depressions	Reduce soil and crop losses	Minimise sediment runoffs
Fencing off drainage lines	Minimise stock disease	Minimise erosion
Fencing off streams to control stock	Reduce erosion of land	Improve water quality
Retarding ponds	Water supply storage	Reduce rate and volume of runoff
		Improve water quality
Revegetation	Provide stock shelter	Improve biodiversity
	Utilise excess rainfall	Reduce groundwater accessions
	Provides aesthetic values	

Technical Assessment Guidelines

Rural drainage issues need to be addressed with stringent but equitable guidelines. This is especially apparent when issuing planning permits for rural drainage activities. This process needs to be undertaken in alignment with the Rural Drainage Strategy Appendix D & E. Actions to address this have already been highlighted in the Rural Drainage Strategy but due to their importance in avoiding water quality problems they have also been included in this Strategy.

NUTRIENT TARGETS

It has been estimated that average annual total phosphorus load would be reduced by 3.7 tonnes as a result of implementing this program.

It has been assumed that the total phosphorus reduction will be 30% from implementing appropriate management practices. More assumptions are highlighted in Appendix K.



Wetlands need to be protected from the impacts of rural drainage.

## IMPLEMENTATION TABLE

		Action	Outcomes	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
Education and awareness	WQ 3.1	Demonstration sites of good rural drainage as related to water quality implemented in the Millicent Coast Basin, as a priority.	5 rural drainage BMP sites completed	H	WCMA	Up to 50% WCMA Up to 50% LG Up to 50% State Up to 50% LH	10 000 (5 yrs)	55 000
	WQ 3.2	Develop up an test and disseminate education and awareness packages and training highlighting the link between rural drainage and water quality in the Millicent Coast Basin	Training courses developed and 5 undertaken and information packages disseminated	M	WCMA	Up to 50% WCMA Up to 50% LG Up to 50% State	30 000	1 281 000
Information gap filling	# WQ 3.3	Support Rural Drainage Strategy 3.1 to undertake the identification and mapping of significant drainage lines	Completed inventory of drains and its potential effect on water quality	VH	WCMA	Costed in RURAL DRAINAGE STRATEGY		
	WQ 3.4	Review and modify rural drainage management practices in relation to water quality gaps	Modified recommended practices completed and distributed to affected landholders and councils	VH	WCMA	Up to 50% WCMA Up to 50% State Up to 50% LG	20 000 (1 yr)	20 000
	WQ 3.5	Research into the effect of drains on water quality in the Millicent Coast Basin	Report on the effect of rural drains and recommended actions in the Millicent Coast	H	WCMA	Up to 50% CMA Up to 50% State Up to 50% LG Up to 50% Fed	60 000 (3 yrs)	193 000
	WQ 3.6	Research into the effect of drains on water quality in the Wimmera River Basin	Report on the effect of rural drains and recommended actions in the Wimmera River Basin	M	WCMA	Up to 50% WCMA Up to 50% State Up to 50% LG	40 000 (3 yrs)	129 000
	# WQ 3.7	Support Rural Drainage Strategy action 4.3 to undertake catchment plans ensuring that water quality issues are addressed.	Management Plans developed considering water quality issues and management	H	LH LG	Costed in RURAL DRAINAGE STRATEGY		
Develop- ment of Catchment plans								



IMPLEMENTATION TABLE

		Action	Outcomes	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
Framework for assessing rural drains	# WQ 3.8	Support Rural Drainage Strategy action 4.6 to further develop Technical Guidelines for assessing drainage works.	Guidelines developed and put in practice, ensuring that water quality is considered	M	LG	Costed in RURAL DRAINAGE STRATEGY		
# These actions support actions from the Rural Drainage Strategy and highlight the importance of these actions in relation to water quality.						Total Cost		\$1 678 000
*Activities for a duration of 30 years unless otherwise stipulated.						Annual cost		\$56 000



Potentially toxic blue-green algae blooms impact on over 40 lakes in the Wimmera.

## OBJECTIVE

To minimise the impact of agricultural and forestry practices on surface, groundwater and wetlands.

This will be achieved through:

- Education and awareness;
- Development of appropriate management practices;
- Planning; and
- Incentives.

## BACKGROUND

The program aligns with the Wimmera Regional Catchment Strategy through the Sustainable Land Management and Productivity Section. This program will complement other land management programs that are occurring in the Region such as Farmbis.

Land management refers a number of different activities including:

- Dryland cropping;
- Irrigation cropping;
- Grazing;
- Intensive industries;
- Horticulture; and
- Forestry.

Most of the activities highlighted in this program are directed at agricultural activities. This is due to the large proportion of area in the Region occupied by agricultural activities.

Use of land for agriculture and forestry purposes has the ability, if not managed adequately, to adversely affect water quality and consequently aquatic fauna and flora. Affects can include increased chemicals, nutrients and sediments or alteration of pH, dissolved oxygen and temperature in wetlands and waterways.

## Education and Awareness

Undertaking education and awareness activities will inform and empower landholders to improve land management practices. Changes will occur from short term planning towards long term land management and whole farm planning. Evaluation of management options to determine the best management practices and whole farm planning will be undertaken. Some programs to align with will include "FertCare", the fertiliser industry BMP, and whole farming planning. This will be coordinated with all stakeholders such as government agencies, Australian Fertilisers Services Association and Agforce.

## Appropriate Management Practices

This will involve implementing appropriate management practices to minimise landuse effects on water quality. This will be applicable to current and future landuse in the Region. This involves the development and implementation of management activities that are applicable to the Wimmera Region.

This may provide an opportunity to undertake a state review of the Forestry Code of Practice with the prospect of ensuring that all water quality aspects are addressed. For example there may be a gap where ephemeral wetlands are concerned.

Appropriate management practices for agriculture will be based on the nutrient minimisation practices for grazing, cropping and irrigation. These are contained in the "Document of Best Management Practices for Nutrient Reduction Management and Management in Dryland and Irrigated Agriculture" prepared by Rendell McGuckian (1996)<sup>(37)</sup>. These may need to be adjusted through the review process to make them locally relevant. Appropriate management practices for each industry are varied and some examples are highlighted below.

Best Management Practices for Grazing:

- Fencing out waterways and having on going maintenance;
- Allowing grass swale development;
- Appropriate application of fertilisers; and
- Whole farm planning.

Best Management Practices for Cropping:

- Cropping away from waterways;
- Appropriate application of fertilisers;
- Reducing soil exposure; and
- Increasing soil structure.

## Planning

This involves considering water quality at the landholder level through such mechanisms as Whole Farm Plans, to reduce the effect of land use on water quality. In regards to intensive industries, reference should be given to intensive land use guidelines where applicable. When organisations are undertaking projects that will improve water quality, the Wimmera CMA should support them e.g. decommissioning of bores and the pipeline project. Local government planning issues that relate to agricultural land use will be addressed in Program 6: Planning.

## Incentives

Investigations need to be undertaken to determine if incentives are economically viable. If the incentive schemes are economically viable then there should be incentives for land managers to undertake activities that ensure water quality benefits, where associated with protection of environmental, economic and social assets of regional, state or national importance.

## NUTRIENT TARGETS

It has been estimated that average annual total phosphorus would be reduced by 8.2 tonnes as a result of implementing this program.

Some of the assumptions made with regard to the target are that there is a reduction in total phosphorus levels of 25% with the adoption of best management practices, more assumptions are highlighted in Appendix K.



**Best Management Practice for grazing will help improve water quality.**

## IMPLEMENTATION TABLE

		Action	Outcomes	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
Education and Awareness	WQ 4.1	Education and awareness activities for appropriate land management for grazing and cropping in priority NMUs 3,4,5,6,7,9,10. <ul style="list-style-type: none"> <li>• WR &amp; north side tribs Joel Joel to Glenorchy</li> <li>• Southside tribs Joel Joel to Glenorchy</li> <li>• Tribs u/s of Lonsdale</li> <li>• WR Glenorchy to Dooen &amp; tribs d/s of Glenorchy</li> <li>• WR &amp; tribs Dooen and O'Brees Crossing</li> <li>• NE Wimmera Distributaries</li> <li>• SW Wimmera terminal streams</li> </ul>	Extension material prepared and distributed as per communication plan	VH	NRE	Up to 100% State Up to 50% WCMA	30 000	1281 000
	WQ 4.2	Ensure that intensive industries refer to relevant intensive landuse guidelines	100% intensive landuse comply with guidelines	VH	Industry EPA	100% Industry	5 000	214 000
	WQ 4.3	Grazing and cropping related BMP training program for extension staff by industry specialists e.g. fertiliser application etc.	10 training sessions held by industry groups and extension staff	M	Industry	Up to 100% State Up to 100% Industry Up to 50% WCMA	5 000	214 000
Planning	WQ 4.4	Encourage whole farm planning and other similar projects especially in priority NMUs 8,9,10,11. <ul style="list-style-type: none"> <li>• WR north of O'Brees crossing</li> <li>• NE Wimmera Distributaries</li> <li>• SW Wimmera terminal streams</li> <li>• NW Wimmera terminal streams</li> </ul>	50% landholders involved in Whole Farm Plans	H	WCMA	Up to 100% WCMA Up to 50% State	10 000 (10 yrs)	119 000
	WQ 4.5	Review and revise Forestry Code of Practice to ensure water quality preserved.	Reviewed Code of Practice	M	EPA NRE	Up to 100% NRE Up to 100% EPA	20 000 (1 yr)	20 000
Appropriate land manage- ment	WQ 4.6	Review and recommend grazing management practices that are locally relevant for the Wimmera River Basin	Report on grazing mgt. practices for the Wimmera River Basin. Report to be distributed to 75% of applicable landholders	VH	NRE	Up to 75% WCMA Up to 75% NRE	60 000 (3 yrs)	193 000

## IMPLEMENTATION TABLE

		Action	Outcomes	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
	WQ 4.7	Review and recommend management grazing practices that are locally relevant for the Millicent Coast Basin	Report on grazing mgt. practices for the Wimmera River Basin Report to be distributed to 75% of applicable landholders	VH	NRE	Up to 75% WCMA Up to 75% NRE	60 000 (3 yrs)	193 000
	WQ 4.8	Demonstration sites for grazing BMP in priority NMUs 6, 10, 5, 7. • WR Glenorchy to Dooen and tribs d/s Lonsdale • SW Wimmera terminal streams • Tribs u/s of Lonsdale • WR& tribs Dooen to O'Brees Crossing	Approximately 15 ha of area undertaking BMP grazing 3 field days will be undertaken at the sites	VH	NRE	Up to 75% WCMA Up to 50% State Up to 50% LH	30 000 (1 yr)	30 000
	WQ 4.9	Demonstration sites for cropping BMP in priority NMUs 6, 7. • WR Glenorchy to Dooen & tribs d/s of Lonsdale • WR& tribs Dooen to O'Brees Crossing	Approximately 5 hectares of area undertaking BMP cropping	VH	NRE	Up to 75% WCMA Up to 50% State Up to 50% LH	10 000 (1 yr)	10 000
	WQ 4.10	Cropping BMP near waterways in high priority NMU 6 • WR Glenorchy to Dooen and tribs d/s Lonsdale	Implement cropping BMP across 1800 ha	H	LH	Up to 75% WCMA Up to 50% State	21 000 (10 yrs)	238 000
	WQ 4.11	Grazing BMP near waterways in high priority NMUs 6,10 • WR Glenorchy to Dooen and tribs d/s Lonsdale • SW Wimmera terminal streams	Impact from 7 000 ha of grazing enterprises are reduced.	H	LH	Up to 50% WCMA Up to 50% State Up to 100% LH	80 000 (10 yrs)	950 000
	WQ 4.12	Grazing BMP near waterways in medium priority NMUs 4,5,7 • South side tribs Joel Joel to Glenorchy • Tribs u/s of Lonsdale • WR & tribs Dooen to O'Brees crossing	Impacts from 11 000ha of grazing enterprises are reduced	M	LH	Up to 25% State Up to 100% LH	110 000 (15 yrs)	1 900 000
	WQ 4.13	Cropping BMP near waterways in medium priority NMUs 4,7 • South side tribs Joel Joel to Glenorchy • WR & tribs Dooen to O'Brees crossing	Impacts from 3 800ha of cropping enterprises are reduced	M	LH	Up to 25% State Up to 100% LH	50 000 (15 yrs)	944 000

IMPLEMENTATION TABLE

		Action	Outcomes	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
Investigation	WQ 4.14	Impact of irrigation on water quality, especially in regards to nutrients determined for the Wimmera Region	Report on irrigation impact to Regions water	M	NRE	Up to 75% WCMA Up to 75% NRE	20 000 (1 yr)	20 000
	WQ 4.15	Undertake a benefit cost analysis in regards to incentives for landholders to implement appropriate management practices.	Report on the viability of benefits produced	H	NRE	Up to 50% State Up to 50% WCMA	20 000 (1 yr)	20 000
						Total Cost	\$6 346 000	
						Annual cost	\$212 000	

\*Activities for a duration of 30 years unless otherwise stipulated.



Water quality needs to be improved to protect beneficial uses.



### OBJECTIVE

To improve understanding of nutrients and active processes and effectiveness of management actions in surface, groundwater and wetlands to enable implementation of improved management.

This will be achieved through:

- Research and investigations;
- Monitoring and Evaluation; and,
- Information management.

### BACKGROUND

A thorough understanding of water quality in the Wimmera Region is essential for successful water quality management. This has been highlighted as an action in the Regional Catchment Strategy and will be undertaken in alignment with this program.

Without extensive knowledge of water quality it is difficult to undertake management actions to improve water quality. Lack of information can result in undertaking activities that will not have beneficial implications on water quality. Through gaining this information and distributing it widely, water quality can be managed efficiently and effectively. This information will also assist in determining the effectiveness of the Strategy implementation on improving water quality in the Region.

#### Research and Investigation

In the Strategy development process information gaps were highlighted. These included:

- Validity of land connectivity principles;
- Actual nutrient loads from different landuses in the Region;
- Impact of emerging intensive animal industries;
- Understanding of groundwater processes and interrelationship with surface water;
- The amount of nutrients naturally in the soil;
- Sustainable management of instream nutrients;
- Identification of point sources; and
- Biological diversity of wetlands in the Millicent Coast Basin.

### Monitoring and Evaluation

Monitoring water quality will determine the success of the implementation of this Strategy and be used in the review of the Wimmera Water Quality Strategy. This monitoring will also assist in testing the assumptions associated with nutrient reduction estimates. This monitoring will complement monitoring already occurring in the Region through organisations and community programs such as EPA, NRE and Waterwatch. Monitoring provides a good understanding of the physical, chemical and biological status of the Region. It will assist in directing future management action. A comprehensive evaluation program will be developed in association with the development of the Regional Catchment Strategy. This will assist in evaluating the success of implementing the Wimmera Water Quality Strategy.

### Information Management

All stakeholders that are involved in managing water quality need timely and accurate information about regional water quality. Wimmera CMA is in a good strategic position to assist others accessing information. Computer software such as Global Information Systems (GIS) will allow information related to water quality management to be recorded. Many types of information can be stored on the GIS including blue green algae bloom history, water quality trends and work sites.

### NUTRIENT TARGET

Nutrient reduction will occur due to the increase in awareness and information regarding water quality and management. Actual nutrient targets have not been calculated, as the change in information, perception and management were difficult to calculate.

This program will also assist in measuring Strategy implementation progress against targets.

Note: it was not possible to develop research projects and therefore to cost actions.

## IMPLEMENTATION TABLE

		Action	Outcomes	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
Research and Investigation	WQ 5.1	Determine land and water connectivity	Report on land connectivity	VH	WCMA			
	WQ 5.2	Revise estimates of nutrient loads from Wimmera landuses	Report on nutrient loads and landuse in the Wimmera	VH	WCMA			
	WQ 5.3	Determine the water quality impact of emerging industries in the Wimmera Region	New industries are assessed with regards to water quality	VH				
	WQ 5.4	Determine the groundwater processes and interrelationship with the surface water	Report on the surface and ground water relationship	VH				
	WQ 5.5	Identify the amount of nutrients naturally in the soil	Baseline information regarding soils and nutrients	VH	NRE			
	WQ 5.6	Map point sources on GIS	Point sources are identified and assessed against SEPP (where possible)	VH	EPA			
	WQ 5.7	Qualitify and evaluate the implementation of best management practices	Quantifiable analysis of implementing BMP, which will refine the management practices. Individual reports will be produced.	H	NRE CMA			
	WQ 5.8	Investigate the declaration of water supply catchments for urban systems	Catchments are assessed as water supply catchments	H	GW WCMA WMW			
	WQ 5.9	Investigate innovative management techniques to control blue green algal blooms	Innovative techniques for managing nutrients are assessed and recommendations made	H				

IMPLEMENTATION TABLE

		Action	Outcomes	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
Research and Investigation	WQ 5.10	Review options for long term management of macrophytes in hotspots in the Region	Hotspots and guidelines for sustainable management of instream nutrients in the Wimmera	M				
	WQ 5.11	Special issues research inc. carp impacts, pesticides, macroinvertebrates, pathogens, aquaculture, gravel roads. Could include specific monitoring to determine effect of implementing specific actions or programs from this Strategy	Research information on water quality related issues	M				
Water monitoring	WQ 5.12	Water Quality Monitoring and investigations- Wetlands in the Wimmera River Basin	Annual report on water quality information	VH	EPA			
	WQ 5.13	Water Quality Monitoring and investigations- Wetlands in the Millicent Coast Basin	Annual report on water quality information	VH	EPA			



Good water quality equals a good ecosystems.  
Photo courtesy of David Fletcher

IMPLEMENTATION TABLE

		Action	Outcomes	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
	WQ 5.14	Regular and coordinated water quality monitoring in the Waters of the Wimmera River	Annual report on water quality information	VH	EPA			
	WQ 5.15	Regular and coordinated water quality monitoring in the Waters of the Millicent Coast Basin	Annual report on water quality information	VH	EPA			
	WQ 5.16	Ensure ongoing regulation of premises licensed to discharge to waters	Continues monitoring to ensure that licensed discharge to waters protect beneficial uses.	VH	EPA			
	WQ 5.17	Review water quality monitoring network arrangements	Appropriate monitoring sites in the Region to determine the water quality trends	VH	WCMA	Up to 100% WCMA Up to 100% State	\$50 000	\$50 000
	WQ 5.18	Review monitoring program for the Region every 5 years	Monitoring program reviewed	H	WCMA			



Monitoring water quality.

## IMPLEMENTATION TABLE

		Action	Outcomes	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
Information Manage- ment	WQ 5.19	Maintain data base of algal blooms	Information on waterbodies, algal blooms and their characteristics held centrally and available to all stakeholders	H	WMW			
	WQ 5.20	Ensure relevant information is sought and stored at the WCMA office and linked to the regional data net	Relevant water quality information held centrally and available to all stakeholders	H	WCMA			
	WQ 5.21	Incorporate findings of annual water quality findings into planning processes	Water quality information included in plans	M	WCMA			

**Note:** costings for actions, lead agencies and cost shares have not been determined. This is as the costings for the actions at this point of time could not be determined with any accuracy. Cost shares have not been determined because the actual project and location will assist in determining them. Some of the lead agencies have not been highlighted due to this varying depending on the project, location and outputs. EPA, NRE, Waterwatch and other relevant data should be utilised to complement monitoring initiated from the implementation of this Strategy.

\*Activities for a duration of 30 years unless otherwise stipulated.

## OBJECTIVE

To ensure that water quality is considered in the planning processes at all levels.

To be achieved through:

- Ensuring water quality issues are considered in statutory planning processes

## BACKGROUND

It is essential that water quality management is considered when planning is undertaken. Without this consideration, development and management may cause detrimental effects on water quality. If degradation occurs, the Region can suffer economically, socially and environmentally.

### Planning

Through appropriate planning prior to release of management plans information can be disseminated to and discussed with the wider community. Wimmera stakeholders should ensure plans meet water quality best management practices. This program also allows the future industries including both agriculture and recreation to be planned appropriately to minimise any adverse affects on surrounding water quality.

## NUTRIENT TARGET

Nutrient reduction will occur due to the increase in water quality consideration in planning. These reductions will occur throughout the Region. The actual nutrient targets have not been calculated, as the change in planning and avoided activities and therefore costs were difficult to calculate.

Planning also avoids potential future sources of nutrients with inappropriate locating of landuses and developments.



**Rural roads require ongoing maintenance to protect water quality.**



## IMPLEMENTATION TABLE

		Action	Outcomes	Pri ority	Lead Ag'cy	Cost Share	Costs \$/Yr*	30 year NPV \$
Planning	WQ 6.1	Incorporate water quality into Municipal Strategic Statement for each local council and try to encourage common policies and procedures where possible	5 Local government planning documents to incorporate water quality best management practices	VH	LG	Up to 50% WCMA Up to 100% LG	5 000	214 000
	WQ 6.2	Ensure that water quality is considered in all planning permits and development application	100% future development to consider water quality	VH	LG	Up to 75% CMA Up to 75% LG	5 000	214 000
	WQ 6.3	Ensure that water quality is addressed in the local government Municipal Emergency Management Plans	100% contingency plans developed for accidental pollution events that affect water quality	VH	CMA	Up to 50% WCMA Up to 100% LG	5 000	214 000
	WQ 6.4	Specific urban waters planning activities highlighted in action WQ 2.8	HIGHLIGHTED IN PROGRAM 2 URBAN WATERS					
	WQ 6.5	Specific agricultural and forestry planning activities highlighted in action WQ 4.4, 4.5	HIGHLIGHTED IN PROGRAM 4 MINIMISING THE IMPACTS OF AGRICULTURAL AND FORESTRY					
						Total Cost		\$624 000
						Annual cost		\$21 000

\*Activities for a duration of 30 years unless otherwise stipulated.

### OBJECTIVE

To ensure that catchment and river health management in the Region will result in improved water quality.

To be achieved through:

- Waterway Repair and Maintenance;
- Flow Regimes;
- Riparian Management; and
- Catchment Management.

### BACKGROUND

There are a number of Wimmera strategies and plans that address both catchment and river health management. The Wimmera CMA has a direct waterway and river health management role. Examples of this include instream waterway works and riparian fencing and management incentives.

Catchment and river health management has the ability to reduce degradation in areas, which may be contributing to poor water quality. It is therefore important that any catchment and river health strategies or onground activities consider water quality. This program aims to ensure that this occurs. The actions will be the primary responsibility of the Water Quality Coordinator.

#### Waterway Repair and Maintenance

The Waterway Strategy will undertake bed stabilisation, bank protection, in stream sediment and native vegetation management and breakaway stabilisation. This will decrease sediment and nutrients entering the waterway thereby improving water quality.

#### Flow Regime

The Waterway Strategy and Wimmera Water Resource Management Plans are addressing flow regimes, as regulation and water harvesting has altered water flow regimes in the Wimmera River. Field inspections and geomorphologic assessments have indicated possible detrimental impacts of present flow delivery regimes in the Wimmera River in terms of exacerbated growth of macrophyte and in stream aggradations. Flow can affect water temperature, dissolved oxygen levels, sediment and nutrient loads. There is a need for flow regimes to be determined with consideration of river ecology and water quality requirements.

#### Riparian Management

A comprehensive study of crown frontage was undertaken in the Wimmera CMA and these results provide the basis for priority riparian management. Activities such as fencing and revegetation, crown frontage assessment and pest plant and animal control will assist in improving the riparian zone. It is necessary that crown frontage licenses consider water quality. Riparian management can improve the biodiversity, water temperature, dissolved oxygen levels, sediment and nutrient loads.

#### Catchment Management

Catchment management involves activities such as gully and land erosion stabilisation. It is necessary that catchment management activities consider water quality in the planning and implementation processes. Catchment management can improve the biodiversity, water temperature, dissolved oxygen levels, sediment and nutrient loads.

### NUTRIENT TARGETS

It has been estimated that average annual total phosphorus load would be reduced by 24.1 tonnes as a result of implementing this program.

The assumptions behind this nutrient target are that total phosphorus loads would decrease by 50%. More assumptions are highlighted in Appendix K.

IMPLEMENTATION TABLE

		Action	Outcomes	Pri ority	Lead Ag'cy	Costs \$/Yr*	30 year NPV \$
Waterway repair and maintenance	WQ 7.1	Support activities undertaken to repair and maintain waterways, and ensure that water quality is considered in the planning and implementation. Need to prioritise NMUs 5,7,10 <ul style="list-style-type: none"><li>Tribs u/s of Lonsdale</li><li>WR &amp; tribs Dooen to O'Brees Crossing</li><li>SW Wimmera terminal streams</li></ul>	Waterways repaired in NMU 5,7,10	VH	WCMA	5 000	214 000
Flow Regime	WQ 7.2	Support the development of Water Resource Management Plans, ensuring that water quality is considered	100% Water Resource Management Plans consider water quality	VH	WCMA	5 000	214 000
Riparian Manage- ment	WQ 7.3	Support riparian management activities, and ensure that water quality is considered in the planning and implementation.	100% riparian management activities consider water quality	VH	WCMA	5 000	214 000
Catchment Manage- ment	WQ 7.4	Support catchment management activities involving land and gully stabilising and ensure that water quality is considered in the planning and implementation.	100% catchment management activities consider water quality	VH	WCMA	5 000	214 000
						Total Cost	\$1 070 000
						Annual cost	\$36 000

\*Activities for a duration of 30 years unless otherwise stipulated.

Photo: Courtesy of M.Domaschenz



Wetlands can receive water during flood events.

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# Appendix A Location of Blooms in Wimmera River Basin

Location	Date	Algae	Comments
Boco Lake	November 1994	Anabaena	Warning signs
Darragan Gravel Pit Reserve	December 1997	Anabaena	Warning signs
Dimboola Weir	February 1988	Anabaena & Microcystis	Closed
Dock Lake	April 1992	Anabaena	
	November 1993	Anabaena	
	February 1994	Anabaena	
Green Lake	March 1990	Microcystis	Closed 3 months
	April 1992	Microcystis	
	January 1993	Microcystis	Closed
	December 1993	Anabaena & Microcystis	Lake Closed
	January 1997	Undetermined	Lake Closed
Hopetoun Storage	January 1987	Aphanizomena	CuSO <sup>4</sup> dosing
	February 1990	Anabaena	CuSO <sup>4</sup> 8 weeks
	December 1990	Diatoms & Greens	Pumped out and dried
Lake Lonsdale	January 1993	Microcystis	Unknown
Lake Whitton	March 1990	Microcystis	CuSO <sup>4</sup> , 2-3 weeks
	April 1990	Chlorella	
Mitre Dam	February 1997	Microcystis	Warning signs
Natimuk Lake	January 1993	Anabaena & Microcystis	Warning signs
	January 1996	Anabaena	Warning signs
Nhill Lake	April 1996	Anabaena	Warning signs
Taylor's Lake	April 1993	Anabaena	Warning signs
Whitton Storage No.2	January 1991	Anabaena & Microcystis	CuSO <sup>4</sup> , 2-3 weeks
	February 1997	Microcystis	CuSO <sup>4</sup> , 2 weeks
Wimmera River	January 1991	Anabaena	Closed to recreation
	March 1997	Anabaena	
Wimmera River, anabranch	December 1991	Microcystis	Closed 1 week
Yaapeet Storage	January 1987	Anabaena	CuSO <sup>4</sup> dosing
Yarriambiack Creek	December 1991	Anabaena	Closed, CuSO <sup>4</sup>
	January 1992	Anabaena	
	January 1997	Anabaena	Warning signs

*Location of recorded blue green algae blooms in the Wimmera River Catchment (after Cottingham, et. al 1995)*

Note: treatment with copper sulfate is no longer appropriate action in waters containing fish species listed under the Flora and Fauna Guarantee Act 1988.



# Appendix B Location of Blooms in Millicent Coast Basin

Location	Date		Algae	Comments
Booroopki Swamp	February	1993	Microcystis	Warning signs
	February	1997	Microcystis	Warning signs
	March	1998	Anabaena and Nodularia	Warning signs
Camp Swamp	February	1998	Anabaena	Warning signs
Lake Bringalbert	February	1995	Microcystis	Warning signs
Lake Carpolac	February	1991	Microcystis	Warning signs
	February	1997	Microcystis	Warning signs
Lake Charlegrark	March	1998	Microcystis	Warning signs
	September	1999	Microcystis	Warning signs
Lake Jaie Jaie	March	1993	undetermined	
Lake Ratzcastle	March	1993	Anabaena	Warning signs
Lake Wallace	April	1989	Microcystis	CuSO <sub>4</sub> 4 weeks
	March	1990	Microcystis	Monitored, 3 weeks
	November	1991	Anabaena & Microcystis	Closed, 3 months
	January	1992	Microcystis	Warnings given
	April	1994	Anabaena & Microcystis	Warning signs
	November	1995	Anabaena	Warning signs erected and used bores for town supply.
	May	1996	Microcystis	Warning signs erected and used bores for town supply.
	December	1999	Microcystis	Warning signs erected
Mulla Lakes	March	1993	undetermined	
Murrambool Swamp	February	1997	Microcystis	Warning signs
Plonkies Swamp	February	1993	Anabaena	Warning signs
Serviceton Reservoir	April	1996		Warning signs
Walley Allens Swamp	March	1997	Anabaena	Warning signs
Johnsons Lakes	December	1999	Nodularia	Warning signs

*Location of recorded blue green algae blooms in the Millicent Coast Basin (after Cottingham, et. al 1995)*

# Appendix C Landuse in NMU's

Landuse	Nutrient Management Unit						
	1 WR & tribs upstream of Eversley	2 WR & tribs Eversley to Joel Joel	3 WR & north side tribs Joel Joel to Glenorchy	4 South side tribs Joel Joel to Glenorchy	5 Tribes upstream of L Lonsdale	6 WR Glenorchy to Dooen & tribs down - stream of Lonsdale	7 WR & tribs Dooen to O'Bree's Crossing
Grazing - typical	10,928	26,853	22,776	27,223	47,362	35,684	44,331
Grazing - BMP	2,712	6,713	5,674	6,806	11,821	6,120	11,083
Grazing - high erosion	3,054	6,844	15,297	18,342	0	0	0
Conventional cropping	0	0	2,214	1,482	0	33,009	76,004
Conservation cropping	0	0	0	0	0	0	21,831
Dry Forest	5,059	2,040	7,543	3,245	40,005	26,752	8,246
Wet Forest	9,606	3,130	0	0	0	0	35,709
Irrigated	80	0	297	0	995	1,369	3,657
Urban	130	9	80	80	1,255	0	1,870
<b>Total</b>	<b>31,569</b>	<b>45,589</b>	<b>53,881</b>	<b>57,177</b>	<b>101,438</b>	<b>102,934</b>	<b>202,731</b>

Land Use	Nutrient Management Unit					
	8 WR north of O'Bree's Crossing	9 NE Wimmera Distri- butaries	10 SW Wimmera terminal streams	11 NW Wimmera terminal streams	12 SW border streams (west flowing)	Total
Grazing - typical	0	0	120,633	0	82,249	418,039
Grazing - BMP	0	0	30,158	0	20,562	101,649
Grazing - high erosion	0	0	0	0	0	43,537
Conventional cropping	0	0	0	0	0	829,060
Conservation cropping	85,502	174,202	45,846	171,914	103	499,398
Dry Forest	47,712	9,957	216,100	19,203	13,613	399,475
Wet Forest	0	0	0	0	112	48,557
Irrigated	31	712	2,964	1,233	286	11,624
Urban	305	730	340	400	60	5,259
<b>Total</b>	<b>261,803</b>	<b>446,903</b>	<b>484,811</b>	<b>450,621</b>	<b>117,140</b>	<b>2,356,597</b>

Land use in each Nutrient Management Unit (hectares)

Land use	Export TP	Export TN
Grazing - typical	0.20	1.60
Grazing - BMP	0.10	1.00
Grazing - high erosion	0.40	2.20
Conventional cropping	0.20	1.60
Conservation cropping	0.10	1.00
Dry Forest	0.03	1.30
Wet Forest	0.09	2.00
Irrigated	0.50	3.20
Rural Residential	0.40	3.00
Urban	1.80	6.80

Nutrient generation rates determined from the Wimmera CMA nutrient model (kg per hectare per year)

# Appendix D Total Phosphorus Loads

Land Use	Nutrient Management Unit						
	1 WR & tribs upstream of Eversley	2 WR & tribs Eversley to Joel Joel	3 WR & north side tribs Joel Joel to Glenorchy	4 South side tribs Joel Joel to Glenorchy	5 Tribes upstream of L Lonsdale	6 WR Glenorchy to Dooen & tribs down - stream of Lonsdale	7 WR & tribs Dooen to O'Bree's Crossing
Grazing - typical	739	1,623	1,587	1,874	3,039	1,528	1,360
Grazing - BMP	92	203	198	234	379	131	170
Grazing - high erosion	413	827	2,132	2,525	0	0	0
Conventional cropping	0	0	154	102	0	1,414	2,331
Conservation cropping	0	0	0	0	0	0	335
Dry Forest	51	18	79	34	385	172	38
Wet Forest	292	85	0	0	0	0	493
Irrigated	14	0	52	0	160	147	280
Urban	234	16	144	144	2,259	0	3,366
Point sources	0	0	0	0	0	0	0
Waterways	1,201	2,067	3,152	3,577	2,972	2,543	3,756
Gullies	1,201	2,067	3,152	3,577	2,972	2,543	3,756
<b>Total</b>	<b>4,237</b>	<b>6,907</b>	<b>10,649</b>	<b>12,067</b>	<b>12,166</b>	<b>8,478</b>	<b>15,884</b>

Land Use	Nutrient Management Unit					
	8 WR north of O'Bree's Crossing	9 NE Wimmera Distri- butaries	10 SW Wimmera terminal streams	11 NW Wimmera terminal streams	12 SW border streams (west flowing)	Total
Grazing - typical	0	0	5,235	0	4,639	21,624
Grazing - BMP	0	0	654	0	580	2,641
Grazing - high erosion	0	0	0	0	0	5,898
Conventional cropping	2,462	3,292	2,985	8,303	9	21,053
Conservation cropping	821	1,097	995	2,768	3	6,019
Dry Forest	137	19	1,407	93	115	2,548
Wet Forest	0	0	0	0	3	873
Irrigated	1	22	322	99	40	1,137
Urban	549	1,314	612	720	108	9,466
Point sources	0	0	0	0	0	0
Waterways	1,141	950	2,485	2,414	1,796	28,053
Gullies	1,141	950	2,485	2,414	1,796	28,053
<b>Total</b>	<b>6,253</b>	<b>7,644</b>	<b>17,180</b>	<b>16,810</b>	<b>9,089</b>	<b>127,365</b>

Estimated Total Phosphorus loads (kg per year generated from urban areas and connected diffuse sources)

# Appendix E Total Nitrogen Loads

Land Use	Nutrient Management Unit						
	1 WR & tribs upstream of Eversley	2 WR & tribs Eversley to Joel	3 WR & north side tribs Joel Joel to Glenorchy	4 South side tribs Joel Joel to Glenorchy	5 Tribes upstream of L Lonsdale	6 WR Glenorchy to Dooen & tribs down - stream of Lonsdale	7 WR & tribs Dooen to O'Bree's Crossing
Grazing - typical	5,913	12,981	12,698	14,993	24,312	12,225	10,879
Grazing - BMP	917	2,028	1,977	2,343	3,792	1,310	1,700
Grazing - high erosion	2,272	4,549	11,727	13,890	0	0	0
Conventional cropping	0	0	1,234	816	0	11,308	18,651
Conservation cropping	0	0	0	0	0	0	3,348
Dry Forest	2,224	801	3,417	1,452	16,685	7,446	1,644
Wet Forest	6,497	1,892	0	0	0	0	10,954
Irrigated	87	0	331	0	1,021	938	1,795
Urban	884	61	544	544	8,534	0	12,716
Point sources	0	0	0	0	0	0	0
Waterways	13,433	16,689	23,538	25,120	34,357	24,920	36,728
Gullies	13,433	16,689	23,538	25,120	34,357	24,920	36,728
<b>Total</b>	<b>45,660</b>	<b>55,690</b>	<b>79,006</b>	<b>84,279</b>	<b>123,059</b>	<b>83,068</b>	<b>135,142</b>

Land Use	Nutrient Management Unit					
	8 WR north of O'Bree's Crossing	9 NE Wimmera Distri- butaries	10 SW Wimmera terminal streams	11 NW Wimmera terminal streams	12 SW border streams (west flowing)	Total
Grazing - typical	0	0	41,884	0	37,111	172,995
Grazing - BMP	0	0	6,544	0	5,799	26,411
Grazing - high erosion	0	0	0	0	0	32,438
Conventional cropping	19,700	26,339	23,877	66,428	70	168,423
Conservation cropping	8,208	10,975	9,949	27,678	29	60,187
Dry Forest	5,954	815	60,962	4,019	4,991	110,411
Wet Forest	0	0	0	0	63	19,405
Irrigated	10	144	2,058	635	258	7,277
Urban	2,074	4,964	2,312	2,720	408	35,761
Point sources	0	0	0	0	0	0
Waterways	11,291	8,201	31,130	21,163	16,107	262,678
Gullies	11,291	8,201	31,130	21,163	16,107	262,678
<b>Total</b>	<b>58,527</b>	<b>59,640</b>	<b>209,846</b>	<b>143,806</b>	<b>80,941</b>	<b>1,158,663</b>

Estimated Total Nitrogen loads (kg per year generated from urban areas and connected diffuse sources)

# Appendix F Incidence of Toxic Algal Blooms

A risk assessment was used to formulate a scenario describing the likely number of blooms over the next decade. To do this, as a generalization, the blooms incidence scores would translate into the following number of toxic blue green algae blooms over the next decade.

Bloom incidence score	Number of blooms per decade
1	Nil
2	1
3	2
4	3

For the purpose of this assessment, the following duration of blooms was assumed.

Location	Duration (weeks)
Rivers	4
Green Lake and Dock Lake	12
Other Waterbodies	9

The estimated frequencies should be viewed as indicative estimates of the potential number of blooms in the future, with and without a nutrient management strategy being implemented.

Location	No Intervention	With Strategy
<b>On-Farm Systems</b>		
Farm Dams - <b>dryland</b> (per dam)	0.8	0.5
<b>Waterways</b>		
Wimmera River @ Horsham	12	7
Wimmera River @ Glenorcy	4	2
Wimmera River at Dimboola	8	5
Wimmera River at Jeparit	4	2
Typical reach of the Wimmera	4	2
Yarriambiack Creek @ Warracknabeal	8	4
<b>Storages</b>		
Wartook Reservoir	9	5
Lake Lonsdale	18	10
Lake Bellfield	9	5
Green Lake & Dock Lake	96	56
Pine Lake	9	5
Taylors Lake	18	11
Lake Fyans	9	5
Lake Wallace	63	25
Lake Whitton	27	15
Yaapeet storages	18	15
Lake Marma	9	5
<b>Lakes</b>		
Lake Hindmarsh @ Picnic Point	18	11
Boorooopki Swamp	36	14
Lake Bringalbert & Lake Dumbopperty	18	7
Lake Carpolac	27	11
Lake Charlegrark	36	14
Lake Ratzcastle, Lake Karnak & Johnsons Lakes	18	7
Natimuk Lake	27	14
Nhill Lake	18	16
Collins Lake	9	4
Lake Yallakar	9	4
Newlands Lake at Apsley	9	7
<b>Other wetlands</b>	16	8

*Incidence of toxic blooms with and without proposed strategy*

# Appendix G Relevant Agencies Involved

Agency	Responsibility	Street Address	Postal Address	Phone	Fax
Department of Natural Resources and Environment	Developing management tools and incentives to, and providing information on, protecting and rehabilitating catchments, rivers, wetlands, lakes, estuaries and marine environments and their beneficial uses.	110 Natimuk Road Horsham 3400	Private Bag 260 Horsham 3402	(03) 5362 0750	(03) 5381 0268
Environment Protection Authority	Development and co-ordination of the implementation of SEPP Waters of Victoria	43 Williamson Street Bendigo	43 Williamson Street Bendigo 3350	(03) 5442 4393	(03) 5442 6555
Grampians Water	Urban water supplies	11 McLachlan Street Horsham	PO Box 481 Horsham 3402	(03) 5382 4611	(03) 5381 9881
Horsham Rural City Council	Water quality issues in Horsham weir pool. Urban stormwater quality, planning scheme	Roberts Avenue Horsham	PO Box 511 Horsham 3402	(03) 5382 9777	(03) 5382 1111
Hindmarsh Shire Council	Water quality issues in Jeparit and Dimboola weir pools Urban stormwater quality, planning scheme	92 Nelson Street Nhill	PO Box 250 Nhill 3418	(03) 5391 1811	(03) 5391 1376
Northern Grampians Shire Council	Urban stormwater quality, planning scheme	Town Hall, Main Street Stawell	PO Box 581 Stawell 3380	(03) 5358 8700	(03) 5358 4151
Parks Victoria	Water quality in wetland reserves	State Government Offices, 21 McLachlan Street Horsham	PO Box 487 Horsham 3402	(03) 5381 1255	(03) 5381 0268
Pyrenees Shire Council	Urban stormwater quality, planning scheme	5 Lawrence Street Beaufort	5 Lawrence Street Beaufort 3373	(03) 5349 2000	(03) 5349 2068
West Wimmera Shire Council	Urban stormwater quality, planning scheme	49 Elizabeth Street	PO Box 201 Edenhope 3318	(03) 5585 9900	(03) 5585 9950
Wimmera Catchment Management Authority	Coordination of Water Quality Strategy Implementation	26 Darlot Street Horsham	PO Box 479 Horsham 3402	(03) 5382 1544	(03) 5382 6076
Wimmera Mallee Water	Water quality issues in stock and domestic system	24 Darlot Street Horsham	PO Box 19 Horsham 3402	(03) 5362 0200	(03) 5382 6192
Yarriambiack Shire Council	Water quality issue in Brim, Warracknabeal, Murtoa, and Beulah weir pools. Urban stormwater quality, planning scheme	34 Lyle Street Warracknabeal	PO Box 243 Warracknabeal 3393	(03) 5398 0100	(03) 5398 2502

*Agencies involved in the implementation of the Wimmera Water Quality Strategy*



Nutrient management units	Important areas	Reason for significance	Likely benefits from Strategy	Potential risks from poor water quality
1	Wimmera River	Important River System	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic.	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Increased growth of aquatic weeds, affecting aquatic flora and fauna. Decreased amenity and recreational value. Potentially increased toxins from blue green algae.
2	Wimmera River	" "	" " " "	" " " "
3	Glenorchy River Road to Lubeck Road	Fauna	Improved consumption for native fauna	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Potentially increased toxins from blue green algae.
	Green Creek Swamp	Other	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic.	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Increased growth of aquatic weeds, affecting aquatic flora and fauna. Decreased amenity and recreational value. Potentially increased toxins from blue green algae.
4	Wimmera River	Important River System	" " " "	" " " "
5	Lake Lonsdale-pleasant Creek woodlands	Fauna	Improved consumption for native fauna	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Potentially increased toxins from blue green algae.
	The ironbarks	Flora and fauna	" " " "	" " " "
6	Barrabool Flora and Fauna Reserve	Flora and fauna	" " " "	" " " "
	Lake Lonsdale-Lease hold on northern shore	Flora and fauna	" " " "	" " " "
	Luebeck Road to Dadswell Bridge road	Fauna	" " " "	" " " "

Nutrient Management Units and the environmental assets.

Nutrient management units	Important areas	Reason for significance	Likely benefits from Strategy	Potential risks from poor water quality
7	Darlot Swamp	Flora	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity.	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Increased growth of aquatic weeds, affecting aquatic flora and fauna. Decreased amenity and recreational value.
	Golton Creek National Park	Flora and fauna	Improved recreational and tourism use from improved water quality. Increased beneficial use for consumption. This is important due to the significant fauna and flora.	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Potentially increased toxins from blue green algae.
	Grampians National Park	Natural sites	" " " "	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Potentially increased toxins from blue green algae. Decreased amenity and recreational value.
	Sawpit Swamp	Wildlife Reserve	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic.	" " " "
	Telphers Swamp	Flora	" " " "	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Increased growth of aquatic weeds, affecting aquatic flora and fauna. Decreased amenity and recreational value.
8	Lake Albutya	RAMSAR	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic. Improved beneficial use such as migratory bird habitat and educational purposes.	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Increased growth of aquatic weeds, affecting aquatic flora and fauna. Decreased amenity and recreational value. Potentially increased toxins from blue green algae.
	Lake Hindmarsh	Important wetland	" " " "	" " " "

*Nutrient Management Units and the environmental assets.*

# Appendix H Environmental Assets

Nutrient management units	Important areas	Reason for significance	Likely benefits from Strategy	Potential risks from poor water quality
9	Outlet Creek North of Lake Albacutya	Flora and fauna	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic. This is important due to the significant fauna and flora. Protection of native riparian vegetation highlighted in this program will have beneficial affects to the flora in this Region	" "
	Pink Lake	Important wetland	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic. Improved beneficial use such as migratory bird habitat and educational purposes.	" "
	Coker Dam	Wildlife Reserve	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic. This is important due to its value as a wildlife reserve.	" "
	Coorong Swamp	Wildlife Reserve	" "	" "
	Chain of Lakes	Flora & other	Water quality increases usage for recreational and tourism purposes. Increase in water quality, increasing its beneficial use for consumption. It also has reduction in blooms and an increase in biodiversity. This is important due to the significant flora.	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Increased growth of aquatic weeds, affecting aquatic flora and fauna. Decreased amenity and recreational value.
	Lake Marma & reserve	Natural sites	Water quality increases usage for recreational and tourism purposes. Increase in water quality, increasing its beneficial use for consumption. It also has reduction in blooms and an increase in biodiversity. This is important due to the significant flora. This will help improve native vegetation from the waterway management Strategy	" "
	Yarriambiack Creek	Flora	" "	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Increased growth of aquatic weeds, affecting aquatic flora and fauna. Decreased amenity and recreational value.

Nutrient Management Units and the environmental assets.

# Appendix H Environmental Assets

Nutrient management units	Important areas	Reason for significance	Likely benefits from Strategy	Potential risks from poor water quality
10	Red Bluff Fauna and Flora Reserve	Flora and Fauna	Improved consumption for native fauna	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Potentially increased toxins from blue green algae.
	Minimay Swamp	Wildlife Reserve	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic. This is important due to its value as a wildlife reserve	" "
	O'Keefe Swamp	"	" "	" "
	McCossan Swamp	"	" "	V
	Champion Swamp	"	" "	" "
	Lake Dewabbin	"	" "	" "
	Kurrayah Swamp	"	" "	" "
	Red Gum Swamp	"	" "	" "
	Sheepwash Swamp	"	" "	" "
	Woolshed Swamp	"	" "	" "
	Lake Koynock	"	" "	" "
	Lake Karnak	"	" "	" "
	Yarrackigarra Swamp	"	" "	" "
	School Swamp	"	" "	" "
	Wanum Swamp	"	" "	" "
	Darragan Swamp	Flora and fauna	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic. This is important due to the significant fauna and flora.	" "
	Grass Flat Swamp	Important wetland	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Improves beneficial uses such as migratory bird habitat and educational purposes.	" "

Nutrient Management Units and the environmental assets.

# Appendix H Environmental Assets

Nutrient management units	Important areas	Reason for significance	Likely benefits from Strategy	Potential risks from poor water quality
	Bitter Swamp	"	" "	" "
	Hartleys Lake	"	" "	" "
	Mitre Lake	"	" "	" "
	Heard Lake	"	" "	" "
	Jallumba Swamp	Fauna	Improved consumption for native fauna	" "
	Jilpinger Flora and Fauna Reserve	Fauna	" "	" "
	Little Desert National Park	Natural sites	Improved recreational and tourism use from improved water quality. Increased beneficial use for consumption. This is important due to the significant fauna and flora.	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Increased growth of aquatic weeds, affecting aquatic flora and fauna. Decreased amenity and recreational value.
	North Lake-Centre Lake wetlands, Bow Lake Mobal Lake	Fauna & other	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic. This is important due to its significant fauna.	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Potentially increased toxins from blue green algae.
	Nurrabiell Swamp	Flora	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic.	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Increased growth of aquatic weeds, affecting aquatic flora and fauna. Decreased amenity and recreational value.
	Olivers Lake	Flora and fauna	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic. This is important due to its significant flora and fauna	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Potentially increased toxins from blue green algae.
	St Marys Lake	Fauna	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic. This is important due to its significant fauna.	" "
	Brooks Swamp	Wildlife Reserve	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic. This is important due to its value as a wildlife reserve	" "

Nutrient Management Units and the environmental assets.

# Appendix H Environmental Assets

Nutrient management units	Important areas	Reason for significance	Likely benefits from Strategy	Potential risks from poor water quality
11	Peechember Swamp	Wildlife Reserve	" "	" "
	Tarringinne Harding Swamp	Wildlife Reserve	" "	" "
	Big Desert National Park	Natural sites	Improved aesthetic value. Water quality increases usage for recreational and tourism purposes. Also increases its beneficial uses.	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Increased growth of aquatic weeds, affecting aquatic flora and fauna. Decreased amenity and recreational value.
	Gerang Gerung Flora Reserve	Natural sites	Improved water consumption for fauna.	" "
	Glenlee Flora and Fauna Reserve	Natural sites	" "	" "
	Kiata Flora Reserve	Natural sites	" "	" "
	Paradise Flora and Fauna Area	Natural sites	" "	" "
	Yarrangook Natural Area	Natural sites	" "	" "
12	Leah Dixon Swamp	Wildlife Reserve	Reduction in nutrients, which reduces potential algal blooms. Improved water quality and biodiversity. Increased beneficial uses including recreational, tourism and aesthetic. This is important due to its value as a wildlife reserve	Increased frequency and intensity of algal blooms, ruining ecological structure of the river. Potentially increased toxins from blue green algae.

*Nutrient Management Units and the environmental assets.*

## Definitions;

### Important River System:

These are as defined by Environmental Protection Agency Database

The significant fauna, flora, natural sites and others were located from the CFA Region 17 Rural Directory, Wimmera Area (1997).

### Wildlife Reserve:

This is an area where it is desirable to conserve specific animal species and their habitat. These sites were located from the Country Fire Authority Region 17 Rural Directory, Wimmera Area (1997).

### RAMSAR:

Wetlands of international importance as recognised under the Convention on Wetlands agreement (RAMSAR, 1971)

### Important Wetland:

These are as defined by Environmental Protection Agency Database



Nutrient generation rates depend on the connectivity of land and water. Connectivity relates to the topography and presence or absence of a drainage line or waterway. A highly connected system has a slope greater than 10° adjoining a stream and has a high movement of sediments and nutrients. In poorly connected systems, the slopes are separated by flatter areas or long distances. Much of the Wimmera Region is poorly connected with its waters.

The following information is extracted from the Wimmera CMSS Model: 1997, Water ECOscience <sup>(42)</sup>.

The Catchment Management Support System (CMSS) was developed by the CSIRO to help resource managers assess the potential impact of management decisions on the nutrient status of catchments. CMSS was designed to aid those involved in catchment management by providing a means of assessing various catchment management scenarios on the nutrient status of catchments. In essence, CMSS acts as a technical base from which to evaluate catchment management options aimed at reducing nutrient inputs to surface waters. CMSS calculates nutrient loads exported from various point and diffuse sources from catchment Regions and designated sub-catchments. This assists the user to locate areas that generate high nutrient loads or "hotspots" within a catchment. CMSS also incorporates an instream assimilation component that calculates the level of phosphorus and nitrogen being transported from one-sub-catchment to the next via rivers and streams.

The Wimmera Nutrient Management Working Group (WNMWG) chose to use CMSS to aid the development of the Wimmera Water Quality Management Strategy (WWQMS). The CMSS model was used to:

- Estimate nutrient loads exported from various diffuse and point sources;
- Identify nutrient "hotspots";
- Aid the assessment of the nutrient reduction and cost efficiency of various management options.

Output includes nutrient loads exported from land and at various sites along the Wimmera River, nutrient reduction resulting from modelling management actions and costs associated with nutrient reductions.

The figures produced in this document are estimations and should not be construed as actual figures. The CMSS model has many underlying assumptions and data entered into the model (i.e. nutrient export rates, landuse information and management action costs and nutrient reduction capacity) was the most accurate data at the time of development. Our knowledge of nutrient export rates and Best Management Practices (BMP's) is constantly improving and the information in the model can be updated at any time.

### Nutrient export rates extracted from the Wimmera CMSS model.

Landuse	Export rates		
	TP	TN	Units
Wet forest	0.09	2.0	kg/ha/yr
Dry forest	0.03	1.3	kg/ha/yr
Mallee scrub	0.03	1.3	kg/ha/yr
Rural residential	0.4	3.0	kg/ha/yr
Urban	1.3	5.0	kg/ha/yr
Grazing - steep active gully	0.4	1.0	kg/ha/yr
Grazing - upland alluvial	0.2	0.3	kg/ha/yr
Grazing - sedimentary rises	0.4	1.0	kg/ha/yr
Grazing - neutral grey clay	0.08	0.3	kg/ha/yr
Grazing - acidic dispersive	0.2	0.3	kg/ha/yr
Grazing - Mallee soils	0.03	0.2	kg/ha/yr
Irrigated pastures	0.4	4.0	kg/ha/yr
Cropping - upland alluvial	0.3	0.5	kg/ha/yr
Conv. cropping ngc	0.23	0.5	kg/ha/yr
Cons. cropping ngc	0.2	0.5	kg/ha/yr
Cropping acidic dispersive	0.3	0.5	kg/ha/yr
Conv. cropping - Mallee soils	0.1	0.3	kg/ha/yr
Cons. cropping - Mallee soils	0.1	0.3	kg/ha/yr
Vineyard	0.08	0.	kg/ha/yr
Lucern	0.1	0.3	kg/ha/yr
Unsewered urban	1.3	9.9	kg/ha/yr
FR piggery	0.03	0.9	kg/pig/yr
Dairy shed	0.12	0.36	kg/cow/yr
Wannon transfer	435	1125	kg/yr
Rocklands transfer	790	39,000	kg/yr

### SUB-CATCHMENTS AND EXPORT RATES

List of sub-catchments included in the Wimmera CMSS model.

No.	Sub-catchment	No.	Sub-catchment
101	Mt Cole	218	Wartook
102	Elmhurst	219	Nurrabel
103	Crowlands	220	Burnt Creek
104	Landsborough	221	The Lakes
105	Seven Mile	222	Drung
106	Upper Wimmera	223	Horsham
107q	Great Western	224	Quantong
108	Moyston	225	Polkemmet
109	Bellfield	226	Dimboola
110	Halls Gap	227	Jeparit
111	Jallukar	228	Hindmarsh
112	Stawell	229	Exit from Hindmarsh
113	Lake Lonsdaleq	301	Ararat Water Supply
114	Deep Lead	302	Charlton Stock and Domestic
115	Ledcourt	303	Exit to Richardson
116	Walwal	304	Exit to Ouyen
117	Lake Wartook	305	Exit to Yarriambiack

# Appendix J Cost Sharing Guidelines

Nutrient management activity Types	Source of funds for activity				Comments
	Landholder 1	Industry 2	Industry 3	Government	
Development and ongoing administration of catchment nutrient management plans	x		√	√	Government may assist in paying for the cost of their development, but the community actually develops plans and overviews their implementation
Land Holder Extension	√	√	√	√	Traditionally a role for government and regional authorities. Industry is also currently incorporating extension activities as components of industry funded projects. In some cases, community groups raise funds to pay for extension activities.
Improved fertiliser management	√	x	x	x	Essentially a private good, therefore landholder responsibility. However, peak groups, government and fertiliser companies may promote best fertiliser practice.
Dairy shed management	√	x	x	x	Essentially a private good, therefore landholder responsibility. However, peak groups and government develop and promote dairy shed best management practice
On-farm drainage re-use schemes	√	x	x	√	Essentially a private good, therefore landholder responsibility. However, government currently contributes to encourage the uptake of the of drainage re-use schemes as part of a government endorsed salinity management plan to reduce salinity and nutrient impacts of drainage.
Drainage diversion	√	x	x	√	Essentially a private good, therefore landholder responsibility. However, government currently contributes to encourage drainage diversion as part of a government endorsed salinity management plan to reduce salinity and nutrient impacts of drainage.
Improved cultivation techniques	√	x	x		Essentially a private good, therefore landholder responsibility. However, peak groups and government develop and promote advice through best management practices guidelines.
Improved grazing management practices	√	x	x	x	Essentially a private good, therefore landholder responsibility. However, peak groups and government develop and promote advice through best management practices guidelines.
Use of riparian buffer and filter strip[s]	√	x	√	√	Essentially a landholder responsibility (for private and licensed crown frontage). In some cases, may be a role for local community and government for protecting broader environmental and recreational values along waterways.
Developing property management plans	√	x	x	√	Government funds through Farm\$mart and salinity programs; some landholders contribution. Program includes landholder, industry and government involvement.
Improved management of drains in irrigation areas	√	x	√	x	May involve a range of activities. Generally a responsibility of landholders and rural water authorities to minimise the nutrient impacts of drains
Nutrient traps on drains in irrigation areas	√	x	√	√	In this specific case, existing salinity program cost sharing guidelines apply to the capital costs of a drain (nutrient traps are included in the capital cost of a drain)
Waterway management activities(i.e. Part 10 of Water Act 1989)	√	x	√	√	A role for catchment management authorities, from both State Government and local funding. Also a role for landowners and Landcare groups to fund cooperative works

# Appendix J Cost Sharing Guidelines

Nutrient management activity Types	Source of funds for activity				Comments
	Landholder 1	Industry 2	Industry 3	Government	
Sewerage treatment	x	x	√	√	A water authority obligation. However, government may, for equity or environmental reasons, contribute to accelerate initial capital works which are not financially viable for an authority
Urban stormwater management	x	x	√	√	Responsibility of local municipalities to manage urban stormwater (possibly with involvement from catchment management authorities). However, peak groups (e.g. MAV) and government fund development and promotion of best management practice guidelines. Also, government may provide funds if public benefits, such as wetland development and waterway protection and enhancement are involved
Disposal of effluent from intensive animal and processing industries	√	√	x	x	Essentially a private good, therefore a landholder or individual industry group responsibility. However, peak groups and government may promote advice through the best management practice guidelines.
Management of septic tanks	√	x	x	x	Responsibility of individual landholders. State and local government may promote advice through the best management practices guidelines.
Improved forestry management practices on public land	x	x	x	√	Role of government as a manager of public forests (NRE). Also industry groups and government promote advice through the Code of Forest Practices.
Improved forestry management practices on private land	√	√	x	x	Essentially a private good, therefore an individual landholder or company responsibility. Also, industry groups and government promote advice through Code of Forest Practices.
Research, investigations and development of best management practices					Industry peak groups and the private sector often provide R&I into new products and better nutrient management activities and relevant extension
Community education and extension (in general-applicable to any of the above activities)	x	√	√	√	Essentially a role of government and local authorities. However, peak organisations often promote best management practices.
Water quality monitoring	√	√	√	√	Traditionally a role for government. However, growing awareness that monitoring is also a community obligation and a legitimate ongoing cost of activities that impact on waterways (e.g. irrigation and stormwater drainage).

1 landholder includes individual landholders and community groups such as irrigators on a community surface drainage scheme or a Landcare group

2 industry includes intensive animal, food processing and industry groups (to distinguish from individual landowners

3 regional includes local authorities such as urban water authorities, rural water authorities, catchment management authorities and local municipalities

Government refers to State and Federal

## SOME ASSUMPTIONS ASSOCIATED WITH THE MODELING AND COST BENEFIT ANALYSIS (READ AND STURGESS, 2001)

There are a number of assumptions associated with both the CMSS modeling and the cost benefit analysis, some of which are highlighted below.

### Model Assumptions

- \* Areas with a mean gradient than 5 m per Km, all land within one Km of a waterway or wetland is connected and nutrients generated from land within that zone would reach waterways, but nutrients generated outside that zone would not reach waterways
- \* For areas with a mean gradient of less than 5 m per Km, all land within 0.5 Km of a waterway or wetland is "connected" and only nutrients generated within that zone would reach waterways
- \* Generalised nutrient generation rates for each landuse; as documented in Appendix A, B and C
- \* 1% reduction in TP equals 1% reduction in algal blooms
- \* For the Wimmera river catchment upstream of Horsham, 40% of non urban loads generated are derived directly for surface runoff from agricultural or forestry landuse. It is assumed that 30% loads are derived from stream erosion and 30% from gully erosion.
- \* For the remainder of the CMA region, 45-60% of the non urban loads generated are derived directly from surface runoff from agricultural or forestry landuses.

### Economic Assumptions

- \* That all algal blooms have been included when many would go unreported or unrecorded, especially when they occur on private property
- \* Equal costs of algal blooms
- \* Acknowledge that not all social and environmental costs are included
- \* Estimates of the economic impacts have a large confidence interval of 50%
- \* That we can accurately determine the risk of algal blooms (this is included in the report)

### Grazing Assumptions

- \* In the upper catchment 10-15% are sown perennials, 12% are natives, 8% are unimproved perennials and the remainder are sown annuals
- \* For the nutrient model, 20% has been specified as

good grazing lands as providing good ground cover and have used lower nutrient generation rates for that area

- \* Data may over estimate the level of active erosion
- \* There is a major assumption that Best Management Practice involves a mixture of appropriate activities would vary between farms: An appropriate mixture would include:
- \* Maintenance of vegetation cover along drainage lines and construction of barriers to flow for minor rainfall events.
- \* Improved grazing and fertiliser management, particularly along riparian zones, drainage lines and for highly erodible areas of farmlands.
- \* Restricted access of livestock to waterbodies and waterways.
- \* Restricted grazing of hilltops that are highly connected to streams.
- \* Controlled stocking to maintain vegetative cover, particularly along riparian zones and drainage lines.
- \* Strategic placement of grassed/treed 'filter strips' that would intercept nutrient laden runoff.
- \* Improved drainage for irrigated enterprises.
- \* BMP grazing will reduce the total phosphorus levels by 25% and would cost \$120 per hectare
- \* A 50-meter strip is adequate as a buffer strip in grazing situations

### Cropping Assumptions

- \* That an estimated 60% of land used for agriculture, corresponding to more than 1.2 million hectares, is used for extensive cropping of grains, pulses, oilseeds and pasture seed production. Wheat and barley remains the most important agricultural crop in terms of area with over 700,000 hectares sown in 1996.
- \* More that 500 000 hectares of the land used for cropping in the Wimmera River catchment is considered at risk from soil erosion and soil structure decline. Conventional cropping removes protective vegetation covers and increases the risk of soil erosion. A survey in 1997 indicated that of this area 40% is conservation farmed.
- \* BMP cropping will reduce the total phosphorus levels by 25% and would cost \$120 per hectare
- \* A 50-meter strip is adequate as a buffer strip in cropping situations

### Irrigation Assumptions

- \* Current area of irrigated pasture is 5,000 hectares. Types of land irrigated are primarily pasture (perhaps 85%), but includes some cropping and horticulture.
- \* Irrigation efficiency improves and drainage run-off,

through sprinkler to micro-irrigation. As water becomes more highly valued, we could expect that irrigation efficiencies would improve due to either the adoption of reuse systems or installing superior irrigation technologies.

- \* Implementation of irrigation BMP would cost a once-off expenditure of \$100 per hectare and would reduce the total phosphorus generation rates by 25%.

## **Rural Drainage Assumptions**

- \* The rural drainage Strategy recommends the adoption of the best management practices. Implementation of best management practices in regards to rural drainage management would cost \$10 000 per kilometer and that it would reduce the total phosphorus generation loads by 30%

## **Additional Extension Aimed At Changing Techniques On Farm Assumptions**

- \* That the extension program would result in a change of onground action and that people want to change their management practices
- \* The development of Whole Farm Plan results in its implementation and therefore changes onground
- \* Current extension programs are working 10% reduction in nutrient exports

## **Urban Stormwater Management Assumptions**

Community Education Program assumptions are highlighted below:

- \* That the program would facilitate such changes by encouraging the adoption of measures such as:
- \* Appropriate siting of developments and roads (to be incorporated into plans and planning schemes)
- \* The use of low phosphorus detergents and pesticides/herbicides in domestic and commercial activities
- \* Minimisation of detergent runoff from machinery and car washing activities
- \* Improved street cleaning methods
- \* Improved landscape and construction practices
- \* Improved street cleaning methods
- \* Minimisation of nutrient export during fertiliser application to lawns and gardens
- \* Training of works crews and planning officers
- \* Appropriate management of dog faeces
- \* That the education activities result in on ground change and therefore nutrient reduction
- \* Implementation of this program would reduce nutrients in stormwater by 15%

## **Urban Stormwater Works Assumptions**

- \* Wetland construction will cost \$50 000 per hectare with an annual maintenance of \$5000 per hectare per year. Wetlands would cover 2% of each major urban catchment. In small towns 2% of land would be covered with other stormwater management tools and would cost \$5000 per hectare
- \* Reduce nutrient input by 60%

## **Waterway Program Assumptions**

- \* There is an existing Wimmera Waterway Strategy which waterway actions have been costed. These would have a water quality improvement benefits, costings have not been included in this Strategy.
- \* The implementation of the Wimmera Waterway Strategy would reduce the nutrient load by 50%



## Wimmera River Basin Significant Fauna <sup>(41)</sup>

Australasian Bittern  
Australasian Shoveler  
Australian Bustard  
Baillon's Crake  
Bandy Bandy  
Bardick  
Barking Owl  
Black Falcon  
Black-eared Miner  
Blue-billed Duck  
Brolga  
Brown Quail  
Brush-tailed Phascogale  
Brush-tailed Rock-wallaby  
Bullant  
Bush Stone-curlew  
Cape Barren Goose  
Caspian Tern  
Cattle Egret  
Chestnut-rumped Heathwren  
Common Dunnart  
Common Greenshank  
Common Sandpiper  
Common Tern  
Curlew Sandpiper  
Diamond Dove  
Dwarf Galaxias  
Eltham Copper  
Fat-tailed Dunnart  
Fork-tailed Swift  
Freckled Duck  
Freshwater Catfish  
Glossy Ibis  
Golden Perch  
Golden Sun Moth  
Great Egret  
Greater Long-eared Bat  
Grey Falcon  
Grey Goshawk  
Grey Plover  
Grey-crowned Babbler  
Grey-headed Flying-fox  
Gull-billed Tern  
Hardhead  
Heath Mouse  
Intermediate Egret  
Large Ant Blue  
Latham's Snipe  
Leadbeater's Possum

Lewin's Rail  
Little Bittern  
Little Button-quail  
Little Egret  
Little Pygmy-possum  
Long-nosed Potoroo  
Maggie Goose  
Mallee Emu-wren  
Mallee Ningau  
Malleefowl  
Marsh Sandpiper  
Masked Owl  
Mitchell's Hopping-mouse  
Mountain Galaxies  
Murray Cod  
Musk Duck  
Nankeen Night Heron  
Painted Honeyeater  
Pectoral Sandpiper  
Pied Cormorant  
Plains-wanderer  
Powerful Owl  
Rainbow Bee-eater  
Red-backed Kingfisher  
Red-chested Button-quail  
Red-lored Whistler  
Red-necked Stint  
Red-tailed Black-Cockatoo  
Regent Honeyeater  
Regent Parrot  
River Blackfish  
Rosenber's Goanna  
Royal Spoonbill  
Ruddy Turnstone  
Samphire Skink  
Sciron Skipper  
Short-tailed Sandpiper  
Short-tailed Shearwater  
Silky Mouse  
Silvered Skipper  
Slender-billed Thornbill  
Small Brown Azure  
Smoky Mouse  
Speckled Warbler  
Square-tailed Kite  
Squirrel Glider  
Stripped Legless Lizard  
Striped Worm-Lizard  
Sun Moth (5091)  
Swamp Skink  
Swift Parrot  
Tree Goanna

Unspecked Hardyhead  
Warty Bell Frog  
Western Blue-tongued Lizard  
Western Whipbird  
Whiskered Tern  
White-bellied Sea-Eagle  
White-throated Needletail  
Wood Sandpiper  
Yarra Pigmy Perch

## Millicent Coast Basin Significant Fauna <sup>(41)</sup>

Australasian Bittern  
Australasian Shoveler  
Australian Bustard  
Baillon's Crake  
Bardick  
Blue-billed Duck  
Brolga  
Brown Quail  
Brush-tailed Phascogale  
Bullant  
Bush Stone-Curlew  
Cattle Egret  
Chestnut-rumped Heathwren  
Common Dunnart  
Common Greenshank  
Common Tern  
Curlew Sandpiper  
Fat-tailed Dunnart  
Fork-tailed Swift  
Glossy Ibis  
Golden Perch  
Great Egret  
Greater Long-eared Bat  
Grey Goshawk  
Grey Plover  
Grey-crowned Babbler  
Hardhead  
Heath Mouse  
Large Ant Blue  
Latham's Snipe  
Leadbeater's possum  
Little Bittern  
Little Button-quail  
Little Egret  
Little Pygmy-possum  
Magpie Goose  
Malleefowl  
Marsh Sandpiper  
Mitchell's Sandpiper

Mountain Galaxias  
Murray Cod  
Musk Duck  
Nankeen Night Heron  
Pectoral Sandpiper  
Pied Cormorant  
Port Lincoln Snake  
Powerful Owl  
Rainbow Bee-eater  
Red-necked Stint  
Red-tailed Black-Cockatoo  
Regent Honeyeater  
Regent Parrot  
River Blackfish  
Rosenberg's Goanna  
Royal Spoonbill  
Ruddy Turnstone  
Samphire Skink  
Sciron Skipper  
Sharp-tailed Sandpiper  
Short-tailed Shearwater  
Silky Mouse  
Slender-billed Thornbill  
Small Brown Azure  
Striped Worm-Lizard  
Unspecked Hardhead  
Variegated Pigmy Perch  
Warty Bell Frog  
Western Blue-tongued Lizard  
Western Whipbird  
Whiskered Tern  
White-bellied Sea Eagle  
White-throated Needletail  
Wood Sandpiper  
Yarra Pigmy Perch

# Glossary

**Playas**

Flat dried up area, especially a desert basin from which water evaporates off quickly.

**Fluvial**

Of or found in an ordinary river or rivers

**Aeolian**

Wind borne

**Alluvial**

Of or relating to alluvium, which is a sedimentary deposit of fine, often fertile soil, sand, etc., found on flood plains or in river beds

**Intrusive**

An influx of molten rock between or through strata etc but not reaching the surface

**Extrusive**

Thrust or forced out

**Marine**

Of, found in, or produced by the sea

**Paludal**

Of a marsh

**Recharge of an aquifer**

This is when surface water leaches or drains into the groundwater system

**Internal Loading**

Nutrients stored in the sediments of a waterbody can be released into the water.

**Runoff**

Once soil becomes saturated with water, water will start to pool and flow off the land.

**NTU**

Quantitative measurement of turbidity

**Heritage River**

Heritage River is a river that has a substantial part of its system with outstanding nature conservation, recreational, scenic and/or cultural heritage values. The corridor includes the stream-bed and banks and a 200m wide strip beside each stream bank, or the public land water frontage reserve, or as others mapped.

**RAMSAR**

Is the international treaty to protect wetlands that contain unique, rare and diverse ecosystems.

**JAMBA**

Japanese Australian Migratory Bird Agreement

**CAMBA**

Chinese Australian Migratory Bird Agreement

**Point Source**

Where nutrients enter the water body at an identifiable point e.g. wastewater treatment plant or urban stormwater runoff.

**Diffuse Source**

Nutrients enter a water body where there is no clear defined point source e.g. soil erosion or agricultural

runoff.

**Internal Loading**

Nutrients stored in the sediments of a water body can be released into the water. This may be an important source of nutrients long after external nutrients have been decreased.

**Anaerobic Conditions**

An environment where there is no oxygen

**10th percentile**

Below which 10% of the results lie

**90th Percentile**

Below which 90% of the results lie

**Median**

Below which 50% of the results lie, 50th percentile







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