

An assessment of water use and environmental flow requirements for the Moorabool River

(Outcomes of the Moorabool Water Resource Assessment Project)



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Our Water
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Salinity & Water
AUSTRALIA

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Foreword

The Moorabool River and Catchment are environmentally degraded. Some 70 per cent of the river and tributaries are already graded “poor” or “very poor”, using standard Index of Stream Condition methodology. If nothing is done, this can be expected to get worse, as more water is extracted, and less is available to sustain the river’s ecological processes. Unchecked, the trend is for the Moorabool to become little more than a drain, with consequent impacts downstream in the Barwon, in Lake Connewarre, and on the coast.

Yet the river’s finite water resources are already fully committed – if not over-committed – to legitimate urban and rural users, even before taking into account the river’s ecological needs, or future growth in consumptive uses, or the effects of climatic change on rainfall volumes and variability.

When the river’s waters were committed to the cities of Ballarat and Geelong and other towns, and to irrigators, little was known scientifically about flows required to sustain river health. Nor was anything known of how much water was being captured at source in thousands of farm dams.

This study redresses those knowledge gaps for the first time. It provides a comprehensive assessment of the catchment’s current inflows, and outflows to various users. It applies standard methodology to assess the river’s environmental flow requirements, which are unsurprisingly well above what is currently provided by “passing flows” stipulated in reservoir operating rules.

There is hope, however. The Victorian Government has recognised the plight of the Moorabool and other stressed rivers by placing a moratorium on further diversions, pending the preparation of studies like this one. Further, the Government requires the development of a water sharing strategy for the whole Central Region, well beyond the Moorabool Catchment boundaries. The results of this study will be essential for that strategy.

The study incorporates the views and knowledge of many community participants, and their input and patience is gratefully acknowledged. They can be assured that this study, along with current environmental flow studies on the Barwon and Gellibrand rivers, are regarded very seriously by my Board. Together these studies are viewed as a flagship for the Corangamite CMA in the implementation of its new responsibilities as manager of the environmental water reserve. It is part of history in the making, and I, for one, am most excited by it.

Establishing an environmental water reserve for the Moorabool is clearly critical, but it is not the only measure required to ensure the survival of the river. Other studies have established that catchment vegetation is also associated with river condition. So, in association with the community, the Authority will be applying other catchment management measures to make the environmental water reserve as effective as possible.



A handwritten signature in black ink, appearing to read 'Peter Greig'. The signature is fluid and cursive, written over a light grey background.

Peter Greig
Chairman

1. Introduction

STUDY CONTEXT

There is an increasing awareness of the need to incorporate environmental requirements of ecosystems in the water resource planning process. The Victorian River Health Strategy provides a framework that aims to maintain and, where possible, restore the environmental values of rivers and wetlands, whilst recognising the needs of other water users.

Changes to natural flow regimes can have a significant impact on river health and as such providing environmental flows is a key part of the water resource planning process. Environmental flows are flows that mimic the natural variability of stream flow. They are important for both ecological and physical processes such as the movement of nutrients and sediment within catchments, and the breeding of native fish, aquatic plants and bugs.

The Moorabool River is the primary source of water for Ballarat and a major source of water for Geelong and surrounding areas. There are also numerous on-stream and off-stream farm dams and licensed diversions, and extensive use of groundwater in the upper catchment.

The Moorabool River is considered one of the most heavily committed and therefore flow stressed rivers in Victoria due to the high competition between water users and environmental needs for water. The Moorabool River currently receives less than half its annual natural flow, and even less than this in drought years. For instance in 2003/2004 only 14 percent of the total flow was available for the environment, with 86 per cent extracted by water users. This places the river under extreme stress and significantly reduces its ability to provide other services (such as high quality water for urban and rural users), and to sustain its ecology in the long term.

A stream flow management plan process was initiated in the Moorabool Catchment a number of years ago. The committee, developing the plan, was unable to reach consensus on the sharing of water, as it was felt that meeting environmental flow requirements would significantly affect the reliability and quantity of supply to rural and urban water users, indicating that water in the Moorabool Catchment was already over allocated.

In response to increasing concern about the health of the Moorabool River and the status of water allocation, the Corangamite Catchment Management Authority (CMA) initiated the Moorabool River Catchment Project. Funding was obtained through the joint Victorian and Australian Government initiative, the National Action Plan (NAP) for Salinity and Water Quality.

The Moorabool River Catchment Project comprises four major sub-projects:

1. Water resource assessment
2. Lower Moorabool on-stream storage investigation
3. Upper catchment on-stream storage assessment
4. High priority riparian revegetation program.

While this report focuses on the water resource assessment, an overview of the outcomes of each of the other three components is provided. *See section 7.*

PROJECT OBJECTIVES

The Moorabool River Water Resource Assessment project examined these competing demands for water and the degree to which environmental flows can be improved. The objectives of the project were to:

- ◆ Estimate the impact of current and future water use and allocation on natural flow conditions
- ◆ Provide an assessment of water requirements for human uses and the environment
- ◆ Identify and evaluate options for improving stream flow for the environment.

A Technical Reference Group and a Community and Stakeholder Reference Group were established to review and discuss findings from the study. The Technical Reference Group consisted of representatives from the Department of Sustainability and Environment, Corangamite CMA, Barwon Water, Central Highlands Water and Southern Rural Water. The Community and Stakeholder Reference Group had representatives from the irrigation community, landcare, recreational users, environment groups and the broader community.

2. Catchment description and assets

THE MOORABOOL CATCHMENT

The Moorabool River Catchment covers approximately 1,150 square kilometres extending from the Great Dividing Range near Ballarat to the Barwon River, west of Geelong (Figure 1). The east and west branches rise in the southern ranges of the Wombat State Forest. Each branch flows in confined valleys to their confluence near Meredith. Below this point, the river continues through a tightly confined valley that broadens downstream to the junction with the Barwon River at Fyansford, near Geelong.

About 75 per cent of the catchment is used for agriculture, with 99 per cent of this agricultural land devoted to dryland farming, consisting of sheep and cattle grazing while cereal production also is important. In the upper reaches (upstream of Lal Lal Reservoir), beef cattle are grazed and irrigated vegetables (potatoes) are grown. Further south, sheep grazing and cropping dominate, with some viticulture around Bannockburn and vegetable growing between Batesford and Fyansford.

ENVIRONMENTAL ASSETS

Native fish

Twelve native freshwater fish species have been recorded in the Moorabool River system. One species, the Australian Grayling, is listed as vulnerable in Victoria, under the *Flora and Fauna Guarantee Act 1988* and is listed as vulnerable under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* as well as being on the 2002 International Union for the Conservation of Nature Red List of Threatened Species. Australian Grayling have become extinct in a major part of its range which is attributable to the construction of dams and weirs restricting fish migration to estuarine waters, as well as the alteration of natural stream flow and temperature regimes. Five other migratory fish have been recorded in the Moorabool River.

Figure 1: The Moorabool River Catchment



Non-migratory species that have been recorded in the Moorabool River include River Blackfish, Southern Pygmy Perch and Australian Smelt. River Blackfish and Australian Smelt have a wide distribution in the Moorabool River that extends from the junction with the Barwon River to the junction with Coolebarghurk Creek near Meredith. Mountain Galaxias has been recorded upstream of Lal Lal Reservoir on the west branch and as far downstream as Sheoaks on the main stem.

Aquatic bugs

In general, aquatic bug communities in the Moorabool River Catchment appear to be indicative of moderate environmental condition. The major threats to aquatic bugs in the river are the lack of habitat due to reduced flows (ie. Riffles – small rapids) and in-stream vegetation, as well as sedimentation and water quality.

Water birds

Floodplain and coastal wetlands within and downstream of the Moorabool Catchment are likely to provide important habitat for water-dependent birds in the area. A total of 11 Victorian threatened water-dependent bird species have been recorded within the Moorabool River Catchment.

Water-dependent birds will be strongly influenced by the condition of weir pools and freshwater and coastal lakes fed from the Barwon River Catchment and Moorabool River.

Lake Connewarre

The Moorabool River contributes water to the lower Barwon River which is important to the health of Lake Connewarre and associated wetlands, Reedy Lake, Hospital and Salt Swamps. Reedy Lake and Lake Connewarre are recognised as wetlands of international importance under the Ramsar convention.

In setting an environmental water reserve for the Moorabool River, it is essential that the freshwater needs of Lake Connewarre are considered. This will be considered in further water resource planning processes.

SOCIAL AND ECONOMIC ASSETS

The draft Corangamite Regional River Health Strategy considered the Moorabool River a high priority for actions because of its economic value as a major urban water supply for Geelong and Ballarat. Actions are detailed to protect water quality, through the provision of stream side buffer strips and planning controls.

The river also provides water for irrigated crops such as vegetables, grapes and lucerne. The catchment also attracts tourism. There is an increase in 'lifestyle' properties throughout the catchment.

Social assets in the catchment include parks, picnic sites, lookouts, swimming holes, fishing areas and wineries. There are also heritage-value assets, such as historic bridges. The catchment has a high landscape value for residents and visitors.



3. Modelling of the catchment's water resources

THE REALM MODEL

Urban and rural water authorities, and more recently catchment management authorities, must consider current and projected water availability in making decisions about development, infrastructure needs and environmental outcomes. A Resource Allocation Model (REALM) is used to assist with this process. By providing inputs such as climate, rainfall, evaporation, water use demands and environmental flow needs, the model can enable water resource managers to calculate security of supply.

REALM is a computer model which simulates the distribution of water within a river and/or water supply system on a daily, weekly or monthly basis. A REALM model of the Moorabool system was developed, using historical flow data from 1965 to 2002. This data when used in the model will help to determine current and natural flows which will assist with the modelling of environmental flow recommendations and test the impact of flow improvement options by running various scenarios.

CHANGES IN FLOW PATTERNS

Outputs from the REALM model were used to determine current and natural flows at key locations. Natural flows in this study can also be termed 'unimpacted' flows, or flows that have the effects of water harvesting removed. 'Unimpacted' flows are derived under current land-use conditions. Weekly model output was converted to a daily output by using the historical records of flow patterns. This flow data has contributed to the development of environmental flow recommendations.

The river was divided into four reaches as shown in figure 1. The REALM model and the environmental flow study used the reaches, which were:

- ◆ **Reach 1** East Moorabool River from Bostock Reservoir downstream to the confluence with the West Moorabool River
- ◆ **Reach 2** West Moorabool River between Moorabool and Lal Lal reservoirs
- ◆ **Reach 3** Moorabool River below Lal Lal Reservoir to She Oaks
- ◆ **Reach 4** Moorabool River below Sharp Road, She Oaks.

Comparisons of current and natural flows were undertaken for each of the four reaches of the study.

In the East Moorabool River downstream of Bostock Reservoir the results indicate that average flow has dropped from 3 ML/day to 2 ML/day. Low flows have actually risen, as the result of passing flows provided from the Reservoir. The stream now dries up less frequently, around 13 per cent of the time, compared to 35 per cent of the time under natural conditions.

In the West Moorabool River upstream of Lal Lal Reservoir, current water use levels have resulted in an average flow of approximately 8 ML/day, compared with 36 ML/day under natural conditions. The low flow (exceeded 80 per cent of the time) has dropped from 15 ML/day to 1 ML/day. The stream now ceases to flow around 12 per cent of the time, whereas under natural conditions it would rarely have stopped flowing.

Table 1: Licensed volume and current use in the Moorabool Catchment

Diverter	Bulk Entitlement & Licensed Volume (megalitres)	Current use (average annual megalitres)
Upper West Moorabool (CHW)	10,500	
Lal Lal Reservoir (CHW)	14,000	
Central Highlands Water total	24,500	16,600
Lal Lal Reservoir (BW)	7,000	
She Oaks (BW)	2,000	
Meredith (BW)	600	
Upper East Moorabool (BW)	9,000	
Barwon Water total	18,600	7,600
Southern Rural Water Customers		
Private diverters (surface water)	2,700	1,200
TOTAL	45,800	

The local catchment below Lal Lal Reservoir experiences an artificially high flow regime (high flows in summer) and decreased hydrological variability due to its use as a conduit to transfer water for Geelong between Lal Lal and She Oaks.

In the Moorabool River below She Oaks, current water use levels have resulted in an average flow of approximately 12 ML/day, compared with 65 ML/day under natural conditions. Low flows (80 per cent exceedence) have dropped from 22 ML/day to 5 ML/day.

BULK ENTITLEMENTS AND WATER USE LICENSES

Water in the Moorabool Catchment has many uses, including:

- ◆ Urban water supply for Ballarat and Geelong
- ◆ Groundwater pumping
- ◆ Farm dams
- ◆ Private diversions.

Water users are subject to constraints, including those set out in Bulk Entitlements (i.e. requirements for volumes to be extracted and passing flows) applying to urban extraction, as well as other rules, such as seasonal requirements applying to urban and rural diverters.

Table 1 (*page 8*) shows the estimated licensed volume and current use of water in the catchment.

An important measure used in water resource planning for urban and rural users, and in more recent times the environment, is the term 'security of supply'. Security of supply is expressed either in terms of the percentage of years without restrictions, or the percentage of years where full supply is provided.

Under current usage, a 92 per cent security of supply (defined as a percentage of years without restrictions) was determined for Central Highlands Water while a 94 per cent security of supply was calculated for Southern Rural Water (defined as a percentage of restricted requirements supplied in any year). It should be noted that security of supply is greatly reduced if use increases to full entitlements.

Security of supply at the current usage level could not be calculated for Barwon Water as it models its entire water supply network, including supply from both the Moorabool and Barwon catchments.

ISSUES ASSOCIATED WITH THE LEVEL OF WATER USE AND ALLOCATION

The Moorabool River Catchment supplies drinking water to Geelong and Ballarat, rural water users and the environment. Competition for limited water resources is intense, with the environment showing strong signs of stress. This project occurs in the context of these competing demands. Key issues that need to be addressed include:

Significant and increasing urban water use

Barwon Water's usage is expected to increase due to a new treatment plant at She Oaks and the ability to treat water with higher salinity levels for potable supply. The Melbourne 2030 report has designated Geelong and Ballarat as networked cities.

These are cities which are likely to attract an increasing number of residents willing to commute to Melbourne. The introduction of better rail networks to both centres will encourage urban growth as people seek a rural lifestyle with lower property values and relatively short travel times into Melbourne. This growth is expected to result in an increase in water consumption by Central Highlands Water and Barwon Water.

Impact of farm dams on flows

Prior to 2002, farm dams did not require licensing and there was no record of the number or volume of water captured by them. In order to consider the impact of farm dams on stream flow in the Moorabool Catchment, the Tool for Estimating Dam Impacts (TEDI) was used along with aerial photography of the catchment. TEDI is also a hydrological computer model.

Farm dams, which capture water before it reaches the river, are having a significant impact on river inflows. The catchment contains more than 4,000 dams, with an estimated total storage capacity of 14,401 ML. Modelling of farm dams indicates that the collection of water in farm dams results in a reduction in stream flow of 12,300 ML. In addition, there has been an estimated 150 per cent increase in storage volumes since 1965. In 2002, commercial and irrigation farm dams were incorporated into the water allocation framework and now require licensing under the *Water Act 1989*, with existing dams able to be used according to historical use under a registration licence. Domestic and stock farm dams do not require licensing or registration if they are filled from rainfall and runoff.

Table 2 (*page 10*) shows the distribution of farm dams, identified from aerial photography, in the Moorabool Catchment.

Impact of groundwater extraction on flows

There is extensive groundwater use in the upper west part of the catchment. The degree to which this affects surface water flows was broadly considered as part of the study. This assessment indicated a strong interaction between surface water and groundwater particularly in the upper west Moorabool Catchment, where it was assumed for modelling purposes that 60 per cent of groundwater extractions come from base flows in the Moorabool River. This assumption could be further tested to improve modelling outcomes. As with farm dams, this water is removed from the system before other users can gain access.

Table 2: Summary of estimated volume of farm dams in the Moorabool Catchment

Sub-area	Catchment area (km ²)	Number of farm dams	Volume of dams (ML)
Upstream of Moorabool Reservoir	29	65	146
Upstream of Moorabool channel / pipeline	45	238	1,323
Between Moorabool and Lal Lal Reservoirs	42	190	904
Tributaries upstream of Lal Lal Reservoir	174	1,283	3,686
Upstream of Korweinguboora and Bostock Reservoirs	127	398	1,009
Between Lal Lal Reservoir, Bostock Reservoir and Morrisons	218	672	3,109
Between Morrisons gauge and Batesford gauge	537	1,927	4,224
TOTAL	1,172	4,773	14,401

Suitability of passing flows specified in existing Bulk Entitlements

Bulk Entitlements are held by Central Highlands Water and Barwon Water. Bulk Entitlement passing flow rules for the reservoirs require inflows (up to a set threshold) to be passed through. Inflows exceeding passing flows are generally retained for urban use. Inflows to some reservoirs have been decreasing over time, even before the current drought. Modelling shows that this is caused by the increased number of farm dams and upstream groundwater pumping. Historically passing flows in Bulk Entitlements have not been required to take account of the environmental flow needs.

Climate Change

The study investigated catchment behaviour under current climatic conditions and projected climate change. Based on work by the CSIRO, the projected impact of climate change in the Moorabool Basin in 30 years time is a 0 to 2 per cent reduction in annual rainfall and a 7 to 9 per cent increase in annual evaporation. Taking the average of both these ranges, modelling has estimated this will result in a reduction in inflows of 9 per cent, an increase in urban demands of 5 per cent and an increase in irrigation demands of 11 per cent.

Over-allocation of water

There are many competing needs in the catchment, all with valid claims to water. The extent of allocation is such that there is a degree of overlap between Bulk Entitlements, private water users including diverters, farm dam owners and groundwater users.

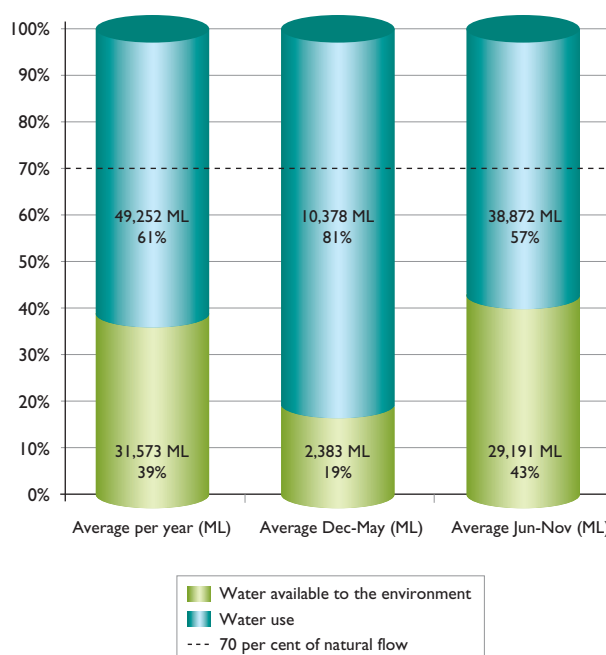
The proportion of water available for the environment is shown in Figure 2. On average 39 per cent of water in the Moorabool River is available to the environment, whilst 61 per cent is collected by water users. Of particular concern for river health is the December to May (summer/ autumn) period, where only 19 per cent of the stream flow is available for the environment. Water use during the winter/ spring period is also substantial with only 43 per cent of the water available for the environment. These figures represent river flows in the lower Moorabool River at Batesford under current use and operating rules.

The Victorian Government's Green Paper identified that, river systems with less than 70 per cent of natural flows are very likely to be stressed, and unable to provide a healthy environment. Figure 2 clearly shows that the environment of the Moorabool is receiving significantly less than this value.

If bulk entitlement and licence holders took their full allocations, as is anticipated, then the Moorabool River would be further stressed. These levels of extraction will result in significant impacts on security of supply for all users as well as impacts on stream condition, including:

- ◆ Decline in the health of streamside vegetation
- ◆ Loss of native and recreational fish species
- ◆ Decline in water quality, leading to episodes of blue green algal bloom and high salinity
- ◆ Downstream effects on the Ramsar listed Lake Connewarre and the lower Barwon River.

Figure 2: Average proportion of water available for environmental flows and water use under current use and operating rules in the Moorabool River.



4. Determining environmental flow requirements

In Victoria, environmental flow requirements are determined using the Victorian FLOWS methodology. A panel of expert river scientists have used the methodology to determine environmental flows for the Moorabool River. The findings of the expert panel have been peer reviewed by CSIRO.

The FLOWS methodology uses a series of environmental objectives for each reach to develop the final environmental flow recommendations. The ecological objectives are linked to a particular environmental asset, such as native fish, water quality, stream channel form or aquatic bugs. The water requirements of the environmental asset are linked to a particular flow component, which are described below. An example using the Australian Grayling is shown in Table 3A and 3B below.

Table 3A: Example of Ecological Objective for Australian Grayling

Objective	Rationale	Timing of Flow Component	Relevant Flow Component
Maintain self-sustaining population of Australian Grayling	Provide adequate habitat all year	All year	Low flow

Table 3B: Example of Flow Recommendation for Australian Grayling

Season	Flow Component	Magnitude	Frequency	Duration
Summer Dec-May	Low flow	21 ML/day	Annual	Dec-May

Table 4: Summary of environmental flow requirements

Reach	Flow component						Average volume required (ML/yr)
	Cease to flow	Summer low (Dec-May) ML/day	Summer fresh ML/day	Winter low (Jun-Nov) ML/day	Winter fresh ML/day	Winter high ML/day	
Reach 1	Max 2 times for 30 consecutive days	NR	> 2 min 2 times for 10 consecutive days	8	> 37 min 2 times for 10 consecutive days	> 641 annual for 1-3 consecutive days	1,426
Reach 2	Max 2 times for 8 consecutive days	4	> 7 min 4 times for 7 consecutive days	22	> 40 min 3 times for 10 consecutive days	> 525 annual for 1-2 consecutive days	5,046
Reach 3	Annual for 10 consecutive days	20	> 31 min 3 times for 10 consecutive days	83	> 146 min 2 times for 5 consecutive days	> 3,000 annual for 1-2 consecutive days	18,812
Reach 4	Not recommended for this reach	21	> 32 min 3 times for 10 consecutive days	83	> 162 min 3 times for 10 consecutive days	> 3,000 annual for 1-2 consecutive days	20,861

Flow components include low and high flows for summer and winter, freshes, and cease to flow. An expert panel of river scientists determined the objectives and flow components required in each reach of the river, and the volume associated with each flow component. A description of each of the flow components is provided below.

Cease-to-flow

The cease-to-flow is the period of no discernible flow in a river, or in practice when there is no measurable flow at a stream gauge, representative of the relevant reach. This may lead to either total or partial drying of the river channel, depending on the specifics of the system. Cessation of flow is a common natural occurrence in Australian rivers and a range of ecological functions is provided by this flow component.

Low-flow

The low flows may be described as a continuous flow through the channel within the representative reach. The flow may be limited to a narrow area of the channel in the high points of the stream, but will provide connectivity between habitats within the channel.

Freshes

A fresh is the term used to describe small duration peak flow events. These are flows that last for at least several days, often as a result of intensive and sometimes localised rainfall. They are different from large high flow and flood events. Freshes generally occur in summer or spring.

High-flow

The key characteristics that distinguish this flow component from freshes or other large flows are the persistent increases in the seasonal base flow that remain within the channel. These flows are those which cover the bed of the stream and creating further habitat. These flows occur in late autumn, winter and spring.

The environmental flow recommendations for the Moorabool River are summarised in Table 4.

5. Assessment of options to provide environmental flows

Two tasks were undertaken to determine options for improving environmental flow. Firstly, criteria were developed against which different options could be measured. These criteria were sent to the Technical Reference group for comment and discussed for approval by the Community and Stakeholder Reference Group. The criteria were weighted and an order of priority agreed as shown below.

The criteria in order of priority were:

1. Protect and improve the river environment
2. Ensure long-term viability of water supply for agricultural and urban water users
3. Maintain security of supply for users
4. Have no impact outside the catchment
5. Minimise financial cost
6. Add value to the region.

Secondly, a brainstorming meeting was held with the Community and Stakeholder Reference Group to develop ideas for enhancing flows. These ideas were discussed at a meeting of the Technical Reference Group and a shortlist of 10 options agreed on for assessment. These options were:

- ◆ Encourage use of rainwater tanks, reuse etc around the home
- ◆ Reallocation of 50 per cent of water savings from implementation of demand management to the environment
- ◆ Enhance flows passed downstream from major storages
- ◆ Connect Barwon Water to the Upper Werribee system and buy/trade back some of their share of Lal Lal
- ◆ Find an augmentation option for Ballarat and get back part of Moorabool or Lal Lal Reservoirs: Bores (west of Ballarat)
- ◆ Buy back licenses/sleepers
- ◆ Transfer Ballarat South recycled water into Moorabool Basin
- ◆ Farm dams to pass summer flows
- ◆ Potable water substitution for Ballarat
- ◆ Environmental water allocation
- ◆ No change, current management.

As a comparison, each option was investigated in terms of its:

- ◆ impact on security of supply
- ◆ environmental costs and benefits
- ◆ socio-economic costs and benefits
- ◆ financial costs and benefits.



Key findings from the options analysis include:

- ◆ none of the options assessed was able to maintain security of supply at the current level (even with environmental flows at lower levels to those recommended to sustain ecological health)
- ◆ all options have a high financial cost (well above the cost of permanent water), but as cost was given a low weighting this did not affect rankings
- ◆ as all options were similar in terms of numeric results, rankings were driven by the scoring of subjective criteria, such as adding value to the region and ensuring long-term viability.

6. Conclusions

Over-allocation of water

Based on existing use and the identified environmental flow needs, the Moorabool Catchment is clearly over-allocated. Additional use or allocation will further degrade the environmental condition of the river and users' security of supply. There are many competing needs in the catchment. The introduction of recommended environmental flows would have a major impact on security of supply at existing levels of use.

Significant and increasing urban water use

Urban use consumes a significant proportion of the water in the Moorabool Catchment. Recent changes to the operating procedures of Barwon Water and the construction of a water treatment plant at She Oaks may result in that Authority using more of its allocation than was taken historically. Growth in the major urban centres of Ballarat and Geelong also will affect available resources and have a subsequent impact on the environment.

As water demands increase through the full take up of entitlements and licenses, the deficiencies of the current system of water allocation will become apparent and the impacts on the health of the Moorabool River will become more significant. When this project considered the impact on flows of increasing the urban water use from current levels to full entitlement levels the modelled annual average stream flow at Batesford would be reduced by a further 15 per cent from 31,573 to 26,200 ML/year, compared with the average annual stream flow for the past 55 years of 53,000 ML/year.

Impact of farm dams on flows

The historical unregulated growth of farm dams in the catchment has resulted in an estimated 14,400 ML of storage volume. At 18 per cent of mean annual inflow to the Moorabool Basin, this has had a marked impact on the water available for other users. A moratorium on new allocations is in place and will control new commercial and irrigation use, but will have no impact on stock and domestic dams.

Impact of groundwater extraction on flows

For the first time, groundwater contribution to stream base flows in the Moorabool River have been considered in water resource modelling. Indicatively, of the estimated 2,000 ML currently being extracted under groundwater licenses, approximately 1,200 ML or 60 per cent would be sourced from water contributing to stream base flows. Whilst this is an estimate only which could range from one to six per cent of total surface water use, it is a small component of the total water use. If the full allocation of 6,600 ML were used then the impact on surface water would be greater.

Review of this project by CSIRO has identified the need for further studies to quantify this contribution in the West Moorabool River.

Suitability of passing flows specified in Existing

Bulk Entitlements

As passing flow requirements are related to inflows to the reservoirs, the rate of passing flow is being affected by users taking water upstream of the reservoirs. Minimum passing flow requirements in the Bulk Entitlements do not meet the environmental flows recommended in this study. However, if the full recommended environmental flows were adopted in the Moorabool system, security of supply would drop markedly.

Protection of remaining areas with significant environmental values in the catchment

Although the Moorabool River is recognised as one of the most flow-stressed rivers in Victoria, it still retains some significant environmental values, particularly in the mid to lower reaches around She Oaks. These values include native fish of high conservation value, such as the Australian Grayling, and areas of remnant vegetation. Streamside values, predominantly in the upper catchment, are significantly degraded as a result of grazing and land-use change. Although exotic species, both aquatic and terrestrial, are significant components of communities in some reaches, native plant species are still abundant in others.

These significant environmental values are under threat from the current flow regime.

Stream flow is the key limiting factor for improving environmental condition of the Moorabool River. Indicatively and in accordance with the ecological objectives, the ecosystem of the Moorabool River will respond favourably to increased environmental flows. Conversely, if environmental flow requirements are not met, because of the projected increased water use, the environmental condition of the river will further decline.

7. Outcomes from the other work in the Moorabool River Catchment Project

LOWER MOORABOOL RIVER ON-STREAM FARM STORAGE REVIEW

The lower Moorabool on-stream storage investigation identified the condition and usage of weirs on the Moorabool River between She Oaks and Batesford. The project identified ownership, usage, condition, functioning and environmental values for each of the nine weirs.

Key findings were:

- ◆ The weirs were a barrier to most native fish migration
- ◆ Some weirs had little use and could be replaced with smaller, more environmentally friendly structures
- ◆ Some weirs needed urgent maintenance to ensure they were safe, met water user needs and could be managed according to licence conditions
- ◆ The weir pools provided a certain level of environmental value.

The Corangamite CMA and Southern Rural Water are seeking funds to address some of these findings from the report.

UPPER MOORABOOL RIVER ON-STREAM FARM STORAGE REVIEW

Officers from Southern Rural Water assessed all on-stream storages in the upper tributaries of the Moorabool. The study found that more than 70 per cent could not pass flows unless full and overflowing. Southern Rural Water is addressing this issue through the continuing process of registering farm dams and enforcing licence conditions.

MOORABOOL RIPARIAN REVEGETATION PROJECT

The Corangamite CMA has been assisting landholders in the Moorabool Catchment with fencing and replanting river frontages. The program has been highly successful and will continue subject to funding. Revegetation and fencing river frontages will help protect water quality in the urban water supply catchments.

8. Future directions

The water resource assessment has documented the requirements of all users within the Moorabool Catchment. It has clearly identified that there is no easy solution for striking a balance between users. This report – and additional work by Central Highlands Water and Barwon Water in developing their long-term water resource strategies – indicates that actions to alleviate flow stress, improve river health and maintain an adequate supply security will involve implementing a combination of options both within and external to the Moorabool Catchment.



Since the project began in 2002, there has been a substantial strengthening of government policy direction for water resource management and river health. These changes have a direct impact on the future of the Moorabool Catchment. The most significant is the recently completed Victorian Government's *Our Water Our Future* action plan which, among other initiatives, set caps for seven basins south of the Great Dividing Range (including the Moorabool). This means that no further water use licenses can be issued.

The government has identified that the issues raised in this report, including providing a sustainable water supply for Geelong and Ballarat, will need to be resolved in the large-scale water resource planning process, the Central Region Sustainable Water Strategy. This strategy will consider the needs of central Victoria, including Melbourne, Geelong and Ballarat, for the next 50 years.

While developing the Central Region Sustainable Water Strategy, the needs of urban users, agricultural users and the environment will be addressed. Priorities will be set to improve the environmental water reserve of rivers such as the Moorabool, Werribee, Maribyrnong, Tarago, Latrobe, Yarra, Barwon and Thomson, all of which are part of the central region.

In accordance with the *Our Water Our Future* action plan, the Corangamite CMA, as manager of the environmental water reserve will use the outcomes from this water resource assessment as a basis for negotiations towards providing a sustainable environmental water reserve for the Moorabool River.

Glossary & Key references

GLOSSARY

Base flow - The component of stream flow supplied by groundwater discharge.

Bulk entitlement (BE) - The property right to water held by water and other authorities defined in the *Water Act*. The BE defines the amount of water that an authority is entitled to from a river or storage and may include the rate at which it may be taken and the security of the entitlement.

Cap - An upper limit for the diversion of water from a waterway or catchment.

Catchment - The region which drains all the rainfall, other than that removed by evaporation, into a stream, which then carries the water to the sea or a lake.

Environmental flow - A flow regime aimed at maintaining or improving environmental values associated with aquatic ecosystems.

Environmental water reserve - The share of water resources set aside to maintain the ecological values of a waterway.

Exceedence flow - A flow which is equalled or exceeded a certain percentage of the time.

Estuary - The zone where a river meets the sea, influenced by river flows and tides and characterised by a gradient from fresh to salt water.

Farm dam - A storage which is primarily filled by rainfall, runoff or a spring.

Flow regime - The volume, timing and duration of flows throughout the year which may include low flows, flood events, high flows and cease of flow.

Groundwater - All subsurface water, generally occupying the pores and crevices of rock and soil.

Hydrology - The science dealing with surface and groundwater of the earth; their occurrence, circulation and distribution.

Megalitre (ML) - One million litres of water.

ML/day - Megalitres per day.

Natural flow - Estimated flow which would have occurred with current land use conditions if no water was harvested from the catchment or waterways by any use.

Off-stream dam - A storage that is not located on a waterway.

Registration licence - A licence issued for farm dams which existed prior to April 2002.

KEY REFERENCES

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