Review of the Operation of the Cap

Overview Report of the Murray-Darling Basin Commission

Including the four Companion Papers

AUGUST 2000
I am pleased to present to the Ministerial Council the final report on the Review of the Operation of the Cap by the Murray-Darling Basin Commission.

At Council’s direction, the Commission has performed this major review of the Cap’s operation, and not the Cap itself, after five years of implementation. The Review has been conducted in four components to ensure all aspects of the Cap’s operation have been addressed. The four components were:

- Ecological Sustainability of Rivers;
- Economic and Social Impacts;
- Equity; and
- Implementation and Compliance.

The design, carriage and execution of the Review have been the responsibility of the Murray-Darling Basin Commission through the Cap Project Board. The members of the Cap Project Board were:

- Commissioner Bernard Wonder (Chair);
- Commissioner Scott Spencer;
- Deputy Commissioner David Leece; and
- Deputy Commissioner Campbell Fitzpatrick.

The Commission considered the Review of the Operation of the Cap at Meeting 55 – 18 July 2000 in Goondiwindi, Queensland, and agreed to provide this final report to the Council at its meeting on 25 August 2000.

The Commission appreciates the Council’s commitment to the Cap, and its awareness of the need for a comprehensive review to address any matters that may not have been resolved in the initial phase of implementation.

The Murray-Darling Basin Commission acknowledges the cooperation of State and Territory Government agencies and the submissions made to the Review in November 1999 and July 2000 by:

- the partner Governments to the Murray-Darling Basin Agreement (Commonwealth, NSW, VIC, SA, QLD and the ACT);
- the Community Advisory Committee of the Murray-Darling Basin Ministerial Council (CAC);
- other stakeholders throughout the Basin; and
- the Office of the Murray-Darling Basin Commission.

I commend the final report of the Review of the Operation of the Cap to Council. I hope this report serves Council well in its future deliberations on the operation of the Cap.

Roy Green
President
Murray-Darling Basin Commission
August 2000
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The following four Companion Papers, one for each component of the Review of the Operation of the Cap, are also available:

• Companion Paper 1 — Ecological Sustainability of Rivers

• Companion Paper 2 — Economic and Social Impacts
  Report of Marsden Jacob Associates – March 2000

• Companion Paper 3 — Equity

• Companion Paper 4 — Implementation and Compliance
Executive Summary

The Cap on Diversions in the Murray-Darling Basin

In response to declining river health coupled with the incremental erosion of security of supply for existing irrigators, the Murray-Darling Basin Ministerial Council at its June 1995 meeting decided to introduce a Cap on the diversion of water from the Basin’s river system.

The introduction of the Cap was seen as an essential first step in establishing management systems to achieve healthy rivers and sustainable consumptive uses. In other words, the Ministerial Council determined that a balance needed to be struck between the significant economic and social benefits that have been obtained from the development of the Basin’s water resources on the one hand, and the environmental uses of water in the rivers on the other.

The Cap is a key policy decision in support of the goal of the Murray-Darling Basin Initiative which is to promote and co-ordinate effective planning and management for the equitable, efficient and sustainable use of the water, land and other environmental resources of the Murray-Darling Basin.

As such, the Cap is not an end in itself, but rather a first step towards achieving the longer-term objective of the Initiative. Striking the correct balance in the Murray-Darling Basin is, and will continue to be, an ongoing process.

The Review of the Operation of the Cap

As part of the decision by the Ministerial Council to introduce a permanent Basin-wide Cap on diversions, a major Review of the Operation of the Cap was scheduled for 2000 which marks five years of Cap implementation.

The decision of the Ministerial Council to commission a review reflects their commitment to the Cap. It also indicates an awareness of Council that a major policy initiative such as the Cap cannot be implemented without a comprehensive review. This Review steps back from the detailed annual audits of Cap implementation conducted by the Independent Audit Group (IAG) and looks to identify and address any matters that may not have been resolved in the initial phase of implementation.


This report provides a collation of the work specifically commissioned through two consultancies and the IAG designed to inform the Review process. This work has considered the submissions made to the Review in both November 1999 and July 2000 from the partner Governments, the Community Advisory Committee (CAC), and other interested stakeholders.

Ecological Sustainability of Rivers

The Commission has concluded that the Cap has been an essential first step in providing for the environmental sustainability of the river system of the Basin. Without the Cap, there would have been a significantly increased risk that the environmental degradation of the river system of the Murray-Darling Basin would have been worse. While there are aspects of the operation of the Cap where potential for improvement has been identified, the Cap has had a positive impact and should be maintained.

However, the Commission recognises that there is no certainty that the Cap on diversions at its current level represents a sustainable level of diversions - the level at which it is set being that which existed at the time when it was decided to introduce a Cap.

Further, the Commission recommends that as better information informs our management of the Basin’s resources, the level at which the Cap is set should continue to be refined to reflect our increased understanding. It is likely that such refinements may lead to the lowering of the level of the Cap in some valleys. Indeed, some jurisdictions have already increased the environment’s share, via access restrictions in addition to that required by the Cap, as part of their longer-term direction of improved water management.

The Commission also supports a regular Sustainable Rivers Audit of the Basin where the Cap would be cast as an input to Basin health rather than an outcome in itself.
Review of the Operation of the Cap — Ecological Sustainability of Rivers

The Commission concludes that:

- the Cap has supported the Murray-Darling Basin Ministerial Council's aim of achieving the ecological sustainability of the Basin's river systems (Conclusion 1);

- while the Cap does not necessarily provide for a sustainable Basin ecosystem, it has been an essential first step in achieving this outcome (Conclusion 2);

- all water users throughout the Basin need to recognise that the water they use is part of the reduced water available to the environment (Conclusion 3);

- that without the Cap there would have been a significantly increased risk that the environmental degradation of the river system of the Murray-Darling Basin would have been worse (Conclusion 4);

- the degradation caused by the current level of diversions ("the Cap") may well become more severe than that now apparent (Conclusion 5); and

- the catchment scale is the necessary spatial resolution to effectively manage our natural resource systems (Conclusion 6).

The Commission recommends that:

- the Cap should be maintained (Recommendation 1);

- the precautionary approach is appropriate (Recommendation 2);

- the benefit to the environment stemming from the water available to it should be maximised (Recommendation 3);

- a high priority be given to further improving the knowledge base available to natural resource managers, especially our understanding of the ecology of the Basin (Recommendation 4);

- as better information informs our management of the Basin's resources, the level at which the Cap is set should continue to be refined to reflect our increased understanding (Recommendation 5); and

- a Sustainable Rivers Audit, casting the Cap as an input to Basin health rather than an outcome in itself, be developed and implemented (Recommendation 6).

Economic and Social Impacts

The Commission considers that the overall benefit of the Cap, especially from ensuring security of supply at a valley level and providing an environment within which water trading and related reforms could be developed, has been a positive one and that the net benefit will increase over time.

The results of research conducted for the Review make it clear that, in the absence of the Cap, the erosion of security of supply for irrigators and other users would have been significant. These analyses were performed on several systems across the Basin reflecting diverse agricultural practices and climatic conditions.

Against this background, one benefit of the Cap is the guaranteeing of security of water supply at the valley level. Without the Cap, there would have been continued development and activation of water entitlements that had not been fully used (so called "sleepers" and "dozers") without a method of overall control. Through guaranteeing security, the Commission views the Cap as having provided a more certain climate for long-term investment and development, particularly in high value agriculture and value adding processing, as well as providing benefits to the environment.

The Commission considers that the Cap has provided a mechanism for restraining growth in diversions while enabling economic development to proceed. The Cap has enabled better definition of property rights governing water availability and provided an incentive for the States to establish market arrangements for trading in water entitlements (which has and will continue to encourage water to go to its highest value use). The Cap has also helped provide a focus for community discussions on resource sustainability which have helped to alleviate tensions over resource distribution and environmental degradation between irrigator groups and between urban and rural Australians.

The Commission recognises that this strong positive conclusion will not be the perception of every stakeholder in the Basin. However, the Commission concludes that the overall benefit of the Cap, especially from ensuring security of supply at a valley level and providing an
environment within which water trading and related reforms could be developed, has been a positive one.

Review of the Operation of the Cap — Economic and Social Impacts

The Commission concludes that:

• that the overall benefit of the Cap, especially from ensuring security of supply at a valley level and providing an environment within which water trading and related reforms could be developed, has been a positive one and that the net benefit will increase over time (Conclusion 7);
• the Cap has provided a more certain climate for long-term investment and development (Conclusion 8);
• the Cap has reduced the sensitivity of irrigated agriculture to extreme climatic events (Conclusion 9);
• the Cap has stimulated the streamlining of property rights to facilitate water trading (Conclusion 10);
• the Cap has accelerated water trade and increased the associated benefits such as improved confidence amongst traders to invest to achieve good economic outcomes (Conclusion 11);
• the Cap has, through protecting security of supply, circumvented tensions between irrigator groups (Conclusion 12);
• the Cap, through preventing the accelerated degradation of the riverine environment, has benefited the social cohesion of Australia by preventing a further increase in the perceived division between urban and rural Australians (Conclusion 13);
• the Cap has produced generally positive social outcomes through the flow-on effect of its economic benefits, and these positive effects will increase over the longer term (Conclusion 14); and
• the Cap, through protection of the natural capital stock from accelerated decline, has generated direct economic benefits to non-agricultural enterprises such as tourism, recreation and real estate amenity (Conclusion 15).

The Commission recommends that:

• partner Governments consider the opportunity provided by the 2001 Census to supplement the socio-demographic data it will provide with further information to improve our understanding of the social impacts of the Cap (Recommendation 7); and
• partner Governments strive to better inform and engage stakeholders on major policy initiatives such as the Cap through improved communication (Recommendation 8).

Equity

There are several equity issues (notably Cap arrangements for Queensland and the ACT) of longstanding duration that require urgent resolution. In addition there are several more recently identified equity issues (floodplain and overland flows and diversions, farm dams and tree plantations) also requiring attention. The effective management of these issues will necessitate an integrated catchment management approach to water management that embraces both surface and groundwater resources.

The Commission focused on equity issues arising from the implementation of the Cap between jurisdictions and between river valleys within States. In several cases, the submissions received by the Review of the Operation of the Cap raised equity issues that are about the details of implementation within valleys. These issues are outside the jurisdiction of the Murray-Darling Basin Commission and Ministerial Council processes. The vast majority of such issues related to the recognition of licensed entitlement versus history of use, specifically in New South Wales (the “sleeper/dozer” issue). The draft Overview Report recommendation that such issues be referred to the particular jurisdiction concerned was not considered satisfactory by many of the submissions received on the draft Overview Report. The Commission reiterates the finding that such issues must be dealt with by individual jurisdictions and recommends that all parties to the Murray-Darling Basin Agreement work to improve community understanding of the various roles within the Agreement.
Review of the Operation of the Cap — Equity

The Commission recommends that:

- the Cap adjustments for Lake Mokoan (VIC) and Pindari Dam (NSW) be resolved by June 2001 and late 2000 respectively in the interest of increasing Government and community confidence in the Cap (Recommendation 9);
- the Cap arrangements for the Queensland component of the Murray-Darling Basin be resolved in the anticipated timeframes specified in Section 4.3 (Recommendation 10);
- the Cap for the ACT, including the arrangements for trade with New South Wales, be resolved as a matter of high priority (Recommendation 11);
- all forms of water use be incorporated in Cap management arrangements as they are recognised and can be quantified (Recommendation 12);
- an integrated catchment management approach is required to address the equity issues associated with the Cap (Recommendation 13);
- diversions from floodplain and overland flows be included in Cap accounting arrangements as a matter of priority (Recommendation 14);
- farm dam water use should be included in Cap accounting arrangements as soon as practicable and all future administrative arrangements should support this outcome (Recommendation 15);
- water use by tree plantations eventually be considered for inclusion in the Cap where it is found to be significant (Recommendation 16);
- the outcomes of the Salinity Management Strategy be integrated into Cap implementation procedures (Recommendation 17);
- each Government give consideration to issues raised in the Review of the Operation of the Cap that are outside the jurisdiction of the MDBC (Recommendation 18); and
- the Murray-Darling Basin Commission and the individual jurisdictions work to increase community understanding of their roles and responsibilities within the Murray-Darling Basin Agreement (Recommendation 19).

Implementation and Compliance

The Commission recognises that the management of a scarce water resource is an ongoing task. In the Murray-Darling Basin, the Cap on diversions is a central feature of this management.

The work of the IAG on the ongoing implementation of the Cap and compliance of actual diversions with Cap target diversions has provided a clear direction for the finalisation of the implementation phase of the Cap. The Commission generally supports the IAG recommendations.

The Commission supports the recommendation that groundwater be managed on an integrated basis with surface water within the spirit of the Cap and recommends further work towards this goal.

Significantly, effective compliance tools (computer simulation models used to determine Cap target diversions) have not yet been developed and the Commission recommends that a high priority be given to the finalisation of these models.

The Review has found that Victoria and South Australia have complied with the Cap, while Queensland and ACT are yet to complete the establishment of their respective Caps. Nevertheless, it is apparent that in Queensland there has been significant growth in storage which will impact on the water available for alternative consumptive and environmental uses. In New South Wales, the Cap has been breached in the Barwon-Darling system, with other valleys being within Cap limits.

The Commission supports the improved implementation of the Cap in the areas identified under the Review and reiterates the importance of compliance of actual diversions with Cap targets.
Review of the Operation of the Cap — Implementation and Compliance

The Commission recommends that:

• groundwater be managed on an integrated basis with surface water within the spirit of the Cap (Recommendation 20);

• a Murray-Darling Basin Groundwater Management Strategy be developed by the Groundwater Technical Reference Group that is based on jurisdictional management of groundwater through sustainable yields and includes investigations clarifying how groundwater management practices may impact upon the integrity of the Cap in the future (Recommendation 21);

• a high priority be given to the finalisation of the compliance tools (computer simulation models) to determine Cap compliance (Recommendation 22).

Schedule F – Cap on Diversions

The most important challenge in Cap implementation is to finalise the arrangements under “Schedule F – Cap on Diversions” to the Murray-Darling Basin Agreement. This schedule is the primary tool for defining Cap arrangements especially those concerned with assessing compliance and its consequences. With the intent of improving the operation of the Cap through the development of fair and meaningful compliance arrangements, three modifications to Schedule F were canvassed in the draft Overview Report on the Review.

The outcome of the Review of the Operation of the Cap in regard to Schedule F is to:

End-of-valley flows

• remove references to end-of-valley flows as a method for Cap compliance except for Queensland alone as an interim measure until December 2002;

Remedial actions in case of Cap exceedance

• accept the arrangements for remedial actions in the case of Cap exceedance (“to ensure that cumulative diversions are brought back into balance with the cap”) noting that the cumulative diversions on the Register defined in the Schedule will be used as the basis for determining Cap compliance; and

Commencement date for Cap accounting

• retain 1997/98 as the water year for the commencement of accounting for diversions under the Cap for New South Wales, Victoria, South Australia and the Australian Capital Territory (as it is part of the greater Murrumbidgee valley) with Cap accounting for Queensland to commence upon the finalisation of Cap arrangements in that jurisdiction.

The revised version of Schedule F incorporating these changes is at Appendix E. The Commission fully expects the revised Schedule F will:

• lead to the more effective future operation of the Cap;

• enhance community confidence in Cap arrangements across the Basin; and

• be a major milestone in the implementation of the Cap.

Review of the Operation of the Cap — Schedule F – Cap on Diversions

The Commission recommends that:

• the revised version of Schedule F be adopted by the Ministerial Council as a permanent part of the Murray-Darling Basin Agreement incorporating the changes made to the Schedule through the Review of the Operation of the Cap (Recommendation 23).

Sustainable Rivers Audit

With the implementation of the Cap nearing completion in most jurisdictions, there is now the opportunity to take the “next step” and to consider the environmental outcomes of the Cap from a whole of Basin perspective.

In line with Recommendation 6, the Commission supports the introduction of a regular environmental audit of the Basin’s rivers, a Sustainable Rivers Audit, which would cast the Cap as an input to Basin health, rather than an outcome in itself.

Whereas the Cap is seen as the first step towards achieving the longer-term objective of the Initiative, a Sustainable Rivers Audit can be viewed as the next step in the process of achieving this objective.
1. Introduction

1.1 The Cap on Diversions in the Murray-Darling Basin

1.1.1 Background

The last 100 years has seen large increases in the extraction of water from the river system of the Murray-Darling Basin. Diversions grew from the 1870s but the rate of growth increased sharply in the 1950s and 1960s. For example, water extractions in the Basin more than tripled in the 50 years to 1994. This development of the Basin’s water resources received active government and broad community support throughout most of this period.

However, by the early 1990s it had become clear that the rivers of the Murray-Darling Basin were under stress. The level of salinity in the Lower Murray was causing concern, the numbers of native fish were in severe decline, wetlands and red gum forests were suffering from a reduction in the frequency of flooding and in 1991 a toxic blue-green algae bloom extended for 1000 km along the Darling River. The level of diversions in the Basin’s river systems and the changed flow regimes they had produced came under increased scrutiny at this time. A need to strike a balance between consumptive and instream uses of the water was identified and there was a realisation that there was a finite amount of water in the Basin. Also, it was clear that any further increase in extraction would affect the security of supply to existing users.

Since 1985, the organisation that has facilitated the interstate cooperation on the management of the Basin’s natural resources has been the Murray-Darling Basin Ministerial Council (the “Ministerial Council”). The Ministerial Council consists of the ministers responsible for land, water and environmental resources in each of the Commonwealth, New South Wales, South Australia, Victoria, Queensland and Australian Capital Territory Governments. Being a political forum, the Ministerial Council has the power to make decisions for the Basin as a whole. Resolutions of the Council require a unanimous vote. This means that decisions taken by the Council represent a consensus of Government opinion and policy across the Basin.

1.1.2 The Audit of Water Use in the Murray-Darling Basin


The Audit confirmed increasing levels of diversions and the consequent decline in river health. From 1988 to 1994, water consumption in the Basin increased by 8% overall (see Figure 1). By 1994, water consumption in the Basin had reached approximately 11,000 GL per year. In the northern parts of the Basin, the percentage increases were very much greater, largely as a result of the expansion of the cotton industry, though large increases were also experienced in other areas.

Among other things, the levels of water diversion have significantly reduced flows in the lower reaches of the River Murray. Under 1994 levels of development, median annual flows from the Basin to the sea are only 21% of those that would have occurred under natural conditions (see Figure 2). The reduction in flow has affected most notably the small to medium size flood events. The frequency of these events has been substantially reduced and many of them are completely harvested. One consequence is that the lower reaches of the Murray now experience severe drought-like flows in over 60% of years compared with 5% of years under natural conditions (see Figure 2).
FIGURE 1 — Growth in Water Use in the Murray-Darling Basin (projections as at 1995 without a Cap).

FIGURE 2 — Flow Duration Curve for the Mouth of the River Murray.
The Audit also examined the scope for diversions to grow further under the water allocation system that existed at that time. The existing system had evolved at a time when water managers were trying to encourage development of the Basin’s water resources. As such, the system rationed water during periods of shortage but was not effective for controlling diversion during non-drought conditions. In the five years before the Audit, only 63% of the water that was permitted to be used was used, leaving considerable scope for further increases in consumption, without any change in entitlements.

The Audit found that average diversions could increase by a further 15% if all existing water entitlements were fully developed. Such an increase in diversion would reduce security of supply for existing irrigators. Increased diversions would mean that the level of reserves held in the storages would be lower than is currently the case. This would reduce the capacity of the storages to be a reliable source of supply during long periods of drought. Under this scenario, water supplies for existing irrigators would have become less secure and river health problems would have been exacerbated.

1.1.3 The Decision to Cap diversions

In response to the issues raised by the Audit, the Murray-Darling Basin Ministerial Council at its June 1995 meeting decided to introduce a Cap on the diversion of water from the Basin’s river system. In the first two years, interim arrangements were used while details of the long term Cap were developed. In December 1996, partner Governments then confirmed a permanent Cap effective from 1 July 1997. June 2000 marks five years of Cap implementation.

The introduction of the Cap was seen as an essential first step in establishing management systems to achieve healthy rivers and sustainable consumptive uses. In other words, the Ministerial Council determined that a balance needed to be struck between the significant economic and social benefits that have been obtained from the development of the Basin’s water resources on the one hand, and the environmental uses of water in the rivers on the other.

The Ministerial Council in its landmark decision to establish the Cap recognised that the two primary objectives driving the decisions to implement the Cap were:

1) to maintain and, where appropriate, improve existing flow regimes in the waterways of the Murray-Darling Basin to protect and enhance the riverine environment; and

2) to achieve sustainable consumptive use by developing and managing Basin water resources to meet ecological, commercial and social needs.

Since 1996 the Ministerial Council have used the following definition of the Cap:

“The volume of water that would have been diverted under 1993/94 levels of development. In unregulated rivers this Cap may be expressed as an end-of-valley flow regime.”

This has been the way the Cap has been applied, with small variations, in New South Wales, Victoria and South Australia (who between them extract 95% of the water diverted in the Basin). In Queensland and the Australian Capital Territory (total of 5% of Basin diversions), the final arrangements of the Cap are yet to be fully determined.

The definition adopted for the Cap in each jurisdiction is provided at Appendix A.

Diversion under 1993/94 levels of development does not mean the volume of water that was used in 1993/94. Rather, the Cap in any year is the volume of water that would have been used with the infrastructure (pumps, dams, channels, areas developed for irrigation, management rules, etc.) and management rules that existed in 1993/94, assuming similar climatic and hydrologic conditions to those experienced in the year in question. Thus, the Cap provides scope for greater water use in certain years and lower use in other years. The Cap itself does not attempt to reduce Basin diversions, merely prevent them from increasing. New developments are possible under the Cap provided that the water for them is obtained by improving water use efficiency or by purchasing water from existing developments.

1.1.4 Significance of the decision to Cap diversions

Against a backdrop of over 100 years of active development of the water resources of the Basin, the Ministerial Council decision to cap diversions from the Murray-Darling Basin river system is the single most significant water resources...
initiative in the Basin since the establishment of the Ministerial Council in 1985.

It is now recognised as a landmark decision in natural resource management.

The Cap is a key policy decision in support of the goal of the Murray-Darling Basin Initiative which is to promote and co-ordinate effective planning and management for the equitable, efficient and sustainable use of the water, land and other environmental resources of the Murray-Darling Basin.

As such, the Cap is not an end in itself, but rather a first step towards achieving the longer-term objective of the Initiative. Striking the correct balance in the Murray-Darling Basin is, and will continue to be, an ongoing process.

The heavy dependence of the Basin’s economy (and in turn national and State economies) on the availability of water makes any major water management initiative a public policy issue. Water management in the Murray-Darling Basin potentially affects the well being of the Basin’s 2 million inhabitants and a further 1 million people outside the Basin that are heavily dependent on its water.

Thus, the Cap on diversions is a major public policy issue affecting the lives of up to 3 million Australians and the health of our most important natural resource system, the Murray-Darling Basin.

1.2 The Review of the Operation of the Cap

1.2.1 The Review

As part of the decision by the Ministerial Council to introduce a permanent Basin-wide Cap on diversions, a major Review of the Operation of the Cap was scheduled for 2000. This Review has been a central feature of Cap implementation in 1999 and 2000 and aims to provide for improved Cap implementation across the Basin.

This Review was not about whether or not we need a Cap but is, however, a review of the operation of the Cap and how it can be further refined to meet the needs of the communities within the Murray-Darling Basin. It steps back from the detailed annual audits of Cap implementation conducted by the Independent Audit Group (IAG) and looks to identify and address any matters that may not have been resolved in the initial phase of implementation.

From its inception, the Cap on diversions has had the support of each of the partner Governments to the Murray-Darling Basin Agreement reflected in unanimous support at Ministerial Council level for the arrangements in place.

This Review underscores the commitment of the Ministerial Council to the Cap on diversions. Also it reflects the awareness of Council that a major policy initiative such as the Cap cannot be implemented without a comprehensive review to address any matters that may not have been resolved in the initial phase of implementation.

The Review recognises that water management issues will arise from Cap implementation on an ongoing basis and the various policy responses that have been required since the decision to Cap diversions. Leadership has been shown by each of the Governments in managing water use in compliance with Cap levels. Policy and management decisions will continue to be made to ensure water use throughout the Basin remains within Cap levels.

The Review of the Operation of the Cap has four components as follows:

- Ecological Sustainability of Rivers;
- Economic and Social Impacts;
- Equity; and
- Implementation and Compliance.

The Cap Project Board has directed this Review of the Operation of the Cap on behalf of the Murray-Darling Basin Commission. This report is the final report of the Murray-Darling Basin Commission on the Review of the Operation of the Cap.

The Terms of Reference for the Review are at Appendix B.

1.2.2 Advice sought by the Cap Project Board

To inform the Review, four separate pieces of work were commissioned by the Cap Project Board on behalf of the Murray-Darling Basin Commission – one for each of the four components of the Review. For each of these
pieces of work, project briefs were developed specifically designed to support the Review process. In each case the brief required consideration of the submissions made to the Review.

**Consultants**

Under two components of the Review, consultants were appointed after a competitive tendering process. The successful tenderers were:

- Ecological Sustainability of Rivers – CRC for Freshwater Ecology, Albury, NSW; and
- Economic and Social Impacts – Marsden Jacob Associates, Camberwell, VIC.

The two reports of the consultants are available as Companion Papers 1 and 2 respectively. The Murray-Darling Basin Commission has used these reports to inform their deliberations on the Review of the Operation of the Cap, however the opinions expressed in this document are those of the Commission.

**The Independent Audit Group (IAG)**

The Independent Audit Group (IAG) has been involved in the implementation of the Cap on diversions since 1996 and, under present arrangements, are to continue with its annual audits of Cap implementation through to at least 2004. The IAG was engaged to conduct the work under the other two components of the Review:

- Equity; and
- Implementation and Compliance.

The two reports of the IAG are available as Companion Papers 3 and 4 respectively.

This report and the reports of the consultants and the IAG are available upon request from the Office of the Commission and on the Commission’s web site: www.mdbc.gov.au

**1.2.3 Submissions to the Review - November 1999**

Submissions to the Review were made in November 1999 by:

- the partner Governments to the Murray-Darling Basin Agreement (Commonwealth, NSW, VIC, SA, QLD and the ACT);
- the Community Advisory Committee of the Murray-Darling Basin Ministerial Council (CAC);
- other stakeholders throughout the Basin; and
- the Office of the Murray-Darling Basin Commission.

All submissions made to the Review in November 1999 are available on the Murray-Darling Basin Commission web site (www.mdbc.gov.au) and from the Office of the Commission. A list of these submissions is at Appendix C.

The submissions received formed a significant part of the Review process. Submissions were an important input into the deliberations of the consultants and the IAG. Each of the four reports under the Review address issues raised by the submissions.

In several cases, the submissions received by the Review of the Operation of the Cap raised issues that are about the details of implementation within valleys which are outside the jurisdiction of the Murray-Darling Basin Commission and Ministerial Council processes. Such issues need to be dealt with by the particular jurisdiction concerned. For discussion of these issues and their treatment see Section 4.5.

In order that all submissions receive appropriate attention, these submissions and that of the CAC have been referred to the appropriate Government for consideration and reply.

**1.2.4 Draft Overview Report of the Cap Project Board – March 2000**

In March 2000, the Ministerial Council considered a draft Overview Report prepared on behalf of the Murray-Darling Basin Commission by the Cap Project Board. At that time, the Ministerial Council released the draft report on the Review of the Operation by the Cap for public comment through to 10 July 2000.

The draft Overview Report was widely distributed for comment to:

- Basin Stakeholders (including those who made a submission in the first phase of the Review in November 1999);
- all members of the Community Advisory Committee of the Murray-Darling Basin Ministerial Council (CAC), along with all
Catchment Coordinators, and the Cap Project Board Chair attended CAC Meeting 24 – 27 June 2000 to discuss the Review; and

- partner Governments (who were free to engage agencies and stakeholders in their jurisdictions as they saw fit to ensure that existing consultative processes were respected).

Submissions on the draft Overview Report were made in July 2000 by:

- four partner Governments to the Murray-Darling Basin Agreement (NSW, VIC, SA and QLD); and

- the Community Advisory Committee of the Murray-Darling Basin Ministerial Council (CAC); and

- other stakeholders throughout the Basin (63 submissions).

All submissions made on the draft Overview Report in July 2000 are available on the Murray-Darling Basin Commission web site (www.mdbc.gov.au) and from the Office of the Commission. A list of these submissions is at Appendix D.

The final report of the Murray-Darling Basin Commission is based upon the draft report released by the Ministerial Council in March 2000 modified to reflect comments received in the public consultation process. This final report was presented to Ministerial Council Meeting 29 – 25 August 2000 for consideration and endorsement.
2. Ecological Sustainability of Rivers

2.1 Introduction

The Ecological Sustainability of Rivers component of the Review addressed the contribution of the Cap to the ecological sustainability of the river system of the Basin which was identified at inception as one of the primary objectives of the Cap.

Sustainability requires that a balance exists between supporting consumptive use and ensuring sufficient water is available to our rivers to maintain ecological processes. Achieving sustainability is of paramount importance as it will underpin the capacity of future generations to respond to hazards such as salinity and blue-green algae while maintaining an economically viable level of agricultural production.

The CRC for Freshwater Ecology were engaged to complete a piece of work designed specifically to inform this component of the Review. The full report of the CRC for Freshwater Ecology (February 2000) is the first of the Companion Papers to this document.

Informed by the work of the CRC for Freshwater Ecology and the submissions made to the Review on the draft Overview Report of the Cap Project Board, the Commission provides several conclusions and makes a number of recommendations in regard to this component of the Review of the Operation of the Cap.

2.2 Summary of Submissions on Draft Overview Report

The submissions received in July 2000 on this component of the draft Overview Report were generally supportive of the provisional findings of the Review recognising the positive contribution of the Cap to the ecological sustainability of the river system of the Murray-Darling Basin. There was also general support for the statement that that there is no certainty that the Cap on diversions at its current level represents a sustainable level.

Many submissions emphasised the need for more and better science to continually inform the water resource management practices throughout the Basin. The Sustainable Rivers Audit being developed by the Commission addresses this issue.

Recognising the views expressed in the submissions on the draft Overview Report, the Commission has fashioned advice to Council as conclusions and recommendations in the following section.

2.3 The Ecological Sustainability of the Basin’s Rivers

Cap be maintained

Through restricting further diversions in all rivers, the Cap has protected riverine environments from much greater levels of degradation than would have occurred without the Cap. For this reason, the Commission very strongly supports the maintenance of the Cap recognising it as the first step toward striking the balance between instream and consumptive uses. While there are aspects of the operation of the Cap where potential for improvement has been identified, the Cap has had a positive impact and should be maintained.

The Commission has concluded that:

- the Cap has supported the Murray-Darling Basin Ministerial Council’s aim of achieving the ecological sustainability of the Basin’s river systems (Conclusion 1).

Recognising the positive impact of the Cap, the Commission recommends that:

- the Cap should be maintained (Recommendation 1).
No certainty the Cap represents a sustainable level of diversions

The Commission saw no evidence to provide them with certainty that the Cap on diversions at its current level represents a sustainable level of diversions. The current level for the Cap on diversions is just the level that existed at the time it was decided that a limit needed to be introduced. The introduction of the Cap was in response to the 1995 "Audit of Water Use in the Murray-Darling Basin" which recorded the then existing levels of diversion in response to growing concerns about the health of the river system.

Views expressed in the submissions included that refinements to Cap levels should not be limited to decreases only and that the Cap could be loosened (raised) in particular valleys. These views are consistent with the opinion often expressed throughout the Basin that "our little bit won’t hurt" and does not recognise the impact of all diversions in any part of the Basin on the health of the river system throughout the Basin. The Commission feels there is a need to develop an understanding of the impact of the diversion activity in any one part of the Basin on the health of the river system throughout the Basin.

The Commission concludes that:

• while the Cap does not necessarily provide for a sustainable Basin ecosystem, it has been an essential first step in achieving this outcome (Conclusion 2).

• all water users throughout the Basin need to recognise that the water they use is part of the reduced water available to the environment (Conclusion 3).

Environmental degradation worse without the Cap

A clear correlation exists between increases in diversions, our single biggest intervention in the Murray-Darling Basin, and decline in river health. Any further increases in diversion, anywhere in the Basin, will decrease the health of the river ecosystem. Increased diversions would also exacerbate the detrimental effect of introduced species, such as European carp.

Based on the evidence collated by the CRC for Freshwater Ecology and the submissions made on the draft Overview Report, the Commission has concluded:

• that without the Cap there would have been a significantly increased risk that the environmental degradation of the river system of the Murray-Darling Basin would have been worse (Conclusion 4).

Time lags in environmental response

There are significant time lags in the Australian environment between human intervention and the manifestation of the impacts of this intervention. Decades, or even centuries, are often required for the environmental effects of our activities to become apparent. Accordingly, the level of degradation apparent in the Basin in the early 1990s, which was sufficient for the Ministerial Council to commission the Water Audit and for it to respond with the Cap, was the result of past exploitation which occurred over many years, when diversions were considerably lower.

Recognising this, the Commission realises that the consequence of the current levels of diversions under the Cap may not be known for several decades. As such, the Commission concludes that:

• the degradation caused by the current level of diversions ("the Cap") may well become more severe than that now apparent (Conclusion 5).

Under these circumstances, the Commission recommends that:

• the precautionary approach is appropriate (Recommendation 2).

Need to maximise benefit to the environment of the environment’s share

The Cap on diversions, which limits the further growth in consumptive use in the Basin, has provided a platform for increased scrutiny of extractions from the river system of the Basin and has consequently encouraged many improvements in water use practices. An equivalent level of performance should also be expected of the water reserved for the environment. There is a clear need to maximise the benefit to the environment of the environment’s share. The development and introduction of environmental flow objectives and rules is an example of increased attention being paid to this issue.

Further, improved management of the environment’s share more generally, including
accounting for environmental water, and savings and losses of this water is also required. Improvements in the data available to assess the impact of diversions on the ecological health of the Basin’s river system will also complement this objective.

The Commission recommends that:

- the benefit to the environmental stemming from the water available to it should be maximised (Recommendation 3).

**Exposure of environment’s share to reduced catchment yield**

The Cap as currently defined focuses on consumptive uses and prohibits the absolute quantum of this share increasing over time. This in turn protects the share of available resource for the environment in so far as the size of the total available resource can be considered constant. If catchment yield were to be significantly reduced by climate change or land use change, the reductions would be largely at the expense of the environment’s share (see CRC for Freshwater Ecology, Section 6.7). Under the Implementation and Compliance component, the IAG has made some recommendations in regard to land use changes such that the integrity of the Cap is protected. Climate change cannot be similarly controlled. Consequently, the catchment scale is seen as the necessary spatial resolution to effectively manage our natural resource systems.

The Commission concludes that:

- the catchment scale is the necessary spatial resolution to effectively manage our natural resource systems (Conclusion 6).

**Cap should be refined based upon increased understanding**

While many submissions in the first phase of the Review criticised the level of science behind the introduction of the Cap, to do nothing was not possible in the face of the evident degradation of the Basin. Notwithstanding the fact that the Ministerial Council acted positively through the introduction of the Cap, the refinement of the Cap, specifically the level at which it is set, should be considered as our knowledge base improves.

The knowledge base available to natural resource managers has improved markedly since the introduction of the Cap and it will continue to improve over the coming years.

The Commission recommends that:

- a high priority be given to further improving the knowledge base available to natural resource managers, especially our understanding of the ecology of the Basin (Recommendation 4); and

- as better information informs our management of the Basin’s resources, the level at which the Cap is set should continue to be refined to reflect our increased understanding (Recommendation 5).

It is likely that such refinements may lead to the lowering of the level of the Cap in some valleys. Indeed, some jurisdictions have already increased the environment’s share, via access restrictions in addition to that required by the Cap, as part of their longer-term direction of improved water management.

**Recommendation of a regular Sustainable Rivers Audit**

Many submissions to the Review discussed the need for an assessment of the contribution of the Cap on diversions to the health of the Basin’s rivers. This is consistent with the needs to maximise the benefit to the environment of the environment’s share and incorporating an improved understanding of the ecology of the Basin in Cap management.

A regular environmental audit of the Basin’s rivers, a Sustainable Rivers Audit, would serve to inform the debate on the effectiveness of the Cap on an ongoing basis. This is consistent with the view of the IAG who believe that, with the implementation of the Cap nearing completion in most jurisdictions, there is now the opportunity to take the next step and to consider the environmental outcomes of the Cap from a whole of Basin perspective (see further discussion in Section 7).

To monitor the environmental health of the Basin’s rivers and to inform the community of the location and extent of degradation, the Commission supports a regular Sustainable Rivers Audit. This audit would cast the Cap as an input to Basin health rather than an outcome in itself and would bring into focus the effect of past and recent levels of diversion on the health of the Basin.

The Commission recommends that:

- a Sustainable Rivers Audit, casting the Cap as an input to Basin health rather than an outcome in itself, be developed and implemented (Recommendation 6).
2.4 Component Summary

The Commission has concluded that the Cap has been an essential first step in providing for the environmental sustainability of the river system of the Basin. Without the Cap, there would have been a significantly increased risk that the environmental degradation of the river system of the Murray-Darling Basin would have been worse. While there are aspects of the operation of the Cap where potential for improvement has been identified, the Cap has had a positive impact and should be maintained.

However, the Commission recognises that there is no certainty that the Cap on diversions at its current level represents a sustainable level of diversions – the level at which it is set being that which existed at the time when it was decided to introduce a Cap.

Further, the Commission recommends that as better information informs our management of the Basin’s resources, the level at which the Cap is set should continue to be refined to reflect our increased understanding. It is likely that such refinements may lead to the lowering of the level of the Cap in some valleys. Indeed, some jurisdictions have already increased the environment’s share, via access restrictions in addition to that required by the Cap, as part of their longer-term direction of improved water management.

The Commission also supports a regular Sustainable Rivers Audit of the Basin where the Cap would be cast as an input to Basin health rather than an outcome in itself.

Review of the Operation of the Cap — Ecological Sustainability of Rivers

The Commission concludes that:

- the Cap has supported the Murray-Darling Basin Ministerial Council’s aim of achieving the ecological sustainability of the Basin’s river systems (Conclusion 1);
- while the Cap does not necessarily provide for a sustainable Basin ecosystem, it has been an essential first step in achieving this outcome (Conclusion 2);
- all water users throughout the Basin need to recognise that the water they use is part of the reduced water available to the environment (Conclusion 3);
- that without the Cap there would have been a significantly increased risk that the environmental degradation of the river system of the Murray-Darling Basin would have been worse (Conclusion 4);
- the degradation caused by the current level of diversions (“the Cap”) may well become more severe than that now apparent (Conclusion 5); and
- the catchment scale is the necessary spatial resolution to effectively manage our natural resource systems (Conclusion 6).

The Commission recommends that:

- the Cap should be maintained (Recommendation 1);
- the precautionary approach is appropriate (Recommendation 2);
- the benefit to the environmental stemming from the water available to it should be maximised (Recommendation 3);
- a high priority be given to further improving the knowledge base available to natural resource managers, especially our understanding of the ecology of the Basin (Recommendation 4);
- as better information informs our management of the Basin’s resources, the level at which the Cap is set should continue to be refined to reflect our increased understanding (Recommendation 5); and
- a Sustainable Rivers Audit, casting the Cap as an input to Basin health rather than an outcome in itself, be developed and implemented (Recommendation 6).
3. Economic and Social Impacts

3.1 Introduction

The Cap is one of the many influences on the economy and social structure of the community of the Basin. This component of the Review analyses the contribution of the Cap, both positive and negative, to the economic performance of communities across the Basin and the related social impacts.

Marsden Jacob Associates were engaged to complete a piece of work designed specifically to inform this component of the Review. The full report of the Marsden Jacob Associates (March 2000) is the second of the Companion Papers to this document.

Informed by the work of Marsden Jacob Associates and the submissions made to the Review on the draft Overview Report of the Cap Project Board, the Commission provides several conclusions and makes a number of recommendations in regard to this component of the Review of the Operation of the Cap.

3.2 Summary of Submissions on Draft Overview Report

From the submissions received in July 2000 on this component of the draft Overview Report, the consensus view was that the Cap has laid the foundation for economic and social benefits that will be realised over the longer term. The respondents to the Review were generally supportive of the Cap, though some were of the opinion that the benefits arising from the implementation of the Cap had been overstated others expressed concerns in reference to specific claims made regarding the benefits that have been delivered.

The finding that the Cap has provided security on a valley by valley basis was very strongly supported throughout the submissions, though the distinction between valley security and individual security was emphasised. Points raised included:

- the Cap has accelerated the activation of sleeper and dozer licences, thereby eroding individual security (see Section 4.5);
- increased use upstream is eroding the security of downstream users; and;
- there is no security of supply without well-defined property rights.

The proposition that compelling evidence existed in regard to the benefits delivered by the Cap was contested, with several submissions citing a lack of evidence to support the claim. Some submissions claimed evidence existed in contradiction of this statement, others that the benefits are not Basin wide and that there had been negative local impacts. A number of submissions suggested that the Cap has laid the foundation for economic and social benefits that will be realised over the longer term.

The assertion that the Cap had restrained growth, while allowing for economic development was generally supported by the submissions, though it was widely questioned whether this restraint had occurred in an "orderly fashion". A range of opinions were presented in relation to whether a more certain climate for long term investment had been achieved. Arguments against the proposition were given both from the perspective of a perceived decrease in the individuals' security of supply, and under the assumption that current diversion levels are too high to be sustained. The respondents generally agreed a move was being made to high-value agriculture, though some questioned whether this was actually a desirable outcome for the community.

The methodology employed in the Marsden Jacob report was questioned by a number of respondents, citing a lack of evidence provided in support of some of the conclusions presented.

While some questioned the overall benefit to the community of water trading and change of resource use, respondents generally concurred that the Cap had both provided an environment conducive to water trade, and facilitated the movement of resources to high value agriculture.

3.3 The Economic and Social Impacts of the Cap

3.3.1 General

The Murray-Darling Basin Commission believes that the implementation of the Cap has had a positive impact on the economic and social health of the Basin community. However the Commission recognises certain negative local impacts due to the introduction of the Cap as identified in some of the submissions to the Review, but is of the opinion that, in time, all communities throughout the Basin will reap the benefits of Cap implementation.
The economic and social impacts of the Cap are discussed throughout the Marsden Jacob Associates report with Chapter 6 of that report presenting a summary and overview of the arguments presented.

Without the Cap, responses to water resource constraints brought about by continued development would have been arbitrary and lacking in cohesion. This would have resulted in greater economic impact among irrigation communities through reduced resource security and greater adjustment pressures. Also, there would probably have been heightened social tensions between irrigator groups, between river valleys and between urban and rural Australians.

With this in mind, the Commission considers that the Cap has provided a mechanism for restraining growth in diversions while enabling economic development to proceed. In doing so it has documented some of the more serious economic and social effects of severe resource constraint which would have eventuated with continuing increases in diversions along with a severe decline in river health.

The combination of the Cap with water trading arrangements has ensured that placing a limit on consumptive use in the Basin has not stifled development. Indeed, this combination has been favourable to the development of enterprises where water is put to its highest value use. As a result, the water extracted from the Basin’s river system is increasingly providing an enhanced economic benefit to the Basin.

Notwithstanding these findings, the Commission is aware that the Cap, and the modified water management practices it has been instrumental in driving, have had differential impacts across the Basin community.

Lower allocations due to resource availability will impact greatest on those enterprises that are most reliant on high allocations, including the historic ability to utilise the unused allocations of other entitlement holders. However, the costs would have been even higher to existing irrigators if the Cap hadn’t been introduced and the resource became fully developed, reducing security of supply further.

Although there may be short term costs to specific locations through the introduction of the Cap, the benefits of guaranteed security represents a major net benefit to the Basin in the longer-term.

The Commission concludes that:

- that the overall benefit of the Cap, especially from ensuring security of supply at a valley level and providing an environment within which water trading and related reforms could be developed, has been a positive one and that the net benefit will increase over time (Conclusion 7).

### 3.3.2 Benefits and costs to the agricultural economy

The Cap has guaranteed security of supply at the valley level

The results of research conducted for the Review make it clear that, in the absence of the Cap, the erosion of security of supply for irrigators and other users would have been significant. These analyses were performed on several systems across the Basin reflecting diverse agricultural practices and climatic conditions.

Against this background, one benefit of the Cap is the guaranteeing of security of water supply at the valley level. Without the Cap, there would have been continued development and activation of water entitlements that had not been fully used (so called “sleepers” and “dozers”) without a method of overall control. Through guaranteeing security, at the valley level, the Commission views the Cap as having provided a more certain climate for long-term investment and development, particularly in high value agriculture and value adding processing, as well as providing benefits to the environment.

The Commission concludes that:

- the Cap has provided a more certain climate for long-term investment and development (Conclusion 8).

As noted above, the benefits of providing long-term security are potentially offset by the costs associated with the reduced development opportunities as a result of the introduction of the Cap. However, based upon the analysis of Marsden Jacob Associates (see Chapter 6 – Companion Paper 2) the Commission believes that these costs would have been minimal so far.

### Reduced exposure to climatic extremes

Without the Cap, the growth in diversions towards full development of the resource would increase the sensitivity of irrigated agriculture to...
extreme climatic events. Consequently there would be a heightened impact of drought conditions on cash flow and greater recourse to debt financing of commitments. The Cap is therefore an important tool for maintaining the viability of irrigated agriculture in the Basin and preventing irrigators from having to leave the land due to financial ruin. The Commission views this as a further benefit of the Cap.

The Commission concludes that:
• the Cap has reduced the sensitivity of irrigated agriculture to extreme climatic events (Conclusion 9).

Improved codification of property rights and entitlements over water

The introduction of the Cap provided the stimulus for codifying and improving property rights and entitlements to water. By placing a finite limit on diversions across the Basin, a stronger property right is established by providing known and guaranteed security. The Commission also views the Cap as having stimulated the streamlining of property rights to facilitate water trading.

The Commission concludes that:
• the Cap has stimulated the streamlining of property rights to facilitate water trading (Conclusion 10).

Acceleration of water trade

The Commission concludes that the Cap has provided the impetus to facilitate trade. This has led to the fostering of better trading rules, third party protection and easier movement of water to high value activities. It has also provided entitlement holders with a tradeable asset. The Commission acknowledges the view expressed in some submissions that the transfer of water to maximise economic benefit may have an associated social cost, but notes that increased mobility of the resource was generally supported by stakeholders. By allowing water to move to higher value uses through water trade, the economic cost of compliance with the Cap and environmental flow rules is substantially reduced. Although trade would have occurred in the absence of the Cap, the Cap has accelerated trade and increased the associated benefits such as improved confidence amongst traders to invest to achieve good economic outcomes.

The Commission concludes that:
• the Cap has accelerated water trade and increased the associated benefits such as improved confidence amongst traders to invest to achieve good economic outcomes (Conclusion 11).

Tension between irrigator groups circumvented

Without the Cap, the water resource would have continued to be developed, reducing resource security. This would undoubtedly have led to increased tensions between irrigator groups and between regions and water trading would have become more aggressive. There would have been a disordered scramble and lack of process. The Commission views as a benefit of the Cap that it has allowed the valleys and States in the Basin to avoid these disputes.

The Commission concludes that:
• the Cap has, through protecting security of supply, circumvented tensions between irrigator groups (Conclusion 12).

Increased tension between urban and rural Australia circumvented

Without the Cap on diversions from the Basin’s river systems, continued development would lead to consequential reductions in river flows and accelerate the degradation of the riverine environment. The metropolitan electorate would become increasingly impatient with the irrigation community and the unwillingness of governments to halt the degradation. Some submissions expressed scepticism regarding the influence of the Cap in alleviating community tensions, however the Commission contends that it has when compared to a no Cap scenario and therefore views the Cap as having benefited the social cohesion of Australia by preventing a further increase in the perceived division between urban and rural Australians.

The Commission concludes that:
• the Cap, through preventing the accelerated degradation of the riverine environment, has benefited the social cohesion of Australia by preventing a further increase in the perceived division between urban and rural Australians (Conclusion 13).

Social impacts of the Cap

The Commission recognises the difficulties facing rural and regional Australia, and specifically the
Murray-Darling Basin. These difficulties have been produced by a complex set of factors. For instance, over the five years since the implementation of the Cap, farming communities in the Basin have had to respond to a wide range of external pressures and risks (see Marsden Jacob Associates, Section 5.6 – Companion Paper 2). These include:

- shifts in international commodity prices and declining producer terms of trade;
- demographic shifts in population from rural communities to major regional centres;
- a reduction in the number and an increase in the size of farms;
- wider pressures for increased productivity; and
- wide ranging water reforms.

This complex environment has led to many social problems, such as relationship difficulties, stress-related illnesses, declining rural services and increases in crime rates which were variously identified by some submissions to the Review in November 1999. In the context of this complex environment, further compounded by Australia’s climatic variability, the Commission considers that it is difficult to attribute such specific social impacts to the Cap.

In fact, in light of the positive net economic benefits of the Cap identified in the work of Marsden Jacob Associates, and submissions to the draft Overview Report the Commission concludes the Cap is likely to have produced generally positive social outcomes through the flow-on effect of these economic benefits, and these positive effects will increase over the longer term.

The Commission concludes that:

- the Cap has produced generally positive social outcomes through the flow-on effect of its economic benefits, and these positive effects will increase over the longer term (Conclusion 14).

The Commission recognises an upcoming opportunity to improve our understanding of the social impacts of the Cap. The current socio-demographic profile data of the Basin extends only up to 1996 and therefore does not capture many of the more recent impacts of the Cap. The 2001 Census will provide new socio-demographic data on the Basin. At this time, partner Governments should be encouraged to assemble other socio-demographic data to build upon the information available through the Census.

The Commission recommends that:

- partner Governments consider the opportunity provided by the 2001 Census to supplement the socio-demographic data it will provide with further information to improve our understanding of the social impacts of the Cap (Recommendation 7).

**Misperceptions concerning the "No Cap" case**

A misperception identified in the process of the Review was that a number of submissions judged the Cap’s impacts by comparing the situation since the Cap’s introduction with the circumstances that existed pre-Cap in the early 1990’s prior to significant resource constraints (see Marsden Jacob Associates, Section 6.3). The Commission notes that the appropriate scenario for assessing the Cap’s impact is with the circumstances that would exist today had the Cap not been introduced, involving continued resource development, resource scarcity and reduced security.

In response to these misperceptions, the Commission fully supports the need to better inform and engage stakeholders on major policy initiatives such as the Cap. This will require an extensive communication strategy. Issues that should be targeted for better communication include:

- an appreciation that the impacts of the Cap should be compared with what the circumstances would have been like today had the Cap not been introduced, rather than the situation in the early 1990’s prior to the Cap’s introduction;
- the separation of the impacts of resource scarcity from the impacts of the Cap, including the activation of sleeper and dozer licences; and
- the major direct benefit to irrigated agriculture that the Cap provides through guaranteeing resource security.

The Commission recommends that:

- partner Governments strive to better inform and engage stakeholders on major policy initiatives such as the Cap through improved communication (Recommendation 8).
In addition to informing stakeholders outside the partner Governments to the Agreement, the Commission is in complete support of the recommendation that information sharing between the partner Governments should be encouraged across the Basin. This will serve to inform resource managers within the Basin to ensure their decisions and actions produce the best possible economic and social outcomes.

Further, another misperception reflected in some submissions is that the actions of individuals are not fully appreciated as having a Basin-wide impact. This has led some groups to support the Cap generally but seek special consideration to increase their own level of diversions.

3.3.3 Benefits and costs to the non-agricultural economy

Economic benefits to non-agricultural enterprises

The River Murray in South Australia provides a major source of drinking water for Adelaide. The protection provided by the Cap to Adelaide’s water supply, especially the deferral of the date at which it would have become necessary to treat this water for salinity under a “No Cap” scenario, clearly has significant economic benefits.

Through the Cap’s protection of the natural capital stock from accelerated decline, the Commission notes that this has, in turn, generated direct economic benefits to non-agricultural enterprises such as tourism, recreation and real estate amenity.

The Commission concludes that:

- the Cap, through protection of the natural capital stock from accelerated decline, has generated direct economic benefits to non-agricultural enterprises such as tourism, recreation and real estate amenity (Conclusion 15).

The intrinsic value of the riverine environment

The riverine environment has an intrinsic ‘existence’ value to most Australians. Although the costs of a high level of river degradation are intangible, the Commission believes that the Cap has slowed this degradation and the loss of capital value is therefore reduced.

3.4 Component Summary

The Commission considers that the overall benefit of the Cap, especially from ensuring security of supply at a valley level and providing an environment within which water trading and related reforms could be developed, has been a positive one and that the net benefit will increase over time.

The results of research conducted for the Review make it clear that, in the absence of the Cap, the erosion of security of supply for irrigators and other users would have been significant. These analyses were performed on several systems across the Basin reflecting diverse agricultural practices and climatic conditions.

Against this background, one benefit of the Cap is the guaranteeing of security of water supply at the valley level. Without the Cap, there would have been continued development and activation of water entitlements that had not been fully used (so called “sleepers” and “dozers”) without a method of overall control. Through guaranteeing security, the Commission views the Cap as having provided a more certain climate for long-term investment and development, particularly in high value agriculture and value adding processing, as well as providing benefits to the environment.

The Commission considers that the Cap has provided a mechanism for restraining growth in diversions while enabling economic development to proceed. The Cap has enabled better definition of property rights governing water availability and provided an incentive for the States to establish market arrangements for trading in water entitlements (which has and will continue to encourage water to go to its highest value use). The Cap has also helped provide a focus for community discussions on resource sustainability which have helped to alleviate tensions over resource distribution and environmental degradation between irrigator groups and between urban and rural Australians.

The Commission recognises that this strong positive conclusion will not be the perception of every stakeholder in the Basin. However, the Commission concludes that the overall benefit of the Cap, especially from ensuring security of supply at a valley level and providing an environment within which water trading and related reforms could be developed, has been a positive one.
Review of the Operation of the Cap — Economic and Social Impacts

The Commission concludes that:

- that the overall benefit of the Cap, especially from ensuring security of supply at a valley level and providing an environment within which water trading and related reforms could be developed, has been a positive one and that the net benefit will increase over time (Conclusion 7);
- the Cap has provided a more certain climate for long-term investment and development (Conclusion 8);
- the Cap has reduced the sensitivity of irrigated agriculture to extreme climatic events (Conclusion 9);
- the Cap has stimulated the streamlining of property rights to facilitate water trading (Conclusion 10);
- the Cap has accelerated water trade and increased the associated benefits such as improved confidence amongst traders to invest to achieve good economic outcomes (Conclusion 11);
- the Cap has, through protecting security of supply, circumvented tensions between irrigator groups (Conclusion 12);
- the Cap, through preventing the accelerated degradation of the riverine environment, has benefited the social cohesion of Australia by preventing a further increase in the perceived division between urban and rural Australians (Conclusion 13);
- the Cap has produced generally positive social outcomes through the flow-on effect of its economic benefits, and these positive effects will increase over the longer term (Conclusion 14); and
- the Cap, through protection of the natural capital stock from accelerated decline, has generated direct economic benefits to non-agricultural enterprises such as tourism, recreation and real estate amenity (Conclusion 15).

The Commission recommends that:

- partner Governments consider the opportunity provided by the 2001 Census to supplement the socio-demographic data it will provide with further information to improve our understanding of the social impacts of the Cap (Recommendation 7); and
- partner Governments strive to better inform and engage stakeholders on major policy initiatives such as the Cap through improved communication (Recommendation 8).
4.1 Introduction

The resolution of equity issues has been an important feature of the implementation of the Cap since its inception. In their 1996 report “Setting the Cap”, the IAG developed a set of guidelines against which individual issues and matters of equity and consistency can be judged. The IAG identified six principles or “tests” against which to assess equity and consistency issues. The six principles are:

1. no further change be made to flow regimes that would contribute to deterioration of water quality and environment protection (instream, floodplain or estuarine);
2. water allocations be made with extreme sensitivity to the effects on the environment (Precautionary Principle);
3. water is allocated to the highest value use (allocative efficiency);
4. statutory and agreed property rights be recognised;
5. water management processes be transparent and auditable; and
6. a system of administration be implemented which is easily understood and which minimises time and costs (administrative efficiency).

It is recognised that there is a degree of tension between some of the principles as outlined above. In their annual audits of Cap implementation the IAG has frequently referred to these principles, which were endorsed by the Ministerial Council, to guide their deliberations on matters of equity.

Recognising the extended involvement of the IAG in equity issues arising from the implementation of the Cap, the IAG was engaged to identify any outstanding equity issues that have arisen from the implementation of the Cap that may put at risk its future management.


The Commission welcomes the contribution of the IAG to this ongoing discussion about equity issues. Building upon this report the Commission has made several recommendations in regard to the findings of the IAG. The Commission is concerned that the future management of, and community confidence in, the Cap is put at risk by:

• pre-existing equity issues that remain unresolved (Section 4.3);
• newly identified equity issues that require resolution (Section 4.4); and
• an incorrect perception about the ability to resolve certain equity issues through Commission processes that are, in fact, the responsibility of the individual jurisdictions (Section 4.5).

4.2 Summary of Submissions on Draft Overview Report

From the submissions received in July 2000 on this component of the draft Overview Report it was evident that the Review had clearly identified, and brought to the attention of the community, the equity issues requiring resolution to strengthen and refine the operation of the Cap.

The range of views expressed reflects the importance of Cap implementation being applied equally across all jurisdictions in a fair, equitable and timely manner which includes an increase in community consultation and education both at a jurisdictional and Basin scale in the resolution of existing and new equity issues.

Pre-existing equity issues

The resolution of a Cap for Queensland and the ACT are the most significant outstanding equity issues associated with the Cap. Submissions received addressing the Queensland and ACT Caps expressed a strong desire for the Commission and relevant jurisdictions to resolve these issues as quickly as possible.

Substantial frustration, and indeed exasperation, was expressed over the lack of a Queensland Cap and the continued growth in diversions and storage volumes. The submissions indicated that they considered this to be inflammatory and highly unfair to other water users within the Basin and that if the issue remained unresolved...
support for the Cap in other jurisdictions could wane.

The determination of the Lake Mokoan allocation was not addressed in any of the submissions received, however the Pindari Dam allocation was addressed in the submission from the New South Wales Government. This submission noted that the a Cap for the NSW portion of the Border Rivers in relation to Pindari Dam had been completed and that a Cap model and supporting studies would be supplied to the IAG review of Cap implementation in late 2000.

Newly identified equity issues

Submissions addressing the newly identified equity issues stressed the importance of measuring and including all diversions within the Cap accounting arrangements. This included the measurement of diversions from floodplain and overland flows and the volume of water captured and used in on-farm dams in all jurisdictions.

Other submissions supported the implementation of an integrated catchment management approach to water management within the Basin that includes both surface water and groundwater.

A number of submissions also identified the differences in the calculation of the Cap in each jurisdiction as a substantive equity issue. These submissions expressed the opinion that the Cap is being unfairly applied across the Basin and that there has been scope for growth in diversions within some Caps. This highlights the need to have effective compliance tools and this issue is discussed in Section 5.3.

Equity issues outside the jurisdiction of the MDBC

During the first opportunity to make submissions to the Review (November 1999), a number of stakeholders raised equity issues that were outside the jurisdiction of the Murray-Darling Basin Commission and Ministerial Council processes. The vast majority of such issues related to the recognition of licensed entitlement versus history of use, specifically in New South Wales (the "sleeper/dozer" issue).

In recognition that such arrangements are the responsibility of the particular jurisdiction and in order that issues raised by stakeholders receive proper consideration, the draft Overview Report recommended that these issues be referred to the appropriate Government for consideration and reply.

Many submissions on the draft Overview Report expressed concern at this treatment of the "sleeper/dozer" issue. Several stakeholders did not consider referral of this issue back to the particular jurisdiction acceptable.

4.3 Pre-existing Equity Issues

Several pre-existing equity issues remain unresolved.

Determine Lake Mokoan (VIC) and Pindari Dam (NSW) allocations

Lake Mokoan and Pindari Dam both represent an investment in a major asset that had not been fully developed at the time of the introduction of the Cap. In 1996, the Ministerial Council agreed to consider an increase in the Cap for each development with the exact quantum to be determined through the appropriate water allocation studies. The estimated completion dates for the determination of the Cap adjustments for these developments are now:

- Lake Mokoan: June 2001; and
- Pindari Dam: late 2000 (NSW will progress the resolution of this issue with the IAG during its annual review of Cap implementation in October 2000).

The Commission recognises the revised deadlines for these analyses and stresses the need for these studies to bring these issues to a close. Resolution should improve the future operation of the Cap, lead to increased Government and community confidence in the Cap and mitigate the risk that the Cap be undermined through incomplete implementation.

The Commission recommends that:

- the Cap adjustments for Lake Mokoan (VIC) and Pindari Dam (NSW) be resolved by June 2001 and late 2000 respectively in the interest of increasing Government and community confidence in the Cap (Recommendation 9).

Finalise Cap limits in the Queensland valleys

Cap limits for the Queensland valleys have yet to be determined. Whereas other States agreed to a
Cap in 1995, Queensland agreed to undertake a process to determine the appropriate Cap arrangements for their component of the Murray-Darling Basin. The processes adopted, and their expected completions dates, for the various Queensland valleys are:

- Moonie: Water Management Plan (WMP) – September 2000;
- Paroo/Warrego/Nebine: Water Management Plan (WMP) – November 2000; and

The lack of clear resolution of Cap limits for the Queensland valleys is a significant risk to the Cap – certainly to its integrity in Queensland and also throughout the Basin. Lack of clear arrangements in Queensland potentially serves to undermine implementation efforts in other jurisdictions. The risk associated with the lack of formal Cap arrangements in Queensland was confirmed by the opinions expressed in the submissions on the draft Overview Report.

The Commission supports the attempts of the Queensland Government to finalise the development of Cap limits for the Queensland valleys. The Commission notes that the IAG has recommended prohibiting further growth in diversions while these arrangements are completed to ensure the present equity in resource distribution is maintained.

The Commission recommends that:

- the Cap arrangements for the Queensland component of the Murray-Darling Basin be resolved in the anticipated timeframes specified above (Recommendation 10).

Resolve ACT Cap (and trading with New South Wales)

The Commission welcomes the forthcoming proposal from the ACT Government on an appropriate Cap for the ACT. Concurrently, arrangements for water trading with New South Wales need to be clarified in order to provide the ACT with the necessary confidence to establish a Cap limit.

The Commission recommends that the Cap for the ACT, including the arrangements for trade with New South Wales, be resolved as a matter of high priority. Although the volume of diversion in the ACT is not as large as that in Queensland, the risk is similar in that the Cap will be undermined if a perception were to form that a particular jurisdiction is exempt.

The Commission recommends that:

- the Cap for the ACT, including the arrangements for trade with New South Wales, be resolved as a matter of high priority (Recommendation 11).

4.4 Newly Identified Equity Issues

Since the original June 1995 decision of the Murray-Darling Basin Ministerial Council to introduce a Cap on diversions, all forms of consumptive water use in the Basin have been included under the Cap. However, in the initial phase of Cap implementation the focus was on the development of Cap management arrangements, including accounting of diversions, for the major extractive uses (eg, river pumpers, gravity diversions). The work of the IAG identified several new equity issues that centre on aspects of water use in the Basin that are not formally covered under present Cap arrangements. These water uses are diversions from floodplain and overland flows and farm dam water use - both of which were included under the original Cap decision. Further the IAG identified water use by tree plantations as a form of water use worthy of future consideration for the Cap.

Potential growth in the aspects of water use identified by the IAG (diversions from floodplain and overland flows, farm dam water use and water use by tree plantations) become equity issues between existing users and new developers. Also, where such impacts cross state and territory borders (eg, the impact of developments in the NSW catchment of Hume Dam on Victorian users), these issues become inter-jurisdictional. The types of water use that the IAG have identified as giving rise to equity issues are discussed in this section. The Commission views the inclusion in Cap management arrangements of each of these types of water use, within an appropriate timeframe, as an opportunity to improve the operation of the Cap. An integrated catchment management approach is viewed as the necessary approach to facilitate the effective management of such issues.
The Commission recommends that:

• all forms of water use be incorporated in Cap management arrangements as they are recognised and can be quantified (Recommendation 12);

• an integrated catchment management approach is required to address the equity issues associated with the Cap (Recommendation 13).

Include diversions from floodplain and overland flows

This is an issue in New South Wales and Queensland. Access to overland flows is also an issue in the upper catchment regions of Victoria. The Commission supports the IAG recommendations that diversions from floodplain and overland flows be measured and included in the relevant Cap accounting arrangements and that a statutory basis for the management of this water be provided where flows are significant. The Commission notes that Queensland has recently released an exposure draft of legislation that includes, for the first time, provisions to manage such flows.

The Commission recommends that this form of water use be included in Cap accounting arrangements as a matter of priority (Recommendation 14).

Include farm dam water use

Farm dam water use has been covered by the Cap since its introduction in June 1995. The first phase of Cap implementation has focused on major extractive uses and the need to extend Cap management arrangements to include accounting for farm dam water use has been identified in the Review. Again, the issue is improved accounting of diversions, in particular any growth that may have occurred since the 1993/94 Cap reference year as appropriate, and not an expansion of the scope of the Cap.

Whilst the difficulties in determining the water used by farm dams is acknowledged, the principle inclusion of farm dam water use in Cap accounting arrangements is supported by the Commission. The Commission also recommends that all future administrative arrangements for farm dam monitoring and management be consistent with the overall goal of inclusion of this form of water use in Cap accounting arrangements. The Commission recommends that this should happen as soon as practicable with priority given to the areas where the scope for growth in this use is the largest.

The Commission recommends that:

• farm dam water use should be included in Cap accounting arrangements as soon as practicable and all future administrative arrangements should support this outcome (Recommendation 15).

Include water use by tree plantations (and ensure consistent arrangements with Salinity Management Strategy)

An emerging equity issue raised in submissions to the Review is the trend towards increased plantations. Increases in tree plantations will reduce catchment yield in a similar way to farm dams and also reduce accessions to groundwater. While the reduction in accession to groundwater could be seen as a beneficial impact in the control of dryland salinity, the reduction in river flows will have an impact on downstream users. As the Salinity Management Strategy being developed for the Murray-Darling Basin is likely to encourage large-scale reafforestation to combat salinity, the significance of this equity issue can be expected to increase over the coming years.

The Commission recommends that the extent of proposed planting across the Basin be ascertained as soon as practicable. The Commission also recommends that water use by new plantations, and other changes in land use, be investigated to determine the impacts of these changes on catchment yield. The Commission also supports the eventual inclusion of this form of water use under the Cap where it is found to be significant.

The Commission strongly supports the integration of the outcomes of the Salinity Management Strategy, including those relating to tree plantations, into Cap implementation procedures to ensure an integrated approach to the management of the Basin’s resources.
The Commission recommends that:

• water use by tree plantations eventually be considered for inclusion in the Cap where it is found to be significant (Recommendation 16).

• the outcomes of the Salinity Management Strategy be integrated into Cap implementation procedures (Recommendation 17).

4.5 Equity Issues Outside the Jurisdiction of the MDBC

The Review of the Operation of the Cap focused on equity issues arising from the implementation of the Cap between jurisdictions and between river valleys within States. A number of stakeholders raised equity issues that are outside the jurisdiction of the Murray-Darling Basin Commission and Ministerial Council processes. The vast majority of such issues related to the recognition of licensed entitlement versus history of use, specifically in New South Wales (the “sleeper/dozer” issue). Such arrangements are the responsibility of the particular jurisdiction. The draft Overview Report recommended that these issues be referred to the appropriate Government for consideration and reply.

Many submissions on the draft Overview Report expressed concern at this treatment of the “sleeper/dozer” issue. Several stakeholders did not consider referral of this issue back to the particular jurisdiction acceptable. In light of the submissions received, the Commission accepts the need for the issues raised to be addressed however it reiterates that this must be done by the individual jurisdictions given the nature of these issues.

The Commission is concerned by the potential for the negative feedback and publicity created by such intra-valley issues to have a detrimental impact on the Cap, and more broadly the Commission and the Murray-Darling Basin Initiative. Accordingly, the partner Governments are urged to give consideration to such issues as soon as possible.

The Commission also recognises the need to improve the understanding of the roles and responsibilities of the MDBC and the individual jurisdictions that are partners to the Murray-Darling Basin Agreement.

4.6 Component Summary

There are several equity issues (notably Cap arrangements for Queensland and the ACT) of longstanding duration that require urgent resolution. In addition there are several more recently identified equity issues (floodplain and overland flows and diversions, farm dams and tree plantations) also requiring attention. The effective management of these issues will necessitate an integrated catchment management approach to water management that embraces both surface and groundwater resources.

The Commission focused on equity issues arising from the implementation of the Cap between jurisdictions and between river valleys within States. In several cases, the submissions received by the Review of the Operation of the Cap raised equity issues that are about the details of implementation within valleys. These issues are outside the jurisdiction of the Murray-Darling Basin Commission and Ministerial Council processes. The vast majority of such issues related to the recognition of licensed entitlement versus history of use, specifically in New South Wales (the “sleeper/dozer” issue). The draft Overview Report recommendation that such issues be referred to the particular jurisdiction concerned was not considered satisfactory by many of the submissions received on the draft Overview Report. The Commission reiterates the finding that such issues must be dealt with by individual jurisdictions and recommends that all parties to the Murray-Darling Basin Agreement work to improve community understanding of the various roles within the Agreement.
Review of the Operation of the Cap — Equity

The Commission recommends that:

• the Cap adjustments for Lake Mokoan (VIC) and Pindari Dam (NSW) be resolved by June 2001 and late 2000 respectively in the interest of increasing Government and community confidence in the Cap (Recommendation 9);

• the Cap arrangements for the Queensland component of the Murray-Darling Basin be resolved in the anticipated timeframes specified in Section 4.3 (Recommendation 10);

• the Cap for the ACT, including the arrangements for trade with New South Wales, be resolved as a matter of high priority (Recommendation 11);

• all forms of water use be incorporated in Cap management arrangements as they are recognised and can be quantified (Recommendation 12);

• an integrated catchment management approach is required to address the equity issues associated with the Cap (Recommendation 13);

• diversions from floodplain and overland flows be included in Cap accounting arrangements as a matter of priority (Recommendation 14);

• farm dam water use should be included in Cap accounting arrangements as soon as practicable and all future administrative arrangements should support this outcome (Recommendation 15);

• water use by tree plantations eventually be considered for inclusion in the Cap where it is found to be significant (Recommendation 16);

• the outcomes of the Salinity Management Strategy be integrated into Cap implementation procedures (Recommendation 17);

• each Government give consideration to issues raised in the Review of the Operation of the Cap that are outside the jurisdiction of the MDBC (Recommendation 18); and

• the Murray-Darling Basin Commission and the individual jurisdictions work to increase community understanding of their roles and responsibilities within the Murray-Darling Basin Agreement (Recommendation 19).
5. Implementation and Compliance

5.1 Introduction

Having looked at the:

• contribution of the Cap to the ecological sustainability of the Basin’s river system;

• the economic and social impacts of the Cap; and

• issues of equity associated with the Cap,

in this component of the Review, attention is turned to implementation and compliance issues.

Managing a finite water resource is an ongoing task. In the Murray-Darling Basin, the Cap on diversions is and remains an important tool in the management of this scarce resource. In all Basin jurisdictions substantial progress has been made in the implementation of the Cap which has been the focus of much activity since its introduction in 1995.

Cap implementation is about maintaining management arrangements sufficient to ensure Cap compliance. The compliance of actual diversions with the Cap provides a singular assessment of the success of the Cap on diversions. Since 1996/97, compliance with the Cap has been assessed annually by the IAG.

The IAG was engaged in this component of the Review to:

• assess progress in implementing the Cap including impediments and constraints to full implementation; and

• address issues associated with ensuring Cap compliance covering the methodology adopted including the proposed Schedule F.

Companion Paper 4 is the complete IAG report (February 2000) on the Review of the Operation of the Cap - Implementation and Compliance. Informed by the work of the IAG and the submissions made to the Review on the draft Overview Report of the Cap Project Board, the Commission makes a number of recommendations in regard to

• Implementation (Section 5.3); and

• Compliance (Section 5.4).

The basis of cooperation throughout the Murray-Darling Basin is the Murray-Darling Basin Agreement. Within the Agreement, Schedule F – Cap on Diversions is the primary tool for defining Cap arrangements. The draft Overview Report invited comments on three changes that were under consideration to the Schedule and the outcome of this process, part of the Implementation and Compliance component of the Review, is covered in Section 6.

Section 7 introduces the Sustainable Rivers Audit as an extension to current Cap implementation arrangements.

5.2 Summary of Submissions on Draft Overview Report

The submissions received were generally supportive of the positions adopted in the draft Overview Report regarding implementation and compliance issues associated with the Cap. There was general agreement that a clear direction for the finalisation of the implementation of the Cap had been provided.

Several submissions called for the inclusion of groundwater usage in the Cap, with its exclusion referred to as the fundamental shortcoming of the Cap. Calls were made for the removal of all restrictions to water trade, though the community benefits of trade were questioned by some.

Implementation

There was strong support expressed for the recommendation that a high priority be given to the development of effective computer models to determine Cap target diversions. Some respondents expressed frustration that this task had not yet been completed. Several submissions proposed that stakeholders be given access to the models to ensure an open and transparent process. Some concerns were expressed regarding the availability and validity of some data inputs to the models.

Compliance

A widely held view throughout the submissions was the need for all States to comply with the Cap. Concerns were expressed that non-compliance in any part of the Basin has the potential to undermine the Cap process throughout the Basin. Several respondents called for penalties to be imposed for non-compliance. Compliance issues raised included the adverse effects on downstream users of increased diversions in Queensland, and the proposition that Victoria and South Australia still have “room to move” with their Cap arrangements. Several respondents called for the IAG to consult with stakeholders during their
annual review of Cap compliance. Throughout the submissions it was noted that at no stage should the action of one valley impact on another. This appeared to be a consistently held view, independent of other opinions expressed regarding the Cap.

5.3 Implementation

Substantial progress has been made toward implementation of the Cap in all jurisdictions. Further, the IAG noted that commitment to the implementation of the Cap is evident within all partner Governments to the Murray-Darling Basin Agreement.

A number of areas where progress can be expected in 2000 will represent a significant advance in the implementation of the Cap throughout the Basin. The Commission supports the developments in each of these areas. These are:

- management of groundwater on an integrated basis with surface water within the spirit of the Cap;
- completion of the compliance tools (computer simulation models used to determine Cap target diversions) throughout the Basin;
- introduction in each jurisdiction of an appropriate quality management system for the management of metering, monitoring and reporting data;
- development of less restrictive trading rules within and between valleys and jurisdictions; and
- development of a register of agreed Cap definitions.

The Commission views the first two of these developments as worthy of further comment.

Management of groundwater on an integrated basis with surface water within the spirit of the Cap

The Cap on surface water diversions has put increased pressure on groundwater resources in some areas. While in some parts of the Basin increased use of groundwater should be encouraged to lower water tables, in large parts of the Basin this increased use of groundwater may lead to a depletion of this resource. Increased groundwater use also leads to reduced surface water availability by reducing baseflow and increasing losses from river channels.

Submissions addressing this area reflected a need for improved understanding and recognition of interaction between ground and surface water throughout the Basin. Many States are adopting similar sustainable yield approaches to groundwater management, and jurisdictions wish to retain associated resource management responsibilities. The Cap is not seen as the best or only means to integrate groundwater management and support for integrated water management through the Cap per se is mixed. A Basin approach to groundwater management that operated alongside the Cap could potentially manage variation in groundwater resource trends, and would be useful if it did not undermine jurisdictional responsibilities.

The draft Overview Report recommended the management of groundwater on an integrated basis with surface water within the spirit of the Cap. Commission and State technical expertise (represented through the Groundwater Technical Reference Group) supports the more integrated management of ground and surface waters throughout the Basin as part of the ongoing activity in each of the jurisdictions. The Commission supports a review of groundwater management throughout the Murray-Darling Basin including an investigation to identify how groundwater management practices may impact upon the integrity of the Cap in the future. The Groundwater Technical Reference Group of the Murray-Darling Basin Commission would be an appropriate forum to guide this review.

The Commission recommends that:

- groundwater be managed on an integrated basis with surface water within the spirit of the Cap (Recommendation 20); and
- a Murray-Darling Basin Groundwater Management Strategy be developed by the Groundwater Technical Reference Group that (Recommendation 21):
  - is based on jurisdictional management of groundwater through sustainable yields; and
  - includes investigations clarifying how groundwater management practices may impact upon the integrity of the Cap in the future.

Effective compliance tools

Effective tools for determining Cap compliance (computer simulation models) have not yet been developed for all valleys. The division of the
Basin into "Designated River Valleys" for Cap compliance under Schedule F along with the Cap for the ACT (still under development) suggests a total of 22 compliance tools are required throughout the Basin. There are no models finalised, and only four at a draft stage (August 2000), for the determination of the Cap in the Murray-Darling Basin. The Commission recommends that a high priority be given to the finalisation of these models.

The Commission recommends that:

- a high priority be given to the finalisation of the compliance tools (computer simulation models) to determine Cap compliance (Recommendation 22).

5.4 Compliance at a Jurisdictional Level

The compliance of actual diversions with the Cap provides a singular assessment of the success of the Cap on diversions. The Review has found that Victoria and South Australia have complied with the Cap, while Queensland and ACT are yet to complete the establishment of their respective Caps. Nevertheless, it is apparent that in Queensland there has been significant growth in storage which will impact on the water available for alternative consumptive and environmental uses. In New South Wales, the Cap has been breached in the Barwon-Darling system, with other valleys being within Cap limits.

The findings of the IAG can be summarised as follows (see IAG Implementation and Compliance, Section 5.1):

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>New South Wales</td>
<td>Barwon-Darling in breach of the Cap.</td>
</tr>
<tr>
<td>Victoria</td>
<td>General compliance</td>
</tr>
<tr>
<td>South Australia</td>
<td>General compliance</td>
</tr>
<tr>
<td>Queensland</td>
<td>Cap arrangements not finalised. Substantial growth in storages and by implication diversions.</td>
</tr>
<tr>
<td>ACT</td>
<td>General compliance (consumption to date is likely to be below any Cap agreed upon).</td>
</tr>
</tbody>
</table>

The Commission reiterates the importance of achieving Cap compliance throughout the Murray-Darling Basin. Progress expected in 2000 will see further development of credible, explainable and repeatable methodologies to achieve Cap compliance. The Commission supports the efforts of the partner Governments to ensure Cap compliance in their jurisdictions.

5.5 Component Summary

The Commission recognises that the management of a scarce water resource is an ongoing task. In the Murray-Darling Basin, the Cap on diversions is a central feature of this management.

The work of the IAG on the ongoing implementation of the Cap and compliance of actual diversions with Cap target diversions has provided a clear direction for the finalisation of the implementation phase of the Cap. The Commission generally supports the IAG recommendations.

The Commission supports the recommendation that groundwater be managed on an integrated basis with surface water within the spirit of the Cap and recommends further work towards this goal.

Significantly, effective compliance tools (computer simulation models used to determine Cap target diversions) have not yet been developed and the Commission recommends that a high priority be given to the finalisation of these models.

The Review has found that Victoria and South Australia have complied with the Cap, while Queensland and ACT are yet to complete the establishment of their respective Caps. Nevertheless, it is apparent that in Queensland there has been significant growth in storage which will impact on the water available for alternative consumptive and environmental uses. In New South Wales, the Cap has been breached in the Barwon-Darling system, with other valleys being within Cap limits.

The Commission supports the improved implementation of the Cap in the areas identified under the Review and reiterates the importance of compliance of actual diversions with Cap targets.
Review of the Operation of the Cap — Implementation and Compliance

The Commission recommends that:

- groundwater be managed on an integrated basis with surface water within the spirit of the Cap (Recommendation 20);
- a Murray-Darling Basin Groundwater Management Strategy be developed by the Groundwater Technical Reference Group that is based on jurisdictional management of groundwater through sustainable yields and includes investigations clarifying how groundwater management practices may impact upon the integrity of the Cap in the future (Recommendation 21);
- a high priority be given to the finalisation of the compliance tools (computer simulation models) to determine Cap compliance (Recommendation 22).
6.1 Introduction

The basis of cooperation throughout the Murray-Darling Basin is the Murray-Darling Basin Agreement. Within the Agreement, Schedule F – Cap on Diversions is the primary tool for defining Cap arrangements especially those concerned with assessing compliance and its consequences. The biggest single risk to the Cap is that Schedule F is undermined or that it is defined in such a way that it does not promote sensible water management. A fair, reasonable and workable Schedule F that is acceptable to all Governments is a fundamental requirement for a successful Cap.

With the intent of improving the operation of the Cap through the development of fair and meaningful compliance arrangements, the following modifications to Schedule F were recommended by the IAG in its work on the Implementation and Compliance component of the Review:

• removal of references to end-of-valley flows as a method for Cap compliance (also remove from Cap definition);
• arrangements for remedial actions in the case of Cap exceedance that should be acceptable to all jurisdictions (“to ensure that cumulative diversions are brought back into balance with the cap” - see recommendation (xiii) of the IAG and further discussion in Companion Paper 4); and
• re-setting the commencement date for accounting for diversions under the Cap to start with the 2000/01 water year (by when the majority of computer simulation models were expected to be complete).

Four of the partner Governments (NSW, VIC, SA & QLD), the Community Advisory Committee (CAC) and 65 stakeholders made submissions in July 2000 on the draft Overview Report of the Review of the Operation of the Cap. The four partner Governments, the CAC and 31 of the 65 stakeholder submissions specifically addressed the issues associated with Schedule F.

The Murray-Darling Basin Commission held its 55th meeting on 18 July 2000 in Goondiwindi, Queensland. At this meeting the Commission discussed the revision of Schedule F in light of the submissions received on the draft Overview Report on the Review of the Operation of the Cap. The submissions on the draft Overview Report that addressed the proposed revisions to Schedule F were summarised for this meeting to assist the Commission in its deliberation on this issue.

Taking into account the outcomes of the public consultation process and the positions stated by the partner Governments, this section of the report details the outcome in regard to the three suggested modifications to Schedule F.

A revised Schedule F (see Appendix E) incorporating the outcome of the Review of the Operation of the Cap was considered at the meeting of the Murray-Darling Basin Ministerial Council on 25 August 2000 in Mildura, Victoria.

The Commission recommends that:

• the revised version of Schedule F be adopted by the Ministerial Council as a permanent part of the Murray-Darling Basin Agreement incorporating the changes made to the Schedule through the Review of the Operation of the Cap (Recommendation 23);

6.2 Removal of references to end-of-valley flows

The 1999 version of the draft Schedule F made provision for a Cap to “be expressed in terms of a flow regime to be maintained at the end of a designated river valley”. This provision was included at the request of the Queensland Government although, in principle, it could have been applied more widely throughout the Basin. The reasons behind the IAG’s recommendation to remove references to end-of-valley flows were:

• an end-of-valley flow and the diversion from a valley are two different measures of the consumptive use in that valley (ie, the end-of-valley flow depends upon the diversion);
• the accuracy of measuring and modelling of diversions will always be much greater than the accuracy of measuring and modelling of river flows which is made difficult by the variability of river losses; and
• end-of-valley flow targets do not protect the security of supply in a valley from reduced inflows from either unregulated parts of the valley or upstream valleys.

Comments were invited on the proposal to remove references to end-of-valley flows in Schedule F as part of the public consultation period on the draft Overview Report.
The proposal received strong support from the CAC and the partner Governments with the exception of Queensland who advised that it would not agree to the removal of references to end-of-valley flows, at the very least until the completion of the Water Resource Planning Process in that State. Of the twenty four (24) Basin stakeholders who addressed this issue in their submissions, 71% were in support of the proposal and 29% were against.

The Commission discussion of the range of views expressed in the submissions explored a number of options for the resolution of this issue. The Commission therefore agreed to retain references to end-of-valley flows as an optional interim measure for Queensland alone and only until December 2002. Thus the Commission has placed a sunset provision on the use of end-of-valley flows for the purpose of assessing Cap compliance.

In line with this outcome, the Commission expectation is that Queensland will ensure compliance of diversions under the Cap on the same principles as other States from December 2002 onwards.

6.3 Remedial actions in case of Cap exceedance

Much of the debate associated with the draft Schedule F has centred on the outcomes and consequences of non-compliance with the Cap. The recommendation of the IAG in its February 2000 report was that States be required “to ensure that cumulative diversions are brought back into balance with the cap” (see recommendation (xiii) of the IAG and further discussion in Companion Paper 4). The IAG believed this wording should have been acceptable to all Governments.

Again, comments were invited on this proposal for remedial action in case of Cap exceedance (“to ensure that cumulative diversions are brought back into balance with the cap”) as part of the public consultation period on the draft Overview Report.

The proposed modification received the support of the CAC however a range of opinions were expressed by the partner Governments. Of the twenty nine (29) Basin stakeholders who addressed this issue in their submissions, 79% were in support of the proposal and 21% were against.

The assessment of the submissions made in regard to remedial actions in case of Cap exceedance identified the need to explicitly address the interpretation of the words “cumulative diversions are brought back into balance with the cap”.

The Commission agreed on the revised arrangements for remedial actions in the case of Cap exceedance proposed by the Independent Audit Group under the Review of the Operation of the Cap (“to ensure that cumulative diversions are brought back into balance with the Cap” – Clause 17). This means cumulative diversions must be less than or equal to the cumulative cap target from the commencement date of the Register described in Clause 11(7). This was considered the most effective solution from an economic, equity and, to some extent, ecological perspective.

As described in Section 6.2, cumulative end-of-valley flows remain an optional interim measure for Queensland compliance with the Cap until December 2002 after which time compliance with the Cap in Queensland will be on the same principles as other States.

6.4 Commencement date for accounting for diversions under the Cap

The commencement date for accounting for diversions under the Cap (an ongoing record of actual diversions and Cap target diversions) has been an issue associated with Schedule F. The IAG recommended in its February 2000 report that the account for diversions under Schedule F commence with the 2000/01 water year.

Again, comments were invited on this proposal as part of the public consultation period on the draft Overview Report.

Of the partner Governments, New South Wales and Victoria did not support the proposal with South Australia providing conditional support. Queensland did not support the proposal stating that the timeframe suggested was incompatible with progress being made with water resource planning in that State. The CAC supported the proposal with the condition that there be no further modifications to the starting date. Of the twenty one (21) Basin stakeholders who addressed this issue in their submissions, 38% were in support of the proposal and 62% were against.
With the benefit of the submissions provided on the draft Overview Report, the Commission considers that while, in principle, a simultaneous starting date across all jurisdictions and retention of the original announced starting date is desirable, this is not practical in all jurisdictions.

Accordingly, the Commission agreed that an effective solution is:

- the retention of the original (1997/98) starting date for New South Wales, Victoria and South Australia;
- the adoption of the original (1997/98) starting date for the Australian Capital Territory once a Cap has been determined for the ACT given:
  - ACT diversions since this date are likely to be below the level of any Cap agreed upon; and
  - this jurisdiction is part of the greater Murrumbidgee valley where 1997/98 has been adopted as the starting date; and
- that Cap accounting for Queensland commence upon the finalisation of Cap arrangements in that jurisdiction.

### 6.5 Summary

The most important challenge in Cap implementation is to finalise the arrangements under “Schedule F – Cap on Diversions” to the Murray-Darling Basin Agreement. This schedule is the primary tool for defining Cap arrangements especially those concerned with assessing compliance and its consequences. With the intent of improving the operation of the Cap through the development of fair and meaningful compliance arrangements, three modifications to Schedule F were canvassed in the draft Overview Report on the Review.

The outcome of the Review of the Operation of the Cap in regard to Schedule F is to:

#### End-of-valley flows

- remove references to end-of-valley flows as a method for Cap compliance except for Queensland alone as an interim measure until December 2002;

#### Remedial actions in case of Cap exceedance

- accept the arrangements for remedial actions in the case of Cap exceedance (“to ensure that cumulative diversions are brought back into balance with the cap”) noting that the cumulative diversions on the Register defined in the Schedule will be used as the basis for determining Cap compliance; and

#### Commencement date for Cap accounting

- retain 1997/98 as the water year for the commencement of accounting for diversions under the Cap for New South Wales, Victoria, South Australia and the Australian Capital Territory (as it is part of the greater Murrumbidgee valley) with Cap accounting for Queensland to commence upon the finalisation of Cap arrangements in that jurisdiction.

The revised version of Schedule F incorporating these changes is at Appendix E. The Commission fully expects the revised Schedule F will:

- lead to the more effective future operation of the Cap;
- enhance community confidence in Cap arrangements across the Basin; and
- be a major milestone in the implementation of the Cap.

### Review of the Operation of the Cap — Schedule F – Cap on Diversions

The Commission recommends that:

- the revised version of Schedule F be adopted by the Ministerial Council as a permanent part of the Murray-Darling Basin Agreement incorporating the changes made to the Schedule through the Review of the Operation of the Cap (Recommendation 23).
7. The Sustainable Rivers Audit — "The Next Step"

7.1 Introduction

The IAG noted, in their report on Implementation and Compliance, that compliance of actual diversions with Cap targets is only part of the objective of the Ministerial Council decision to introduce a Cap in that, in itself, this does not address the objective to "protect and enhance the riverine environment". With the implementation of the Cap nearing completion in most jurisdictions, the IAG identified an opportunity to take the next step and to consider the environmental outcomes of the Cap from a whole of Basin perspective.

An environmental audit of the Murray-Darling Basin, as a "mirror image" of the annual audit of implementation by the IAG, was recommended by the IAG and a regular environmental audit of the Basin’s rivers, a Sustainable Rivers Audit, was proposed in the draft Overview Report.

This is consistent with the findings of the Ecological Sustainability of Rivers component of the Review. Under that component, the Commission supported a Sustainable Rivers Audit to monitor the environmental health of the Basin’s rivers and to inform the community of the location and extent of degradation. This audit would cast the Cap as an input to Basin health rather than an outcome in itself and would bring into focus the effect of past and recent levels of diversion on the health of the Basin.

7.2 Summary of Submissions on Draft Overview Report

The proposed Sustainable Rivers Audit was very strongly supported throughout the submissions received. The support appeared to be given both as a logical extension of the Cap, and also to allow a stronger scientific base for debate in relation to ecological, environmental and social considerations associated with water management in the Basin. The submissions also emphasised that the effects of the Cap cannot be isolated from other factors.

Respondents observed that a steering committee of appropriate representatives of each jurisdiction, and the community through the Community Advisory Committee, should be established as a matter of urgency to design and guide the audit.

7.3 A Sustainable Rivers Audit of the Murray-Darling Basin

The Commission supports a regular environmental audit of the Basin’s rivers, a Sustainable Rivers Audit. Whereas the Cap is seen as the first step towards achieving the longer-term objective of the Initiative, a Sustainable Rivers Audit can be viewed as the next step in the process of achieving this objective.

The Commission considers that it will be important for the audit to develop and monitor useful indicators that can be clearly understood by all sections of the Basin community. This will be best achieved through community involvement in the audit process. Also, it will be important that the audit builds upon and draw from the activities of the partner Governments and that it does not lead to any confusion with current activities in the various jurisdictions.

Since the release of the draft Overview Report, a substantial effort has gone into a scoping study for the Sustainable Rivers Audit at the direction of the Ministerial Council and further development of the Audit arrangements will take place during 2000 and 2001.

The Sustainable Rivers Audit will be an important and ongoing feature of the Commission’s activities in future years.

7.4 Summary

With the implementation of the Cap nearing completion in most jurisdictions, there is now the opportunity to take the “next step” and to consider the environmental outcomes of the Cap from a whole of Basin perspective.

In line with Recommendation 6, the Commission supports the introduction of a regular environmental audit of the Basin’s rivers, a Sustainable Rivers Audit, which would cast the Cap as an input to Basin health, rather than an outcome in itself.

Whereas the Cap is seen as the first step towards achieving the longer-term objective of the Initiative, a Sustainable Rivers Audit can be viewed as the next step in the process of achieving this objective.
APPENDIX A — Definition of the Cap in Each Jurisdiction

The definition adopted for the Cap in each jurisdiction is provided below.

Note, diversion under 1993/94 levels of development does not mean the volume of water that was used in 1993/94. Rather, the Cap in any year is the volume of water that would have been used with the infrastructure (pumps, dams, channels, areas developed for irrigation, management rules, etc.) and management rules that existed in 1993/94, assuming similar climatic and hydrologic conditions to those experienced in the year in question. Thus, the Cap provides scope for greater water use in certain years and lower use in other years.

New South Wales

- The Cap is the volume of water that would have been diverted under 1993/94 levels of development.

- In the NSW Border Rivers valley, the Cap allowance for the enlarged Pindari Dam has not yet been determined (see Section 4.3).

Victoria

- The Cap is the volume of water that would have been diverted under 1993/94 levels of development.

- In the Goulburn/Broken/Loddon valley, the Cap allowance for the Lake Mokoan development has not yet been determined (see Section 4.3).

South Australia

- The Cap on diversions from the River Murray is defined in the following components:
  - a fixed allocation of 50 GL per year for country towns;
  - a five-year non-tradeable rolling allocation of 650 GL over the five year period (notionally 130 GL per year) for metropolitan Adelaide; and
  - an average of 524 GL per year allocation for irrigation including private, industrial, recreation, environment and stock and domestic (524 GL includes 440.6 GL pumped irrigation allocation and 83.4 GL for lower Murray swamps).

Queensland

- The Cap arrangements in the Queensland component of the Murray-Darling Basin are yet to be finalised however a moratorium on issuing new diversion licences is in place.

- A description of the processes underway in Queensland to determine Cap limits for their valleys is provided in Section 4.3.

Australian Capital Territory

- The Cap arrangements in the Australian Capital Territory are yet to be finalised.

- A description of the current situation in the ACT is provided in Section 4.3.
APPENDIX B — Terms of Reference for the Review

Review of the Operation of the Cap

Terms of Reference

The Terms of Reference for the five-year Review of the Operation of the Cap are:

1. To review the operation of the Cap (and, importantly, not the Cap itself) and provide suggestions for the more effective future operation of the Cap through obtaining independent assessments (involving the Independent Audit Group and partner Governments to the Initiative as appropriate) in each of the following areas:

   (a) **Ecological Sustainability of Rivers**
   
   through addressing the impact of the operation of the Cap in achieving its objectives to ensure ecological sustainability of the Murray-Darling Basin river system;

   (b) **Economic and Social Impacts**
   
   by determining whether the Cap has generated significant economic and social benefits or costs;

   (c) **Equity**
   
   by addressing issues of equity that have arisen in the process of implementing the Cap (between river valleys within States and between States); and

   (d) **Implementation and Compliance**
   
   by assessing progress in implementing the Cap including impediments and constraints to full implementation and addressing issues associated with ensuring Cap compliance covering the methodology adopted including the proposed Schedule F.

2. To consult with:

   (a) the Community Advisory Committee of the Murray-Darling Basin Ministerial Council (CAC);

   (b) other stakeholders as identified by the CAC, Commission and individual jurisdictions; and

   (c) the MDBC committee processes, as appropriate, to ensure inter-jurisdictional ownership of the outcomes of the Review and commitment of the jurisdictions to contributing to the Review.
## APPENDIX C — Submissions to the Review
November 1999

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## JULY 2000 STAKEHOLDER SUBMISSIONS

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This Appendix contains the full text of “Schedule F – Cap on Diversions” to the Murray-Darling Basin Agreement. This is the Schedule agreed upon by the Murray-Darling Basin Ministerial Council at Meeting 29 – 25 August 2000.

Schedule F — Cap on Diversions

Purposes

1. The purposes of this Schedule are:
   (a) to establish long-term diversion caps from rivers within the Murray-Darling Basin, in order to protect and enhance the riverine environment; and
   (b) to set out action to be taken by the Ministerial Council, the Commission and State Contracting Governments to quantify and comply with annual diversion targets; and
   (c) to prescribe arrangements for monitoring and reporting upon action taken by State Contracting Governments to comply with annual diversion targets.

Definitions

2. In this Schedule, except where inconsistent with the context:
   “baseline conditions” means the level of water resource development for rivers within the Murray-Darling Basin as at 30 June 1994 determined by reference to:
   (a) the infrastructure supplying water; and
   (b) the rules for allocating water and for operating water management systems applying; and
   (c) the operating efficiency of water management systems; and
   (d) existing entitlements to take and use water and the extent to which those entitlements were used; and
   (e) the trend in the level of demand for water within and from the Murray-Darling Basin at that date.

   “designated river valley” means a river valley or water supply system referred to in, or designated under, sub-clause 3(1).

   “historical data” means data relevant to the period from 1 July 1983 to 30 June 1994, or such other period as the Commission may from time to time determine.

   “Register” means the Register referred to in sub-clause 11(7).

   “river valley” means a river valley within the Murray-Darling Basin referred to in sub-clause 3(2).

   “water year” in relation to a river valley or a water supply system means the relevant 12 month period applicable to the allocation of water entitlements and measurement of diversions in that river valley or water supply system.

River Valleys and Designated River Valleys

3. (1) Subject to sub-clause 3(3), the river valleys or water supply systems listed at Schedule 1 are “designated river valleys” for the purposes of this Schedule.

   (2) Subject to sub-clause 3(3), the river valleys listed at Schedule 2 are “river valleys” for the purposes of this Schedule.

   (3) The Ministerial Council may, from time to time, on the recommendation of the Commission:
   (a) amend the description of:
      (i) any designated river valley described in Schedule 1; or
      (ii) any river valley in Schedule 2;
   (b) designate, for the purposes of this Schedule, any river valley or water supply system not referred to in Schedule 1; or
   (c) add any river valley to those set out in Schedule 2.
Long-term diversion cap for New South Wales

4. (1) The Government of New South Wales must ensure that diversions within each designated river valley in New South Wales do not exceed diversions under baseline conditions in that designated river valley, as determined by reference to the model developed under sub-clause 9(4).

(2) In calculating baseline conditions for the Border Rivers, allowance must be made for such annual volume as the Ministerial Council may, from time to time, determine in view of the special circumstances applying to Pindari Dam.

Long-term diversion cap for Victoria

5. (1) The Government of Victoria must ensure that diversions within each designated river valley in Victoria (including the upper River Murray) do not exceed diversions under baseline conditions in that designated river valley, as determined by reference to the model developed under sub-clause 9(4).

(2) In calculating baseline conditions for the Goulburn/Broken/Loddon and/or the Murray Valley water supply systems, allowance must be made for an additional 22 GL per year, or such other annual volume as the Ministerial Council may, from time to time, determine in view of the special circumstances applying to Lake Mokoan.

Long-term diversion cap for South Australia

6. (1) The Government of South Australia must ensure that diversions from the River Murray within South Australia:

(a) for water supply purposes delivered to Metropolitan Adelaide and associated country areas through the Swan Reach-Stockwell, Mannum-Adelaide and Murray Bridge-Onkaparinga pipeline systems do not exceed a total diversion of 650 GL over any period of 5 years;

(b) for Lower Murray Swamps irrigation do not exceed 83.4 GL per year;

(c) for water supply purposes for Country Towns do not exceed 50 GL per year; and

(d) for all other purposes do not exceed a long-term average annual diversion of 440.6 GL.

(2) Subject to sub-clause 6(3), the Ministerial Council may alter the annual diversion cap set out in:

(a) paragraph 6(1)(b) after considering a submission from the Government of South Australia on the 1993/94 level of diversions for the purposes referred to in that paragraph; and

(b) paragraph 6(1)(c) after considering the outcome of modelling studies.

(3) The Ministerial Council may only alter an annual diversion cap under sub-clause 6(2) in order to represent more accurately diversions under baseline conditions.

(4) The Government of South Australia must ensure that no part of any entitlement created in South Australia with respect to the diversion referred to in paragraph 6(1)(a) is either used, or transferred for use, for any purpose other than use in Metropolitan Adelaide and associated country areas, unless the Ministerial Council determines otherwise.

(5) If the Government of South Australia supplies any of the diversions referred to in paragraph 6(1)(d) through the Swan Reach-Stockwell, Mannum-Adelaide and Murray Bridge-Onkaparinga pipeline systems in any year, it must:

(a) record the volume of water so delivered for that purpose in that year; and

(b) account for that volume against the long-term average annual diversion referred to in paragraph 6(1)(d), when monitoring and reporting to the Commission under clause 11.
Long-term diversion cap for Queensland

7. (1) The Government of Queensland must ensure that diversions from each designated river valley in Queensland do not exceed such long-term diversion caps as may be fixed by the Ministerial Council on the recommendation of the Commission.

(2) Until December 2002 –

(a) a long-term diversion cap fixed under sub-clause 7(1) may be expressed in terms of a long-term pattern of flow to be maintained at the end of a designated river valley; and

(b) if the long-term diversion cap is so expressed, in order to determine whether the cap has been complied with in Queensland:

(i) the expressions “diversion” or “diversions” occurring in clauses 9-17 must be read as if they referred to “end-of-valley flow” or “end-of-valley flows” respectively; and

(ii) the expression “credit” in paragraph 11(8)(b) must be read as if it referred to “debit”; and

(iii) the expression “debit” in paragraph 11(8)(c) must be read as if it referred to “credit”.

(3) On or before 30 June 2000, the Government of Queensland will prepare and publish water management plans and water allocation management plans for all river valleys in Queensland.

(4) After considering the plans referred to in sub-clause 7(3), the Commission must make the recommendations referred to in sub-clause 7(1).

Power of Ministerial Council to alter long-term diversion caps

8. A long-term diversion cap referred to in clause 4, 5, 6 or 7 from time to time:

(a) must be altered by the Commission, to reflect the result of trading water entitlements within a State or between States; and

(b) may be altered by the Ministerial Council, on the recommendation of the Commission, for any other reason.

Developing Analytical Models

9. (1) The Commission must develop analytical models for determining the annual diversion targets for the upper River Murray.

(2) Subject to sub-clause 9(1), the Governments of New South Wales, Victoria and Queensland must each develop analytical models for determining the annual diversion target for each designated river valley within the territory of that State.

(3) The Government of South Australia must develop analytical models for determining the annual diversion target for diversions referred to in paragraph 6(1)(d).

(4) An analytical model developed under this clause:

(a) must simulate the long-term diversion cap in the relevant designated river valley; and

(b) must be tested against relevant historical data to determine the accuracy of the model in estimating the annual diversion; and

(c) must be approved by the Commission before it is used to determine an annual diversion target under this Schedule; and

(d) may, from time to time, be modified in such ways as the Commission may approve; and
(e) must be used to determine the average annual diversion under the conditions of the relevant long-term diversion cap determined under clause 4, 5, 6 or 7 for either:

(i) the period between the start of the 1891 water year and the end of the 1997 water year; or

(ii) such a lesser period as may be approved by the Commission.

(5) The Commission may only approve an analytical model or a modification to an analytical model if the Commission considers that the model, when approved or modified, will fairly determine the relevant annual diversion target given the climatic conditions experienced in any year.

Monitoring and Reporting

11. (1) Each State Contracting Government must, for each water year and in relation to each river valley specified in Schedule 2 within its territory, monitor and report to the Commission upon:

(a) diversions made within and to; and
(b) water entitlements, announced allocations of water and declarations which permit the use of unregulated flows of water within; and
(c) trading of water entitlements within, to or from the territory of that State in that water year.

(2) Each State Contracting Government must, for each water year and in relation to each designated river valley within its territory, monitor and report to the Commission upon:

(a) the compliance by that State with each relevant annual diversion target calculated under this Schedule for that water year; and
(b) such actions which the State proposes to take to ensure that it does not exceed the annual diversion targets calculated under this Schedule for every ensuing water year.

(3) For the purpose of sub-clauses 11(1) and (2) the expression “river valley within its territory” in relation to Victoria, includes that portion of the upper River Murray forming the border between Victoria and New South Wales.

(4) A report under sub-clause 11(1) or (2) must be given to the Commission within two months of the end of each relevant water year or by such other time as the Commission may determine.

(5) On the basis of the calculations referred to in sub-clause 10(1) and reports given to it under sub-clauses 11(1) and (2) the Commission:

Calculation of annual diversion targets

10. (1) Within two months after the end of the relevant water year and using the analytical models developed and approved under clause 9:

(a) the Commission must calculate the annual diversion targets for New South Wales and Victoria for that year for the upper River Murray; and

(b) subject to paragraph (a), the Governments of New South Wales, Victoria, South Australia and Queensland must, for each designated river valley within the territory of that State, calculate the annual diversion target for that year.

(2) The Commission must promptly inform the Governments of New South Wales and Victoria of the results of every calculation made under paragraph 10(1)(a) with respect to the upper River Murray.

(3) The Government of New South Wales, Victoria, South Australia and Queensland, respectively, must each promptly inform the Commission of the results of every calculation made by it under paragraph 10(1)(b).
(a) must, in relation to each State Contracting Government, produce a water audit monitoring report which includes information about that Government’s compliance with the annual diversion target calculated for each designated river valley in the territory of that State and for the whole of the State in the relevant water year; and

(b) may publish any such report, or a summary thereof, in such manner as it may determine.

(6) A water audit monitoring report under sub-clause 11(4) must be produced by 31 December following the conclusion of each relevant water year, or by such other time as the Commission may determine.

(7) The Commission must maintain a Register which records:

(a) for each designated river valley; and

(b) for each State,

the cumulative difference between actual annual diversions and the annual diversion targets calculated under this Schedule.

(8) The Register must:

(a) include information about every water year concluding after:

(i) 1 November 1997 for each State other than Queensland; and

(ii) for Queensland, a date determined by the Ministerial Council when it fixes long-term diversion caps under sub-clause 7(1); and

(b) if cumulative actual diversions for any designated river valley or for any State are less than the cumulative annual diversion targets calculated under this Schedule, as the case requires, record the difference as a credit; and

(c) if cumulative actual diversions for any designated river valley or for any State are greater than the cumulative annual diversion targets calculated under this Schedule, as the case requires, record the difference as a debit.

(9) The Commission must include a report on the operation of this Schedule in any report made to the Ministerial Council under clause 84 of the Agreement.

Appointment of Independent Audit Group

12. The Commission must appoint an Independent Audit Group for the purpose of this Schedule.

Annual audit by the Independent Audit Group

13. (1) The Independent Audit Group must, until 31 December 2004, annually audit the performance of each State Contracting Government in implementing the long-term diversion cap in each water year which concludes on or between 1 June 1999 and 1 November 2004.

(2) The Commission may direct the Independent Audit Group to audit the performance of any State Contracting Government in implementing the long-term diversion cap in any water year concluding after 1 November 2004.

(3) The Independent Audit Group must report to the Commission on any audit conducted under this clause.

Power to require a special audit of a designated river valley

14. If, after receiving a report from a State Contracting Government under sub-clause 11(2) for any year, the Commission calculates that either:

(a) the diversion for water supply to Metropolitan Adelaide and associated country areas over the last five years has exceeded 650 GL; or
(b) the cumulative debit recorded in the Register exceeds 20% of the average annual diversion determined under paragraph 9(4)(e) for a particular designated river valley within that State, the Commission must direct the Independent Audit Group to conduct a special audit of the performance of that State Contracting Government in implementing the long-term diversion cap in the relevant designated river valley.

Special audit by Independent Audit Group

15. (1) In conducting a special audit under clause 14, the Independent Audit Group must consider:

(a) data on diversions and annual diversion targets recorded on the Register; and

(b) data submitted by the relevant State Contracting Government, including, for example, data about areas under irrigation, storage capacities, crop production, irrigation technology and the conjunctive use of groundwater in the designated river valley; and

(c) the impact that policies implemented by the State Contracting Government may have on the expected pattern of annual diversions; and

(d) whether the diversion for all years on the Register exceeds the long-term diversion cap for those years, and

(e) any other matter which the Independent Audit Group considers relevant.

(2) The Independent Audit Group must:

(a) determine whether the long-term diversion cap has been exceeded in the designated river valley; and

(b) report to the Commission on the special audit and advise the Commission of its determination within six months after a direction given under clause 14.

Declaration that diversion cap has been exceeded

16. If the Commission receives a report under sub-clause 15(2) which determines that a State has exceeded the long-term diversion cap in a designated river valley, the Commission must:

(a) forthwith declare that the State has exceeded the Murray-Darling Basin diversion cap; and

(b) report the matter to the next meeting of the Ministerial Council.

Advice to Ministerial Council on remedial actions

17. (1) The Government of a State referred to in sub-clause 16(a) must report to the next Ministerial Council after a declaration is made under that sub-clause, setting out:

(a) the reasons why diversions exceeded the Murray-Darling Basin diversion cap; and

(b) action taken, or proposed to be taken by it to ensure that cumulative diversions recorded in the Register are brought back into balance with the cap; and

(c) the period within the relevant model referred to in clause 9 predicts that the cumulative diversions recorded in the Register will be brought back into balance with the cap.

(2) The Government of a State that has been required to report to the Ministerial Council under sub-clause 17(1) must report to each subsequent meeting of the Ministerial Council on action taken, or proposed to be taken by it to ensure that cumulative diversions recorded in the Register are brought back into balance with the cap, until the Commission revokes a declaration pursuant to sub-clause 17(3).

(3) When the Commission is satisfied that a State in respect of which a declaration has been made under paragraph 16(a) has brought the cumulative diversions recorded in the Register back into balance with the cap and is once more complying with the Murray-Darling Basin diversion cap in all respects, it must:

(a) revoke the declaration; and

(b) report that fact to the next meeting of the Ministerial Council.

Schedule 1
Designated River Valleys

1. New South Wales
   The New South Wales portion of the Border Rivers.
   The New South Wales portion of the following river valleys
   - Moonie, Big Warrambool, the Culgoa/Birrie/Bokhara/Narran water supply system, Warrego, Paroo.
   Gwydir.
   Namoi.
   The Macquarie/Castlereagh/Bogan water supply system.
   The Barwon/Upper Darling water supply system and the Lower Darling from the furthest upstream reach of the Menindee Lakes to the furthest upstream reach of the Wentworth Weir Pool.
   Lachlan.
   Murrumbidgee.
   The New South Wales portion of the Murray Valley including the portion of the Lower Darling influenced by the Wentworth Weir Pool.

2. Queensland
   The Condamine/Balonne water supply system.
   The portion of the Border Rivers in Queensland.
   The portion of the Moonie in Queensland.
   The portion of the Warrego in Queensland.
   The portion of the Paroo in Queensland.

3. Victoria
   The Goulburn/Broken/Loddon water supply system.
   Campaspe
   The Wimmera/Mallee water supply system.
   The Victorian portion of the Murray Valley including the Kiewa and Ovens.

4. South Australia
   The pumps on the Murray within South Australia used to supply Metropolitan Adelaide and associated country areas.
   Lower Murray Swamps irrigation.
   Country Towns water use.
   All other uses of water from the Murray within South Australia.

5. In this Schedule, “Border Rivers” has the same meaning as in the Border Rivers Agreement between New South Wales and Queensland.
Schedule 2

River Valleys

1. New South Wales

   The portion of the Border Rivers in New South Wales.

   The portion of the Moonie in New South Wales.

   The portion of the Big Warrambool in New South Wales.

   The portion of the Culgoa/Birrie/Bokhara/Narran water supply system in New South Wales.

   The portion of the Warrego in New South Wales.

   The portion of the Paroo in New South Wales.

   Gwydir.

   Namoi.

   The Macquarie/Castlereagh/Bogan water supply system.

   The Barwon/Upper Darling water supply system.

   Lower Darling from the furthest upstream reach of the Menindee Lakes to the furthest upstream reach of the Wentworth Weir Pool.

   Lachlan.

   Murrumbidgee.

   The New South Wales portion of the Murray Valley including the portion of the Lower Darling influenced by the Wentworth Weir Pool.

2. Queensland

   The Condamine/Balonne water supply system.

   The portion of the Border Rivers in Queensland.

   The portion of the Moonie in Queensland.

   The portion of the Warrego in Queensland.

   The portion of the Paroo in Queensland.

3. Victoria

   Kiewa.

   Ovens.

   Goulburn.

   Broken.

   Campaspe.

   Loddon.

   Wimmera/Mallee

   The Victorian portion of the Murray Valley.

4. South Australia

   The pumps on the Murray within South Australia used to supply Metropolitan Adelaide and associated country areas.

   Lower Murray Swamps irrigation.

   Country Towns water use.

   All other uses of water from the Murray within South Australia.

5. In this Schedule, “Border Rivers” has the same meaning as in the Border Rivers Agreement between New South Wales and Queensland.
Review of the Operation of the Cap

Ecological Sustainability of Rivers of the Murray-Darling Basin

John Whittington
Peter Cottingham
Ben Gawne
Terry Hillman
Martin Thoms
Keith Walker
The Cooperative Research Centre for Freshwater Ecology aims to improve the health of Australia's rivers, lakes and wetlands.

The Cooperative Research Centre for Freshwater Ecology is a collaborative venture between:

- ACTEW Corporation
- CSIRO Land and Water
- Department of Land and Water Conservation, NSW
- Department of Natural Resources, Queensland
- Department of Natural Resources and Environment, Victoria
- Environment ACT
- Environment Protection Authority, NSW
- Environment Protection Authority, Victoria
- Goulburn-Murray Rural Water Authority
- Griffith University
- La Trobe University
- Lower Murray Water
- Melbourne Water
- Monash University
- Murray-Darling Basin Commission
- Murray-Darling Freshwater Research Centre
- Sunraysia Rural Water Authority
- Sydney Catchment Authority
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Executive Summary

The Ministerial Council introduced the Cap on diversions from the Murray Darling Basin river system in June 1995, which in 1997 was confirmed as a permanent Cap. Two primary objectives for implementing the Cap were:

- the need to maintain and, where appropriate, improve existing flow regimes in the waterways of the Murray-Darling Basin to protect and enhance the riverine environment; and,
- to achieve sustainable consumptive use by developing and managing Basin water resources to meet ecological, commercial and social needs.

With the introduction of the Cap, the Ministerial Council undertook to review its operation in the year 2000. The Ecological Sustainability of the Rivers component of the Review was undertaken by the Cooperative Research Centre for Freshwater Ecology, with input from submissions received from partner governments, the Community Advisory Committee and directly from stakeholders.

The main conclusions of the Review are as follows:

- Sustainability in the Murray-Darling Basin should be defined as the indefinite preservation of:
  - a functional and diverse ecosystem which, as well as meeting aesthetic and ethical requirements, provides a natural resource suitable for (all) human uses and production; and
  - a socio-economic system capable of using the natural resource productively to the maximum good of the current and future communities.

- The development of the Basin's water resources, and in particular the reduced flows associated with these developments, has had a major impact on the riverine ecosystem. Impacts related to reduced flows include:
  - reduced areas of wetlands;
  - degradation of floodplain forests;
  - less diverse and reduced populations of native plants and animals;
  - exacerbation of problems of salinity, pest species, eutrophication and blue-green algal blooms; and
  - alteration of the shape of the Basin's rivers.

- Because of water resource development, the Basin ecosystem is moving to a new and different state. This transition will require many decades to complete – with the full impacts of the current level of abstraction yet to be realised.

- The Cap is set at a level of diversions that contributed to the current degradation of the riverine environment, and while the Cap is an essential step in slowing on-going decline, there should be no expectation that the Cap, at its current level, will improve the riverine environment.

- However, without the Cap it is most probable that the health of the Basin's river system would be significantly poorer, as extractions approached the Full Development Scenario level.

- Determining an appropriate level for the Cap requires science to identify ecological impacts of the current level of diversions and describe the long-term consequences of these impacts on sustainability. It is the role of the community, using this understanding, to strike the balance between the economic benefits and ecological costs of diversions. The level of the Cap needs to reflect this balance. However, the ecosystem itself will decide if the level of diversions is sustainable.
• For the main part, the environmental benefits of the Cap, and hence its contribution to sustainability of the system, will depend on the skill with which the environment's allocation is managed. Provision of effective environmental flows are constrained by a lack of ecological knowledge, limitations of infrastructure, state boundaries, the wish to protect floodplain developments and timing and volume constraints imposed by the need to deliver water for consumptive use.

• Indications of continued decline in river health suggest that current land and water management practise will require that the Cap allow significantly less extraction if the Cap alone is expected to achieve environmental sustainability.

• Increasing the level of diversions in upstream rivers will further exacerbate environmental degradation downstream. These effects must be recognised when determining the level of the Cap in upstream jurisdictions.

• The Cap has contributed (or will when fully implemented) to the sustainability of the river system by:
  - Restricting further diversions in all rivers, regardless of their current level of water resource development, thus protecting all riverine environments to the benefit of the whole Basin;
  - Protecting important high flow events – through limitations on access to off-allocation that have been introduced to ensure Cap compliance;
  - Providing an incentive for more accountable water resource management, including conversion to volumetric allocations; and
  - In conjunction with other water reforms, provided a framework for water trading to develop.

• The Cap's contribution to ecological sustainability would be enhanced by:
  - Reducing transmission losses across the Basin;
  - Returning all government funded water savings to the environment;
  - More efficient management of the environments allocation;
  - Basin-wide adoption of diversions models for evaluating compliance;
  - Rapid development of Computer Simulation Models to replace Demand Models for determining the Cap;
  - Defining the Cap so as to protect the proportion allocated to the environment from the effects of reduced catchment water yield;
  - Adopting the principle that all water in excess of the Cap is considered the environment's entitlement; and,
  - Integrating management of groundwater and surface water.

• There is a need for an annual Ecological Audit of the Basin's river system. An Ecological Audit would assess the Basin-wide coordination, effectiveness and ecological outcomes of environmental flow management undertaken by the State's and the ACT. The Ecological Audit would also comment on the health of the Basin's river system by reporting the condition of a number of performance sites across the Basin.

In terms of the specific questions raised in the project brief, the responses are:

1. **Collate and assess relevant scientific and policy reports and submissions of the partner Governments and the CAC addressing the ecological sustainability of the river system of the Basin.**

   A considerable body of scientific and management literature indicates that the health of the Murray-Darling Basin's river system has declined as a result of water abstraction, and that
this decline is likely to continue as the full effects of past management practise occur. Scientific evidence indicates that further extractions from the river system are not ecologically sustainable, and that the existing level of extraction may not be sustainable. Much of this information is synthesised in the book, "Rivers as Ecological Systems - the Murray-Darling Basin". Relevant reports include the Stressed Rivers Assessments, Water Allocation Management Planning Reports, Scientific Panel Reports for the Murray, Barwon-Darling and the River Murray Barrages, and the NSW Wales Rivers Survey.

Submissions to the Review were received from the partner governments to the Murray-Darling Basin Initiative, The Community Advisory Committee of the Murray-Darling Basin Ministerial Council (CAC), industry groups and directly from other stakeholders throughout the Basin. A number of issues relating to the ecological sustainability of the Basin's rivers emerged from the submissions including:

- no consistent definition of ecological sustainability;
- widespread support for a Cap to protect the ecological health of the river system;
- disagreement over existing levels of environmental degradation and its causes;
- difficulties in striking the balance between environmental impact and economic benefit;
- insufficient scientific input into setting and evaluating the Cap;
- no agreement on a sustainable level for the Cap;
- greater accountability for management of environmental allocations;
- the Cap alone will not ensure sustainability – other water management policies will be required;
- the Cap needs to be supported by an integrated approach to catchment management;
- confusion between impacts of the Cap and other water reforms; and
- confusion about what the Cap is intended to achieve.

2. **Address the impact of the operation of the Cap in achieving its objectives to ensure ecological sustainability of the Murray-Darling Basin river system by examining the following questions:**

2.1. **How Should Sustainability be defined for the purposes of the Cap?**

The Cap aims to make increases in production sustainable by fostering development, through more efficient use of diversions, without allowing growth in diversions.

Production will only be sustained if both the ecosystem and the socio-economic system are sustained in the long-term. Recognising that sustaining the ecosystem that maintains the resource is the key component to the future of the Murray-Darling Basin, sustainability should be defined as the indefinite preservation of:

- a functional and diverse ecosystem which, as well as meeting aesthetic and ethical requirements, provides a natural resource suitable for (all) human uses and production; and
- a socio-economic system capable of using the natural resource productively to the maximum good of the current and future communities.

In terms of its operation, the Cap must seek to apportion water between the riverine ecosystem and consumptive human uses such as to:

- reserve sufficient water to maintain the ecosystem in line with ESD principles; and
- preserve a supply of water suitable for human use.
Leaving aside the socio-economic component, sustainability should address three fundamental ecological values: biodiversity, ecosystem function and ecosystem integrity. The appropriate spatial scale for assessing the Cap's contribution to sustainability is basin-wide and over a temporal scale of decades.

The long-term decline in the Basin's natural capital (soil and water resources) indicates that we are failing the test of intergenerational equity, a fundamental tenet of sustainability.

2.2. What does science tell us about the suitability of the level at which the Cap is set?

Determining an appropriate level for the Cap is a three-stage process – science addresses the first two stages:

- The effects of the current level of diversions on the ecology of the river system have to be determined,
- The long-term consequences of these ecological effects have to be clearly understood, and
- With this understanding, the community has to make an assessment of the benefits and costs of diversions to determine an appropriate level for the Cap.

Current levels of water abstraction are having a significant impact on the ecological sustainability of the Basin's river system. Throughout the Basin, Scientific Panel Assessments, Stressed Rivers Assessments and state water management planning reports have documented environmental impacts associated with reduced flows. These impacts include reduced areas of wetlands, less diverse plant and animal populations, and reduced populations of native fish, birds, macroinvertebrates and aquatic and floodplain plants. Reduced flows will continue to exacerbate problems of salinity, pest species, eutrophication and blue-green algal blooms. Reduced flows are altering the shape of the major rivers. In summary, reduced flows are a major cause of reduced river health in the Murray-Darling Basin. However, the full impacts of the current level of abstraction and other changes to the Basin's land and water resources are yet to be realised. The various ecological and geomorphic responses to the altered conditions that have been imposed will require many decades to complete.

Assessing the suitability at which the Cap is set is complicated by the long-term natural variability in stream-flow of the Basin's river system and the long time-period over which changes occur. Also, there are few pre-Cap data against which to assess the environmental impact of the Cap. The focus should be on determining whether the current (capped) levels of diversions will conserve ecosystem function, integrity and biodiversity. This will require the continued development of ecological tools and techniques for assessing whether this has been achieved.

It is clear from submissions to the Review that there is community disquiet over the state of the Basin's rivers. There is a strong desire to see an improvement in river health. It is also clear that further abstractions, anywhere in the basin, will decrease the health of the river ecosystem.

2.3. What aspects of the operation of the Cap constrain or support the sustainability of the river system?

The Cap contributes to the sustainability of the Murray-Darling Basin river system by protecting end-of-system flows through limiting the growth in diversions, regardless of
a river's current level of diversions. This protects the few remaining relatively undeveloped rivers from exploitation. The Cap has protected ecologically important medium and high flow events through limitations on access to off-allocation that have been introduced to ensure Cap compliance. In conjunction with other water reforms, the Cap has provided incentive for conversion to volumetric allocations and provided a framework for water trading to develop.

Reducing transmission losses on water diverted to agriculture would enhance the Cap's contribution to sustainability of the Murray-Darling Basin river system. Information supplied by the Commission indicates that basin-wide at least 25% of diverted water is lost in transmission. Evidence from rehabilitation of South Australian irrigation schemes indicates much of this water can be reclaimed. At the Basin-scale river health will be improved by increasing the environment's share of water. Water saved from government-funded programs to reduce transmission losses should be removed from the Cap and be allocated to the environment. Water currently outside of the Cap (in-stream and environment's share) should not be traded into consumptive use.

The volume of water needed to achieve sustainability will depend upon the provision of effective environmental flows. The delivery of these is constrained by a lack of ecological knowledge, limitations of infrastructure, the wish to protect floodplain developments, state boundaries and timing and volume constraints imposed by the need to satisfy consumptive users.

Diversion models provide a more robust method of supporting the Cap than end-of-valley flow regimes, which have clear technical problems with accurate measurement. Climate adjustment of diversions in the southern parts of the Basin ensures that a greater proportion of total stream-flow is diverted in dry years. Over time, the Cap should be defined so that it both limits diversions and guarantees a minimum proportion of stream-flow for the environment.

3. At a Basin scale, assess the potential hazards and level of risk to the health of the riverine environment (including algal blooms and salinity), and comment on the role of the Cap in containing these hazards and reducing the level of risk to riverine health.

Export of salt from dryland sources to the aquatic environment is a major threat to water quality in the Basin and will impact on both water users and the riverine environment. Additional diversions from the Basin's rivers will increase the salinity of the remainder of the river downstream. The availability of dilution flows, the volume of which is protected by the Cap, will be an increasingly important constraint on salinity management in the future.

Warm, slow moving, nutrient rich waters promote the development of blue-green algal blooms. Increasing flow can dissipate existing blooms. Further diversions from the Basin's rivers will increase the likelihood of conditions favouring the development of blooms. Also, increased diversions will reduce the capacity to provide flushing flows for diluting nutrient or dissipating developing blooms. The introduction of the Cap has not led to a reduced frequency and intensity of blue-green algal blooms however, it is likely that without the Cap, the frequency and intensity of blue-green algal blooms would be greater than it currently is.

Predicted long-term changes in climate and land use in the catchment will significantly reduce catchment water yield, and consequently the volume of water in the Basin's rivers. This will have the effect of increasing the long-term proportion of stream-flow diverted from the Basin's rivers. Reductions in water yield from a catchment disproportionately impact on the environment's share.
4. Using two river valleys as the basis for case studies, assess the impact of the Cap to the sustainability of these valleys.

4.1. Lower Murray
Regulation has significantly reduced the annual flow to the Lower Murray and the variability of mid-range flows so that the present regime is dominated by low flows with occasional high flows. As regulation has increased there have been declines in the range and abundance of many species of native plants and animals, including fish, crayfish, turtles, frogs, birds and mammals. In their place, species like carp and willows predominate.

Modelling of the effects of Full Development Scenario have shown that the Cap has protected against further reductions in short-term variations in flow and the magnitude, duration and frequency of floods. Expansion to Full Development Scenario would exacerbate the loss of habitat diversity, reduce the frequency and duration of exchanges between the channel and the floodplain and change the metabolic functioning of the Lower Murray aquatic system.

Due to the variability of the system, and the long lag times between the imposition of a stress and the ecological response, it is not possible to say whether the Cap has halted the decline in the integrity of the Lower Murray. It is possible to say that if the Cap had not been imposed, the move toward a Full Development Scenario would have resulted in further dramatic declines in the condition of the river. This decline would have affected areas such as the Coorong and Lake Victoria far more severely than other ecological components.

4.2. Condamine Balonne
Large-scale intensive irrigation and flow regulation began relatively recently in the Condamine Balonne system. Diversions in the late 1990's from the Condamine Balonne system were nearly double the diversions reported in the 1995 Water Audit.
Flow regulation now has a significant impact on the hydrology of the river, which has impacted on the fish and macroinvertebrate fauna.

Further development in the Condamine Balonne catchment is likely to have a dramatic impact on ecological functions and eventually the sustainability of the river system downstream of Bourke. There is a serious risk that a Cap implemented in the Condamine Balonne (based on the WAMP) will fail to recognise the relative importance and potential impact of water resource development in this sub catchment on the ecological sustainability of the entire Basin.
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1 Introduction

The Cooperative Research Centre for Freshwater Ecology was appointed to undertake the Review of the Cap – Ecological Sustainability of Rivers. This review forms part of a wider review of the operation of the Cap and how it can be refined to better meet the needs of the Murray-Darling Basin community, which is being undertaken by the Murray-Darling Basin Ministerial Council.

The Cap on diversions in the Murray-Darling Basin was introduced in response to the Water Audit, which indicated that:

- the river system was showing signs of stress;
- there was no certainty that the current riverine environment is sustainable with the current regime;
- increased growth in diversions would reduce security to existing irrigators; and
- there was no margin of safety for any further changes that will have an adverse impact on water quality (eg, the emerging problems of dryland salinity)

From the Cap's inception, ecological sustainability has been identified as one of the primary objectives of the Cap. In their November 1996 report, “Setting the Cap” the Independent Audit Group (IAG) made the following recommendations in regard to the objectives and definition of the Cap:

_The IAG recommends that the Ministerial Council confirm its previous statement of aims adopted by the IAG as the primary objectives of the decision to implement the Cap, namely:

- to maintain and where appropriate, improve existing flow regimes in the waterways of the Murray-Darling Basin to protect and enhance the riverine environment; and
- to achieve sustainable consumptive use by developing and managing Basin water resources to meet ecological, commercial and social needs._

This review proposes a definition of sustainability as it refers to water resource development in the Murray-Darling Basin. The Review collates the work done to date on assessing the ecological sustainability of the Basin’s river system both at a large scale and by way of two case studies, the Lower Murray and the Condamine Balonne. In the specific context of the operation of the Cap, the contribution of the Cap to the ecological sustainability of the Basin is assessed. This Review considers the role of the Cap in relation to the emerging hazards of salinity, blue-green algae and changing water yield from the Basin's catchments. Suggestions for refining the Cap to improve its contribution to salinity are made.

Submissions to the Review received from the partner governments to the Murray-Darling Basin Initiative, The Community Advisory Committee of the Murray-Darling Basin Ministerial Council (CAC), industry groups and directly from other stakeholders throughout the Basin were used as reference material for this review.
2 Terms of Reference

The Murray-Darling Basin Commission provided the following terms of reference for the Five Year Review of the Operation of the Cap:

To review the operation of the Cap (and, importantly, not the Cap itself) and provide suggestions for the more effective future operation of the Cap through obtaining independent assessments (involving the Independent Audit Group and partner Governments to the Initiative as appropriate) in each of the following areas:

*Ecological Sustainability of Rivers*

*Through addressing the impact of the operation of the Cap in achieving its objectives to ensure ecological sustainability of the Murray-Darling Basin river system.*

Main Tasks:

1. Collate and assess relevant scientific and policy reports and submissions of the partner Governments and the CAC addressing the ecological sustainability of the river system of the Basin.
   Such reports include but are not limited to:
   - “Long Term Water Management in NSW – Moving Towards a Sustainable Future for the Murray-Darling Basin”;
   - Ecological Flow Handbook;
   - River Murray Scientific Panel Report;
   - Queensland WAMP reports;
   - NSW environmental objectives documentation.

2. Address the impact of the operation of the Cap in achieving its objectives to ensure ecological sustainability of the Murray-Darling Basin river system by examining the following questions:
   (i) How should sustainability be defined for the purposes of the Cap?
   (ii) what does the science tell us about the suitability of the level at which the Cap is set?
   (iii) what aspects of the operation of the Cap constrain or support the sustainability of the river system?

3. At a Basin scale assess the potential hazards and level of risk to the health of the riverine environment (including algal blooms and salinity) and comment on the role of the Cap in containing these hazards and reducing the level of risk to riverine health.

4. Using two river valleys as the basis for case studies, assess the impact of the Cap to the sustainability of these valleys.
Collate and assess relevant scientific and policy reports and submissions of the partner Governments and the CAC addressing the ecological sustainability of the river system of the Basin.

The Murray-Darling Basin Commission describes the Cap on diversions as "the single most significant water resources initiative in the Basin since the establishment of the Murray-Darling Basin Ministerial Council in 1985" (Blackmore, 1999). Government and community submissions to the Review support the need for a Cap with many arguing strongly that the Cap is crucial to the long-term health of the Basin's rivers. The evidence for the need for a Cap was initially detailed in the Audit of Water Use in the Murray-Darling Basin (Water Audit, MDBMC 1995). By calculating existing usage and modelling future demand, the Water Audit indicated that any further increase in the extraction of water from the river system in the Basin would erode the security of supply of existing diverters, and cause a continued decline in the health of the river system. A considerable body of scientific evidence from studies in the Murray-Darling Basin and elsewhere supports the view that the health of the Murray-Darling river system has declined as a result of water extraction, and is likely to continue to do so. This Review argues that the Cap has been critical to the maintenance of river health in the Murray-Darling Basin.

3.1 Overview of Scientific support for the Cap.

The Cap was implemented to restrict further growth in diversions with the view to prevent further decline in the environment. It is appropriate then, to ask:

- what is the evidence that the Basin's riverine environment was declining;
- is the Basin's riverine environment continuing to decline; and if so,
- is water extraction to blame?

There is a considerable body of scientific and management literature focused on the river system of the Basin. This information has been synthesised in several books. By describing how the Basin's rivers function, the book "Rivers as Ecological Systems – the Murray-Darling Basin" aims to improve the information base upon which natural resource management decisions are made. In writing the book, over 1000 books, papers and reports relevant to understanding riverine ecology in the Murray-Darling Basin were accessed (Young, 2000). Several other recently published books also advance our understanding of how the rivers of the Basin function including, "A free flowing River: the Ecology of the Paroo River" (Kingsford, 1999), "Australian Freshwater Ecology – Processes and Management" (Boulton and Brock, 1999), and "Wetlands in a dry land: Understanding for Management" (Williams ed. 1998). Books and brochures such as "Living on the Floodplains" (Mussared, 1997), "Sustainable Rivers: The Cap and Environmental Flows" (Whittington and Hillman, 1999) and "Murray Darling Basin Resources" (Crabb, 1997) synthesise relevant science and management knowledge for the broader community.

Water Quality is arguably the greatest indicator of a river health to the Basin community. Salinity trends in the River Murray at Morgan have been increasing for more than 80 years – the increase in salinity experienced since the late 1970's mainly due to saline drainage water return associated with the growth in irrigation diversions during this period (MDBC 1999b). While the Salinity and Drainage Strategy implemented in 1988 has successfully halted the increase in salinity, this halt is only temporary (MDBC 1999b). It is anticipated that salinity at Morgan will
continue to rise for the next 100 years (MDBC 1999b, MDBMC, 1999) as dryland catchments continue to leak salt to the rivers (Walker et al, 1999).

Eutrophication, the process of nutrient enrichment of water bodies by nitrogen and phosphorus, is a major water quality problem facing the Murray-Darling Basin. The concentrations of nitrogen and phosphorus influence the growth of algae and along with flow, turbidity and climate, influence the type of algae present (e.g. Oliver and Ganf 1999). It is generally considered that eutrophication of the Basin's rivers is increasing as loads of nitrogen and phosphorus increase. However, in most cases long term data have not been collected to demonstrate this (SoE, 1996). In recent years there has been an increase in the reporting of blue-green algal blooms (BGA Task Force, 1992). In the Basin's rivers, blue-green algal blooms generally develop during periods of low flows (Hotzel et al 1994, Webster et al. 1997, Oliver et al 1998). Extractions of water from the rivers have increased periods of low to no flow. While an increased awareness of the issues associated with blue-green algal problems will have contributed to their increased reporting, it is also likely that increased nutrient loads and altered flow regimes are increasing the frequency and intensity of blue-green algal blooms (SoE, 1996, BGA Task Force, 1992).

There are many other indicators that the Basin's health is in decline. The New South Wales Rivers Survey (Harris and Gehrke 1997) clearly shows that rivers in the Murray region are seriously degraded. Carp dominate the Murray regions fish population – there are few native fish. The Darling Region is less regulated (Gehrke et al 1995) than the Murray region and this was reflected in the NSW Rivers Survey finding about ten times more native fish in the Darling region compared to the Murray region. However, the fish population of the Darling Region is also impacted by water resource development. For example, the fish population in the Culgoa River at Weilmoringle, NSW was assessed as poor in the Condamine-Balonne WAMP Environmental Flows Technical Report (QDNR 1999). This was associated with water extraction. Across the Basin, Gehrke et al (1995) found a significant trend of reduced native fish species diversity in increasingly regulated catchments.

In the Murray river system as a whole, arguably 15 - 16 species of native fish are threatened and five are vulnerable and in the lower Murray regional extinctions are well advanced for five species (Walker and Thoms 1993). Historical catches of callop and Murray cod from the River Murray in South Australia declined by an order of magnitude since the expansion in water resource development after 1950. The Murray now has the lowest commercial fish yield per square kilometre of floodplain of any of the world's major rivers, although historical catches were comparable (Walker and Thoms, 1993).

The distributions and numbers of other biota have also reduced, including crayfish, freshwater mussels and snails (Walker and Thoms 1993, Sheldon and Walker 1997). There have also been changes in the composition of biofilms, which are an important food resource for riverine biota (Burns and Walker 2000). Changes in the flow regime of rivers and wetlands have impacted more on some water birds than others. Waterfowl species such as ibis, egrets and waders have probably decreased in abundance, as they rely on wetting and drying cycles of wetlands for food supply and breeding habitat (Scott 1997), whereas others that rely on a permanent water supply may have increased in abundance (Scott 1997). The abundance and diversity of waterbirds in the Murray-Darling Basin is strongly dependant on the maintenance of suitable wetland habitat, which due to water resource development has declined significantly (MDBMC, 1998). For example, as the Macquarie Marshes have reduced in area by 40 to 50% the numbers of breeding colonial waterbirds (ibis, herons, egrets and spoonbills) in the Marshes have also reduced (Kingsford and Thomas 1995, Kingsford1998). Drying out of much of the Gwydir wetlands has significantly reduced foraging areas for feeding waterbirds (McCosker and Duggin, 1992) and this is likely to have impacted on their populations.
A consequence of water resource development has been the dramatic reduction in the size and frequency of flooding events throughout many of the Basin's rivers (eg. MDBMC 1995, Close 1990, Thoms et al 1996, MDBC 1998b etc). This has contributed to the drying out and eventual disappearance of a significant proportion of the Basin's wetlands (MDBMC 1998, See Table 3.5) and the degradation of much of the remaining wetlands (MDBMC 1998). Floodplain vegetation has also been negatively affected by changes in the flow regime (eg Partners et al 1990). Even relatively recent water resource development has resulted in reduced floodplain vegetation vigour in the lower Balonne (Simms et al 1999). The timing, frequency, duration, extent and depth of inundation all influence where which aquatic, riparian and wetland plants will grow (Brock 1998). Water resource development has dramatically altered these aspects of flow regime in much of the Basin, and consequently altered the distribution of aquatic, riparian and wetland vegetation.

The Basin's river system has degraded and is heading to a new and different state. There is considerable evidence that it has not reached that new state, and is unlikely to do so for decades, if not hundreds of years (Walker et al 1995, Young 2000). The time-scales for some ecological changes in riparian systems (Church 1995, Young 2000) and geomorphology (Walker and Thoms 1993, Walker et al 1995, Young 2000, Church 1995) are likely to be in the order of centuries. The effects seen now are the result of past levels of water extraction and the impacts of current and past catchment management will impose a progressively greater stress on the river system for many decades to come. For example, inputs of salt to the river system (and therefore salinity) will continue to rise Basin-wide for at least the next century (MDBMC 1999).

In short, the riverine environment has degraded, and as a result of previous land and water management is likely to continue to degrade for many decades to come.

An assumption made to support the implementation of the Cap is that water extraction is a major contributor to the decline in ecosystem health. It is not possible to completely separate the effects of water extraction from other effects of water resource development, which include altering the timing and variability of flows, however it is clear that extraction is a major contributor to the decline. The Stressed Rivers Assessment undertaken in NSW (DLWC 1998) indicates that 49% of unregulated streams in the Basin in NSW exhibited a high degree of environmental stress. Water extraction was a major contributor to the environmental stress, with 32% of all unregulated streams exhibiting a high level of hydrological stress (DLWC 1998). It is often argued that Queensland's rivers are relatively under-developed, however, as a result of water abstraction, the flow regime below of the Lower Balonne has been assessed as poor (QDNR 1999). It is believed that flow changes resulting from water extractions for irrigation are the cause of the degraded fish and macroinvertebrate fauna in this region (QDNR 1999). Another example is the Barwon-Darling system where river regulation, resulting primarily from water extraction, has led to habitat degradation with reduced habitat availability and food sources for aquatic invertebrates (Thoms et al 1996).

Water extraction has reduced the frequency and magnitude of flood events in many of the Basin's rivers (MDBMC 1995). This has reduced the connectivity of the river with the floodplain. Connectivity is critical for maintaining ecosystem integrity and function (Junk et al 1989, Ward 1995, Ward and Stanford 1995). Altering the wetting and drying cycles of the floodplain changes the cycling of nutrients on the floodplain and between the floodplain and the river (Baldwin 1999, Baldwin and Mitchell 2000). Evidence from the Condamine Balonne indicates this can have major implications for downstream supply of carbon (Thoms and McGinness, in press. See also Condamine Balonne Case Study in this Report).

Reducing the flooding regime impacts on native fish and invertebrate populations. For some species of native fish (eg. Golden Perch, Silver Perch) increases in flow provide a cue to initiate migration, maturation and spawning, and flooding may open up important spawning and rearing habitat (Lake 1967, Harris and Gehrke 1994). For other species, despite the fact that they spawn...
independent of high flows, flooding indirectly benefits them through input of nutrients or food (Humphries et al 1999). Aquatic invertebrates in dryland ecosystems mediate many ecological processes in the channel and on the inundated floodplain (Boulton 1999). Most native invertebrates have opportunistic, flexible life histories that enable them to cope with the variable flow regime, indeed the spectrum of habitats provided by this variability promotes their survival. Maintenance of biodiversity requires a mosaic of both ephemeral and permanent wetlands (Hillman 1998, Hillman and Quinn 2000). Reducing the flooding regime reduces the available habitat for invertebrates and will lead to a loss of biodiversity (Boulton and Jenkins 1998, Boulton 1999).

This brief overview of scientific and management literature indicates that the Basin's riverine environment has degraded. It is also clear that reduced flows are a major cause of this decline. The Cap, by restricting further growth in diversions, is an important step in reducing further decline in the riverine environment.

3.2 Information directly addressing the Cap.

Most of the current literature directly addressing the Cap concentrates on issues of compliance and implementation – on gigalitres diverted (eg. Review of Cap Implementation reports for 97/98 and 98/99, (MDBMC 1999 & 2000) and the Water Audit Monitoring Reports for 94/95, 96/97 and 98/99 (MDBC 1998, 1999c & 1999d)). As audits of water diverted, the annual reports produced by the Commission and the Independent Audit Group are valuable. However, considering the widespread community interest and the importance of the Cap, there is little information in the public domain that discusses:

- the specifics of how the Cap is determined;
- ecological objectives of the Cap; and
- impacts of the Cap and other Water Reforms on the health of the river system.

A literature search using the Australian database Streamline (which attempts to include published material from a broad base including LWRRDC, MDBC and government publications) revealed eleven articles directly addressing the Cap (Appendix 4). Of these, about half mention the condition of the Basin's environment. Similar searches using Biosis and Enviroline showed nothing of relevance. The Review accepts that this does not constitute an exhaustive literature search and that other printed material directly addressing the Cap exists. These searches are indicative of the paucity of information regarding the role and value of the Cap in promoting ecological sustainability in the public domain.

The annual implementation reports of the Commission and IAG provide an important overview of water use across the Basin and should continue to be published annually. These reports however, are not intended to assess the Cap against any ecological (or social and economic) objectives. The value of the reports to the community would be significantly improved an assessment of the effect of the Cap on the ecological health of the Basin – from a whole-of-Basin perspective (as this review is intended to achieve).

An Ecological Audit administered in conjunction with the Independent Audit Group's Cap Implementation Reviews would achieve this. The Ecological Audit could be undertaken by an ecologist appointed to the Independent Audit Group, or by creating a separate Ecological Audit Group.

The Ecological Audit would comment on the Basin-wide implications, effectiveness and ecological outcomes of environmental flow management undertaken by the State's and the ACT. Environmental flows impact downstream jurisdictions therefore close coordination across State
and territory boundaries is required and this should be assessed by the Ecological Audit. The Commission should facilitate interstate coordination.

The Ecological Audit would also comment on the condition of the Basin's river system. This could be achieved by identifying a number of representative river reaches in the Basin to be used as performance sites, much like Morgan has been used for reporting salinity trends within the Basin for many years. The choice of performance reaches could include areas of ecological significance, such as RAMSAR sites etc. Significant ecological events related to the flow regime would be highlighted, for example, successful bird breeding and fish recruitment. The environmental condition of these sites (measured using a variety of indices1) could be monitored annually by the States and the ACT and the results of this presented to the Ecological Audit. This will require the appointment of Environmental Resource Managers by the States and the ACT to be responsible for managing, monitoring and reporting on environmental flows and outcomes.

| An Ecological Audit be undertaken on annual basis and the results be made available to the Basin community. |
| To prepare an annual environmental report card provides significant challenges, including: |
| - the completion of the flow models to calculate the climate-adjusted Cap targets for each river valley, |
| - the collection (or compilation), analysis and interpretation of environmental data, |
| - linking environmental data with hydrological data, |
| - communication of the environmental 'report card' to the Basin community. |

While these are difficult challenges, it is clear is from a number of submissions to the Review the community expects this information be made available.

### 3.3 Overview of Submissions

Submissions addressing issues associated with the Ecological Sustainability of Rivers were received from:
- the partner governments to the Murray-Darling Basin Initiative (Commonwealth, New South Wales, South Australia, Queensland, Victoria and Australian Capital Territory);
- the Community Advisory Committee of the Murray-Darling Basin Ministerial Council (CAC);
- industry groups; and
- directly from other stakeholders throughout the Basin.

A summary of the submissions made by partner governments and the CAC is presented in Appendix 1. A full listing of submissions addressing Ecological Sustainability of Rivers by Basin stakeholders made directly to the Commission can be found in Appendix 2.

Submissions to the Review indicate a high level of community awareness and interest in the Cap and the effectiveness of its contribution to Basin sustainability. Several key points related to the ecological sustainability of rivers emerged from the submissions to the Review. These are:

1 Tools for assessing 'river health' are improving with indices such as AUSRIVAS, the Index of Biological Integrity (IBI), and the Index of Stream Condition (ISC) currently available. Also, a method for detecting environmental effects of flow change (Integrated Monitoring of Environmental Flows, IMEF) is currently being developed by New South Wales Government Agencies which appears promising.
- no consistent definition of ecological sustainability;
- widespread support for protecting the ecological health of the river system with a Cap;
- disagreement over existing levels of environmental degradation and its causes;
- difficulties in striking the balance between environmental impact and economic benefit;
- insufficient scientific input into setting and evaluating the Cap;
- no agreement on a sustainable level for the Cap;
- greater accountability for management of environmental allocations;
- the Cap alone will not ensure sustainability – other water management policies will be required;
- the Cap needs to be supported by an integrated approach to management the catchment; and
- confusion between impacts of the Cap and other water reforms.

On these key points a range of views was expressed to the Review, which are discussed below. Issues in this section form the basis for discussions in following sections of the Review.

### 3.3.1 No consistent definition of ecological sustainability.

Sustainability is a term that means different things to different people. This is reflected in the submissions presented. While most submissions argue that the definition of sustainability has to balance both environmental and economic sustainability, there is no consensus as to where that balance lies. For example, the Twynam Group argues "Financial viability of all stakeholders is an essential ingredient for the long-term ecological sustainability of rivers in the MDB.” The Murrumbidgee River Management Committee adopts a different view: "Ecological sustainability is taken to mean the long-term maintenance of the ecological processes on which life depends.”

A number of non-government submissions indicate that to ensure intergenerational equity, sustainability to has to be defined over a time scale of generations not a few decades. This is supported by the submissions of the New South Wales Government and the Commonwealth, which indicated sustainability has to comply with the Principles of Ecologically Sustainable Development as set out in their respective Acts and Policies. These include:

- the Precautionary Principle,
- inter-generational Equity,
- conservation of biodiversity and ecological processes; and
- the improved valuation and pricing of environmental resources.

It is clear that a widely accepted definition of sustainability is fundamental to a better understanding of the outcomes expected from changed water management associated with the Cap.

The Review proposes a definition of sustainable as it refers to the establishment, operation, and performance review of the Cap as the indefinite preservation of:

- a functional and diverse ecosystem which, as well as meeting aesthetic and ethical requirements, provides a natural resource suitable for (all) human uses and production; and,
- a socio-economic system capable of using the natural resource productively to the maximum good of the current and future communities.
3.3.2  Widespread support for a Cap on diversions

Submissions from non-government stakeholders generally recognise that water abstraction in the Basin has negative impacts on the riverine environment, with most submissions supporting the need to have some controls on the levels of abstraction from the Basin's river system. For example, the Southern Riverina Irrigation Districts Council "accepts the suggestion that continued river extractions would result in a decreased ecological health of our river system".

State Government and Commonwealth submissions provide unanimous support for the Cap. There is a recognition that the Cap, in isolation, will not result in a sustainable Basin. The South Australian Government submission argues "the Cap does not effectively address ecological sustainability—although it has been effective in slowing the decline." A similar argument is made by the New South Wales Government, "While the Cap alone will not achieve ecological sustainability, it is fundamental to achieving the benefits targeted by the environmental flow rules and other water reform initiatives". There is disagreement as to whether the Cap, as implemented, is the most appropriate resource management tool to provide resource security and environmental protection.

The Cap is critical to the sustainability of the Basin, however in isolation, the Cap does not represent a sustainable level of water use.

The Cap is set at a level of diversions that contributed to the current degradation of the riverine environment. The Cap was implemented with the aim of restricting growth in diversions with the view to stopping further decline in the riverine environment. There should be no expectation that the Cap, at its current level will improve the riverine environment.

However, the Cap is an essential first step in providing sustainable water resource management.

3.3.3  Disagreement over existing levels of environmental degradation

There is considerable disagreement over the existing level of environmental degradation of the Basin's river system, and of the need to restrict further impacts. Inland Rivers Network argues that current environmental degradation in the rivers and wetlands of the Murray-Darling Basin clearly indicates that too much water is being extracted. Similarly, ACF argues "river regulation and diversion of water resources represent the key threatening process for the ecology of the Murray Darling". The North West Catchment Management Authority argues that "The major problem is, that Cap or not, present diversions and practises threaten a salinity problem perhaps equal to the Aral Sea and certainly equal to the Nile." However, not all submissions agree on the level of degradation of the riverine environment, for example the submission from the Shire of Brewarrina, "the potential hazards and risk to the health of the riverine environment appear to have been grossly exaggerated in a number of aspects".

The South Australian Government submission argues that even with the Cap in place, "significant degradation continues in major parts of the Basin". However, submissions from the more northerly areas of the Basin often question the level of environmental degradation resulting from water abstraction, perhaps reflecting the relatively lower levels of abstraction in these valleys. This view is also reflected in the Queensland Government submission, which argues that the low level of abstraction in the Western Rivers of that State indicate, "some scope for further development may be possible without causing any significant detrimental impacts to the overall health of the stream or the interests of downstream users". A similar argument, that water resources are not heavily developed in their jurisdiction, is presented by the Australian Capital Territory "The Cap must acknowledge that the ACT's water resources are
significantly under developed …", and "….the ACT approach to water resource management results in a sustainable system which includes provision for further utilisation".

The evidence indicating many of the Basin's rivers are stressed, and that the current levels of abstraction are a major cause of this, is overwhelming (See Sections 3.1, 5.2, 5.3, 8 & 9). Evidence includes reductions in areas of wetlands and degradation of floodplain woodlands, changes in the shape of the river channels (including closing of the Murray Mouth), increasing salinity and eutrophication, declines in the range and abundance of many species of native plants and animals, including fish, crayfish, turtles, frogs, birds and mammals. In their place, species like carp and willows have become established.

Increased water abstraction anywhere in the Basin will increase this stress. The effects of increased diversions in relatively 'under developed' headwater streams will impact in downstream (and often interstate) rivers (See Section 9.4), most of which are already showing significant signs of stress. There are arguments, based on equity, for transferring allocations (diversions) into upstream jurisdictions, which are beyond the scope of this review. The important principle is that these transfers should be within the Cap and not increase total diversions within the Basin.

Community confidence in the Cap will be eroded unless there is a rapid Basin-wide implementation of the Cap.

### 3.3.4 Striking a balance between consumptive use and the environment

There is consensus that a balance needs to be struck between the damage caused to the riverine environment from water abstraction and the economic and social benefit derived from water use. There is disagreement as to where an equitable and sustainable balance lies, no doubt further complicated by environmental values being different between stakeholders. The submissions suggest that considerably more effort to inform stakeholders of the need for, and the aim of, water resource management initiatives is required.

The Murray Darling Association argues that there is a relatively poor understanding of the variability of the Australian climate and the relationship between the lack of rainfall and the availability of water resources for distribution within the Basin community. Unless the Basin community understands the physical constraints on the supply and delivery of irrigation water as well as the ecosystem's water requirements, it will be impossible to strike a universally accepted balance between abstraction and the environments water requirements.

A number of submissions to the Review call for increased transparency of scientific studies and greater communication of their results to Basin community. The Southern Riverina Irrigation Districts Council asks "…have any studies been completed [that aim to determine the environmental outcomes of the Cap] and if there has, why has this knowledge not been imparted to the wider valley communities?"

The community expects rigorous science to underpin water management decisions and that the anticipated outcomes from water management be expressed in quantifiable and understandable way. A number of submissions strongly argue that it is the responsibility of water resource managers to assess and disseminate the outcomes of water management.

Determining an appropriate level for the Cap requires science to identify ecological impacts of the current level of diversions and describe the long-term consequences of these impacts on sustainability. It is the role of the community, using this understanding, to strike the balance
between the economic benefits and ecological costs of diversions. The level of the Cap needs to reflect this balance.

At present, the community does not have access to sufficient ecological information to make these complex decisions. However, there is community disquiet over the state of the Basin’s rivers and there is a strong desire to see an improvement in river health. The challenge for science is to provide the ecological understanding needed by the community. The challenge for the Commission and other water resource managers is to ensure that this information is available to the community.

3.3.5 Insufficient scientific input into setting and evaluating the Cap.

Many non-government submissions argue that there is little baseline ecological data against which to assess the impact of the Cap on the environment. This view is typified by Murray Irrigation Limited, which “is not confident there is sufficient scientific information available to evaluate the effectiveness of the MDPC Cap of achieving ecological sustainability on a valley by valley basis”. This view is supported by the Commonwealth submission, which states, “…long term baseline data on river health required to assess the effectiveness of management strategies (including the Cap) on the riverine environment are limited or unavailable”.

Many non-government submissions are disappointed that, despite the lack of existing information, there appears little effort to collect the data required for measuring the effectiveness of the Cap in achieving positive ecological outcomes. The Commonwealth submission does point out however, a number of programs and policies currently in operation that aim to measure, albeit indirectly, the effectiveness of environmental allocations.

A number of non-government submissions argue that water allocation decisions have to be based on the best possible science, for example Berrigan Shires' submission states "...efforts to improve sustainability should be based on objective data, not simple perceptions or notions". Similarly, there is considerable concern that the hypothesis "less extraction is better for the environment" needs to be rigorously tested before it is applied. The Commonwealth submission acknowledges that "the level that the Cap was set, however, was not based on scientific knowledge of ecological water requirements of the riverine environment."

A number of submissions also note that it is too early in the life of the Cap to be assessing environmental outcomes of the Cap. This is exacerbated by the lack of baseline information, understanding of how the river system functions and the dry spell in the southern region of the Basin. For example, the West Corurgan Private Irrigation District submissions states, "The time span between initial Cap implementation and today, coupled with the climatic resource constraints during this period do not, I believe, permit science to be in a position to accurately assess sustainability levels."

On the other hand, there are submissions arguing that the Cap has failed because the Commission, and science generally, have not demonstrated any discernible environmental improvements resulting from the Cap.

While many hope the Cap represents a sustainable level of diversions, the level of the Cap was not chosen to be this. Rather, the Cap was set in response to the Water Audit which recognised that the levels of abstraction and the potential for their growth were leading to a long-term decline in riverine health and threatened security of supply for existing users.

There are some limited data available to assess the impact of the Cap on the ecological health of the Basin's rivers. However, the riverine ecosystem will require many decades to complete its
various ecological and geomorphic responses to the altered conditions that have been imposed on it.

In most cases it will not be possible to separate the impacts on ecosystem health of the Cap from other water reforms and environmental flows.

The Commission has to regularly demonstrate both compliance with and effectiveness of the Cap. This can be achieved by providing an annual Environmental Audit for the Basin's river system in conjunction with the Water Audit Monitoring Reports.

3.3.6 Disagreement on a sustainable level for the Cap

Submissions to the review argue for and against changing the level of diversions allowable under the Cap. Arguments are presented for an increase, for maintaining the status quo, and for decreasing the level of diversions.

The Government submissions of Queensland and the Australian Capital Territory argue that in their jurisdiction, there is scope for a sustainable increase in diversions. Both submissions acknowledge that there would be downstream effects of increased diversions, however these would be small in their jurisdiction.

The Commonwealth submission argues that diversions are likely to be too high and will have to be reduced to achieve sustainability. "As the knowledge of environmental flow requirements improves, the provision of environmental allocations is likely to require adjustment to the level of the Cap to remain consistent with the COAG water reform requirements".

Current indications of continued decline in river health suggest that with current land and water management practices, the Cap does not reserve enough water for the environment.

Increasing the level of diversions in upstream rivers will further exacerbate environmental degradation downstream and these effects must be recognised when determining the level of the Cap in upstream jurisdictions.

3.3.7 Better management of environmental allocations

Submissions call for water allocated to the environment to be managed to achieve best environmental outcomes and, importantly, that this management and its outcomes be evident to the Basin community.

There is a need for a regular Ecological Audit of the Murray-Darling Basin river system. The Ecological Audit would report on the efficiency, coordination and ecological outcomes of environmental flows Basin-wide (See Section 3.2).

Improving the efficiency with which water is used to satisfy ecosystem requirements will require improved ecological knowledge. Water resource management requires a strategy for identifying knowledge gaps, seeking knowledge to fill those and for incorporating this knowledge into their operations.

The outcomes of water management should be available to all interested stakeholders. Principle 12 of the National Principles for the Provision of Water to Ecosystems is relevant here: All relevant environmental, social and economic stakeholders will be involved in water allocation planning and decision making on environmental water provisions.
3.3.8 The Cap alone will not ensure sustainability

Most submissions accept that in isolation the Cap is unlikely to significantly improve river health. However, the reasons for this are varied. Some non-government submissions indicate that much damage has already occurred, probably at lower levels of abstraction than at present. Their conclusion – that the level of the Cap is too high.

Many submissions argue that improved environmental flow rules will be required to support the Cap. For example, the New South Wales Murray Wetlands Working Group indicate that the Cap needs to be supported with an "assessment of the environmental flow requirements of the rivers of the Basin and implementation of these actions to meet flow requirements...". This is supported by the Governments of NSW and South Australia and by the Commonwealth. For example, the South Australian Government argues the need for "a complete sustainable rivers program that would address flow regimes, timing and quality issues in addition to the volumetric rationale of the Cap."

For the main part, the environmental benefits of the Cap, and hence its contribution to sustainability of the system, will depend on the skill with which the environments allocation is managed.

The amount of water required to achieve a sustainable ecosystem will depend on the efficiency with which water is used to satisfy ecosystem requirements.

3.3.9 Integrate river and catchment management.

It is widely acknowledged by the submissions that the Cap on diversions limits further extractions for consumptive use, but this alone will not guarantee the long-term maintenance of a healthy river system. Submissions indicate that not all river health issues are flow-related, and that there is an over-reliance on managing river-flow to achieve river-health objectives. "The lack of any strategic plan to address the degradation of the upper catchments, with the attendant effects on water quality, is to be condemned. ..... Until there is an integrated approach to managing the entire catchment in an ecologically sustainable fashion, there will be no improvement in the riverine channel itself." [Namoi Valley Water Users Association].

Concern is emerging about the impacts of changed land-use on catchment water yield and stream flow. This is highlighted in the Victorian Government submission, which indicates re-afforestation of Victoria's Northeast is likely to dramatically reduce water yield.

There is recognition of the physical connectedness of groundwater with surface water and how supply of one affects demand on the other. Victorian Government and the Commonwealth submissions call for the coordinated management of groundwater and surface water resources.

Integration of catchment and water management is required. A better understanding of long-term changes in catchment water-yield is critical for water allocation planning.

Groundwater and surface water are physically interconnected, and for some users alternate sources of water. The Cap does not assess the extent of conjunctive use of groundwater and surface water and the level and extent to which capping surface water leads to switching to groundwater use. It is critical that surface water and groundwater management is integrated if both resources are to be conserved.
3.3.10 Confusion between impacts of the Cap and other water reforms.

There is some understanding that the Cap is just one of a number of water management reforms introduced during the last 5 years, however the impacts of the Cap are regularly confused with other water reforms. Many non-government submissions indicate a need for considerably greater effort aimed at assessing the ecological impacts of the Cap and distinguishing these from the effects of other water reforms. The MIA Council of Horticultural Associations argues "that a proper scientifically rigorous process be established so that each particular [water reform] initiative can be assessed in its own right, rather than as a combination of effects". The Commonwealth recognises the difficulty of this task, "...differentiating between the impact of the Cap from other management strategies such as water trading, water pricing or allocation of environmental flows on river health may prove difficult".

At the Basin-scale it will not be possible to differentiate between the ecological impact of the Cap and many other management strategies. The aim should be to assess the impact of river management as a whole and to educate the community as to why the Cap, in conjunction with other management initiatives, is critical to the sustainability of the Basin.

3.3.11 Confusion about what the Cap is expected to achieve

Submissions to the Review highlight a lack of understanding about the implementation of the Cap, but more importantly, they highlight a lack of understanding of the ecological, social and economic goals of the Cap. The goals of the Cap need to be clearly expressed and ecological targets set, against which the Cap can be assessed, otherwise there will be unrealistic expectations of the Cap. For example, some in the community expect the Cap to improve river health in the Basin and make consumptive use of water sustainable. While this is clearly an aim of the Commission, it is not a realistic objective of the Cap in isolation. This misunderstanding is not surprising. The Commission's often-stated primary objectives for implementing the Cap are:

- to maintain and where appropriate, improve existing flow regimes in the waterways of the Murray-Darling Basin to protect and enhance the riverine environment; and
- to achieve sustainable consumptive use by developing and managing Basin water resources to meet ecological, commercial and social needs.

The message from these objectives is that implementation of the Cap will ensure sustainable water use in the Basin. In a bid to garner support for the Cap, which is undoubtedly a critical water resource issue, there is the clear danger of 'over-stating' its short-term benefits. If these benefits are not realised, for example if blue-green algae continue to bloom and carp dominate recreational fish catches, the Cap no matter how successfully implemented, will be viewed as failing.

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\[2\] For example, Review of Cap implementation 1996/97 & 1997/98 MDBMC. Canberra.
4 Defining Sustainability

Address the impact of the operation of the Cap in achieving its objectives to ensure ecological sustainability of the Murray-Darling Basin river system by examining the question, “How Should Sustainability be defined for the purposes of the Cap?”

4.1 Introduction

Conservation of water is an urgent issue. It is true that water, the compound (H₂O), is a renewable resource, it is continuously cycled between the earth and the atmosphere via evaporation and rainfall, fairly independently of how well rivers and lakes are managed. However, the water resource is significantly more than H₂O. The water resource involves considerations of quality, timing and reliability. These are very susceptible to human activity, both directly through water resource development and pollution, and indirectly through damage to the complex ecosystems essential for maintaining the quality of the resource.

Sustainability has been a primary objective of the Cap since its inception. These objectives are expressed as:

- “To maintain and were appropriate, improve existing flow regimes in the waterways of the Murray Darling Basin to protect and enhance the Riverine environment, and

- To achieve sustainable consumptive use by developing and managing Basin water resources to meet ecological, commercial, and social needs”.

Published discussions and submissions to this review revealed a variety of assumed meanings for the word sustainability. This is not surprising. Along with such terms as biodiversity and river health, sustainability is what Gaston (1996) refers to as a pseudo-cognate term. It describes a concept that is generally comprehended, but for which a shared definition is often elusive. This section does not attempt a universal definition of sustainability, but rather seeks to reach a shared interpretation as it refers to the establishment, operation, and Review of the Cap.

4.2 Some Background

In a global sense, Costanza & Daly (1992) describe ecosystem resources such as water, air and soil as Natural Capital. These resources can be renewable or non-renewable. The other form of capital is Industrial Capital, which consists of Manufactured Capital such as physical enterprises and farm machinery, and Human Capital such as skills and knowledge. Production results from the combining of Natural and Industrial Capital (Fig. 4.1). As an example, irrigated farming combines skill and knowledge, the farm infrastructure, and natural resources such as soil, water, and nutrients to produce rural commodities. A system is sustainable when both Natural Capital and Industrial Capital are sustained in the long-term.

There are many pressures, including population growth and a desire for increased ‘standards of living’, which drive increased production. Production can only be increased by increasing the rate at which Natural Capital (such as water, soil, nutrient) is used and/or by increasing the input of Industrial Capital. The former increases the pressure on the ecosystem, which in the Murray-Darling Basin is already in decline. Increasing inputs of Industrial Capital require either

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3 As well as being used directly by the human community Natural Capital also supports ‘ecosystem services’.
4 This was initially described as Man-made Capital by Constanza and Daly (1992).
increased inputs of Manufactured Capital (machinery, irrigation infrastructure etc.) which can threaten economic viability, or increased inputs of Human Capital (skills, knowledge etc.).

From another angle, increases in production can be achieved either through growth and/or development. Growth is achieved by increasing the amount of Natural Capital used (i.e. more water, nutrient and soil). Development results from increases in the amount of Industrial Capital used, often Human Capital (skills, knowledge), without changing the use of Natural Capital.

The Cap aims to sustainably increase production by fostering development, through more efficient use of existing diversions, without allowing growth in diversions. This model of sustainability fits that proposed by the North-West Catchment Management Committee, “sustainability must be defined in such a way that it does not restrict further development but prevents the further growth of diversions”.

**Figure 4.1** Production results from combining Natural Capital and Industrial Capital. Production is not sustainable if either is depleted in the long term.

### 4.3 What is to be sustained?

One of the most divergent aspects of the submissions to the Review relates to assumptions about what the Cap is to sustain. For the most part sustainability is taken to refer to aspects of the riverine ecosystem such as biodiversity, the condition of the resource, or various aspects of the human use of the resource, such as farm economic viability.

Production will collapse if the drain on either Industrial Capital or Natural Capital becomes too great – if it is not sustainable. There is, however, a significant difference in the time scale of these responses. Response to depletion of Natural Capital, in this case the riverine ecosystem, is likely to be very much slower than the response to the depletion of Industrial Capital. It is also possible that increases in Human Capital (skill, technology) will maintain production and mask the decline in Natural Capital in the short to medium term. Some marine fisheries enterprises are a good example of this. Advances in tracking and catching technology can mask the decline in fish stocks. Fish catches remain constant until there are too few to catch fish (because their
population collapsed), and then the fishery collapses. If current management initiatives, including the Cap, fail to halt the decline in the riverine ecosystem, then increases in Human Capital, such as efficiencies in water use and ability to manage declining water quality, will merely mask the progression towards collapse of both the ecosystem and the socio-economic system. If the ecosystem or socio-economic system collapses then a Cap of any size is unlikely to restore production or the ecosystem. As stated by the Lower Murray Catchment Committee, “the purpose of the Cap should be to halt decline”.

Leaving aside the socio-economic component, which is considered in the Economic and Social Impacts Review, sustainability of the riverine ecosystem should address three fundamental ecological values:

- Biodiversity;
- Ecosystem function; and
- Ecosystem integrity.

4.3.1 Biodiversity
Diversity is the basis of adaptation. At the genetic level it provides the basis for selection of appropriate individuals in response to changing environmental pressures. At the community level it provides a suite of species which, collectively, has the capability of supporting ecological functions in the spectrum of conditions encountered in a variable environment such as the Murray-Darling Basin. The capacity of an ecosystem to rebound from unusual events is dependent on biodiversity.

The significance of sustaining biodiversity has received wide-ranging support. It is the subject of international agreements to which Australia is a signatory. The NSW EPA, as part of setting water quality and river flow objectives (EPA 1999) identified sustaining biodiversity as the highest environmental objective in a recent community survey.

Definition, description, and objective measurement of biodiversity has proved very difficult (Heywood 1995), but some of the metrics used to assess ‘river health’ may provide a means of assessing biodiversity relatively over time.

We now have very few data on which to assess the effect of river management and, specifically, the operation of the Cap on biodiversity. This urgently needs redressing if managers are to be able to address national obligations or the wishes of the Basin community.

4.3.2 Ecosystem Function
With regard to the Murray-Darling Basin there are two aspects of ecosystem function which bear on sustainability; general ecosystem services and that component of the riverine ecosystem which maintains the utility of the water resource.

Globally the biosphere is a self-sustaining (though changing) system founded on solar energy. As part of the biosphere humans derive a number of benefits which are referred to collectively as Ecosystem Services. Clean water, pure air, soil formation and protection, foods, fuel, fibres, and naturally occurring drugs are examples of these benefits, as are aspects of the climate. If production in the Murray Darling Basin results in a reduction in ecosystem services it is important to include the value of those forgone benefits in assessing the sustainability (or cost-effectiveness) of that production.

The quality, and therefore the utility, of the water resource is maintained through the functioning of the riverine ecosystem, including the catchment. It is reasonable to assume that any diversion of water will have some effect on the ecosystem, and there is a point at which
further diversion will result in its collapse. Avoiding collapse of the ecosystem is an important function of the Cap. Attempting to sustain ecosystem function without addressing biodiversity and larger scale issues of ecological services and ecosystem integrity is a minimal response likely to be effective only in the short-term, at best.

4.3.3 Ecosystem Integrity

The third characteristic of ecological value is ecosystem integrity. Ecosystems that are quite different may support similar levels of ecosystem services and have similar biodiversity. However, these ecosystems might be quite different in terms of wider ecological values or from the human perspective. For example, low flow may facilitate a shift in algal community structure from one dominated by diatoms to one dominated by blue-green algae. In these two communities biodiversity and ecosystem function may remain unchanged, however ecosystem integrity has altered in a direction the community would perceive as bad. Another example is the shift from aquatic plant-dominated to algal-dominated waterbodies resulting from increased turbidity and/or eutrophication.

There are other aspects of ecosystem integrity, such as local depletion of endangered or highly valued organisms, which reflect ethical and aesthetic aspects of community values (perhaps reflecting a wish for intergenerational equity as well) which need to be accounted for in managing for sustainability.

4.4 Spatial and temporal dimensions.

4.4.1 Spatial scale.
The current debate regarding deficiencies in the Murray-Darling Basin and a requirement for environmental releases in the Snowy, exemplifies the importance of considering sustainability at appropriate scales. Although it may be necessary to identify sacrificed zones in the future management of the system, such decisions must be made as free as possible from political and interstate pressures.

The Cap is a basin-wide measure and needs to be operated at that scale for the good of the Basin is a whole.

At the smaller scale, management practices that depend on a program of retiring irrigation land and commencing new sites is of dubious sustainability.

4.4.2 Temporal scale.
The temporal scale is very important in measuring sustainability. Short term considerations of sustainability may overlook gradual degradation of the ecosystem if it is masked by development (increased use of technology etc.). Objectives for sustainability over a long-time scale are likely to be complicated by future changes (eg. meteorological change) outside the influence of river management. Where the objectives of sustainable management are expressed only in terms of production outcome, then assessments over short time scales can result in apparently sustainable production but at the expense of the ecosystem (rather than maintaining its function).

Assessment of ecological sustainability has to be made over appropriate time-scales – which are often considerably longer than those used in conventional economic assessments of sustainability.

3 There is no particular reason to assume that the relationship between abstraction and ecological damage is linear, however.
4.4.3 Inter-generational Equity
Considerations of time scale introduce the issue of intergenerational equity. Intergenerational equity is an important issue and is succinctly analysed in the ACF submission to the Review\(^6\). A productive system cannot be considered sustainable if either the Industrial Capital or the natural resources and ecosystem that supports it are handed on to the next generation in a worse condition than that in which they were received. This evokes the notion of resource stewardship and the obligations which that implies.

In the case of the Murray-Darling Basin there appears to be little disagreement that the Natural Capital are currently in worse condition than it was when the current generation undertook this stewardship.

We are currently failing the test of intergenerational equity.

4.4.4 Future technological advances
It is tempting to excuse robbing future generations for current gain on the assumption that future technological development will redress the imbalance. This is probably the last vestige of the confidence of the mid-20th-century (see eg. Water into Gold, Hill 1951), which recognised the dedication and ingenuity of ‘pioneer generations’ and the power of technological advancement at the time. The conclusion was drawn that human resourcefulness and science would lead to boundless production and development. We now recognise that bounds exist and importantly, we may be reaching or even exceeding these bounds. This change has come about partly from being confronted by issues such a salinity, but also by a growing understanding of the ecological systems which underpin our natural resources. We are now beginning to recognise that the functioning of these systems is governed by laws of nature which technology can scarcely influence – let alone override. In other words, until recently, production was limited by Industrial Capital, which technology was able to improve significantly. Increasingly, production is now limited by Natural Capital that is virtually beyond the influence of technology. The messages from this are:

- We cannot expect technological advances to compensate for our borrowing from future generations any longer; and,

\(^6\) (ACF Submission to Review)

Inter-generational equity requires that the present generation ensures that future generations inherit an environment that maintains or improves current levels of welfare. It involves the following principles:

- ensuring a constant stock of natural capital* (*air, water quality, species and ecosystems, soil composition and structure, climate, and natural cycles such as carbon and hydrology);
- operating within biophysical limits to natural resource use, acknowledging that uncertainty and time irreversibility demand a precautionary approach;
- efficiency of resource use maximises benefits, and minimises costs to the future;
- resilience in natural systems and economic structures alike; and
- external balance in economic terms is important in minimising pressure to deplete natural capital.
In terms of scientific advances, future benefits are likely to be gained by increasing our knowledge of ecological systems that underpin the water resource and thereby learning efficiencies in supplying the water required for its maintenance.

We have used up the credit gained by technology and can no longer depend on it to pay our debts to future generations.

4.5 Defining Sustainability for the purposes of the Cap

The discussion paper, ‘Managing Natural Resources in Rural Australia for a Sustainable Future’ (Gorrie and Wonder 1999) states that the outcomes of future management should be:

- Healthy ecosystems and catchments in which the integrity of soils, water, flora, and fauna is maintained or enhanced whenever possible;
- Innovative and competitive industries that make use of natural resources within their capability, to generate wealth for social and economic well-being; and
- Self sustaining, proactive regional communities that are committed to the ecologically sustainable management of natural resources in the region.

The discussion paper further indicates that this level of management should lead to ecologically sustainable development (ESD) for which they quote the National Strategy for Ecologically Sustainable Development definition:

Ecologically sustainable development is using, conserving, and enhancing the community’s resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.

The objectives of ESD are expressed as:

- To enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- To provide for equity within and between generations;
- To protect biological diversity and maintain essential ecological process and life-support systems.

These descriptions incorporate the main aspects of sustainability and include issues such as production, quality of life, maintaining the ecosystem that maintains the resource, biodiversity, intra- and intergenerational equity. These are also the main issues raised in submissions to the review. However, mainly because of their global nature, they do not definitely answer questions such as:

- How long is long-term?
- How do we quantify sustainability against the background of extreme variability and unpredictability that characterises much of the Murray Darling Basin?

Costanza points out that measuring sustainability, including the measurement of success in adaptive management programs, is difficult because the achievement of sustainability, is by definition, at some point in the future.
The reference point for sustainability in the Murray Darling Basin is a sustained or increasing level of rural production achieved at an acceptable level of Industrial Capital (finance and ingenuity) at no cost to future generations. For production to be sustainable it must be achieved without:

- damaging or degrading the Natural Capital;
- contravening international biodiversity agreements; or
- resulting in unacceptable (to current of future communities) aesthetic damage.

The problem is how to strike a balance between water use for human and ecological uses. Failure to meet either requirement will result in collapse of the current system of production.

By limiting allocation for human use, the Cap, in effect, reserves a volume of water for ecosystem maintenance. The Cap does not prescribe how it is to be used. Currently, in many parts of the Basin, the community, with managers and other experts, are attempting to determine ways in which to deliver water to sustain the ecosystem – to provide environmental flows. This process will be continuously refined as additional ecological knowledge becomes available. However, it should be noted that it is the system itself – not the scientists, managers, or users - that will determine whether the quantity of water or its deployment is sufficient to sustain the ecosystem, and therefore sufficient to sustain production.

Production will only be sustained if both the ecosystem and the socio-economic system are sustained into the long-term. Collapse of production through failure of the socio-economic component is unlikely to harm the Murray-Darling Basin ecosystem. However, collapse of production through failure of the ecosystem will mean the collapse of the socio-economic component of the Murray-Darling Basin.

Recognising, then, that the ecosystem maintaining the resource is the key component to the future of the Murray-Darling Basin, sustainability should be defined as the indefinite preservation of:

- a functional and diverse ecosystem which, as well as meeting aesthetic and ethical requirements, provides a natural resource suitable for (all) human uses and production; and
- a socio-economic system capable of using the natural resource productively to the maximum good of the current and future communities.

In terms of its operation, the Cap must seek to apportion water between the riverine ecosystem and consumptive human uses such as to:

- reserve sufficient water to maintain the ecosystem in line with ESD principles; and
- preserve a supply of water suitable for human use.

It should be noted that the term ‘preservation’ is not meant to imply a static condition. Long-term rainfall patterns, climate change, changes in catchment management are all capable of producing significant changes to the amount of water available. Likewise socio-economic development will change production requirement (and, perhaps, ethical, aesthetic, and recreational views on the riverine ecosystem). This means that the Cap and any other means of sustaining the Murray Darling system, will need sufficient flexibility to achieve that goal whilst managing a changing resource.

### 4.6 Delivering a sustainable Cap

Flow management deals with a subset of factors required to sustain the riverine ecosystem. It does not take into account contaminants, alien species, or catchment management. It follows
that flow management can do little more than provide hydrological and other habitat requirements which, in the absence of limitation by other factors, will support a riverine ecosystem which, in turn, will sustain a given level of exploitation indefinitely. The amount of water required to maintain an ecosystem will depend on the efficiency with which the water is used to satisfy the ecosystems requirements. Just as productivity of irrigated agriculture depends on the efficiency with which that water is used, not just the quantity provided – so too does the ecological benefit derived from the environments allocation. Efficient use depends on ecological knowledge.

Essentially, a sustainable Cap requires an amount of water which, when used efficiently, will result in the indefinite support of the riverine ecosystem to the level that, in turn, supports exploitation indefinitely. The following should be noted:

- this amount of water is essential but not always sufficient, in that factors other and hydrology suppress ecosystem performance. This means that maximum use of water can be sustained only if all environmental factors are effectively managed;
- this definition of sustainability is entirely human oriented. The community may choose larger environmental allocations to achieve conservation and aesthetic goals outside those relating solely to production.

As a means of insuring sustainability, the Cap is a blunt instrument. In effect, by limiting the level of abstraction, it preserves a quantity of water for the riverine ecosystem. It says nothing about the way in which this water is to be used. There are direct environmental benefits of the Cap. For example, the Cap prevents further increases in the return frequency of very low flows which, under natural circumstances, could be considered as drought. For the main part however, the environmental benefits of the Cap, and hence its contribution to the sustainability of the system, will be dependent on the way in which the remaining water is managed.

It is most likely that the Cap would need to allow significantly less diversions if it were expected to achieve environmental sustainability on its own. Fine-tuning of environmental flows, based on ecological knowledge not yet to hand, is the only means of achieving environmental sustainability with a Cap that preserves something approaching current exploitation rates. Current indications of continued decline in the riverine environment indicate that the Cap is necessary, but not sufficient, to ensure sustainability.

In the interim, we are faced with making decisions regarding the use of the water reserved by the Cap to maximise the ‘health’ of the riverine ecosystem. This requires an adaptive management approach, because, whilst it is necessary for the community with management and technical support to make decisions about the allocation of water to support the ecosystem, it is the system itself which will decide if that is sufficient.

What then is the connection between the Cap and the indefinite sustainability of the Murray Darling Basin as a functioning socio-economic and ecological system? Blackmore (1999) states that “The Cap is critical to the long-term health of the Basin’s rivers and hence to all water users, now and in the future, and will be a permanent feature of water management in the Basin”. Submissions to this review indicate widespread agreement with the significance and intent of the Cap.

As the Western Catchment Management Committee suggest “Sustainability needs to be defined in the first instance by determining a flow regime which relates to actual needs under present developed circumstances and not by assuming that flow patterns can be made to revert to those which existed prior to irrigation development.” This describes clearly our present dilemma. It can be summarise as follows:
We have some understanding of the human requirements for the water resource, the possible efficiencies (in water use and delivery), and their likely cost;

There are generally accepted signs that the ecosystem which supports that resource is changing in the direction of functional breakdown in response to altered flow;

In the absence of adequate ecological knowledge, the surest way to support the riverine ecosystems is to increase the amount of water remaining in the system and to aim at restoring pre-European flow patterns (the level of sophistication in the management of environment's share compares unfavourably with what is expected of other water users);

Efficiency in producing ecological gains from environmental water allocations is dependant on increased knowledge of the relationship between ecological function and flow; and

With current land and water management the quantity of water reserved by the Cap is probably insufficient to halt ecological decline. We can expect a worsening quality of the Basin's water resource. However, knowledge-based increases in efficiency of supplying environmental water will tend to redress this situation.
5 Is the Cap at a sustainable level?

Address the impact of the operation of the Cap in achieving its objectives to ensure ecological sustainability of the Murray-Darling Basin river system by examining the question, "what does science tell us about the suitability of the level at which the Cap is set?"

"After years of extensive development of freshwater resources, particularly for agriculture, water demand management and water quality degradation have become important concerns" (OECD, 1989).

Historically, the environment used every drop of water from rivers within the Murray-Darling Basin. Once water is diverted from the river system there is an impact on the environment. The challenge for scientists is to identify, measure and understand that impact of current and future water diversions. The challenge for the community is to decide how much of an impact is acceptable. The ecosystem itself will decide if the system is sustainable. Adaptive management is needed to reach a sustainable balance and to adjust that balance for future changes.

The environment today is not what existed in the past. The Basin is moving to a new and different state. Water chemistry, hydrology, geomorphology and biota of the Murray-Darling river system have changed dramatically since the period of rapid expansion in diversions and they will continue to change, with changing patterns of water usage and as sufficient time passes for the slow-changing impacts occur. To decide on an acceptable level of diversions the community requires knowledge about how the environment is likely to function now and in the future at different levels of diversions.

Determining the limit of acceptable change in the Basin's river systems is arguably the most complex decision confronting the community. This section of the Review describes what science presently understands to be the effects of diversions and other water resource development on the function and sustainability of the river system as well as what constrains this understanding.

5.1 Improving scientific knowledge

Historically, the fundamental objective of water management was to regulate rivers to:

- meet demands for water supply by creating sufficient storage to control seasonal and between-year variations in flows⁷, and
- maximise consumptive use of the resource by minimising the amount 'lost' to the sea.

The emphasis is now changing toward allocating water to sustain natural ecosystems, to restore rivers degraded by over-abstraction or inappropriate regulation of the past, and to protect biodiversity for future generations (Petts 1996). The challenge for science is to provide the knowledge to achieve these aims in the most 'water efficient' manner.

In the five years since the Cap was introduced there has been considerable effort aimed at understanding the environmental water requirements of the Basin's rivers. Impetus for this

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⁷ Increases in storage capacity are still increasing in the Basin. Current storage capacity in the Basin is approximately 36,000 GL, more than 3 times the median flow to the ocean. Whilst most of the larger rivers are now regulated by large dams, storage capacity in the Basin continues to climb, with on-farm storage capacity continuing to grow at 2% each year (MDBC unpub. data).
understanding was provided by the adoption of the Council of Australian Governments’ (COAG) Water Resource Policy. The aim of the Policy is to achieve an efficient and sustainable water industry in Australia. A major component of the policy is the provision of water for the environment. To guide water management, the National Principles for the Provision of Water for the Ecosystems were jointly developed in 1996 by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Australian Resource Management Council of Australia and New Zealand (ARMCANZ). As signatories to the COAG Water Resources Policy and the National Principles for the Provision of Water for the Ecosystems, partner governments have committed to using the best science available in determining water regimes and to improving our knowledge of environmental water requirements.

5.2 Determining the impacts of diversions

There is considerable evidence that diversions from the Basin’s river system have had a major impact on the riverine ecosystem. It was in response to these, and the declining security of supply to existing water users, that the Cap was introduced. However, many submissions to the Review express disappointment that there is no evidence that the Cap on diversions has improved river health. That the Cap has not led to signs of improved river health is to be fully expected. There are a number of reasons for this, including:

- the Cap was implemented to restrict growth in diversions with a view to reduce further degradation of the riverine environment – not to improve the riverine environment;
- limited data (and tools) are available to quantify changes in river health;
- lack of dedicated program to identify impact of diversions and Cap;
- a growth in diversions since the implementation of the Cap;
- impacts of water resource development (other than the volumetric issues dealt with by the Cap) and catchment management confound impacts of water abstraction;
- impacts of other Water Reforms (eg trading, environmental flows) make it harder to isolate the impact of Cap from other reforms;
- time-lags between changing the level of diversions, first detecting an impact and reaching a new stable state.

5.2.1 Failure to quantify the impact of the Cap

A clear message from the submissions to the Review is that science has failed to demonstrate the environmental impact of the Cap, quite apart from whether the Cap actually has had an impact. A question often asked is, "does science have the tools, knowledge and data to demonstrate the environmental impact of the Cap - even if there is one?"

Since the introduction of the Cap, there has been increased research activity to understand the hydrological, geomorphological and biological processes occurring within the rivers of the Basin. This research has been undertaken by a number of research institutions including the CRC's for Freshwater Ecology and Catchment Hydrology, CSIRO and research groups in a number of universities and State agencies.

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8 Specifically principles 2 and 11 of the National Principles for the Provisions of Water for Ecosystems: Principle 2... Provision of water for ecosystems should be on the basis of the best scientific information available on the water regimes necessary to sustain the ecological values of water dependent ecosystems. Principle 11... Strategic and applied research to improve understanding of environmental water requirements is essential.
Encouraged by COAG’s Water Resources Policy, the States and Territory have developed programs to determine current condition of their water resources and the environmental water requirements of their rivers. These programs include:

- Queensland Governments Water Allocation Management Plans and Water Management Plans;
- NSW Rivers Survey and aspects of the New South Wales Government’s Water Reforms which includes the Integrated Monitoring of Environmental Flows (IMEF) and the Stressed Rivers Assessment;
- South Australian Government’s State Water Plan and Catchment Water Management Plans; and
- In the Australian Capital Territory the development of Environmental Flow Guidelines for the Water Resources Management Plan.

The Commonwealth has provided funding and policy support for the Basin’s rivers through various programs including:

- National Strategy for Ecologically Sustainable Development;
- National Heritage Trust – particularly the following programs:
  - Murray-Darling 2001
  - National River Health Program
  - Waterwatch;
- National Strategy for Conservation of Australia’s Biological Diversity;
- Wetlands Policy;
- National Water Quality Management Strategy (NWQMS); and
- MDBC Salinity and Drainage Strategy.

Funding has also been provided through the Commission’s SI&E program and LWRRDC to develop tools to determine river health and to estimate environmental water requirements and determine environmental flows.

There has been considerable effort and resources focussed on understanding how the Basin’s river system functions and to developing tools for assessing environmental condition and environmental water requirements. However, there are limited data available to quantify the impact of the Cap and there is no monitoring program designed to determine (either quantitatively or qualitatively) the environmental impact of the Cap. Statewide programs that could be used to determine the impact of the Cap are available. For example, Harris and Silveira (1999) provide a baseline Index of Biological Integrity (IBI) data against which to benchmark change in New South Wales rivers. The Integrated Monitoring of Environmental Flows (IMEF) program currently being developed for assessing the environmental benefits of water reforms in New South Wales will also be a valuable tool. In Queensland, ecological and geomorphological data collected for the WAMP’s will be useful.

Other data and tools are available for assessing river-health in the Basin and could be used to assess the impact of the Cap. These are presented within a listing of ecosystem condition indicators likely to be influenced by alterations in the flow regime was recently developed by the CRC for Freshwater Ecology (Table 5.1). While a sub-set of these indicators would be a minimum requirement for assessing the impact of water diversions (and the impact of the Cap), there are limited data available for much of the Murray-Darling Basin. However, these indicators do provide a starting point for assessing river health.
Table 5.1  Indicators of river health that may be used to assess the impact of the Cap.
(adapted from Technical Review of Elements of the WAMP Process of the Queensland DNR.

<table>
<thead>
<tr>
<th>Habitat variable</th>
<th>Description</th>
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<tbody>
<tr>
<td>Macroinvertebrates AUSRIVAS</td>
<td>The AUSRIVAS approach to sampling and analysis of macroinvertebrate communities provides a valuable index of river health.</td>
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<tr>
<td></td>
<td>AUSRIVAS data are generally the most comprehensive data-set currently available on general river health.</td>
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<tr>
<td></td>
<td>The value of AUSRIVAS predictions relies on the quality and applicability of the reference sites and regional models. There are few valid reference sites in lowland rivers and so analysis will have to consider this limitation. The method has had little validation in lowland rivers, which are the main focus of the Cap.</td>
</tr>
<tr>
<td>AUSRIVAS habitat measures</td>
<td>As part of the NRHP and the FNARH various habitat measures were collected including assessments of:</td>
</tr>
<tr>
<td></td>
<td>• riparian condition</td>
</tr>
<tr>
<td></td>
<td>• bank stability</td>
</tr>
<tr>
<td></td>
<td>• stock access to banks</td>
</tr>
<tr>
<td></td>
<td>• depth of water over riffles</td>
</tr>
<tr>
<td></td>
<td>Little use of these measures has been made in the past, but they do provide the basis for an index of habitat condition.</td>
</tr>
<tr>
<td>Index of Biotic Integrity (IBI), using fish communities</td>
<td>Metrics used in the fish-based Index of Biotic Integrity (IBI) include:</td>
</tr>
<tr>
<td></td>
<td>• Number of native / alien species</td>
</tr>
<tr>
<td></td>
<td>• Numbers of individual fish</td>
</tr>
<tr>
<td></td>
<td>• Species richness</td>
</tr>
<tr>
<td></td>
<td>• Trophic and habitat guilds</td>
</tr>
<tr>
<td></td>
<td>• Condition of fish</td>
</tr>
<tr>
<td></td>
<td>Fish stocking activity and the effect of barriers on fish passage may need to be considered.</td>
</tr>
<tr>
<td></td>
<td>Difficulties with both AUSRIVAS and the IBI include the poor representation of reference condition and the spatial and temporal variability of faunal community structures.</td>
</tr>
<tr>
<td>River Cross-Sections</td>
<td>River cross section is sensitive to gross changes in the flow regime. Channel contraction has been identified as a significant effect of water abstraction.</td>
</tr>
<tr>
<td>Aquatic macrophytes</td>
<td>The presence / absence and the percentage cover of macrophytes can be strong indicators of flow regime, however more research is required to interpret macrophyte data.</td>
</tr>
<tr>
<td>Incidence of fish kills</td>
<td>Fish kills may be flow related and autopsy data plus flow records should indicate if this is the case.</td>
</tr>
<tr>
<td></td>
<td>It may be difficult in some cases to know if fish kills are a response to environmental change or a density-dependent response to successful recruitment.</td>
</tr>
<tr>
<td>Fish Condition (lesions etc)</td>
<td>May be flow related, caused by crowding below barriers during migration, or sudden contraction of habitat through water diversion.</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Water Quality</td>
<td>Turbidity is catchment specific and temporally variable with very high turbidities occurring naturally in most western rivers. Difficult to determine what are &quot;good and bad&quot; turbidity values. A reference-related predictive capability is required. Open water oxygen percent saturation may be a valuable indicator, however it is highly variable over short time scales (e.g. day/night). Temperature data will indicate thermal pollution (such as chilling below a major impoundment or heating through loss of riparian vegetation) and the development of stratification, which is important for blue-green algal growth under low flow conditions.</td>
</tr>
<tr>
<td></td>
<td><strong>Turbidity</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Dissolved oxygen</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Temperature</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Nutrients</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Salinity</strong></td>
</tr>
<tr>
<td>Riparian vegetation</td>
<td>The extent and condition of riparian vegetation can be flow dependent. Structural changes in riparian vegetation and changes in vegetation condition do respond to the flow regime.</td>
</tr>
<tr>
<td>Landuse</td>
<td>Indices such as area of a particular land use upstream, human populations, road development, remnant native vegetation or percentage tree cover may explain some of the variation in river health. Landuse has also to account for quality of land management.</td>
</tr>
</tbody>
</table>

A number of programs have been undertaken across parts of the Murray-Darling Basin to determine environmental water requirements. Some data on ecological condition have been collected. However, without a long-term coordinated program to assess the impact of the Cap on the condition of the riverine environment it is unlikely that an environmental impact of the Cap can be unequivocally shown.

Rainfall and river flows are exceptionally variable in the Murray-Darling Basin. The complexity of measuring the ecological effects of maintaining current levels of diversions with the variability and the long time periods for change to occur makes it unlikely an impact could be quantified over a five year period. Especially since there are few pre-Cap data against which to assess change. The focus should be on conserving ecosystem function, and developing tools and techniques for assessing whether this has been achieved.

### 5.2.2 Why is the Cap set at its current level?
A clear message arising from the submissions to the review was that the level at which the Cap was set, rather than the need for a Cap, was not supported by rigorous science. The Cap was implemented in response to the Water Audit. The Audit showed diversions from the Basin’s rivers were increasing significantly and would continue to rise unless water management arrangements were amended. The Audit concluded that current consumptive use of water was
significantly impacting on the health of the Basin's rivers and increasing diversions would threaten the security of existing allocations.

The Water Audit (MDBMC 1995) listed a number of environmental impacts of consumptive water use on river health. The Water Audit argued that water diversions, by reducing flows, provided conditions that encourage the growth of blue-green algal blooms. These include the development of stratified 'stable' waters, which provide a suitable light climate for buoyant blue-green algae. The Water Audit argued that stratification increased anoxia in the bottom waters and sediments promoting the release of nutrients from the sediments. Also, less water in the rivers reduced the ability to flush blooms when they did form. The Water Audit recognised that reduced flows lead to increased salinity problems because as there is less water in the rivers and a constant or rising salt load, the salt concentration of the remaining water has to increase. The Water Audit recognised that floodplain health is dependent upon frequency of inundation. With fewer floods, the ecological functions performed by wetlands are compromised. For example, with less frequent flooding the Water Audit argues that there would be less nutrient captured and retained on the floodplain. As increased diversions reduce river flows, flooding is less frequent and the Water Audit details the considerable loss in areas of wetlands across the Basin attributable to lack of water. The Water Audit indicated that losses in wetland habitat have resulted in serious reductions in the numbers of the birds, fish, amphibians and insects that depended upon them. The changes in flow patterns in the Basin's rivers resulting from the collection, storage and distribution of water for consumptive use are detailed. The Water Audit indicated that reduced flows in the Basins rivers had decreased the frequency with which weirs drowned out, further restricting the passage of fish. In summary, the Water Audit recognised that current and projected increases in diversions represented a clear danger to the riverine environment. It is important to remember that the environmental impacts documented by the Audit occurred prior to the introduction of the Cap and these problems were probably the result of water diversions below the current level of abstraction allowed by the Cap.

In response to the issues raised by the Water Audit an interim Cap on diversions of water was introduced. This was confirmed as a permanent Cap in 1997. In 1995 the Cap was seen as an essential first step in establishing a management system to achieve healthy rivers. The level of the Cap reflected the levels of diversions at the time of the Water Audit – the climate-adjusted levels of diversion in the last full year of irrigation before its introduction. This is clear from its definition, “The volume of water that would have been diverted under 1993/94 levels of development...” The important point is that the Cap was introduced to stop further expansion of diversions. The Cap was not designed to represent a sustainable level of diversion.

The Water Audit catalogued environmental impacts of water diversions, but importantly, did not attempt to determine a sustainable level of water abstraction required to rehabilitate the river. Therefore there is no a priori reason to expect that the Cap represents a sustainable level of water diversion or a level of diversion that will improve river health.

5.2.3 Diversions continue to increase

At best, the Cap would have restricted diversions from increasing beyond the climate-adjusted levels of 1993/94. This has clearly not happened. Diversions in the northern areas of the Basin have continued to increase and compliance in the mid-sections of the Basin is regularly questioned (eg. MDBC, 1999c,d). In the Southern section of the Basin, diversions in 1997/98, and again in 1998/99 for the River Murray have been constrained by the amount of water in storage, not the level at which the Cap was set.

See section 5.2.5 for a discussion of time lags.

See Section 6.6 for discussion about the suitability of the models used to determine the level of the Cap.
The Cap has constrained the growth in diversions in some of the Basin's river valleys, however in parts of the Basin the trend in diversions is still rising. Rising diversions, wherever they occur in the Basin, impact downstream. While abstractions have continued to rise since the implementation of the Cap, it is not possible to determine whether at the Basin scale the Cap has been exceeded. There are two reasons for this. Computer simulation models required for determining Cap compliance throughout the Basin have not yet been developed. Currently only four of the 22 valleys (18%) have draft models submitted to the Commission. Also, the Cap level has yet to be determined for Australian Capital Territory and Queensland. Until the level of the Cap is determined for all jurisdictions and models are available to assess compliance it will not possible to determine if the Cap is exceeded.

5.2.4 Many factors influence river health

River and floodplain ecosystems are extremely complex, and we do not fully understand how they function. However, based on the best available scientific knowledge, models of river function for the Murray-Darling Basin are being developed. Our models will improve and adapt as more research is undertaken and completed. These models will allow the design of better ways to deliver water downstream – to protect or restore important ecological functions, as well as to provide downstream users with water.

The proportion of flows diverted is a major influence on river health across the Basin. Many factors affect river health and ultimately sustainability. Non-flow factors such as land use and management, introduction of alien species, and the loss of longitudinal and lateral connectivity resulting from the building of physical barriers such as weirs, dams and levees are critical. The way water is captured, stored and delivered also impacts on river health. These impacts on river health, and how water diversions affect them will be discussed.

5.2.4.1 Flow patterns

The flow regime is central to controlling the form and function of a river (Walker and Thoms 1993). The amount of water in a river is an essential component of the flow regime, but so too is the timing of flows. The salient feature of dryland rivers is flow variability (Walker et al 1995). Compared to many of the world's other major river systems, flow regimes of the large Murray-Darling Basin rivers are exceedingly variable. Two aspects of variability are important, the magnitude of the variations and the temporal pattern, or sequencing, of the variations (Young, 2000).

The magnitude of variations, the size of floods and droughts, is altered by the presence of dams. That was why storages were built in the first place – to reduce natural variability. This is clearly expressed by Blackmore (1989). "In their unregulated state, the streams within the Murray-Darling Basin were unreliable, thus putting at risk any permanent development. They generally followed a yearly cycle of flows, which included winter and spring flooding, gradually receding until, between February and May, they were, in many years, reduced to trickles. ...It was the need to overcome this massive variability and provide adequate flows in all years to sustain development that drove regulation of the rivers in the Basin".

Water resource development has successfully reduced variability in streamflow. Currently, the storage capacity in the Basin is 36,000 GL – approximately three years of diversions from the Basin's river system. Storage capacity is more than 14 times the current median annual flow past the barrages in the Lower River Murray. However, large floods and drought-like flows are still a feature of the Murray-Darling Basin river system.
The temporal sequencing of flows has to be considered at a number of time scales, from daily to seasonal to interannual. The huge storage capacity existing in the Basin has led to a more stable water regime. There has been a massive reduction in the small to mid-sized floods below major storages in many of the Basins rivers. For example minor to medium floods (up to one in seven year exceedance level) entering the Coorong have been eliminated (Jensen et al, 1998). Releasing stored water for downstream use results in constant flows for sustained periods at times of the year that would naturally have lower and more variable flows. For example, rivers in the southern part of the Basin, such as the Murray, Goulburn, Campaspe and Murrumbidgee, naturally had high flows in winter and spring and low flows in summer and autumn. Releasing water for irrigation during summer months means that these rivers now have high flows during the naturally dry time of the year. Unseasonable high flows tend to flood wetlands at the wrong time of the year and do not allow natural wetting and drying cycles to occur. During summer and autumn high river flows in the south of the Basin severely reduce the chances of emergent aquatic plants establishing on the riverbed and banks. There are many ecological responses to reduced flow variability. These have been summarised by Young (2000) and presented in Table 5.2.

Flow regulation has generally led to a decrease in short-term flow variability, and has altered the seasonal flow patterns. In the south of the Basin, seasonal patterns are commonly reversed below the major dams, to supply irrigation water during the naturally low-flow summer period. In the north, summer rain dominates, and so regulation has enhanced rather than reversed the seasonal pattern. The impacts of reduced flow volumes on river health are difficult to isolate from those associated with changing the timing of flows and reducing the variability of the flow regime.

Table 5.2. The ecological responses to change in flow variability. (Reprinted from Young, W.J. (Ed) (2000) "Rivers as Ecological Systems – the Murray-Darling Basin", in press.)

**Flow hydraulics:**
- The variability of flow determines the variability of depth, velocity and shear stress. Decreases in flow variability lead to a reduction in the temporal variability of hydraulic conditions. Flow variability may change at the daily and, or seasonal scales. Changes in hydraulic patterns at both scales are important for instream habitat (see below).
- The short-term flow variability associated with freshes and minor floods is important in determining the frequency of lateral connections with the riparian zone.

**Sediment and nutrient transport:**
- The short-term flow variability associated with freshes (within channel high flows) and small floods is important in determining how often the river bed is disturbed. As well as influencing sediment transport, this flow variability determines the disturbance regime for bottom-dwelling (benthic) plants and animals.
- The short-term flow variability of freshes and floods is also important in moving organic material from the riparian zone and backwaters into the main channel.
- Bank slumping (see below) will lead to increases in the amount of sediment entering the channel, leading to local sedimentation and increases in turbidity.
- Changes in the seasonal variability of flow will alter the seasonal pattern of material transport. These may alter important seasonal variations in habitat character. Clean gravels, for example, flushed of fine sediment, are required for the spawning of native fish such as Macquarie perch and Catfish. Changes to the seasonal patterns of flow may mean the required flushing does not occur. Changes in the seasonal pattern of nutrient availability may alter the seasonal patterns of instream production.
**Channel forms:**
- Reduction in the short-term variability of flows often leads to incision of channel banks. Over time, banks may erode sufficiently to cause bank slumping, thus further altering the cross section shape.
- Generally, a reduction in short-term flow variability will reduce the complexity of the channel cross section, making it progressively more canal-like. This in turn will affect transport of material and nutrient processes, as the loss of river structures such as ‘benches’ and other zones of lower velocity, decreases the opportunity for material to be deposited and decomposed.
- Channel benches are related to modal (the most frequent) flows. Where the modal flows change or flows become uniform, changes in cross-sectional shape will occur. Constant flows lead to simple rectangular cross-sectional (canal-like) channels.
- Short-term flow variability provides a diversity of bedforms and substrate types on the river bed. Reductions in flow variability will alter these aspects of channel-bed character.

**Riverine habitats:**
- Reductions in short-term flow variability lead to reductions in habitat diversity. Changes in flow hydraulics are particularly important over short periods of days to weeks. This temporal variability is an important characteristic of aquatic habitat.
- The seasonal pattern of flows is an important feature of instream habitat. Changing the seasonal patterns of flow will alter the seasonal availability of habitats. As well as changing flow hydraulics, a change in seasonal pattern often changes the seasonal thermal regime of aquatic habitats.
- Fish have differing hydraulic preferences for resting, feeding and spawning. The short-term and seasonal changes in flow determine the suitability of instream habitat for different fish species. During short periods of higher flow, for example, fish may seek refuge in backwaters or under banks. Changes in flow variability change the nature of the backwater habitats and change the strength of their connection with the main channel.
- The soil moisture in the riparian zone depends on the water depth in the river. The habitat of deep-rooted riparian plants is characterised by the variability of flow depth. Changes in flow variability will alter the character of these habitats.

**Riverine plants and animals:**
- The habitat changes associated with changes in flow variability will influence the plants and animals in the river system. Where flow variability is reduced, the reduction in habitat diversity is likely to lead to changes in both species composition as well as a reduction in species diversity.
- Reduction in the frequency of depth changes is likely to alter the composition of riparian plant communities, while reduction in the frequency of bed disturbance is likely to lead to less diverse benthic fauna.
- Changes in the seasonal pattern of flows may alter the levels of instream primary production. For example, irrigation release flows, may prevent suitable conditions for algal growth. Alterations to water temperature caused by changes to the seasonal flow pattern also cause changes in the levels of instream production.
- Seasonal flow patterns provide cues for the reproductive behaviour of some animals higher up the food chain. For example, some species of native fish depend on freshes to trigger spawning. Seasonal flow patterns may also trigger non-spawning migratory behaviour in some fish species. In upland river sections, small freshes are often required to enable fish to pass natural barriers such as rock weirs.
- Changes in the seasonal pattern of flows may alter the seasonal growth patterns of deep-rooted vegetation along the river bank.
- Seasonal flow patterns also determine the breeding responses of some bottom-dwelling invertebrates, and hence are important for determining species composition.
- Bank slumping leads to a reduction in littoral and riparian plants, but an increase in the recruitment of large woody debris to the river.
5.2.4.2 Connectivity

"Floodplain river ecosystems are among the planet's most valuable, and most abused, resources. In the unaltered state, they are dynamic in space and time, thereby constituting an environmental mosaic inhabited by lotic, lentic, semiaquatic, and terrestrial species" (Ward 1995).

Rivers are characterised by longitudinal, lateral and vertical gradients of physical and chemical processes and biological communities (Petts 1996). There is an exchange of nutrients, matter and energy downstream (Vannote et al. 1980) and laterally between the river and the floodplain and between surface water and groundwater. These environments, upstream–downstream, in-channel and the floodplain are connected, sometimes intermittently, by water. The need to maintain this connectivity is an important feature of river management. Diverting water from the rivers reduces connectivity.

Ward and Stanford (1995) argue that resource managers should become 'conservators of ecological connectivity'.

Physical barriers, such as the construction of weirs and dams reduce longitudinal connectivity along a river as can water abstraction. Diversions increase the chance of a river ceasing to flow and forming a string of unconnected waterholes. Floodplains connect running waters with standing waters and terrestrial systems with aquatic systems. They are also areas where surface waters and ground waters are linked vertically (Ward, 1995). Water moving over the floodplain–floods, and the disturbance resulting from flooding provides the driving force to maintain the ecological connectivity and integrity of the floodplain ecosystem (Ward and Stanford 1995).

Reductions in connectivity reduce the ecological integrity of river systems. Building levees on the floodplain severs lateral connectivity. Connectivity is also reduced by major changes to the flow regime, such as reducing flood peaks, flood frequency and channel forming flows. Flow regime is influenced by both the amount of water diverted from the rivers and by how water is captured and delivered for downstream use. The Cap protects against further growth in diversions, but other contributors to lost connectivity also require management.

5.2.4.3 Water Quality

Together with the flow regime, land use determines the quantities of sediment and nutrients that move through the river system. Land management determines the amount of salt and nutrient in the soil, the susceptibility of this soil to erosion, and the likelihood of this soil reaching the river system. This in turn is an important determinant of in-stream water quality. Water quality has significant impacts on river health. The impacts of salinity and blue-green algae are discussed in Section 5.1.

Separating the effects on river health of the amount and delivery of water in the river from the effects of water quality is difficult because water quality is dependent on flow regime.

Releasing water from the base of large dams can significantly reduce the temperature of water downstream. This is a common problem with the large, bottom release dams throughout the Basin (Table 5.3).
Cold water releases can have negative impacts on the fish, amphibians, aquatic insects and plants that live below them. In particular, as they are all cold-blooded organisms, cold water slows their growth and development and reduces their chances of successful reproduction. Unless water temperature in these sections of river is increased, sustainable populations of many native organisms will not re-establish.

5.2.4.4 Pest Species
The introduction of alien species, such as carp, has had a major effect on river health. Carp numbers have been correlated with the degree of river regulation. The NSW Rivers Survey (1997) found that carp were most abundant in rivers modified by the effects of dams and agriculture. The effects of alien species are extremely difficult to disentangle from the effects of poor river and catchment management. For example, carp feeding habits have been shown to prevent macrophyte regeneration and to cause water quality problems. This view is expressed by the Lachlan Shire Council, “Yes, water quality has deteriorated, river health has deteriorated but only since the invasion of the carp. Yet the ratbag fringe who have infiltrated NCC and other "quangos" have been able to convince all and sundry that over use of water by greedy irrigators is the root of the problem.”

While carp do exacerbate long-standing river-health problems such as loss of water plants, blue-green algal blooms, bank erosion and poor water quality, they are only adding to and accelerating the effects of long-standing impacts associated with agriculture and water-resource development.

Constant river heights in weir pools, releases from dams and weirs, excessive pumping that accelerates bank instability, trampling of banks by cattle, clearing of riverside vegetation and catchment erosion all contribute to the problem. It is rarely possible to separate the ecological impacts of alien species from the impacts of catchment management and alterations in flow pattern and volume.

5.2.4.5 Conclusion
These examples demonstrate that river health is dependent upon many factors. However, the amount of water in the river system is a critical determinant of river health. Water quality, the influence of alien species, the lack of flow variability and longitudinal and lateral connectivity all influence river health and are dependent upon the amount of water diverted from the
Murray-Darling Basin river system. The impacts of these factors on river health are also modified, at least in part, by how the land and the remaining water in the Basin are managed. Determining a suitable level for the Cap depends upon how well the catchment and non-volume aspects of river regulation are managed. For example, if riparian and floodplain vegetation is being decimated by intensive cattle grazing, restoring flow volumes to 'natural' will not restore the floodplain and riparian vegetation. Similarly, reintroducing flows sufficient to re-instate small to medium sized floods will not increase river–floodplain connectivity if the floodplain is separated from the river by levee banks.

5.2.5 **Time lags**

Significant time lags occur between a change in the flow regime and when an environmental impact can first be detected. There are even longer time lags between a flow change and the development of a new equilibrium. These time lags represent a major difficulty in determining a sustainable level of diversions.

The time-scales for some ecological changes in riparian ecosystems resulting from flow reductions are likely to be in the order of centuries (Church 1995). For example, Young (2000$^{11}$) indicates that Black Box (*Eucalyptus largiflorens*) requires a flood frequency of one in three to one in five years with a duration of two to four months to maintain populations. However, Black Box are quite drought hardy, and have survived on the Chowilla floodplain with considerably reduced flood frequency. Regeneration, however, occurs only after floods when seedlings can take advantage of the moist ground. The impacts of reduced flooding on long-lived species, such as Black Box, may not be apparent for hundreds of years. Time-scales of other riparian responses may be much shorter, with lags of seasons, years or decades before changes become evident.

The time-scales for morphological adjustments in river sectional geometry can be of the order of decades to centuries when flows are reduced (Church 1995). There have been significant changes in the channel profile of the lower reaches of the Murray River as a result of weir building and lower flows. These changes are still incomplete 60–70 years after weir construction and significant increases in diversion (Thoms and Walker 1993). Young (2000) summarises the expected time-scale for various changes to occur to a river in response changes in flow and sediment regime for upland and lowland river sections in the Murray-Darling Basin. This is reproduced in Table 5.4.

Table 5.4. **Time scales of river channel change for upland and lowland river sections in response to natural or human-induced changes in flow or sediment regime.** (Table 3.4 reprinted from Young, 2000).

<table>
<thead>
<tr>
<th>Upland River Sections</th>
<th>Lowland River Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Years</strong></td>
<td><strong>Decades</strong></td>
</tr>
<tr>
<td>Wider</td>
<td>X</td>
</tr>
<tr>
<td>Narrower</td>
<td></td>
</tr>
<tr>
<td>Deeper</td>
<td>X</td>
</tr>
<tr>
<td>Shallower</td>
<td>X</td>
</tr>
<tr>
<td>Straighter</td>
<td></td>
</tr>
<tr>
<td>More sinuous</td>
<td></td>
</tr>
<tr>
<td>Steeper</td>
<td>X</td>
</tr>
<tr>
<td>Flatter</td>
<td>X</td>
</tr>
</tbody>
</table>

$^{11}$Example adapted from Young (2000) pg 139
Walker and Thoms (1993) argue the large temporal variability in the Lower Murray ecosystem suggests that we must view the river over a longer time frame than is necessary for rivers in regions with more stable climate. From an ecological perspective, time-scales of the order of a few hundred years are appropriate for the lower Murray ecosystem. Walker et al (1995) elegantly encapsulate the difficulties of managing low land rivers "A big-river ecosystem is therefore 'a moving target', and we need to consider its trajectory more than its status at merely a few points in space and time."

Recognising the long time-scales over which biological and physical changes occur re-enforces the need for a precautionary approach to be taken. Just as it may take decades or longer to see the full ecological impacts of water diversions, so too it is likely to take decades to see the full ecological impacts of improving flow regimes. This provides a suitable timeframe over which to assess the impacts of the Cap.

The ecological damage evident to the Water Audit in 1995 was the result of exploitation from a number of years before, when diversions were lower. It is essential to recognise that the effects of today's diversion levels may not be fully appreciated for decades to come.

### 5.3 Are current levels of diversions sustainable?

It is clear that to achieve sustainability for the Basin the level of the Cap will depend upon how well the river is managed. The more skilful river management is, the less impact abstractions will have.

Notwithstanding the difficulties of separating out the effects of reduced volumes from other hydrological and land management effects, and the problems of time lags there are a number of indicators that show clearly that with current management practises, current levels of abstractions are not sustainable.

#### 5.3.1 Global perspective

Some 40% of the world's food comes from irrigated agriculture, however globally the productivity of irrigation is threatened by increasing diversions, over-pumping of groundwater and salination of the soil. For example, it is estimated that one in five hectares of irrigated land across the globe is damaged by salt (Postel 1999) The volume of water being diverted from many of the world's big rivers and their wetlands has resulted in serious ecological damage. The total area of wetlands in the world has been halved (Meyers 1997 cited in Cosgrove and Rijsberman 1999). China's Yellow River first ran dry in 1972. Since 1985, it has run dry for part of each year. In 1997, it failed to reach the sea during 226 days. Similarly, much of India's Ganges River is diverted before it reaches the Bay of Bengal. This seriously threatens the unique ecosystem of the Sunderband Wetlands in Bangladesh as the reduced flows have allowed a rapid advance of the saline front across the western portion of the delta. Flows in the Colorado River in south western United States rarely make it to the sea, which has decimated the Gulf of California's fishery. The World Commission on Water for the 21st Century cites the Nile River as having serious problems, as only 10% of its original flow reaches the sea. Consequently the Nile delta is rapidly shrinking. Under natural conditions subsidence in the Nile delta was compensated for by the continual re-supply of sediment from the Nile River. With the completion of the High Dam at Aswan most sediment now does not reach the delta, consequently it is subsiding and shrinking – the town of Borg-el-Borelos is now two kilometers out to sea (Postel, 1999). The character of the Indus delta that borders India and Pakistan is significantly changing as a result of flows to the sea have being reduced to 20% of the annual average flow. This has reduced the delta's extensive mangrove forests by nearly 250,000
hectares and a major prawn fishery the forests support is threatened (Pirot and Meynell 1988). The plight of the Aral Sea is one of the world's graphic environmental disasters. Increases in diversions from the Amu Darya and Syr Darya rivers to support irrigated cotton production between 1960 and 1980 reduced average flows to the Aral Sea to 13%, from 55,000 GL to 7,000 GL. This has resulted in dramatic reductions in biodiversity on the floodplains and deltas of the Amu Darya and Syr Darya rivers as 30,000 ha of wetland are now dry, and has resulted in a lowering of the Aral Sea by 17 metres (UNESCO, 2000). Other problems include the loss of large areas of deltas for agriculture through insufficient freshwater and salination of soils. There are also increased difficulties in providing good quality drinking water as salt concentrations rise. Long-term restoration of the Aral Sea's ecosystem would require that water withdrawals for irrigation be reduced to a fifth of the current level (FAO, 1996). Complete restoration is now considered impossible. The goal of the Governments of Uzbekistan, Turkmenistan and Kazakhstan is not the restoration of the Aral Sea, "...as that would mean curtailing irrigation which is socially and politically unimaginable" but rather to stabilise the environment of the Aral Sea Basin, to rehabilitate the disaster zone around the sea and to improve the management of the international waters of Aral Sea Basin (UNESCO, 2000).

Around the world there is mounting evidence that high levels of diversions have major influences on rivers, the wetlands they support, and on the receiving waters – such as estuaries and oceans. The examples above are regularly cited as high profile, international examples of over abstraction and declining water quality. The sobering reality is that the proportion of abstraction from the Murray-Darling Basin prior to being capped was approaching the proportion of abstraction in these systems.

5.3.2 The Coorong

Under natural conditions, approximately one half the runoff that entered the Murray-Darling Basin river system flowed to the Coorong estuary. At the Cap level of diversions, the median annual flow at the barrages at the lower end of the River Murray is 2,540 GL/year. Therefore, in half of the years, 21% or less of the natural flow of the River Murray reach the Coorong estuary. Coupled with this reduction in median flows, the frequency of extended no-flow periods has increased from one in twenty years to one in two and minor to medium floods (up to one in seven year return frequency) have been eliminated (Jensen et al. 1998). The barrages, which separate the saline Coorong estuary from the fresh waters of the Murray, have reduced the estuary to 11% of its original area.

Reduced freshwater inflows are identified as the major ecological threat to the remaining Coorong estuary. River flow affects the physical and chemical properties of estuaries—the geomorphology, salinity, turbidity and nutrient levels such as nitrogen, phosphorus and carbon. These in turn influence the distribution and numbers of commercially important fish and crustaceans, as well as many other organisms. A reduction in freshwater flows below a certain system-specific level can completely alter the estuarine food web, turning it from highly productive system to one with a substantially reduced productivity (Livingston RJ et al 1997). Loneragan and Bunn (1999) provide a strong correlation between river discharge and production of coastal and marine fisheries in southern Queensland. They also show that the seasonal pattern of flow is equally important as the magnitude of flow. They conclude that river regulation is likely to have a dramatic effect on the production of coastal fisheries. In the Coorong commercial catches of Black Bream, Green Flounder and Mulloway have declined dramatically since significant river regulation. Pre-regulation catches of Mulloway were in the vicinity of 400-600 tonnes per annum, now they are between 40 and 80 tonnes per annum. Similarly, Black Bream catches have declined from a pre-regulation level of 100 tonnes per annum to less than 10 tonnes per annum.
Controlling diversions from the Murray-Darling Basin is seen as a key issue for the sustainability of the Coorong and Lakes Albert and Alexanderina. For example, closure of the Murray mouth is related to the reduced median flows in the River Murray. Lower flows will mean the mouth is more frequently blocked.

The management aim recommended by Jensen et al. (1998) for the Lower Lakes, the remnant Coorong Estuary, the mouth channel and the off-shore zone is to increase the flows from the barrages (Jensen et al 1998). This will require a Basin-wide review of water allocation to decrease the current level of diversions. However, the current Cap is a fundamental tool for ensuring that flows reaching the lower Murray are not reduced further.

5.3.3 Terminal Wetlands

Nearly all of the Basin's major rivers have a large terminal wetland complex in the open floodplain section (Young 2000). These terminal wetlands include the RAMSAR listed Macquarie Marshes, Lake Albacutya, Lower Gwydir Wetlands and the Narran Lakes and other major wetlands of significance including the Great Cumbung Swamp and the Paroo Overflow. Terminal wetlands occur where flows spread out over the floodplain producing large shallow areas of inundation. Under low and medium flow conditions most of this water either evaporates or seeps into the soil. Very little flows out of the wetland. Outflows are only significant during large floods. The international significance of the Basin's terminal wetlands are recognised by their listing as Wetlands of International Importance.

Outflows from terminal wetlands are generally low to zero in all but the wettest years. Low outflows have been used in the past to argue that rivers flowing into terminal wetlands should be considered outside of the Cap. For example, the Lachlan Shire Council states, "The former Director General of "Water", Peter Millington publicly stated the Murray Darling Cap "should not apply to the Lachlan River because for all practical purposes it does not have any effect on the health of the Murray Darling system, positive or negative". Similarly, the Twynam Group argues, "The Lachlan River should be excluded from the MDB Cap as it does not contribute flows to it, emptying into the Great Cumbung Swamp which only connects with the Murrumbidgee in the largest of floods". However, this is not widely held view across the Basin with most submissions recognising that these rivers are an integral part of the Basin's river system and need to be managed accordingly. For example, Lachlan Valley Water recognises the Cap, but questions the appropriateness of its level.

Terminal wetlands are of considerable ecological significance to the Murray-Darling Basin and are seriously threatened by water diversions. Connectivity between rivers like the Paroo, the Lachlan and the Macquarie with the rest of the Basin is critical for maintaining their genetic diversity. As genetic diversity declines the resilience of the ecosystem in these rivers also declines, reducing the ecosystem's ability to adapt to long-term flow change (which ironically includes river regulation) or recover from short-term disturbance, such as drought.

Migration of fish and other aquatic animals requires floodwaters to connect between upstream and downstream of the terminal wetlands. During floods, discharge from the terminal wetlands provides significant water downstream. This water carries with it energy to fuel downstream foodwebs, in the form of organic carbon (See Section 9 – Condamine-Balonne Case Study). The large terminal wetlands of the Basin support massive colonies of migratory birds. There also clear groundwater connections between the upstream rivers and the rest of the Basin.

Across New South Wales, an estimated 50% of wetlands have been lost since river regulation commenced (NSW State of the Environment Report, 1997). The decline in area of wetland has been more dramatic in some regions of the Basin. Examples are presented in Table 5.5
(reprinted from "Floodplain and Wetlands Management Strategy for the Murray Darling Basin" MDBMC 1998). In most cases, reduced flow is the primary reason for reductions in their area. The impacts of changing water regime has been identified as the highest priority issue for the National Wetlands R&D Program. Changes in flow regimes have been listed as seriously threatening the conservation of each of the following Murray-Darling Basin RAMSAR Sites:

- Riverland
- Macquarie Marshes
- The Coorong, Lakes Alexanderina and Albert
- Lake Albacutya
- Barmah Forest
- Kerang Wetlands
- Gunbower Forest
- Hattah-Kulkyne Lakes
- Lower Gwydir Wetlands
- Narran Lakes

These sites, having been nominated as Wetlands of International Importance or RAMSAR Sites, have special ecological character, and often have unique qualities. Australia has an international obligation under the Convention to ensure the special ecological values of these sites are maintained or improved.
Table 5.5  Reductions in areas of wetlands across the Basin. These reductions are primarily the result reduced flows to them. Table from MDBMC 1998.

<table>
<thead>
<tr>
<th>State</th>
<th>River</th>
<th>Floodplain Wetland Type</th>
<th>Original Area of Wetland</th>
<th>Current area of wetland</th>
<th>% reduction in wetland type</th>
<th>Source of Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Victoria</td>
<td>State-wide</td>
<td>Shallow Freshwater marsh</td>
<td>33 531 hectares</td>
<td>9814 hectares</td>
<td>71%</td>
<td>Norman and Corrick 1988</td>
</tr>
<tr>
<td>Victoria</td>
<td>State-wide</td>
<td>Shallow Freshwater marsh</td>
<td>2131 individual wetlands</td>
<td>988 individual wetlands</td>
<td>54%</td>
<td>Norman and Corrick 1988</td>
</tr>
<tr>
<td>Victoria</td>
<td>State-wide</td>
<td>Deep freshwater marsh</td>
<td>109 315 hectares</td>
<td>30 226 hectares</td>
<td>72%</td>
<td>Norman and Corrick 1988</td>
</tr>
<tr>
<td>New South Wales</td>
<td>Gwydir River–Gingham Watercourse</td>
<td>Couch meadow wetland</td>
<td>13500 hectares</td>
<td>1000 hectares</td>
<td>92%</td>
<td>McCosker and Duggin 1993</td>
</tr>
<tr>
<td>New South Wales</td>
<td>Macquarie River</td>
<td>Intermittently flooded floodplains including 40000 hectares of perennial marsh</td>
<td>190000 hectares uncleared</td>
<td>95000 hectares uncleared</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>New South Wales</td>
<td>Gwydir River</td>
<td>Water couch wetland</td>
<td>7500 hectares</td>
<td>5000 hectares</td>
<td>33%</td>
<td>Kyte 1994</td>
</tr>
<tr>
<td>New South Wales</td>
<td>Murrumbidgee River–between Wagga Wagga and Hay Weir</td>
<td>Open water ephemeral wetlands</td>
<td>100% of wetlands intermittently flooded</td>
<td>69% of wetlands intermittently flooded</td>
<td>31%</td>
<td>Thornton and Briggs 1994</td>
</tr>
<tr>
<td>New South Wales</td>
<td>Murrumbidgee River–between Wagga Wagga and Hay Weir</td>
<td>Red gum wetland</td>
<td>Healthy river red gums</td>
<td>570 hectares killed by permanent inundation</td>
<td>Unknown</td>
<td>Thornton and Briggs 1994</td>
</tr>
<tr>
<td>New South Wales</td>
<td>Lachlan River and Murrumbidgee River Confluence–lowbidgee Wetlands</td>
<td>Red gum, black box and lignum vegetation</td>
<td>110000 hectares</td>
<td>90 000 hectares</td>
<td>18%</td>
<td>DWR 1994</td>
</tr>
<tr>
<td>New South Wales, Victoria, South Australia</td>
<td>River Murray–between Hume Dam and Wellington (SA)</td>
<td>Intermittently flooded wetlands</td>
<td>105715 hectares</td>
<td>68715 hectares (37000 hectares are now permanently inundated)</td>
<td>35%</td>
<td>Pressey 1986</td>
</tr>
<tr>
<td>State</td>
<td>River Systems</td>
<td>Wetland Characteristics</td>
<td>Area (ha)</td>
<td>Flooded Area (ha)</td>
<td>Percentage</td>
<td>References</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------</td>
<td>-------------------------------------------</td>
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<td>--------------------------------------</td>
</tr>
<tr>
<td>Victoria</td>
<td>River Murray–Barmah Forest</td>
<td>Moira grass wetland</td>
<td>45,000</td>
<td>1,500</td>
<td>55%</td>
<td>Chesterfield et al 1986, Ward et al 1992</td>
</tr>
<tr>
<td>Queensland</td>
<td>Condamine-Balonne River, Warrego River, Culgoa River, Border Rivers</td>
<td>Intermittently flooded wetlands</td>
<td></td>
<td></td>
<td></td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Undeveloped, unregulated river systems</td>
<td></td>
<td></td>
<td></td>
<td>Wettin et al 1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regulated river systems–flow diversions–increased on-farm water storages</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.3.3.1 Macquarie Marshes
As a result of water diversions and flow management practices since the construction of the Burrendong Dam in 1967 the RAMSAR-listed Macquarie Marshes have reduced in area by 40 to 50% (Kingsford and Thomas 1995). Numbers of breeding colonial waterbirds (ibis, herons, egrets and spoonbills) have also declined. However, the Marshes still represent good examples of inland reedswamps and floodplain wetland. The Macquarie wetlands provide drought refuge when wetland areas in other parts of the Basin are dry.

The management response for the Macquarie Marshes has been the introduction of an environmental water allocation for the Marshes. Up to 125,000 ML per annum from Burrendong Dam, called a wildlife allocation is now allocated to the Macquarie. In the flow range 500-4,500 ML/d, the wildlife allocation is released transparently to match inflows as closely as possible. Also, all tributary flows and unused storage is directed to the Macquarie Marshes during a waterbird breeding event (Blanch 1999).

5.3.3.2 Gwydir River Wetlands
The Lower Gwydir Wetlands are significant because their flooding is not always synchronous with flooding in other nearby wetlands such as the Macquarie Marshes and therefore the wetlands are likely to provide an important drought refuge for the basins waterbird populations. The Gwydir River wetlands have decreased in area by 75% over the last 20 years (NSW SoE, 1997) with plant communities requiring frequent flooding reduced to less than 5% of their original extent (QDNR, 1999). This has resulted from diversions, used primarily for cotton irrigation, reducing flows to the core areas of the Gwydir River wetlands by 70% (QDNR, 1999). Keyte (cited in QDNR, 1999) argues that the Gwydir Wetlands are undergoing a transition from intermittent wetlands to terrestrial ecosystems as a result of the current water regime. There are documented declines in the 'health' of macroinvertebrate communities, fish and waterbird populations (QDNR, 1999).

In response to the degradation of the wetlands, there is now an annual allocation of 25,000 ML from Copeton Dam. However, it is estimated that 75,000 ML is required to adequately flood the Gwydir Rivers terminal wetlands. The annual allocation from Copeton Dam has been used in the each of the last four years to extend flooding in the Gingham wetlands to ensure successful bird breeding in the wetlands. There is also a 50:50 sharing of off-allocation water between consumptive users and the wetlands (when flows at Yarraman >1, 000 ML/d). A minimum flow of 500 ML day\(^{-1}\) is allocated the Gingham and Lower Gwydir wetlands (Blanch 1999).

5.3.3.3 Narran Lakes
The RAMSAR-listed Narran Lakes are terminal wetlands on the Narran River at the lower end of the Condamine-Balonne River system. They remain in relatively natural condition, though this is threatened by water resource development and provide drought refuge for many birds. The Lakes are in New South Wales, however most of the upstream catchment is in Queensland. Flooding in the lakes must persist for a minimum of four months for successful ibis breeding to occur. Modelling undertaken for the Condamine-Balonne Water Allocation Management Plan (QDNR, 1999) clearly indicates that bird populations do not commence breeding until the lakes fill to 95% capacity. Field observations indicate that young birds resulting from this nest are abandoned and die if water levels drop below 86% storage capacity. Diversions upstream have reduced filling events in the Narran Lakes above 85% by approximately half. Consequently, bird breeding events are only initiated half as often as they would have occurred under natural conditions. The Narran Lakes System has been assessed by the Condamine-Balonne Technical Advisory Panel to be in a fair to poor ecological condition (QDNR, 1999). Disappointingly, diversions in the Condamine-Balonne continue to
grow (MDBC, 1999d). A Cap on diversions, at the current levels of diversions, will be the first step in sustaining the Narran Lakes, as an internationally recognised RAMSAR site.

The area of wetland in the Basin has greatly declined as a result of diversions, principally for irrigated agriculture. Most of the documented decline in wetland area occurred at levels of abstraction lower than the level permitted under the current level of the Cap. The Cap is a critical first step in protecting what remains of the Basin's terminal wetlands. However, it has become obvious that for many terminal wetlands the protection offered by the current level of the Cap is insufficient, and more water will have to be returned to them. There is a danger that by focussing environmental allocations primarily upon large wetlands those important ecological processes that are sustained by the cumulative expanse of smaller wetlands will be lost. Similarly, important in-stream ecological processes may be lost.

### 5.3.4 Stressed Rivers

The COAG Water Resources Policy requires that the States identify over-allocated and stressed rivers, and that they be given priority in implementing a better balance between consumptive use of water and the environment\(^\text{12}\).

The New South Wales government undertook a stressed river classification for the States unregulated rivers (DLWC, 1998). The Stressed Rivers Assessment procedure involved determining hydrological and environmental stress separately. An index of hydrological stress was derived by proportioning water extraction to the 80\(^{\text{th}}\) percentile flow (50\(^{\text{th}}\) percentile in some ephemeral streams). Environmental stress was determined using any simple biological, chemical and geomorphological indicators of stream health that were available. The results of the Stressed Rivers Assessment for New South Wales streams in the Murray-Darling Basin indicate that under existing conditions 85\% of unregulated streams exhibit at least a medium environmental stress with 49.6\% of streams exhibiting a high degree of environmental stress. Environmental stress reflects problems caused by water abstraction, land management and pollution. Water extraction was a major contributor to the environmental stress, with 32\% of all unregulated streams exhibiting a high level of hydrological stress (greater than 70\% of 80\(^{\text{th}}\) percentile flow extracted) and a further 24\% had a moderate level of hydrological stress (between 40 and 60\% of 80\(^{\text{th}}\) percentile flow extracted) (DLWC 1998). The high proportion of streams hydrologically and environmentally stressed is a result of past and current levels of diversions. This is a level of diversions permitted under the current level of the Cap. Hydrological stress on New South Wales unregulated rivers is currently being addressed by River Management Committees across the state. A function of these committees is to recommend rules that will result in a flow regime that meets identified river health and water quality objectives. These flow rules can affect both the timing and volume of diversions.

To achieve the desired environmental objectives for many of Basin's New South Wales unregulated rivers the River Management Committees will have to reduce the current levels of diversions.

Existing licences for diversions are considerably higher than current diversions in many New South Wales unregulated streams. The hydrological classification was also calculated assuming full water licence development. For example, it is estimated that in the Billabong Creek – which is considered hydrologically stressed (DLWC, 1999), only 30\% of licences are currently used. Activation of the remaining 70\% would see a great increase in hydrological

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\(^{12}\) COAG Water Resources Policy. Part 4(d) …..In cases where river systems have been over allocated, or are deemed stressed, arrangements will be instituted and substantial progress made by 1998 to provide better balance in water resource use including appropriate allocations to the environment in order to enhance/restore the health of river systems.
stress (in most years there would not be enough flow to supply this level of abstraction). Under full licence development, the proportion of streams having a high level of hydrological stress increases from 32.5% to 52% and the number of low hydrological stress streams reduces from 43.7% to 25.8%.

The Cap is a key protective measure for unregulated streams.

The assessment of stress for Queensland's rivers is currently being undertaken as part of the Water Allocation Management Plan (WAMP) and the Water Management Plan (WMP) process. In general, the basin's rivers in Queensland have lower diversions than in the southern parts of the Basin. Also, the problems of seasonal inversion of flows do not occur to the same extent as the peak period for water use coincides with peak water use in these summer rainfall rivers. However, the Technical Advisory Panel Reports to the Condamine-Balonne WAMP and the Border Rivers WAMP have identified major changes to the flow regimes in both river systems resulting from irrigation diversions.

In the Border Rivers major increases in diversions have occurred since the capacity of Pindari Dam was increased from 37 GL to 312 GL in the early 1990's. Ecological data collected between 1996 and 1999 indicates that the Border Rivers are currently in relatively good ecological condition. However, increases in diversions have occurred very recently, and during a four-year period of above average flows in this river valley. As discussed in Section 3.2.5 it is still much too early to assess the ecological outcomes of these diversions.

The Condamine-Balonne river valley has undergone considerable water resource development in the last ten years, significantly altering the hydrology of the river system. The flow regime of the Upper and Lower Condamine and the Upper Balonne has been assessed as fair to good, while the Lower Balonne has a generally poor flow regime – the result of diversions directly from the channel and from floodplain harvesting. Changes in the flow regime have resulted in the ecosystem of the Lower Balonne to be assessed as poor. River health indices using macroinvertebrates (AUSRIVAS) and fish community condition scores were used for this assessment.

The Cap is currently being determined for the Basin's river system in Queensland – based on the outcomes of the WMP and WAMP process. What is clear, is that the current levels of diversions in Queensland have impacted on the flow regime, and the effects of these diversions on river health are now becoming evident. It will take decades or longer for the full impact of these diversions to occur (see section 3.2.5).

5.3.5 New South Wales Rivers Survey

All regulated rivers in New South Wales have been identified as stressed (DLWC, 1998). This was supported by the New South Wales Rivers Survey (1997). The survey undertaken over two years sampled 80 sites four times across New South Wales. The survey concluded that rivers sustain a large proportion of New South Wales total biodiversity, however biodiversity in the State's degraded riverine ecosystems was rapidly being lost. Evidence is especially clear in the Murray region (which includes the Lachlan and Murrumbidgee systems), particularly in rivers regulated for water supply. An Index of Biotic Integrity was developed to measure the health of rivers at large scales using fish-community attributes (Harris and Silveira, 1999). This index has shown that the Murray region's rivers are in a degraded condition compared to other regions and river types. The primary recommendation from the Rivers Survey "...is to accept that our riverine heritage in New South Wales is in a

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13 Border Rivers WAMP being undertaken jointly between New South Wales and Queensland Governments.
generally degraded condition and in urgent need of restoration. River biota is reflecting problems of river habitats: aquatic biodiversity is rapidly being lost; productivity of natural resources is seriously declining, especially recreational and commercial fisheries; and the values and supply of the basic resource, fresh water, have been damaged. Restoration of river-ecosystem components is needed, especially flow regimes, thermal regimes and river catchments, particularly in the riparian zones. There is an urgent need to control carp and to restore fish passage at barriers such as dams and weirs.'

Gehrke et al. (1995) have shown fish species diversity (as indicated by Shannon's \( H' \)) to be inversely proportional to the amount of river regulation (as estimated by Annual Proportion of Flow Deviation) in the Murray-Darling Basin. Diversity was highest in the Paroo followed by the Darling, Murrumbidgee and then the Murray.

5.3.6 Expert Panels

The Expert Panel Assessment was developed to be a widely applicable and inexpensive method for determining environmental water requirements of a river (Swales and Harris 1995 - cited in Arthington 1998). The assessment involves assembling a group of scientists with expert knowledge of the system to make an interdisciplinary 'best judgement' of the flow needs of a river. The Scientific Panel Assessment Method is a more sophisticated development of this approach. The difference being that "...key ecosystem and hydrological features and their interactions are used for the basis for assessment, rather than visual assessment and interpretation of a trial flow change." (Arthington 1998). Scientific panel assessment reports have been undertaken for the Barwon-Darling River (Thoms et al 1996), the River Murray - Dartmouth to Wellington and the Lower Darling River (MDBC 1998b) and the River Murray Barrages (Jensen et al 1998). The major aim of these studies was to identify key environmental flow requirements of these rivers and identify flow changes to improve their environmental condition.

5.3.6.1 River Murray

The River Murray Scientific Panel found that water resource development has imposed a stable water regime in the Murray River – currently there is less variability over daily, seasonal and inter-annual scales than under natural conditions. Significantly, this loss of variability and other water resource development has resulted in long term, detrimental ecological changes in the River Murray. Flow management activities that threaten ecosystem health include: constant flow for sustained periods, unseasonal flow patterns, increased minimum flow, decreased frequency of flooding periods, reduced duration of individual floods, rapid rates of rise or fall and the development of weir pools.

The report made a number of recommendations to improve the flow regime, some of which will require a reduction in water available for diversions. Changes in flow regime likely to result in a reduction in water available for diversions include:

- reinstating a flooding frequency of no less than 50% of what it was under natural conditions with a duration of flooding as close as possible to natural;
- introducing greater flow variability into the River Murray by allowing a passing flow through major storages during June to September, as they fill; and
- not allowing base flows to drop below 8000 ML per day through weir pools on the Lower Murray for periods of greater than two weeks between November and April.
To be able to undertake the Scientific Panel’s recommendations for the River Murray it is likely that current diversions will have to decrease. Until appropriate scenarios are modelled the amount of water required to fulfil these recommendations is unknown. However, the Scientific panel recommendations indicate that the level of the Cap does not provide sufficient water for the environment’s share.

5.3.6.2 Barwon-Darling River

The Scientific Assessment of Environmental Flows for the Barwon-Darling River (1996) found that abstractions have had a significant impact on flows in the Barwon-Darling River. Under the 1994/95 levels of development, diversions above Menindee were equivalent to approximately 60% of the natural average flow at Menindee. These diversions for irrigation have changed the size, duration and frequency of flows. About 8% of the diversions upstream of Menindee occur in the Barwon-Darling system (Table 5.6).

Table 5.6 Diversions upstream of Menindee in 1997/98. (MDBC, 1999d).

<table>
<thead>
<tr>
<th>System</th>
<th>Diversion (GL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queensland</td>
<td></td>
</tr>
<tr>
<td>Condamine-Balonne</td>
<td>545</td>
</tr>
<tr>
<td>Border Rivers</td>
<td>177</td>
</tr>
<tr>
<td>Macintyre Brook</td>
<td>9</td>
</tr>
<tr>
<td>Moonie</td>
<td>8</td>
</tr>
<tr>
<td>Warrego</td>
<td>2</td>
</tr>
<tr>
<td>Paroo</td>
<td>0</td>
</tr>
<tr>
<td>New South Wales</td>
<td></td>
</tr>
<tr>
<td>Border Rivers</td>
<td>206</td>
</tr>
<tr>
<td>Gwydir</td>
<td>535</td>
</tr>
<tr>
<td>Namoi/Peel</td>
<td>260</td>
</tr>
<tr>
<td>Macquarie/Castlereagh/Bogan</td>
<td>435</td>
</tr>
<tr>
<td>Total Upstream of Barwon-Darling</td>
<td>2177</td>
</tr>
<tr>
<td>Barwon-Darling</td>
<td>186</td>
</tr>
</tbody>
</table>

The majority of diversions occur in the headwaters upstream of the Barwon-Darling system (see Table 3.6), reinforcing the principle that diversions have to be managed at the river basin scale. Management of diversions from one system always impacts downstream. This is clearly recognised by Darling River Food and Fibre (DRFF) "It becomes clear that the Darling River inherits many of its problems from upstream [of the Barwon-Darling river valley]. This must be realised and accepted when we seek solutions" (DRFF, 1998). Just as diversions upstream of the Barwon-Darling Valley impact the Darling River, diversions within the Barwon-Darling valley impact downstream in the River Murray.

River regulation upstream of Menindee has led to habitat degradation in the Barwon-Darling system. In-channel habitat availability and accessibility of important food sources have also declined throughout the Barwon-Darling because of changes in the flow regime. The Scientific Assessment Panel proposed the following management principle for the valley, "It must be recognised that the Barwon-Darling riverine ecosystem is in a state of deterioration and changes in water management are required if its condition is to be improved."

The Barwon-Darling Scientific Panel recommended a number of changes to flow management of the Barwon-Darling and its tributaries. These included an immediate moratorium on additional diversions or the transfer of licences upstream. It was recommended that diversion of water for irrigation cease during low flow periods – when flows fall below
the 80th percentile. DRFF supports the recommendation to protect low flows of less than 1000ML/day from diversion (DRFF, 1999).

Implementation of the Cap at 1993/94 levels of development would satisfy the recommendation for an immediate moratorium on additional diversions. However, many of the upstream tributaries to the Barwon-Darling are yet to have a Cap implemented and large scale increases in diversions continue in some of these valleys (MDBC, 1999d). At present, the Cap does not protect the Barwon-Darling riverine ecosystem from growth in abstractions.

5.3.7 The Paroo – An unregulated river

Currently there are no significant water diversions from the Paroo River in Western Queensland, however this may change as a Cap has not yet been determined for this river valley (MDBC, 1999d). The Paroo River and its wetlands contain exceptional genetic, species and ecosystem diversity and it makes an irreplaceable contribution to the biodiversity and environmental values of the Murray-Darling Basin (Watts, 1999). The development of irrigated agriculture is recognised as the single greatest threat to this ecosystem (Kingsford, 1999). The potential impacts of water extraction and associated activities on three levels of biodiversity in the Paroo River are described in Table 5.7 (reprinted from Watts, 1999).

The Cap plays a critical role in protecting the few remaining unregulated river systems in the Basin.

Table 5.7 Potential impacts of water extraction and associated activities on three levels of biodiversity in the Paroo River (reprinted from Watts, 1999).

<table>
<thead>
<tr>
<th>Level of diversity</th>
<th>Potential Impacts of Water Abstraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetic</td>
<td>Changed flows may fragment populations into smaller breeding groups, resulting in inbreeding and loss of genetic diversity. Presence of pesticides or insecticides may reduce the viability of local populations, resulting in fragmentation and subsequent loss of genetic diversity.</td>
</tr>
<tr>
<td>Species</td>
<td>Fragmentation of populations, loss of water quality or reduced floods may remove cues that stimulate breeding, thus preventing breeding from occurring and ultimately resulting in local loss of species. Fragmentation of populations, loss of water quality or reduced floods may prevent the successful completion of breeding, ultimately resulting in local loss of species. Seed banks may become inviable if the length of time between floods is increased, resulting in loss of plant species. Competition through increased numbers of alien species may result in loss of native species. Presence of pesticides or insecticides may prevent successful breeding from occurring, resulting in loss of species.</td>
</tr>
</tbody>
</table>
Ecosystem

Changed flood regime will result in loss of habitat diversity.

Loss of species diversity will result in loss of diversity of aquatic communities.

Changed flow regimes and community structure will result in changed ecological processes and loss of ecosystem diversity.

5.4 Summary

Determining an appropriate level for the Cap is a three-stage process:

- The effects of the current level of diversions on the ecology of the river system have to be determined,
- The long-term consequences of these ecological effects have to be clearly understood, and
- With this understanding the community has to make an assessment of the benefits and costs of diversions to determine an appropriate level for the Cap.

While it is obvious that current levels of water abstraction are having a significant impact, the full impacts of that abstraction and other changes to the Basin's land and water resources are yet to be realised. The Basin is moving to a new and different state. The riverine ecosystem will require many decades to complete its various ecological and geomorphic responses to the altered conditions that have been imposed on it.

Water resource development in the Basin has had a major impact on the riverine ecosystem. Throughout the Basin, Scientific Panel Assessments, Stressed Rivers Assessments and state water management planning reports have all documented impacts of reduced flows. These impacts include reduced areas of wetlands, less diverse plant and animal populations, and reduced populations of native fish, birds and aquatic plants. Reduced flows will continue to exacerbate problems of salinity, pest species, eutrophication and blue-green algal blooms. Reduced flows are altering the shape of the major rivers. In summary, reduced flows are a major cause of reduced river health in the Murray-Darling Basin.

It is clear from submissions to the Review that there is community disquiet over the state of the Basin's rivers. There is a strong desire to see an improvement in river health. It is also clear that further abstractions, anywhere in the basin, will decrease the health of the river ecosystem.
6 Making the Cap work

Address the impact of the operation of the Cap in achieving its objectives to ensure ecological sustainability of the Murray-Darling Basin river system by examining the question, "what aspects of the operation of the Cap constrain or support the sustainability of the river system?"

6.1 Introduction

The Cap contributes to the sustainability of the Murray-Darling Basin river system by protecting end-of-system flows by limiting growth in diversions. Some aspects of the operation of the Cap enhance its contribution to sustainability, but there is scope for improving the operation of the Cap. This discussion is limited to comments about areas where science indicates that the operation of the Cap might be improved to maximise the Cap's contribution to ecological sustainability. These include:

- increasing efficiency of delivery of diversions;
- returning all government funded water savings to the environment;
- more efficient management of the environments allocation;
- basin-wide adoption of diversions models for evaluating compliance;
- rapid development of Computer Simulation Models to replace Demand Models for determining the Cap;
- redefining the Cap to protect the proportion allocated to the environment in dry years;
- adopting the principle that all water in excess of the Cap is considered the environment's entitlement;
- improving community confidence in the Cap by:
  - Improving compliance with the Cap,
  - Implementing a Cap in all valleys,
  - Not allowing special conditions for some valleys,
  - Demonstrating the environmental benefits of the Cap,
  - Reducing the confusion between the Cap and other water reforms; and
- integrating management of groundwater and surface water.

Many aspects of the Cap support the sustainability of the river system. The operation of the Cap has (or would if fully implemented):

- restricted further diversions in all rivers, regardless of their current level of water resource development, protecting riverine environments of high conservation value (eg the Paroo River) to the benefit of the whole Basin;
- protected important high flow events by limiting access to off-allocation;
- in conjunction with other water reforms, provided a framework for water trading to develop; and,
- provided incentive for conversion to volumetric allocations.

6.2 Efficient delivery of diversions.

It has been conservatively estimated that across the Basin that 14% of all water diverted is lost between the river channel and delivery to the farm gate (Whittington and Hillman, 1999). However, more recent estimates of distribution losses in Victoria and South Australia indicate
that distribution losses could be significantly higher than this (MDBC, unpublished data). Distribution losses averaged over 5 years across Victoria represented 24% of all water diverted, which for Victoria represented 992 GL in 1997/98 (Table 6.1). This loss is the result of seepage and leakage from irrigation canals and from evaporation. It also includes under-reporting of Dethridge wheels, theft, and diverted water that outfalls back to the river. Losses in individual valleys are considerably higher, for example the average loss from the Wimmera-Mallee between 1994/95 and 1998/99 was 55%.

Assuming the losses in transmission of irrigation water in Victoria are similar to transmission losses for irrigation in the remainder of the Basin then transmission losses for the 1997/8 water year were about 2,500 GL Basin-wide. To put this figure into context, it represents about 16 years allocation to metropolitan Adelaide, it is more than three times the current level of diversions in Queensland and it is equivalent to the total annual diversions from the Murrumbidgee River (MDBC, 1999d).


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<tbody>
<tr>
<td>Kiewa</td>
<td>0</td>
<td>48</td>
<td>0%</td>
</tr>
<tr>
<td>Ovens</td>
<td>0</td>
<td>130</td>
<td>0%</td>
</tr>
<tr>
<td>Goulburn/Broken</td>
<td>1,554</td>
<td>6,395</td>
<td>24%</td>
</tr>
<tr>
<td>Campaspe</td>
<td>333</td>
<td>1,812</td>
<td>18%</td>
</tr>
<tr>
<td>Loddon</td>
<td>569</td>
<td>2,208</td>
<td>26%</td>
</tr>
<tr>
<td>Wimmera Mallee</td>
<td>498</td>
<td>906</td>
<td>55%</td>
</tr>
<tr>
<td>Murray</td>
<td>2,010</td>
<td>9,123</td>
<td>22%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,962</strong></td>
<td><strong>20,621</strong></td>
<td><strong>24%</strong></td>
</tr>
</tbody>
</table>

Experience with rehabilitation of irrigation scheme distribution networks in South Australia has shown that rehabilitation can recover most of the water lost during transmission. Commission data indicates that prior to rehabilitation, South Australian Government owned irrigation schemes along the Lower Murray operated at an average efficiency of 64% – 36% of diverted water was lost during transmission – however rehabilitated schemes operated at an average efficiency of 93% (MDBC, unpublished data) (Fig. 4.1). Irrigation schemes need regular maintenance to remain efficient. The efficiency of rehabilitated schemes along the Lower Murray appears to decline over time (MDBC, unpublished data) indicating that vigilance in infrastructure maintenance is required.

NSW department of Land and Water Conservation and Murrumbidgee Irrigation commissioned a study (SKM 1995) to review the system losses for the Murrumbidgee Irrigation Area. Between 1977/78 and 1994/95 diversions to the Murrumbidgee Irrigation Area and Districts averaged 1,163 GL, representing 10.2% of the current Basin-wide Cap target diversions. Over the 18 year period an average of 928 GL/year was accounted for at the

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14 Outfalls back to the river may account for up to 5% of the total water diverted from the river.
farm gate. This represents an average annual loss of 20%. Losses in individual years ranged between 15% and 31%. The report identifies that water is lost to:

- Evaporation, seepage and leaks 8% of diversions
- System Storage 3% of diversions
- Measurement error on diversions ±10% of diversions
- Measurement error on deliveries ±14% of diversions

About half of the system losses in the MIA are actually used by irrigators – however, this water is not accounted for. The report concluded that significant improvements in system efficiency are possible within the MIA Irrigation area with improved management and measurement of diversions.

Approximately 95% of water diverted from the Basin's river system is used for irrigated agriculture. Adoption of best management practices in irrigation will increase productive use of water, reducing the problems such as salinity and nutrient pollution of the river system and may reduce demand pressure on the environment's allocation. Reviewing irrigation farming practices is beyond the scope of this review, but there is little doubt that in many irrigation sectors and districts, significant on-farm savings can be made. For example, it is estimated that some 12.5% of water applied to irrigated pasture runs off as waste water (SKM, 1995). Adoption of more sophisticated irrigation techniques can eliminate this loss.

High diversion losses reflect the historically low value placed on water. With the acceptance that water is a finite resource (and facilitated by the introduction of water reforms) the potential value of transmission losses are now being realised.

Reducing transmission losses and improving on-farm water use efficiency will increase the production per unit of water diverted from the river system and will increase sustainability of the Basin.
6.3 Return government funded water savings to the environment

Under current cost sharing agreements, the ownership of water savings rests with the owner of the entitlements from which savings were made. This Review has shown that current levels of diversions have resulted in considerable degradation of the riverine environment, and will continue to do so. It is important that as water savings are made, regardless of the owner of the entitlement, that consideration is given to returning some or all to the environment.

Returning water saved through government funded rehabilitation of irrigation schemes to the environment is a high priority. This remains as one of the few avenues available for improving river health without reducing current levels of consumption. The Commonwealth submission supports this argument, "The ownership of water savings from system losses rests with the government/s who paid for the water saving measures. These savings were generated through public investments, therefore it is appropriate that it should result in some level of public benefits including returning water for the environment".

![Diagram showing the relationship between total water resource, Cap target diversions and transmission losses.](image)

**Figure 6.2** Diagram showing the relationship between total water resource, Cap target diversions and transmission losses. Transmission losses are included in the Cap target diversions. Savings in transmission losses can either be allocated for consumptive use or returned for in-stream uses and the environment's share.

The division of water outside of the Cap is poorly defined. It includes the environment's share and in-stream uses. The environment’s share is water that is generally available for environmental flows. In-stream uses include water used for dilution flows, for maintaining minimum flows in rivers to retain access for riparian users, for navigation, and for recreation. It is likely that in the future there will be greater demand for water to be used for in-stream uses – particularly the demand for dilution flows as salinity increases. All water outside of the Cap, regardless of what it is used for, should be managed to improve the environmental...
condition of the river system. Any savings in in-stream use should also remain outside of the Cap.

To improve Basin sustainability, water saved by government-funded reductions in transmission losses should be removed from the Cap and allocated to the environment.

6.4 Protecting the Environment's Share

The New South Wales Governments submission argues that "environmental allocations [are viewed] as being separate from the Cap". How environmental allocations are viewed with respect to the Cap is of critical importance to the operation of the Cap, and particularly the ability of the Cap to limit future environmental decline.

The South Australian Government's submission to the Review expresses concern that not all changes to river operation that affect flows are being assessed under the Cap. "It is essential that all activities affecting flows should be assessed, including all proposals for environmental enhancement, such as wetting and drying of wetlands and changes to the flooding regime of the floodplain." The example given by South Australia is the Commission's adoption of the 'Edward-Wakool Rivers Floodplain Management Strategy - stage IV' which will result in the periodic flooding of an additional 2000 hectares of red gum forest in New South Wales. The increased flooding of this forest will result from the removal of levee banks along the Edward and Wakool Rivers. This will have a significant benefit to this floodplain by increasing connectivity with the river, but will inevitably result in lower flows in the Lower Murray. An important ecological principle is that both longitudinal and lateral connectivity is critical to the long-term health and sustainability of the river system. Water resource development has severely reduced connectivity, and whenever possible connectivity should be increased. In the example of flooding of the Edward–Wakool Floodplain, lateral connectivity of the floodplain with the river is being increased at this site. This is potentially at the expense of connectivity downstream, if there are lower flows in the river. While there are significant environmental benefits in proposals such as the Edward-Wakool, these must be assessed against any environmental dis-benefit downstream. If, on-balance, the environmental benefits accrued from an action outweigh the environmental dis-benefits then the water should be allocated from the environment's share. This decision should be coordinated at the Commission level, to ensure all downstream impacts are considered. The effectiveness of this coordination in achieving Basin-wide ecological outcomes would be assessed by the Ecological Audit (See Section 3.2).

The contrary effect to this is the installation of a regulator on Moira Lake in New South Wales to re-instate natural drying phases. Moira Lake's ecology was adapted to regular drying over the summer months, however delivery of irrigation water has resulted in unseasonally high flows in the Murray during the summer months, resulting in summer flooding of Moira Lake. Allowing Moira Lake to regularly dry out during summer will enhance the lake's environment and reduce evaporative and seepage losses. This environmental restoration project will also result in increased water in the River Murray because prior to the installation of the regulator, approximately 2,200ML water was lost through evaporation in the wetland during the summer irrigation period.

This water saving could be retained in the Murray (in Lake Hume, for example) for environmental use at an appropriate time or used consumptively (either by the environment or other users). On the River Murray floodplain of New South Wales, Victoria and South Australia, 37,000 hectares of naturally ephemeral wetlands have been degraded by permanent inundation (Pressey, 1986 cited in MDBMC 1998). However, a further 68,700 hectares of ephemeral wetland are being degraded by reduced frequency of inundation. Water saved from
reducing the levels of permanent inundation in some wetlands is required by wetlands that have a reduced frequency of inundation.

An objective of the Cap is to maintain and where appropriate, improve existing flow regimes in the waterways of the Murray-Darling Basin to protect and enhance the riverine environment. Under no circumstances should trading ‘excess water’ from the environment's share or in-stream use be allowed to be traded into consumptive use – in the short or long term.

Basin-wide, the river system is suffering from a lack of water and at the Basin scale there is no ‘excess water’. Water saved through schemes such as installation of the Moira Lake Regulator should be considered outside of the Cap and become part of the environment's share, and be managed accordingly. Every effort should be made to increase the environment's share by re-instating appropriate wetting and drying phases.

Similarly, if sections of the floodplain are isolated from the river by the construction of levees then the water that would evaporate or seep into the floodplain under natural conditions must remain part of the environment's share. The suggestion that this water should be transferred into the Cap, and can therefore be allocated for consumptive use is highly inappropriate.

The Basin-wide implications of environmental flow decisions must be considered. This will require the coordination of environmental flow management between the States and the ACT. The effectiveness of this coordination in achieving positive ecological outcomes would be assessed at the Basin-wide level by the Ecological Audit (See Section 3.2).

### 6.5 Efficient management of environment's share

The current Murray-Darling Basin river system has a human dominated flow regime. The Cap merely ensures that water in excess of the approved volume of abstractions is left in the river\(^{15}\). What remains in the river is divided into the environment's share and what is available for in-stream use (see Fig 6.2). Sustainability of the river system is constrained by how effectively the environment's and in-stream uses shares are managed. The development of effective flow rules for achieving environmental objectives with these shares is limited by:

- Current understanding of the ecosystem's water requirements;
- Physical and legal constraints on setting environmental flows;
- Continuing needs to provide irrigation flows that conflict with natural flow patterns; and
- State boundaries.

The assessment of river health and the development of environmental flow options are two of the most active research areas in freshwater ecology. These complex tasks are made even more difficult by the lack of adequate baseline information. Inadequate understanding of the system is reflected in the principle that environmental flows should attempt to mimic the natural flow regime – albeit with significantly less water. The translucent dam approach – where a proportion of inflows to the dam is released as it enters, during the dam filling period, is an example of this principle.

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\(^{15}\) The level of diversions permissible under the Cap varies from year to year reflecting climatic conditions and therefore the environment's share varies from year to year depending upon demand and supply of consumptive allocation..
The effectiveness of environmental flows and therefore the sustainability of the Basin are constrained by our limited knowledge of the environment's water requirements. This area requires urgent research effort.

The ability of water resource managers to deliver efficient environmental flows is constrained by physical limitations of water storage infrastructure. For example, the outlet structures on Wyangala Dam allow a maximum flow of 8,000 ML/day, which constrains the maximum flood pulse that can be achieved from Wyangala Dam. The ability to provide effective environmental flows is also compromised by the threat of legal action for compensation by owners of developments on the floodplain. As an example, the maximum flow in the Murray below Lake Hume is 25,000 ML/day. Flows greater than this will flow out onto the floodplain affecting private land. Whilst this may be a high priority environmental goal (at the right time of the year), it is not seen that way by a number of floodplain land-holders.

The creation of "environmental floods" is constrained by the threat of legal compensation in a number of valleys throughout the Basin.

Under the Australian Constitution, primary responsibility for land and water, and therefore natural resource planning and management, rests with the Governments of the States and Territories (Commonwealth submission). Management of water for the environment protected by the Cap is therefore a State responsibility. All States are currently developing environmental flow rules for their regulated and unregulated streams, but implementation is patchy (Cullen et al. 1999). There is some interstate cooperation in setting environmental flows, for example the Border Rivers WAMP is being jointly undertaken by New South Wales and Queensland, however State boundaries still constrain the effective development of environmental flows – and therefore the sustainability of the Cap level of diversions. For example, the Condamine-Balonne WAMP considers the environmental effects of water diversions and environmental flow options within the Condamine-Balonne Valley, however downstream environmental water requirements are not considered. This is expressed in the Commission's submission to the Review of the operation of the Cap. "The impact of [water abstraction] activities (both proposed and existing) in Queensland could be more adequately assessed if this impact was to be considered through to its impact on the River Murray". The problem of State boundaries constraining environmental flow management is recognised in the South Australian Government submission to the Review of the Operation of the Cap. "South Australia is in favour of a complete sustainable rivers program that would address flow regimes, timing and quality issues in addition to the volumetric rationale of the Cap".

There is a need for coordination of environmental flows across the Murray-Darling Basin river system. The Commission should facilitate this coordination to ensure efficient, coordinated delivery of environmental flows, Basin-wide.

While State and territory boundaries have administrative relevance they have no ecological relevance.

Interstate cooperation is required to develop effective environmental flow regimes. This represents a challenge for the State water resource managers and is an area that could be facilitated by the Commission. The effectiveness of management of the environment's should be assessed by an Ecological Audit (See Section 3.2).

### 6.6 Compliance assessment models

A major outstanding project is the completion and approval for models that will be run at the end of each season to calculate the climate-adjusted Cap targets for each river valley. There
are two models for determining Cap target, a diversion model and an end-of-valley flow target. The Diversion Model is to be used for the regulated rivers in New South Wales and Victoria and for assessing South Australian diversions. End-of-Valley flow regime is allowed in unregulated rivers and will be used for assessing all diversions in Queensland.

With the Diversion Model, the Cap target will be compared with measured diversions to determine whether the valley is complying with the Cap. The diversion model provides river management with a clear idea indication of when and where in the valley water is diverted. This is important when assessing the ecological impacts of water diversions along a river valley. The Review supports the use of diversion models for estimating water use.

The use of an end-of-valley flow target to assess diversions requires the actual flow regime to be compared to a target flow regime. The end-of-valley flow target could be expressed in a number of ways, for example as a flow duration curve or simply as annual valley discharge. The accuracy of using end-of-valley flows for determining diversions relies upon the accuracy of gauged flow. The complex network of distributary channels, floodplains and wetlands, the interconnectedness of groundwater and streamflows, coupled with the highly variable nature of stream flows in the Basin's rivers make both setting target flow regimes and gauging flow regimes prone to error. Furthermore, these models are usually at their most accurate for average flows, but become considerably less reliable at high and low flows.

Measurements of end-of-valley flows integrate all of the upstream effects of water resource development. Floodplain development can obscure increases in diversions. For example, reducing connectivity between the floodplain and the river channel can significantly increase total end-of-valley flows. Building levees alienates the floodplain from the river channel. Flood water that would have previously inundated the floodplain now remains within the levees. In effect, levee construction increases end-of-valley flow at the cost of reduced wetland and floodplain inundation.

It is not clear how compliance with an end-of-valley flow target would operate if streamflows in a river valley were reduced as a result of increased use in an upstream river valley (for example, increased use in Queensland impacting on flow régime set for Barwon-Darling River valley). Would diversions from the target river valley be reduced to meet that valley's end-of-flow target or would the end-of-flow target for the valley be altered to reflect changes in water delivery from an upstream valley? The sensible – and only practical – way of using and end-of-valley flow target is to consider the impact of all diversions from the catchment above the gauging point. Attempting to apportion changes in parts of a flow régime to upstream river valleys will have high levels of error.

If land use in the catchment reduces water yield (see Section 5.2), then maintaining an end-of-system flow target will protect the environment's allocation at the expense of the consumptive allocation.

The Commission's submission to the Review of the Operation of the Cap recommends against using end-of-valley targets. "The Office [of the Commission] believes the expression of all Caps throughout the Basin should be in the form of a long term average target diversion... since the accuracy of measuring and modelling diversions will always be much greater than the accuracy of measuring and modelling river flows which is made difficult by the variability of river losses".

There are clear technical problems with accurate assessment of end-of-valley flow regimes. Diversion models provide a more robust method of supporting the Cap than end-of-valley flow objectives, especially in highly variable rivers.
6.7 Climate adjustment does not support ecological sustainability

The Cap allows an annual diversion equivalent to what would have been diverted with the infrastructure (pumps, dams, channels, areas developed for irrigation, management rules, etc) that existed in 1993/94, assuming similar climatic conditions to those experienced during the year in question. The Cap defines a volumetric allocation for consumptive use. The environment's allocation is what remains after consumptive allocation has been determined.

In the southern half of the Basin, demand for water is higher in dry years than wet years, consequently a greater proportion of the total flow is diverted in dry years than wet years. In dry years climate adjustment, (which may be better described as demand and supply adjustment) maintains the historically high ratio of diversions to environmental allocation in the southern regions of the Basin. While this is an important feature of water supply for consumptive use (deliver water when it is required), climate adjustment constrains environmental sustainability.

For example, in the southern New South Wales valleys, diversions between 1983/4 and 1993/94 were inversely proportional to rainfall (DLWC 1999) – water use was higher in dry years than wet years. In the New South Wales Murray Valley, diversions during this period were approximately 1,797 GL when rainfall was 300 mm, and 31% higher at 2,351 GL when rainfall was 100mm. A simple linear relationship, such as this, has been used in some valleys to determine climate adjustment for the Cap until more sophisticated Computer Simulation Models are available. Demand models do not take account of the supply of water, and so in dry sequences of years they considerably over-estimate 1993/94 usage. For example, in the New South Wales Murray Valley the amount of water allocated for diversion under the Cap was a greater volume of water than was available for diversion in the dry years that occurred in 1997/98 and in 1998/99. The apparently illogical situation of a valley being 'resource constrained' rather than Cap constrained is a result of the use of the inadequate demand models.

Computer Simulation Models consider for the amount of water in storage at the beginning of the water year and so give a truer indication of the 1993-94 level of water usage. In a dry sequence of years the Cap is considerably lower than in a wet year. For example, the Lachlan Valley the Cap is less than 50 GL in dry years, whereas the long-term Cap target is 269 GL.

Demand models potentially result in setting a Cap that is considerably above what would have been abstracted in 1993/94 and therefore the use of demand models is a constraint on the sustainability of the Basin. Completion of climate adjustment models, which include both demand and supply, is an urgent priority.

The Cap enshrines the current long-term patterns of usage. This can be clearly seen on the effect of water diversions from the Lachlan valley. With the current infrastructure the long term inflow (from Wyangala Dam, Belubula River and the downstream tributaries) to the Lachlan River is 1,219 GL (Table 4.2). Under natural conditions (i.e. without diversions) the average flow at Oxley\(^{16}\) was 235 GL, or 22% of inflows. The difference between total inflows and flow at Oxley represents reductions in flow that would occur naturally due to evaporation or seepage into groundwater.

\(^{16}\)Oxley is at the downstream (western) end of the Lachlan River, immediately upstream of the 50,000ha Great Cumbung Swamp. Flows at Oxley represent the end-of-valley flows from the Lachlan valley and the inflows to the Great Cumbung Swamp.
Table 6.2  Median and Average Inflows, diversions and end-of-valley flows in the Lachlan River. Data provided from the Lachlan IQQM by NSW DLWC.

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<tr>
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<th>Average 1894-1996</th>
<th>Median 1894-1996</th>
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<tbody>
<tr>
<td>Total System Inflows</td>
<td>1,219 GL</td>
<td>925 GL</td>
</tr>
<tr>
<td>Cap Diversions</td>
<td>268 GL</td>
<td>314 GL</td>
</tr>
<tr>
<td>Percentage of average &amp; median inflows diverted</td>
<td>22%</td>
<td>34%</td>
</tr>
<tr>
<td>End-of-system Flow at Oxley (Natural conditions)</td>
<td>235 GL</td>
<td>202 GL</td>
</tr>
<tr>
<td>End-of-system Flow at Oxley (Cap conditions)</td>
<td>107 GL</td>
<td>38 GL</td>
</tr>
<tr>
<td>Effect of diversions on flows at Oxley (percent reduction from natural flow conditions)</td>
<td>46%</td>
<td>18%</td>
</tr>
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</table>

Under current operating rules (ie with the Cap in place) the average flow at Oxley is reduced to 107 GL. The median end-of-system flows is 38 GL which is about one third of the average. This is because the average is strongly influenced by the rare, but very high flows that do occur. The flow data in Table 6.2 indicates that water resource development in the Lachlan valley has its greatest effect on end-of-system flows in dry to normal years. Fig. 6.3 plots natural flows at Oxley against the flows with the Cap on the level of diversions. At Oxley the long-term average reduction in stream flow resulting from diversions is 46% (dashed line). However, the proportion diverted is considerably greater than this at when natural flows were less than approximately 300 GL. The median flow at Oxley with the Cap operating is only 18% of the natural median flow at Oxley. This trend is similar throughout the Southern parts of the Murray-Darling Basin.

Figure 6.3  Natural and ‘Cap’ flows at Oxley (GL/year). The average affect of diversions is to reduce flows at Oxley by 46% (dashed line). However, at natural flows below 300 GL, the effect of diversions is much greater.
If in the southern parts of the Basin long-term stream flows are reduced, through for example, land use changes in the catchment or climate change, then the long term proportion of total stream flow abstracted will increase. This is because at lower streamflows the Cap allocates a greater proportion of the total flow for consumption. Therefore reductions in water yield from a catchment are at the expense of the environment share. This will increase hydrologic stress on the rivers and is a constraint on sustainability.

The Review recommends that over time the Cap be defined so that it limits diversions and guarantees a minimum proportion of stream flow for the environment, which in valleys like the Lachlan would need to consider the end-of-valley flow regime. A diversion model would still, however, be the primary method for assessment of Cap target compliance.

Defining an appropriate share for the environment reflects New South Wales Government water sharing policy, "that flows needed to restore adequate river health continue to have a prior right over the provision of water for consumptive use." (NSW Government 1999).

6.8 Community Confidence

Community confidence in the Cap is critical for its long-term acceptance. Submissions to the Review of the Operation of the Cap indicate at least five factors that are eroding community confidence in the Cap:

- Non-compliance with the Cap, whether non-compliance is perceived or real.
- Tardy implementation of the Cap
- Special conditions for some valleys
- No demonstrated environmental benefit from the Cap
- Confusion of the Cap with other water reforms

There is a community expectation on the State Governments to ensure that the Cap is clearly defined and implemented transparently across the Basin. Thus far, several jurisdictions have failed to achieve this.

There is a need for appropriately targeted information explaining the development of the Cap, its intent and the impacts of its implementation. The Review of the Operation of the Cap and the MDBC SI&E Riverine Sub Program Project R2 'Explaining the science behind the Cap on diversions' will increase the opportunity for the community to better understand the impacts of the Cap, and differentiate those from other water reforms.

The submission to the Review of the Operation of the Cap from Inland Rivers Network suggests, "...describing the Cap level in terms of 'what it saves', both in terms of environmental benefits and protection of irrigation supplies, there would be much less confusion regarding how 'sustainable' these levels of extractions were. This would better permit society to better judge the trade-offs it makes in managing the Basin's rivers and wetlands".

Describing the Cap in terms of what it attempts to achieve is likely to improve community ownership of the Cap, which is critical for its long-term acceptance. Developing a description of the Cap that better reflects the community's aspirations should be attempted by the Commission. This task may be undertaken as part of the MDBC SI&E Riverine Sub Program Project R2 'Explaining the science behind the Cap on diversions'.
6.9 Groundwater

The Victorian Government submissions to the Review of the Operation of the Cap argues, "it is imperative that groundwater is recognised as a finite resource and allocated on a sustainable basis to ensure consistency with the Cap". Similarly, the Commonwealth's submission argues that groundwater and surface management has to be integrated because the practise of shifting usage from surface water to groundwater "could displace the environmental impacts from one component of the water cycle to another".

There are clearly long term effects of groundwater usage on surface water availability (and vice versa), on natural ecosystems, and on the availability of water resources for future generations (MDBC 1999a).

Groundwater and surface water are physically interconnected, and for some users alternate sources of water. The Cap does not assess the extent of conjunctive use of groundwater and surface water and the level and extent to which capping surface water leads to switching groundwater use. It is critical that surface water and groundwater management is integrated if both resources are to be managed effectively.

6.10 The Cap protects high flows

Small to medium sized floods are critical to maintaining lateral connectivity of the river channel with the floodplain. Historically, in much of the Basin, off-allocation has been allowed during high flow events causing the smaller of these to be extensively harvested. Consequently, off-allocation and other water diversions have significantly reduced the duration and magnitude of the small to medium floods. The basin-wide expansion in off-stream storage seriously threatens the remaining high flow events. The Cap, once implemented, protects these flow events from further harvesting. This is clearly demonstrated in the Murrumbidgee Valley. Access to off-allocation water has been halved in 1999-2000 to a maximum of 220 GL, down from 440 GL in 1998/99. This reduction in off-allocation diversions is a response to the high diversions (with respect to the Cap) in the Murrumbidgee Valley in 1997/98, which where at the upper end of the confidence limit of the diversion model.

In general, the Cap is better at protecting high flow events than low flows. This is clearly seen in Fig. 4.3, which shows that the effect of diversions on flow in the Lachlan River at Oxley at different natural flow conditions. In wet years diversions impact flows at Oxley by less than 20%, compared to more than 80% in drier years.

By constraining access to off-allocation diversions the Cap enhances the sustainability of the river system.

6.11 Water Trading

Water trading provides a mechanism for the Cap to achieve its goal of restricting growth in diversions, without restricting development. "With the Cap in place, new developments should be allowed, provided water for them is obtained by improving water use efficiency or by purchasing water from existing entitlements" (MDBMC 1996). The COAG Water Resource Policy requires that State Governments provide the necessary institutional arrangements to facilitate the trade in water. The aim of water trade is "...to maximise its [water's]
contribution to national income and welfare, within the social, physical and ecological constraints of catchments...” (COAG, 1994).

Water trade supports the sustainability of the Murray-Darling Basin river system when it is undertaken within the ecological constraints of the catchment. A fundamental ecological principle that must be considered when assessing water trade is that the relationship between a volume extracted and river health is likely to be site specific. The relationship will depend upon flow regime, river morphology and the biota. This means that a volume of water diverted from one site is likely to have different ecological impact to the same volume diverted from a different site. This principle is particularly important when inter-valley trades are considered because different rivers will have different flow regimes and levels of abstraction.

Water trade only contributes to the ecological sustainability of the river system if trade reduces the impact of diversions – by either moving abstraction to a more appropriate place or by reducing the total volume diverted.
7 Basin Scale Risks to the Health of Riverine Ecosystems

At a Basin scale, assess the potential hazards and level of risk to the health of the riverine environment (including algal blooms and salinity), and comment on the role of the Cap in containing these hazards and reducing the level of risk to riverine health.

There are many processes (eg. the development of nuisance algal blooms) or activities (eg. increased water extraction) that threaten the health of the riverine environment across the Murray-Darling Basin. The Cap influences these processes and activities. The influence may be positive or negative, however, we do not fully understand riverine processes or the consequences of our activities and so our understanding of the influence of the Cap is likely to change, as more information becomes available. Also, there are a number of threats to the Basin's riverine environment not addressed by the Cap including poor catchment management. This section assesses the role of the Cap in modifying the impacts of various threats to the Basin's riverine system.

7.1 Ecological benefits of the Cap

The adverse environmental impacts of the following processes and activities are likely to be reduced by the implementation of the Cap:

- Salination of the river system;
- Incidence of blue-green algal (cyanobacteria) blooms; and
- Increased water abstraction.

7.1.1 Salinity

The recently released Salinity Audit of the Murray-Darling Basin (MDBMC, 1999) re-confirmed salinity as a major threat to local and regional land and water resources, riverine biodiversity, and rural and urban infrastructure. The Salinity Audit identified trends in salt mobilisation and loads measured on the landscape and in surface waters for each of the major river valleys. It was found that much of the salt mobilised at the landscape level is not transported to the sea. Based on current trends, it has been estimated that by the year 2100 more than 10 million tonnes of salt per year will be mobilised to land surface across the Murray-Darling Basin (Table 7.1). This is double current levels and is likely to lead to:

- Declining water quality in rivers;
- Loss of productive land;
- Damage to built infrastructure such as building and roads;
- Degradation of the environment, including loss of biodiversity.

Table 7.1 Estimated quantity of salt mobilised to the land surface*, 1998-2100 (from MDBMC, 1999)

<table>
<thead>
<tr>
<th>State</th>
<th>Salt mobilised to land surface (tonnes per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1998</td>
</tr>
<tr>
<td>South Australia</td>
<td>434,000</td>
</tr>
<tr>
<td>Victoria</td>
<td>740,000</td>
</tr>
<tr>
<td>New South Wales</td>
<td>3,707,000</td>
</tr>
<tr>
<td>Queensland</td>
<td>&gt;186,000</td>
</tr>
<tr>
<td>Total</td>
<td>&gt;5,070,000</td>
</tr>
</tbody>
</table>

* based on 54% of the Basin for which groundwater information exists
Three distinct groundwater regions have been identified in the Murray Darling Basin:

- The Murray Basin;
- The Darling River drainage basin that overlies the Great Artesian Basin; and

The areas of greatest risk from land and river salinisation are the groundwater discharge areas of the Murray Basin and the fractured rock areas of the Great Dividing Range (Lovering et al., 1998). In the northern areas of the Great Dividing Range (e.g. Macquarie, Gwydir, Namoi, Border and Condamine Rivers), a significant proportion of the groundwater enters the Great Artesian Basin and is carried north and west out of the Murray Darling Basin.

Three important threshold salinity levels were identified in the Salinity Audit for assessing stream salinity across the MDB:

1. 800 EC\textsuperscript{17} units threshold for maintaining safe drinking water;
2. 1500 EC units for protecting aquatic ecosystems; and
3. 5000 EC units that divides fresh water from saline water.

The World Health Organisation (WHO) has recommended a salinity of 800 EC as the upper limit to ensure safe drinking water. The MDB Salinity & Drainage Strategy (MDBC, 1989) adopted the WHO guideline as the basis for its target of maintaining salinity in the Murray River at Morgan, South Australia, below 800 EC for 95% of the time. The Salinity and Drainage Strategy also included the provision of dilution flows and the construction of salt interception works in order to meet this target and, therefore, protect a significant portion of Adelaide’s water supply. The Salinity Audit (MDBMC, 1999) predicts that the average salinity in the Murray River at Morgan will increase from the current 570 EC, to exceed 800 EC in 50 to 100 years time. The current salinity at Morgan would be significantly higher if the current arrangements to provide dilution flows, along with salt interception schemes and other measures, were not in place. These current arrangements have maintained salinity at less than 800 EC for 92% of the time.

While the Salinity and Drainage Strategy focussed on salt export from irrigation areas, it was recognised that there was an underlying trend of increasing salinity due mainly to the influence of dryland salinity entering into the river system, either through rising saline groundwater contributions into tributary streams or overland flows. The large increases in salt export to the river system predicted in the Salinity Audit will be primarily from the dryland catchment rather than irrigation areas. Based on current trends, the Salinity Audit predicts that salinity in rivers such as the Macquarie, Namoi, Lachlan, Castlereagh and Bogan Rivers of NSW will rise to above the 800 EC safe drinking threshold within the next 50 years. Salinity in rivers such as the Condamine-Balonne, Border and Warrego Rivers in Queensland are expected to exceed the 800 EC threshold within 20 years (Table 7.2 to Table 7.5). The Salinity Audit clearly indicates that the salt concentrations of many of the Basin's rivers will increase. This will result in greater demand for in-stream use of water – for dilution flows. The Cap reserves water for environmental and in-stream uses and without the Cap there would be less water available for this purpose.

\textsuperscript{17} EC = Electrical Conductivity units, which is often measured as micro-Siemens per centimetre (µS/cm). 1500 EC units is equivalent to a salt concentration (or Total Dissolved Solids) of approximately 1000 mg/L.
Queensland has yet to implement the Cap on diversions and the level of water extraction in some Queensland valleys has increased significantly since 1993/94. Also, Cap target allocations have been exceeded in other river valleys of the Murray-Darling Basin. The Salinity Audit predicted river salt concentrations assuming no growth in water abstraction beyond the 1993/94 level. If diversions increase, the volume of water remaining in the rivers decreases – the inevitable consequence is an increase in the salt concentration of the rivers (it is unlikely that diversions will reduce salt load in the long-term).

Additional diversions from the Basin’s rivers beyond the 1993/94 levels will result in the Salinity Audit’s predictions to be underestimates of salinity trends for the Basin’s river system.

**Table 7.2** Estimated river salinity, South Australia, 1998-2100 (from MDBMC, 1999)

<table>
<thead>
<tr>
<th>River Valley</th>
<th>Average river salinity (EC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1998</td>
</tr>
<tr>
<td>River Murray</td>
<td></td>
</tr>
<tr>
<td>Murray Bridge</td>
<td>590</td>
</tr>
<tr>
<td>Morgan</td>
<td>570</td>
</tr>
<tr>
<td>Berri</td>
<td>430</td>
</tr>
<tr>
<td>Renmark</td>
<td>400</td>
</tr>
</tbody>
</table>

**Table 7.3** Estimated river salinity, Queensland, 1998-2100 (from MDBMC, 1999)

<table>
<thead>
<tr>
<th>River Valley</th>
<th>Average river salinity (EC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1998</td>
</tr>
<tr>
<td>Warrego River</td>
<td>210</td>
</tr>
<tr>
<td>Condamine-Ballone</td>
<td>210</td>
</tr>
<tr>
<td>Border Rivers</td>
<td>310</td>
</tr>
</tbody>
</table>

**Table 7.4** Estimated river salinity, NSW, 1998-2100 (from MDBMC, 1999)

<table>
<thead>
<tr>
<th>River Valley</th>
<th>Average river salinity (EC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1998</td>
</tr>
<tr>
<td>Murrumbidgee</td>
<td>250</td>
</tr>
<tr>
<td>Wagga Wagga</td>
<td>140</td>
</tr>
<tr>
<td>Lachlan</td>
<td>530</td>
</tr>
<tr>
<td>Cowra</td>
<td>330</td>
</tr>
<tr>
<td>Darling River</td>
<td></td>
</tr>
<tr>
<td>Menindee</td>
<td>360</td>
</tr>
<tr>
<td>Bogan</td>
<td>730</td>
</tr>
<tr>
<td>Macquarie</td>
<td>620</td>
</tr>
<tr>
<td>Narramine</td>
<td>440</td>
</tr>
<tr>
<td>Castlereagh</td>
<td>640</td>
</tr>
<tr>
<td>Namoi</td>
<td>680</td>
</tr>
<tr>
<td>Gunnedah</td>
<td>580</td>
</tr>
<tr>
<td>Gwydir</td>
<td>560</td>
</tr>
<tr>
<td>Macintyre</td>
<td>450</td>
</tr>
</tbody>
</table>
Table 7.5 Estimated river salinity, Victoria, 1998-2100 (from MDBMC, 1999)

<table>
<thead>
<tr>
<th>River Valley</th>
<th>Average river salinity (EC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1998</td>
</tr>
<tr>
<td>Murrumbidgee</td>
<td>250</td>
</tr>
<tr>
<td>Wagga Wagga</td>
<td>140</td>
</tr>
<tr>
<td>Lachlan</td>
<td>530</td>
</tr>
<tr>
<td>Cowra</td>
<td>330</td>
</tr>
<tr>
<td>Darling River</td>
<td></td>
</tr>
<tr>
<td>Menindee</td>
<td>360</td>
</tr>
<tr>
<td>Bogan</td>
<td>730</td>
</tr>
<tr>
<td>Macquarie</td>
<td>620</td>
</tr>
<tr>
<td>Narramine</td>
<td>440</td>
</tr>
<tr>
<td>Castlereagh</td>
<td>640</td>
</tr>
<tr>
<td>Namoi</td>
<td>680</td>
</tr>
<tr>
<td>Gunnedah</td>
<td>580</td>
</tr>
<tr>
<td>Gwydir</td>
<td>560</td>
</tr>
<tr>
<td>Macintyre</td>
<td>450</td>
</tr>
</tbody>
</table>

Average salinity levels in some of the major rivers in the Murray-Darling Basin are expected to exceed 1500 EC during the next 100 years (e.g. Avoca River, Bogan River, Namoi River). This is a commonly accepted threshold, beyond which adverse biological effects are expected in rivers, streams and wetlands. While 1500EC remains a convenient benchmark, for many taxa, abundance will decline at lower salinities, and the effect may not be noticeable for some time. Long term average salinity can mask high salt concentrations that occur for relatively short, but critical, periods of time (e.g. the intrusion of highly saline groundwater into rivers or wetlands during key periods of the breeding cycle of aquatic plants or animals such as fish). Increasing salinity in the Basin's rivers and streams will increase the risk of adverse biological and ecological effects, for example on the development of aquatic plants and fish larvae (James and Hart, 1993; O'Brien, 1997). The rate of change of salinity in freshwater ecosystems, as predicted by the Salinity Audit, will be much higher than the rate at which freshwater biota can evolve or adapt.

Variations in salinity in important floodplain habitat such as wetlands are linked to river flows and wetting and drying cycles. These are both impacted by the rules that control the management and operation of river flows. However, there is little information available to river managers on the relationship between flow patterns, salt levels and environmental damage. Nor is there any information available on how a combination of changes in flow and salt concentration affect river and wetland health, synergistically. This knowledge gap has been identified in a recent Draft Discussion paper "Ecological Effects of Dryland Salinity on Aquatic Ecosystems" produced by the CRC for Freshwater Ecology.

The availability of dilution flows, the volume of which is protected by the Cap, will be an increasingly important constraint on salinity management in the future.

7.1.2 Blue-Green Algae

Provisions in the Cap that have helped to protect low flow conditions, especially in highly regulated rivers, has improved the management of nuisance algal blooms in waterways across
the Murray-Darling Basin. For example, Oliver et al. (1998) reported the findings of a three-year field study of factors controlling algal growth in the Darling River, NSW. The study showed that major blue-green algae (cyanobacteria) blooms in the Darling River were assisted by a sequence of events related to flow conditions. Reduced flow increases water residence times in weir pools and increases the likelihood of thermal stratification of the water column. The development of anoxic conditions following stratification results in changes to chemical and biological processes in river sediments and bottom waters, that in turn promote the release of nutrients such as phosphorus and nitrogen from the sediments in forms readily available for uptake by algae (Donnelly et al., 1999). Groundwater inflows during times of low flow can increase salinity, which in turn precipitates the turbidity in the water column, increasing light penetration through the water.

![Discharge (ML/d)](image)

**Figure 5.1** Relationship between discharge, stratification and Anabaena in Maude Weir pool, Murrumbidgee River, December 1993 to April 1994. Source: Webster et al. (1997)

Overall, the combination of increased light and available nutrients in slow moving water favours the growth of blue-green algae and the formation of blooms. Investigations of blue-green algae in the Murrumbidgee River at Maude Weir (Webster et al., 1997) found that *Anabaena circinalis* counts were highest when discharge through the weir was low and increased water temperature in the surface layer led to stratification (Fig. 5.2). In short, the blue-green alga *Anabaena* blooms under low flow conditions and is reduced to very low numbers at moderate flows.

Increasing extractions from the Basin's rivers would result in reduced flows and also less capacity to provide dilution flows. Lower flows would favour the growth of blue-green algae. Reducing the volume of water for in-stream use (dilution flows) would reduce the ability of managers to provide flushing flows, one of the few proven techniques for managing blue-green algal blooms. The Cap, in isolation, will not lead a reduced frequency and intensity of algal blooms – this will require a coordinated nutrient and flow management strategy.
7.1.3 Water extraction
The effect of water extraction on riverine processes, and the role of the Cap in reducing further degradation has been discussed extensively in other Sections of this Review.

7.2 Potential ecological problems exacerbated by the Cap
Processes or activities whose environmental effects may be increased by the implementation of the Cap include impacts due to reductions in long-term runoff & stream flows, including:

- Reduced stream flow due to climate change
- Reduced stream flow due to changes in land use

7.2.1 Climate change
Changes to stream flow resulting from climate change (e.g. due to the Greenhouse Effect) may vary considerably across the Basin. For example, increased temperatures may result in increased rainfall intensity and frequency in summer rainfall (northern) areas, while rainfall may be reduced in winter rainfall areas (DASET, 1992). Modelling results reported by Bennett (1999) suggest that flows in the Upper Murray, Kiewa, Ovens and Goulburn Rivers in Victoria may decline by up to 36% over the next 30 years in a worse-case response to global warming (Table 5.6). The worse-case scenario also suggests that the frequency of flooding would decrease and that the frequency of drought would increase (Table 5.7). Similarly, modelling suggested that flows in the Macquarie River above and below Burrendong Dam in NSW may decline by up to 30% and 37% respectively. While these are the upper limits of changes modelled in the studies reported by Bennett (1999), and modelling predictions about the sustainability of water resources and agriculture should be treated with caution (Henderson-Sellers, 1996), they highlight the fact that climate change may significantly alter flows in the rivers of the Murray-Darling Basin. If climate change results in reduced streamflows, then the volume of water available for apportioning between diversions, in-stream use and the environment is reduced. Reduced water for in-stream use reduces the availability of water to manage rising salinity and nuisance algae.

Table 7.6: Scenarios for the year 2030 on the effect of climate change on precipitation and streamflow in snow affected (Mitta Mitta and Kiewa Rivers) and snow free catchments (Goulburn and Ovens Rivers) in Victoria (from Schreider et al. (1997) reported in Bennett, 1999)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Precipitation (% change)</th>
<th>Streamflow (% change)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow free</td>
<td>Most dry -7</td>
<td>-36</td>
</tr>
<tr>
<td>Snow affected</td>
<td>Most dry -6</td>
<td>-30</td>
</tr>
<tr>
<td>Snow free</td>
<td>Most wet +13</td>
<td>0</td>
</tr>
<tr>
<td>Snow affected</td>
<td>Most wet +13</td>
<td>+9</td>
</tr>
</tbody>
</table>

Table 7.7: Scenarios for the year 2030 on the effect of climate change on floods and drought in snow affected (Mitta Mitta and Kiewa Rivers) and snow free catchments (Goulburn and Ovens Rivers) in Victoria (from Schreider et al. (1997) reported in Bennett, 1999)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>August – October floods (% frequency)</th>
<th>January – March drought (% frequency)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow free</td>
<td>Most dry -82</td>
<td>+36</td>
</tr>
<tr>
<td>Snow affected</td>
<td>Most dry -83</td>
<td>+36</td>
</tr>
<tr>
<td>Snow free</td>
<td>Most wet +41</td>
<td>+5</td>
</tr>
<tr>
<td>Snow affected</td>
<td>Most wet +62</td>
<td>+1</td>
</tr>
</tbody>
</table>
Reduced stream-flow, due to climate change, will be reflected in the climate adjusted Cap diversion target for the year in question – once appropriate Computer Simulation Models have been developed. However, reduced stream-flows in the Southern parts of the Basin will result in the long-term proportion of total stream flow diverted to increase. This is because at lower stream-flows, the Cap allocates a greater proportion of total flow for consumptive use (See Section 6.7 for further discussion). Reductions in water yield from a catchment therefore, disproportionately impact on the environment's share. This will increase hydrological stress on the rivers and is a constraint on sustainability.

The Review recommends that over time the Cap be redefined so that it guarantees a minimum proportion of stream flow for the environment.

7.2.2 Land use change effects

There are plans to significantly increase plantation areas across the Murray-Darling Basin. For example, the Victorian Government is to invest $8 million in the Replanting Victoria 2020 program (DNRE, 1999) as part of its response to Greenhouse effects and other land and water management issues. Much of the new plantation areas are expected to replace what is currently grassland. It is well known that evapotranspiration rates in plantations are higher than in grasslands, yet there is scant acknowledgment of the fact that stream flows will decline significantly from afforested catchments (Vertessy, 1999).

In a study of 28 sub-catchments of the middle Murrumbidgee River basin, Vertessy and Bessard (1999) reported that the greatest impacts of afforestation might be expected in higher rainfall areas. Average annual runoff declines of up to 500 mm were considered possible with the conversion of grassland to pine plantations, with declines by 100 mm (1.0 ML/ha) possible for 75% of catchment area and 290 mm (2.9 ML/ha) possible for 25% of the catchment area that may potentially be afforested.

Afforestation in Victoria is expected to reduce runoff by approximately 2ML/ha (Government of Victoria submission). As 200,000 ha are expected to be afforested in coming years, runoff reductions in the order of 400 GL may result. This is equivalent to 25% of Victorian abstractions from the Murray valley.

Large-scale bushfires can significantly reduce water yield from a catchment in the medium term until regenerating forest matures. An examination of the long-term hydrologic effects of the 1939 bushfires in the Maroondah catchment near Melbourne suggested that water yield decreased by up to 24% after 48% of the catchment had been converted to regrowth forest. The long-term trend in declining in yield commenced 3-5 years after the fires and reached a maximum after 15-20 years (Langford (1975) in Kuczera, 1985). Further modelling undertaken by Kuczera (1985) for the Murrindindi catchment (Goulburn River catchment) suggested reductions in average annual water yield of approximately 200mm (2 ML/ha) from pre-1939 fire conditions. The modelled reduction in water yield was greater in Melbourne water supply catchments; for example modelling suggested that water yield reductions in the order of 300 - 400mm in the Maroondah catchments. Major bushfires in the forested catchments in SE Australia (for example above Lake Eildon, Victoria) will significantly reduce stream flows in the medium term.

Williams and Karoly (1999) reported that the seasonal fire danger in southeastern Australia is higher in years of strong negative Southern Oscillation Index (SOI), and that the daily Fire Danger Index (FDI) has more days with extreme fire danger during these periods. If climate change were to results in more frequent and sustained periods of negative SOI (increase in El Nino events), then an increase in bushfire frequency might also be expected. While, current
global climate models cannot yet reproduce the behaviour of ENSO events reliably enough to understand the potential effects of global warming and, therefore, test the likelihood of this scenario (Pittock and Henessy, 1996) the potential for increased fire frequency and its impact on medium-term changes in stream flow should be considered.

Reduced stream-flow resulting from land use change will be reflected in the climate adjusted Cap diversion target for the year in question – once appropriate Computer Simulation Models have been developed. However, as with climate change, reduced stream-flows from landuse change in the Southern parts of the Basin will result in the long-term proportion of total stream flow diverted increasing. Reductions in water yield from a catchment therefore, disproportionately impact on the environment's share. It should also be noted that long-term reductions in water yield, regardless of whether it’s the result of climate change or landuse, will also result in lower availability of water for consumptive use.
8 Case Study: The Lower Murray

8.1 Introduction
This study outlines the nature of the Lower River Murray and the hydrological and ecological changes associated with flow regulation. It then considers the hydrological and ecological significance of the Cap, designed to limit diversions to levels that prevailed in 1993-94. Four scenarios are considered:

1. Modelled natural flows (no diversions)
2. Actual flows 1979-91
3. Cap Diversion Target
4. Full Development Scenario

8.2 Study Area
The 830-km course of the ‘Lower Murray’, from the Murray-Darling confluence at Wentworth to the sea near Goolwa (Fig. 6.1), includes floodplain wetlands and woodlands, a spectacular limestone gorge, reclaimed riparian swamplands and shallow freshwater lakes near the mouth. The river is strongly influenced by a series of regulating weirs, and by variable flows from the Darling. It is a distinct ‘environmental unit’ in terms of ecology and management, and as much of the region (648 river km) is within South Australia, it also has some political unity.

Most flow in this tract originates from the Murray above Wentworth. Flows are governed by upstream dams and diversions, and regulated by 10 weirs (height 3 m, capacity 13-64 GL, pool length 29-88 km) between Wentworth and Blanchetown. In addition, the lowermost reaches (274 river km) are controlled by riverbank levees and barrages along the seaward margins of Lake Alexandrina. The Darling’s contribution is highly variable, but averages about 12% of the system’s long-term annual discharge.

There are four main sections:

Valley: Wentworth to Overland Corner (400 river km), including Locks 3-10. Lake Victoria (680 GL) is managed as an offstream storage. The river meanders over a 5-20 km wide floodplain with many anabranches, billabongs and deflation basins, particularly in the Chowilla region (above Lock 6).

Gorge: Overland Corner to Mannum (280 river km), including Locks 1-2. The river flows in a 30-m deep gorge where the floodplain is constrained to 2-3 km and long, straight reaches are aligned by geological faults. Most wetlands are in channel swales, and are physically less diverse than those of the Valley.

Swamplands: Mannum to Wellington (74 river km). The river is flanked by reclaimed swamplands, protected by some 40 km of earthen levees planted with willows (Salix spp.). There are no weirs, but river levels are raised 450-600 mm by the barrages further downstream.

Lakes and Coorong: Wellington to the sea (76 river km), via Lake Alexandrina (2015 GL) and a series of barrages that exclude sea water from the lower reaches. Near the river mouth, the system connects with the Coorong, a narrow, shallow 90-km lagoon that grades from fresh or marine water, depending on discharge from the Murray, toward hyper-saline water (>35 g/L) at its other extremity.
8.3 Effects of Regulation

8.3.1 Hydrological Effects

Base flows to South Australia are set by an annual 1,850 GL ‘entitlement’, determined by parliamentary legislation, although the quota is exceeded in most years. Other hydrological effects of regulation have been to reduce the magnitude and variability of seasonal and annual flows and to limit interchange with floodplain environments (Jacobs 1989; Close 1990; Thomson 1992; Walker and Thoms 1993; Maheshwari et al. 1995; Walker et al. 1995).

Average annual flows in the Lower Murray are now substantially lower than they were under ‘natural’ conditions (simulated flow in the absence of diversions). Annual discharges in 1894-1993 ranged from 1,626 to 54,168 GL, with mean 10,090 GL and median 8,489 GL. The median annual natural flow now is exceeded only 8% of the time (cf. 50% under natural conditions). The average flow at Blanchetown has been reduced by more than half, and flow at the river mouth is reduced by about 80%; indeed, the mouth was closed by shifting sand in 1981 and closure is again imminent (February 2000). The demand for water from other states is such that the 1998 flood in the Darling, statistically a 1-in-30-year event, had no appreciable impact on flows in the Lower Murray.

Regulation has reduced the variability of mid-range flows so that the present regime is dominated by low flows with occasional high flows. Low flows (<5,000 GL) occur 66% of the time under regulation, but only 7% of the time under natural conditions. Despite the prevalence of low flows, the weirs maintain base water levels, and did so even during the major drought of 1967-68. Ninety five percent of annual regulated (in-channel) flows are between 0 GL to 15,000 GL, compared to 2,500GL to 20,000 GL for natural flows. Big floods (recurrence 20+ years) are little affected.

The seasonal extremes of monthly flows still tend to a natural summer–autumn minimum and winter–spring maximum, despite irrigation use. The magnitude of the seasonal peak, however, has decreased markedly.

Figure 8.1 The Lower Murray
8.3.2 Nature of the Cap

Annual diversions from the Murray-Darling Basin (excluding Queensland) increased from 3,000 to 11,000 GL in 1930–91, and were “capped” at 1993–94 levels in 1995 (MDBMC, 1995). The Cap is administered differently in each state, and in South Australia’s case the agreement of the Ministerial Council permitted a minor increase above the initial Cap. The Cap is indexed to inter-annual climatic variations, so that ENSO cycles, for example, are taken into account (See. Section 6.7). The rules for administering the Cap appear to be based on ad hoc judgements rather than a fixed protocol.

Annual statistics may convey a misleading impression of environmental effects. Variability is the hallmark of dryland rivers like the Murray, seen in the dynamics of water and sediment transport and the ecological and evolutionary character of the native flora and fauna. Regulation has altered the degree of variability at various temporal and spatial scales. At a seasonal scale the river now is more stable, but in some areas there are daily changes associated with weir operations (see below) so that, depending on the observer’s viewpoint, regulation has both decreased and increased variability. The significance of spatial scale is illustrated by contrasting hydrological changes with smaller-scale hydraulic changes that affect local erosion and deposition of sediment, the presence of snags and stands of water plants.

8.3.3 Hydraulic Effects

Discharge and volumes are common currency for river operations, including administration of the Cap, but they are difficult to relate directly to biological effects. To characterise the water-regime tolerances of plants and animals, biologists need information about parameters like the depth, timing and duration of inundation, the rates of rise and fall and the time since last wetting. Further, the scale of these changes is much smaller than those implied by discharge variations measured in gigalitres. Some river-edge plants are vulnerable to stage fluctuations of as little as 10 cm (Blanch et al. 1998a). Comparable differences in floodplain elevation determine flooding frequency and hence the localised distributions of familiar plants like river red gum (Eucalyptus camaldulensis) and black box (E. largiflorens).

Stage-discharge relationships developed for the Lower Murray lack sufficient accuracy for most biological applications. This is true, for example, of the River Murray Hydraulic Model maintained by SA Water (Maheshwari et al. 1993; Blanch et al. 1998b). More refined models are under development (e.g. Andrew Close, MDBC).

In this analysis we comment on the sensitivity of ecological (biological) phenomena to variations in stage, but it will be clear from the foregoing that predictions are difficult given only information about discharge at a hydrological scale.

8.3.4 Effects of Weirs

The emphasis on water levels (river stage) in ecological comparisons partly reflects the dominance of weirs as regulating structures on the Lower Murray. Isolated weirs may have minor effects, but the cumulative effects of 10 serial weirs are considerable. Their mere physical presence creates discontinuities in the amplitude of stage variations between successive weirs, and there is little scope to offset these effects by manipulating the crest height or panel and stop-log configurations (Lee et al. 2000). Routine operations by the weir keepers are designed to maintain a nominal tolerance of 50 mm above pool level, and these adjustments typically cause stage fluctuations of ±20 cm daily in the tailwaters (3–5 km) below each weir (Walker et al. 1992). At flows exceeding 60 000 ML d–1 all of the weirs are partly dismantled and present minimal obstructions to flow.

The weirs have changed patterns of sediment transport in the Lower Murray (e.g. Thoms and Walker 1992. Following the era of construction (1922–37), the river initiated a sequence of channel adjustments whereby sediment was eroded from the banks immediately below each weir and deposited in the pool above the next downstream weir. In effect, the river is
assuming a stepped profile (3-m risers) in response to the imposed hydraulic gradient. This process is still incomplete in some pools, and the system may require another 100 years or more to develop a new quasi-equilibrium.

Salinity in the River Murray at Morgan is predicted to rise above 800 EC by 2010, due mainly to the effects of dryland salinity (MDBMC, 1999). In 1978 it was estimated that about one quarter of all salt entering the Murray in South Australia was attributable to the localised hydraulic effects of the weirs (EWS, 1978). Removal or lowering of weirs is not an immediate remedy, however, as there may be short-term increases in river salinity and restoration of a balance would take decades (e.g. NEC, 1988). Saline inflows are exacerbated also by sudden falls in the level of the river, as in the aftermath of a big flood (e.g. DEP, 1988).

### 8.3.5 Water Quality

Anecdotal evidence suggests that water quality in the Murray has declined, but there are few substantive data. For example, many long-time residents believe that turbidity has increased in the last 40 years. If so, this may have been due to the loss of wetlands (and wetland plants), poor land management and, in localised areas, the effects of carp (*Cyprinus carpio*). Regulation is also implicated, in that much of the sediment transported by the Murray is derived from the river banks rather than the catchment (Thoms and Walker 1992).

Regulated inflows of water from the Darling also contribute to turbidity in the Lower Murray. During the El Niño episode of the late 1980s, the demand for irrigation water was such that flows to the Lower Murray were made up mainly by Darling water stored and released via Lake Victoria (Mackay et al. 1988; Walker et al. 1992). Although South Australia’s water needs were met, the characteristically high turbidity of Darling water had striking effects on the growth and distribution of river-edge plants (cf. Walker et al. 1994; Blanch, 1998).

Nutrient levels are likely to have increased, reflecting agricultural and urban inputs (Gutteridge 1992), although the latter have largely been contained. Sedimentation in the weir pools may have increased nutrient storage in the channel and the limited exchanges with the floodplain will have reduced nutrient export.

The frequency of blue-green algal (cyanobacterial) blooms has increased (Codd et al. 1994; Webster et al. 1997), reflecting the coincidence of high phosphorus concentrations, thermal stratification, warm surface water and low flows, promoted by summer irrigation diversions.

### 8.3.6 Flora and Fauna

As regulation has increased there have been declines in the range and abundance of many species of native plants and animals, including fish, crayfish, turtles, frogs, birds and mammals. In their place, species like carp and willows have become naturalised.

Less obvious changes have occurred in the composition of littoral biofilms (e.g. Burns and Walker 2000). Rapid changes in water levels appear to have favoured the development of algae, rather than bacteria, in the biofilms that provide food for grazing invertebrates. This change may explain the decline of aquatic snail species in the Lower Murray (Sheldon and Walker 1997).

Littoral plants are a prominent feature of the channel, but it is not widely realised that prior to regulation the banks were largely bare (Walker et al. 1994; Blanch et al. 1999, 2000). Reeds (*Phragmites australis*), cumbungi (*Typha spp.*) and other plants formerly were best represented in floodplain wetlands, but have invaded the margins of the weir pools. The present riverine littoral community is an artefact of weir construction, but also a refuge for plants and animals, especially those typical of wetlands.

Changes in the flow regime have had major effects on floodplain environments. The eucalypt woodlands are degraded by lack of flooding (hence recruitment), salinisation, grazing and
land clearance (Partners et al. 1990). Some wetlands receive flooding less often than they did under regulation, and others are permanently inundated by water backed up behind weirs. The state of wetlands, and limited opportunities for exchanges with the channel, are responsible for the decline of many aquatic species.

8.4 Analysis

8.4.1 Diversions after 1993-94

The Water Audit (MDBMC 1995) indicated that, if all 1993-94 water entitlements were realised, 12,344 GL would be diverted annually from the Basin. This assumes no significant increases in off-river storage or inter-valley water trading was allowed. In fact, private water-storage capacity has increased 2% annually (5,700-6,200 GL) since introduction of the Cap, substantially so in Queensland (MDBC unpublished data). Trading is also increasing. In 1997-98, 852 GL were traded temporarily or permanently – trading will increase further as rules are clarified. Given these changes, it may be useful to re-assess diversions under the Full Development Scenario of the Water Audit.

If the projected demand for water in Australia were constrained by economic activity alone, and not by water availability, demand in the Murray-Darling Basin would rise at about 2% annually to 18,000 GL/year by 2021 (Thomas 1999). The 1993-94 Allocation Limit of 17,392 GL/year includes sleeper and dozer licences and off-allocation diversions, and from the practise of allocating more water than is available knowing that not all entitlement holders will use their full allocation. Since introduction of the Cap the Allocation Limit has decreased (15,707 GL in 1997-98 (MDBC unpublished data), mainly through restrictions to off-allocation.

The capacity to supply diversions is obviously limited by availability of water in the Basin. In an average year, the Basin water yield is 24,500 GL. Less than half would reach the sea under natural conditions, given losses to evaporation and seepage. Without the Cap, inter-valley trading and storage of off-allocation flows would drive diversions toward the allocation limit, within constraints imposed by climate and water availability.

Total climate-adjusted diversions from the Basin under 1993-94 levels of development (including the Lachlan) were 11,361 GL. Water use has exceeded this in three of the last 5 years, however until the Commission adjusts these diversions for climate it is difficult to ascertain whether they represent increased diversions since the Cap was introduced. The high water-use years are close to the Full Development Scenario of 12,344 GL.

8.4.2 Scenarios

This study compares four scenarios, using 1979-91 data provided by the Commission:

1. Modelled natural flows (no diversions)
2. Actual flows between 1979-91, (average diversions between 1979-91 were 8,532 GL/year)
3. Modelled flows under Cap Diversion Target (average diversion 11 309 GL y⁻¹ which is a 25% increase in 1979-91 average diversions)
4. Modelled flows under Full Development Scenario (average diversion 13 097 GL y⁻¹ which represents a 50% in 1979-91 average diversions).

Scenario 3 is close to the Cap target (11 361 GL/year). Scenario 4 is slightly above the Water Audit Full Development Scenario (13,097 GL/year compared to 12,344 GL/year), but is likely to represent diversions that would occur without the Cap, given demand, the increase in off-stream storage and water trading.

18 ‘Sleepers’ are entitlements that have never been used; ‘dozers’ are entitlements that have been partially used.
The scenarios were used to generate hydrographs at three sites (Wentworth, Lock 1, Barrages, Figs. 8.2a - 8.2b). Abstractions were increased monthly by 25% and 50% to represent the Cap Diversion Target and Full Development Scenario described by the Water Audit. At Wentworth and Lock 1 the minimum flow was set to the South Australian ‘Entitlement Flow’ (1850 GL y⁻¹), and at the Barrages it was set at zero. Abstractions were subtracted from actual flows until the difference fell below the minimal flow threshold, and the deficit then was re-apportioned among months with sufficient flows. This process was repeated until the increase in diversions was removed, and the data were used to generate monthly hydrographs (Figs. 8.2a, 8.2b) and flow duration curves (Fig. 8.3).

### 8.4.3 Hydrological Effects

Without the Cap, flows would have been reduced to base levels, meeting legal entitlements, between 80 and 90% of the time under the Full Development Scenario or 44% to 73% under the Cap Diversion Target compared to the 1979-91 20%. The average duration of periods of base flow would increase from 6 months to 13 or 8 months under Full Development or Cap Diversion scenarios respectively.

#### Table 8.1. Flow regime parameters (1979-91) under the four scenarios described in Section 8.4.2.

<table>
<thead>
<tr>
<th></th>
<th>Natural 1979-91</th>
<th>Actual 1979-91</th>
<th>Cap Diversion Target</th>
<th>Full Development Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Deviation</td>
<td>1,193</td>
<td>658</td>
<td>345</td>
<td>540</td>
</tr>
<tr>
<td>Coefficient of Variation</td>
<td>0.92</td>
<td>1.11</td>
<td>1.45</td>
<td>1.23</td>
</tr>
<tr>
<td>% Time at low flow</td>
<td>2</td>
<td>10</td>
<td>27</td>
<td>42</td>
</tr>
<tr>
<td>Pairs of months with no flow change (%)</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>71</td>
</tr>
<tr>
<td>Minimum flow events</td>
<td>3</td>
<td>12</td>
<td>18</td>
<td>9</td>
</tr>
</tbody>
</table>

In the absence of the cap:
- Short-term variations in flow and stage would be reduced.
- The magnitude, duration and frequency of floods would be reduced. Flood magnitude would be reduced by 30-50%, depending on antecedent conditions.

Table 8.2 shows the frequency and duration of critical flow events (30 GL d⁻¹ to inundate in-channel benches; 60 GL d⁻¹ to inundate the floodplain downstream of the gorge; 100 GL d⁻¹ to inundate the floodplain upstream of the gorge).
Figure 8.2a & 8.2b  Discharge (ML/month at the Barrages. Natural = modelled natural flows with no diversions, Actual = Actual flows between 1979-91 (average diversion during this period was 8,532 GL/year, MDBC = Modelled flows at approximate Cap diversion target (average diversion 11,300 GL/year) and Full Development = Full Development Scenario (average diversion of 13,100 GL/year). Flows at the barrages under the Full Development Scenario (8.2b) are much lower than under the Cap Diversion Target (8.2a). Similar trends were observed at Loch 1 and Wentworth (data not shown).
Figure 8.3  Flow duration curves for Natural = modelled natural flows with no diversions, Actual = Actual flows between 1979-91 (average diversion during this period was 8,532 GL/year, Cap Diversion Target = Modelled flows at approximate Cap diversion target (average diversion 11,300 GL/year) and Full Development = Full Development Scenario (average diversion of 13,100 GL/year). Graphs represent percent time flows (GL/month) are exceeded.
Table 8.2. Critical flow events with and without the Cap. The first number in the No Cap column refers to the Full Development Scenario while the number in brackets refers to the Cap Diversion Target.

<table>
<thead>
<tr>
<th></th>
<th>Percent of Months</th>
<th>Frequency of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual</td>
<td>No Cap</td>
</tr>
<tr>
<td>In-Channel Benches</td>
<td>20</td>
<td>7.5 (15)</td>
</tr>
<tr>
<td>Downstream Floodplain</td>
<td>7</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Upstream Floodplain</td>
<td>2</td>
<td>0 (0.7)</td>
</tr>
</tbody>
</table>

The two development scenarios are founded on two assumptions. The first is that rainfall will remain constant, although global warming models suggest that SE Australia will receive less rainfall. Given lower rainfall, the Cap would protect the current levels of diversion and allow a greater proportion of the available water to be used, decreasing the water available for in-stream use.

The second assumption is that land management practices (hence infiltration and run-off relationships) will remain the same. This may be invalid:

- Global warming, increased demand for paper and declines in native forests point to the growth of agro-forestry, which may decrease water reserves.
- Present legalistic problems with definition of a ‘water course’ are allowing new farm-dam construction and floodplain harvesting in some regions.
- Groundwater utilisation may affect surface water availability. If the Cap induces people to increase groundwater abstraction, discharge to rivers and wetlands would be reduced.

8.4.4 Ecological Effects

8.4.4.1 Channel

The changes described by our scenarios would exacerbate the loss of habitat diversity, reduce the frequency and duration of exchanges between channel and floodplain and change the metabolic functioning of aquatic ecosystems.

Water Quality

Without knowing the relative contribution of Darling water to the Murray, it is not possible to predict the impact of increased diversions on turbidity. If development were to proceed equally across the Basin, and the protocols for regulation were to remain similar to those at present, the proportion of Darling water would remain roughly what it is today, subject to ENSO and other climatic cycles. If most development occurs in the north, the proportion of Darling water, and the turbidity, in the Lower Murray may decrease.

The effect of high turbidity on littoral plants was mentioned earlier (Section 6.3). When the late-1980s El Niño subsided there were dramatic changes in the diversity, distribution and abundance of water plants in the Lower Murray. The MDB later commissioned Water EcoScience (Mt Waverley, Vic.) to determine whether there was a statistical link between high turbidity and low invertebrate diversity, but the analysis was inconclusive. Subsequent experiments suggest that turbidity does affect both the biofilm and the associated invertebrate community (Cooke, 1999).
Depending on the nature of the suspended material (Darling sediment is colloidal), more stable water levels and increased salinity could increase settling and thereby increase water clarity. This may promote growth of some aquatic plants (e.g. ribbonweed, *Vallisneria americana*), and also promote the development of algal blooms.

Reduced flows may reduce the nutrient load, but lead to evaporative concentration and accumulation of nutrients in sediments. Anoxic sediments will release phosphorus, but lead to denitrification. This may further increase the incidence of nitrogen limitation, and encourage blue-green algal blooms, given calm weather. If high-alert levels are to be avoided a flow of over 4000 ML d\(^{-1}\) between November and April is recommended (Jones, 1997). Present data suggest that under the *Full Development Scenario* flows would exceed the threshold in November in only two of 13 years (1979-91).

**Algal Production**

Without the Cap, discharge and short-term flow variation would have been reduced, altering the disturbance (light, exposure, shear stress) regime for biofilms. Low flows would promote biofilms dominated by blue-green algae (Cyanobacteria), but only in the superficial zone that receives light (Mullen, 1998; Burns and Walker 2000). These biofilms are not good-quality food for invertebrates (Sheldon, 1997).

High turbidity will also limit biofilm and macrophyte production and may promote planktonic production dominated by filamentous green and blue-green algae. These do not represent a good food source for zooplankton.

During high flows and floods, coarse organic material is exported from the river to the floodplain. As flow is reduced, CPOM accumulates in areas of low flow. Over time this will lead to oxygen depletion and this will slow the rate of decomposition as anoxic bacteria dominate. This process will reduce the availability of terrestrial carbon sources, effectively reducing metabolic activity in the river. It would also have the effect of releasing phosphorus from sediments, which is then available to planktonic algae. This effect is particularly prevalent in weir pools, but long-term problems are avoided by the regular removal of the weirs which allows the organic matter to be flushed downstream. The *Full Development Scenario* indicates that the frequency of weir removal would have decreased to three years in 10.

**Invertebrates**

Invertebrate communities apparently decline in abundance and species richness downstream from Mildura to Tailem Bend (Bennison, 1989). This decline has been attributed variously to increased salinity, turbidity due to Darling inflows and less seasonal variation in water level, and it may also reflect changes in fauna related to the prevalence of pool habitats and, given a change in faunal composition, the efficacy of the artificial samplers used in sampling. With increased diversions, salinity would increase and flow variability would decline. These factors alone suggest that the invertebrate community would have declined had the Cap not been imposed.

Reduced incidence of high flows will depress the numbers of animals dependent on flowing water and promote those typical of still water. This would reinforce the pattern whereby the channel now supports typical wetland species rather than riverine species, illustrated by the spread of the yabbie (*Cherax destructor*) and the virtual regional extinction of the Murray crayfish (*Euastacus armatus*).

The permanent wetlands associated with the Lower Murray provide an indication of the likely impact of less variable flow. Permanent inundation leads to a decline in invertebrate abundance and diversity (Maher, 1984; Maher, 1984).
Fish

The Lower Murray fish community is severely depleted, with 29% of 55 native species missing and others present in very low numbers (Harris, 1997). Native species represent only about 5% of the fish biomass, and the community is dominated by introduced carp and gambusia. Regulation has contributed by changing the physical habitat, including barriers to fish movement, favouring introduced species and changing the flow regime in ways that impact upon recruitment (cf. Humphries, 1999).

Without the Cap, three factors would be prominent:

1) Migration. Weir removal or over-topping during high flows are necessary preconditions for extensive fish movements in the regulated Lower Murray. Under present conditions, some weirs are removed seven years in every 10, and all would be removed two years in every five. Without the Cap, these figures would decrease to three years in 10 and <1 in 10, respectively. This would favour some species and discourage others (those dependent on floods for spawning or migration). The weirs may need to be removed for maintenance more frequently than these figures suggest, but the timing of weir removal may not coincide with high flows and peak fish movements.

2) Loss of floods. Minor flooding (>60,000Ml/day) occurred twice in the 13 years examined, but without the Cap there could be no floods for even more prolonged periods. This would limit recruitment opportunities for many native fish. Even long-lived species like Murray cod (Maccullochella peeli) probably require floods at minimal 5-7 year intervals to maintain the population against fishing, predation, disease and other factors. Murray cod populations in the Lower Murray already are depleted, and a decrease in flood frequency would prejudice their survival, and that of many other species.

3) Decreased flood duration. Several native (e.g. bony herring, Nematalosa erebi; golden perch, Macquaria ambiguа) and introduced species (e.g. carp) utilise floodplain habitats to spawn during floods. Carp make the most rapid use of these events, while native fish spawning is comparatively delayed (Ebner and Wilson, unpublished). Shorter floods may encourage carp and deny access to native fish.

Littoral Plants

Surveys of aquatic and semi-aquatic plants along the weir-pool margins show that the composition and distribution of species are strongly associated with gradients of water-regime, related to weir operations (Walker, 1992; Walker, 1994; Blanch, 1998; Blanch, 1999; Blanch, 1999). ‘Water regime’ here refers to patterns in the spatial and temporal distribution of water; it is the key environmental variable for wetland plants in habitats prone to drying.
Fig. 8.6  Distributional data for selected littoral plant species with distributions shown as a proportion of weir-pool length rather than absolute distances.
A summary of distributional data for selected species is shown in Fig. 6.6 with distributions shown as a proportion of weir-pool length rather than as absolute distances. To illustrate, the herb *Gnaphalium polycaulon* occurs in areas flooded to >0 cm for a median 299 in 730 days, and in areas exposed by >100 cm for a median 157 in 730 days. This accords with its observed range of 40-85% along a pool, at 1-4 m elevation. Similarly, ribbonweed occurs where flooding is virtually continuous (median 729 in 730 days flooded to >0 cm), and never where exposure is >100 cm.

Forty-one of 48 surveyed species occurred at 4-6 m elevation above pool level in the uppermost 10% of weir pools, where levels fluctuate most, but 1-1.5 m in the lower 10%, where levels are more stable. All are species tolerant of flooding and exposure (e.g. common reed, *Phragmites australis*), equipped to occupy essentially any sites (except those below pool level) at 25-100% along a pool. Typical adaptations include clonal growth (e.g. *Paspalum vaginatum*), rapid seed production (*Xanthium* spp.), below-ground storage (*Bolboschoenus medianus*) and a rapidly elevating canopy (*P. australis*).

The remaining seven species, confined to within ±1 m of the water surface in lower-pool reaches, in water sufficiently shallow to allow photosynthesis (turbidity 30-80 NTU), included aquatic macrophytes like ribbonweed, cumbungi (*Typha* spp.) and ‘mudmats’ (e.g. *Glossostigma elatinoides*).

Without imposition of the Cap, our scenario indicates that flow variations would be restricted in frequency and/or magnitude. This would restrict the range of elevations where littoral plants occur. In effect, tighter control over water levels, as would occur in the absence of the Cap, would cause the littoral plant fringe to become narrower.

Littoral plants are a habitat for a variety of animals including birds (Clamorous reed warbler, *Acrocephalus stentoreus*) and small fish (Lloyd, 1986). It is likely that reductions in the distribution and abundance of plants would also lead to a loss of riparian faunal biodiversity.

It is a minor paradox that the littoral vegetation so conspicuous along the pools of the Lower Murray is an artefact of weir construction. Historical records suggest the banks of the unregulated river were devoid of plants for long periods, but the pools and seasonally more stable flow regime have allowed numerous wetland plant species to invade the channel, where they provide habitat for many aquatic and terrestrial animals.

**8.4.4.2 Floodplain Wetlands**

Wetlands are productive and diverse environments providing water purification, flood mitigation, nutrient cycling, food production and other ‘ecosystem services’. Some Lower Murray wetlands have retained sufficient ecological integrity to warrant regional and national significance. Examples include Chowilla, Lindsay River and Walpolla Creek.

Few are unaffected by regulation. Some are dry for longer, or more often, than they were prior to regulation, and others are wet for longer, or more often, than prior to regulation. Without the Cap, most wetlands would receive shorter, less frequent periods of inundation. The effect would become more pronounced with distance downstream. The exceptions would be those associated with weir pools; these would receive less variable flows, given their direct connection to the channel.

Salinity levels would increase in permanent wetlands, in keeping with the river, and levels in some offstream wetlands would increase due to evaporative concentration, and seepage continue at the same rates. This would also increase nutrient concentrations, and may increase the frequency of blue-green algal blooms.
For permanent wetlands increasing abstraction above current levels may have little additional impact, although the loss of flood flows will further reduce their productivity, and thereby reduce the abundance of some invertebrate groups such as chironomids and yabbies. In the long-term changes in salinity during droughts and changes to water availability in the riparian zone may have an impact on the diversity of both higher plants and invertebrate groups.

Ephemeral wetlands will be far more dramatically affected. In the natural state these wetlands are more productive and diverse than permanent wetlands or the main river channel. Declines in the duration and frequency of inundation will reduce the diversity of those groups which emerge from resting stages in wetland sediments (e.g. rotifers and other zooplankters). Reduced duration may limit the ability of some groups, particularly fish and birds to complete their breeding cycles. This may have implications for populations of these animals in the main river channel or possibly across the basin. Overall damage to these systems would represent a major form of degradation for the whole river system.

8.4.4.3 Lake Victoria

Introduction

The management of Lake Victoria is currently under review. It is currently used as a water storage to ensure that the SA entitlement are available through summer when the Barmah choke would otherwise restrict water delivery. The Lake has also been used for flood mitigation through pre-releases and surcharging. The operation of the lake has been modified recently, primarily in order to ensure protection of culturally sensitive sites around the lake margins. The dynamics of the saline groundwater are also a priority as the operation of the lake has led to the formation of a freshwater halo around the lake and beyond that a rising mound of saline water. There is very little information available about the ecology of the lake, but other deflation basin lakes in the region support abundant populations of native fish, birds and invertebrates.

If abstractions were to increase by to the Full Development Level, the flow regime in Lake Victoria would change quite significantly. The lake is currently essentially permanent although it does experience quite large fluctuations in water level. The amount of water available to fill the lake would decrease, while demands from downstream would increase or remain at current levels. Absolute evaporative losses would probably decrease due to reduced volumes in the lake, but as a proportion of the total volume held in the lake, losses would increase. This would result in the lake filling less frequently and having an increased probability of either drying completely or drying to a residual pool.

Water Quality

The most worrying possibility from this scenario is that the lower water levels and the potential for an extended dry phase during a drought would lead to the movement of highly saline groundwater into the lake. This saline groundwater would have a dramatic impact on the ecology of the lake and significantly reduce water quality for downstream users.

Maintaining the lake at a lower level is likely to have a detrimental impact on other facets of water quality. Shallow water exposes more of the lakebed to wave action that would increase turbidity. Greater proportional evaporative losses would lead to higher levels of salinity and nutrients which may not cause problems within the lake itself but may pose problems once the water is returned to the river.

Biodiversity

If Lake Victoria were to experience saline groundwater intrusion then the ecology would be dominated by this event. Increased salinity would have a rapid and detrimental impact on the diversity and abundance of all groups of plants and animals, with the possible exception of
birds. At salinity levels of around 1500 EC the abundance of a limited number of invertebrate taxa can be quite high which can provide food for wading birds.

If saline intrusion could be avoided, the fluctuations in water level could be expected to lead to an increase in diversity of invertebrates and birds, although possibly a decline in fish species. The transition from terrestrial to aquatic habitat provides a greater diversity of habitats and allows some predator sensitive invertebrate species (e.g. fairy shrimp) to complete their life cycles.

Changes in Lake Victoria’s flow regime and ecology would have a significant impact on the ecology of the river. Decreasing the average volume and therefore depth of the lake may have a beneficial impact on bird populations, but would have a detrimental impact on some other groups of animals, such as native fish (see below).

Fish

The greater variation in water levels may restore some of the boom-bust cycling to the dynamics of the fish community. If the lake experiences pronounced wetting and drying the fish community in the river will assume greater importance as a source of colonists. The absence of the Cap would probably have had a detrimental impact on the riverine fish community, which may have a significant impact on the fish community’s ability to respond to the occurrence of favourable conditions in the lake. This would probably mean that over time, the fish community would be highly variable, but diversity would almost certainly decline.

8.4.4.4 Lakes Alexandrina and Albert

Introduction

Lake Alexandrina and Albert are large lakes that were once part of the Coorong complex, but are now isolated from marine influences by the barrages. The barrages ensure that the water within the lakes and lower river remains fresh to meet the requirements of Adelaide’s urban supply and Mannum’s and Lower Lake irrigation supply.

Increases in abstraction will result in these two lakes being terminal lakes for considerable periods of time. Our scenario predicts that there would be no flow leaving the lakes through the barrages 90% of the time.

Water Quality

The lakes already have significant water quality problems with frequent blue-green algal blooms of *Anabaena* and *Nodularia* and increasing salinity. The dramatic reduction in flow to the lakes would undoubtedly increase the frequency of these blooms. Without frequent floods to flush out sediments and nutrients and no through flow for most of any year the lakes would experience higher rates of sedimentation, increases in nutrient concentrations and increases in the temperature of surface waters. This would increase the likelihood of thermal stratification and phosphorus release from sediments.

With salinity already predicted to increase in this section of the Murray, further reduction of flows would magnify this effect in the lakes, because, although loads will decrease, concentrations will continue to increase as will evaporative concentration as water temperatures rise. As salinity now falls below acceptable levels for diverters, the frequency and severity of this problem would undoubtedly have increased, which would have significant impacts on the economic viability of the surrounding irrigation developments.

The lack of flows and associated increases in sedimentation would also lead to the accumulation of metals and agri-chemicals in the sediments of the lakes.
8.4.4.5 Coorong and Murray Mouth

Introduction

The Coorong is a complex of marine, estuarine, hypersaline and freshwater wetlands of regional, national and international significance. Its importance is reflected in its status as a National Park, a RAMSAR Wetland and its protection under Japan-Australia and China-Australia Migratory Bird Agreements. Protection of the unique character of the Coorong is dependent on maintenance of the quality and diversity of aquatic and riparian habitats, which is dependent on flows through the Murray Mouth.

During winter and spring high flows maintain flows out of the mouth of the Murray, but during the dry summer months and drought years, the tide creates semi-marine conditions around the mouth.

Our scenario indicates that Murray flows into the Coorong would be dramatically reduced without the cap. There would be no significant flow 90% of the time. This would mean that habitat diversity within the Coorong would be reduced and that the dynamics of the Murray mouth would become dominated by marine influences. This would increase the probability of mouth closure, which would in turn lead to further degradation of Coorong habitat and flooding on the rare occasions that water passes the barrages.

Water Quality

Overall water volume will be reduced due to the lack of inflows, which would be exacerbated by closure of the Murray mouth.

Salinity is the over-riding determinant of the distribution of plant and animal communities in the Coorong. Prolonged periods of no freshwater inflows will lead to a significant increase in salinity. A short period of no flow during an El Nino cycle in the early eighties resulted in salinities rising to 140ppt in the south and 35ppt at the mouth (Geddes and Hall, 1992). This increase would be the minimum expected under conditions of increased abstraction. With closure of the Murray mouth and subsequent loss of exchange with the ocean, evaporative concentration would lead to much higher salinities.

Our scenario suggests that the only way that the only way that the Murray mouth could be maintained would be through dredging. The frequency of dredging would depend on the weather and tides but would represent a significant ongoing cost to the MDBC. The environmental cost to the Coorong would be reduced volumes of water that would lead to habitat loss. This scenario would also mean that salinities within the Coorong could only be 35ppt or higher, essentially destroying the Coorong’s estuarine character.

Biodiversity

The Coorong is diverse because of the range of habitat types that are present. These habitats are defined by the salinity regime. The dramatic reduction in freshwater inputs would reduce the diversity of habitats and thereby reduce diversity in the Coorong as a whole. Some vegetation types may be extirpated. The productivity of other vegetation types such as Ruppia spp is likely to be reduced. Prolonged periods of no flow may also reduce water level fluctuations in the Coorong, which would also affect the growth and survival of Ruppia spp. This would have a dramatic impact on the birds that use Ruppia for food (Edyvane et al., 1996).

The invertebrate community in the Coorong is already depauperate with only 21 species. It is thought that this is due to rapid changes in salinity caused by the operation of the barrages. The predicted increases in salinity would worsen the situation. While diversity is low, the
abundances of some groups, such as isopods, are quite high. These invertebrates provide a rich source of food for fish and wading birds. An increase in salinity would reduce the available habitat to these animals as salinity increased above their tolerance threshold of 55ppt.

The bird community includes up to 85 species of water bird that are also dependent on the diversity of habitats provided within the Coorong and Lower Lakes. The lakes are particularly important as a drought refuge for many species.

Fish

The Coorong supports 15 species of native fish, seven of which have some commercial significance. A significant number of these require estuarine conditions to spawn. One example is Black Bream who require floods to achieve spawning condition. Congolli are primarily found in freshwater, but may require estuarine conditions to spawn. Our development scenario would result in prolonged periods, in which these fish would not be able to reproduce, which would significantly increase the risk of their extirpation from the Coorong.

The zooplankton of the Coorong is also dependent on inflows from the Murray. The zooplankton provides an important food source for small fish and the larvae of larger species. Loss of the seasonal inputs of zooplankton may result in decreases in the abundances of fish.

8.5 Conclusions

The projected increase in diversions to the Full Development Scenario would have a detrimental impact on the Lower Murray. The lower volumes passing down the river would mean a great deal less habitat variability, a significant reduction in the extent of interaction between the main river channel and it’s floodplain, and a significant reduction in productivity. These changes are likely to compromise the ecosystem services currently provided by the river-floodplain ecosystem.

One of the most obvious ecosystem services in the provision of clean water. Increases in diversions would have a significant impact on water quality in the Lower Murray. This decline would inevitably have a negative impact on the human communities dependent on the river. It would also have an impact on the diversity and abundance of several groups of organisms including littoral plants and invertebrates.

Under current diversion levels there is some flexibility in the way that weirs, Lake Victoria and the barrages are managed. This flexibility allows water to be used to achieve social, cultural or environmental objectives. Our scenario indicates that if diversions were not capped then this flexibility would be lost and the river would operated purely and simply as a piece of water delivery infrastructure.

While current climactic and rainfall-runoff conditions persist, the Cap provides a measure of protection for the Lower Murray. It ensures that there is at least some water available to maintain natural linkages. Due to the variability of the system, and long lag times between the imposition of a stress and the ecological response it is not possible to say whether the Cap has halted the decline in the integrity of the Lower Murray. It is possible to say that if the Cap had not been imposed, the move toward a Full Development Scenario would have resulted in further dramatic declines in the condition of the river. This decline would have affected areas such as the Coorong and Lake Victoria far more severely than other ecological components.
9 Case Study 2 : The Condamine Balonne

9.1 The catchment

The Condamine Balonne catchment located in South West Queensland comprises 14 percent (143,000 km$^2$) of the Murray Darling Basin. The catchment headwaters are near Killarney, on the Great Dividing Range, and the river flows in a south westerly direction joining the Barwon Darling in north west New South Wales upstream of Bourke. The Condamine Balonne River system is an allogenic river – it forms in a well-watered headwater area and flows for most of its length across a dry landscape.

Figure 9.1: River zones of the Condamine Balonne system.
The Condamine Balonne is a geomorphologically complex river system. Thoms and Burgess (1997) have identified five main river zones (Figure 9.1) each with its own distinct set of riverine habitats. These are described as follows.

- **Constrained upland zone** dominated by a high energy, boulder / cobble bed channel that has no floodplain.

- **Armoured zone** characterised by relatively immobile bed sediment, riffle/pool sequences and small flanking floodplains.

- **Mobile zone** with highly active river bed sediments and channel morphologies.

- **Meandering zone** with extensive floodplains, sandy in-channel sediment deposits, and numerous billabongs and abandoned channels on the floodplain.

- **Anabranch /anastomosing zone** with multiple channels and extensive floodplain wetland system.

A significant feature of the Condamine Balonne system is the large inland floodplain wetland complex located downstream of St George (Figure 9.1). It is listed as an ecologically important Australian Wetland (DRP001QL) and is typical of many floodplain wetland complexes in the Darling catchment. Also located in this region is Lake Narran a RAMSAR listed wetland.

Flow variability is a feature of the Condamine Balonne River system. The co-efficient of variation in average annual discharge ranges from 85 in the Culgoa River at Woolerbilla to over 200 in the Briarie Creek at Hebel. Flow variability is considered to be an important element contributing to the ecological productivity of the riverine ecosystems in the catchment. The Condamine Balonne catchment contributes approximately 20 percent of the long term median annual flows in the Darling River at Menindee. However, there are limited high quality flow data for the river downstream of St George, due large quantities of water conveyed across the extensive floodplain surfaces.

Across the region European settlement commenced in the 1830s, but large-scale intensive irrigation and flow regulation began relatively recently (Thoms et al., 1995). Whilst there are no large dams in the catchment there are a number of smaller structures that essentially regulate flows for irrigation developments and have a significant impact on the hydrology of the river (Table 9.1). Moreover, irrigation development in the catchment is extensive resulting in loss of floodplain area (Table 9.2).
Table 9.1 Hydrological change in the Condamine Balonne system at St George. Simulated flow data (IQQM) are given for the 1900 – 1998 period. [ARI = Average Return Interval]

<table>
<thead>
<tr>
<th>Natural</th>
<th>Current</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median annual (ML)</td>
<td>976,997</td>
<td>688,457</td>
</tr>
<tr>
<td>1.5 ARI (ML/Day)</td>
<td>31,813</td>
<td>16,672</td>
</tr>
<tr>
<td>2 ARI (ML/Day)</td>
<td>56,287</td>
<td>43,879</td>
</tr>
<tr>
<td>5 ARI (ML/Day)</td>
<td>123,663</td>
<td>118,268</td>
</tr>
<tr>
<td>10 ARI (ML/Day)</td>
<td>183,788</td>
<td>166,832</td>
</tr>
</tbody>
</table>

Table 9.2 Floodplain development in the Condamine Balonne downstream of St George.

<table>
<thead>
<tr>
<th></th>
<th>1988</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cropped area (ha)</td>
<td>4,300</td>
<td>38,650</td>
</tr>
<tr>
<td>Dam storage capacity (ML)</td>
<td>54,750</td>
<td>592,500</td>
</tr>
<tr>
<td>Dam surface area (ha)</td>
<td>1,825</td>
<td>19,750</td>
</tr>
<tr>
<td>Total area (ha)</td>
<td>6,125</td>
<td>58,400</td>
</tr>
</tbody>
</table>

9.2 Water management in the Condamine Balonne

The Department of Natural Resources (DNR) administer water management in Queensland under the Water Resources Act 1989. The Water Allocation and Management Planning (WAMP) process (WAMP) implemented by DNR aims to provide guidelines that will encourage efficient and ecologically sustainable use of water. This process has been accepted, by the Ministerial Council’s Independent Audit Group, as the means by which Queensland will comply to the cap. The Queensland Cap is to be established in terms of end of valley flow objectives following completion of the Condamine Balonne WAMP.

A WAMP plan provides environmental and hydrological analyses with the aim of providing a framework for fair, efficient and ecologically sustainable use of water. There is a defined process for developing a WAMP, this being:

1. Define total water resources in the catchment
2. Identify existing entitlements in the catchment
3. Determine environmental flow provisions
4. Reserve additional priority water requirements
5. Define water resources available for further allocation
6. Existing entitlements will be defined under the hydrologic model and, where appropriate will become tradeable
7. Rules for further allocation and management will be described.
At present the Condamine Balonne WAMP has not been implemented. A Cap will be implemented upon completion of the WAMP. However, a condition of the allocation of Bulk Water Entitlements under the WAMP is the development of a River Operations Management Plan (ROMP). The ROMP details the operational procedures and rules to be applied to actually achieve the Environmental Flow Objectives and Water Entitlement Objectives detailed in the WAMP.

Under the Queensland Water Act, water rights are linked to a property therefore water trading requires buying and selling property. Some individuals, particularly those in the lower Balonne, rely on flooding to fill floodplain waterholes and these users are not licensed. Currently there is no provision in the Queensland legislation to control the diversion of water that is not contained within the bed and banks of a watercourse ie, floodwaters. Hence the interim Cap arrangements in the Condamine Balonne are restricted to instream diversions. Floodplain development and water harvesting of floodwaters has continued to occur beyond 1993/94 levels.

9.3 Relevant reports to assist with Water management


9.4 Issues with the ecological sustainability of the Cap in the Condamine Balonne Catchment

The Condamine Balonne WAMP has not as yet been implemented. Hence, the following addresses those issues that are likely to occur upon implementation and compliance to the Cap in the Condamine Balonne.

The hydrological regime is recognised as an important factor in determining the distribution and structure of plants and animals in riverine ecosystems (Clausen and Biggs, 1997; Poff and Allan, 1995; Beumer, 1980; Jowett and Duncan, 1990). The science of environmental flow allocation is concerned primarily with the maintenance of appropriate hydrological regimes in such a manner as to facilitate natural populations of biota and physical and chemical processes. There are many models used for developing environmental flow requirements, such as the Instream Flow Incremental Methodology (IFIM) developed by the United States Fish and Wildlife Service (Bovee, 1982), the physical habitat component of IFIM (PHABSIM) (Jowett, 1982) as well as the Building Block Methodology (King, 1999). The differences between alternative environmental flow models are considerable; however, the
basic premise of maintaining an ecologically sustainable hydrologic regime is common. Emphasis is placed on deriving a regime rather than providing a simple allocation of water.

Rivers are nested hierarchical ecosystems and hydrological change through water resource development may influence all or some of the various hierarchies. Following the scalar approaches of Schumm (1988) for the investigation of geomorphic processes and Salo (1990) for biological communities, it can be shown that ecological processes in rivers may respond to three scales of hydrological behaviour (Thoms and Sheldon, 2000): the flow regime (long term, statistical generalisation of flow behaviour - macro scale influences that extend over 100’s of years); flow history (the sequence of floods or droughts - meso scale influences between 1 to 100 years); and, the flood pulse (a flood event – micro scale influences that generally extend less than one year). It is apparent that water resource development in the Condamine Balonne catchment has had a marked but variable impact on all three hydrological scales.

The Cap, does not recognise the importance of flow changes to the entire hydrological regime. Capping diversions in the Condamine Balonne at the 1993/94 level only addresses flow regime issues. Flow history and flood pulse parameters will also have important influences on the structure and functioning and ultimate health of riverine ecosystems. For example, Baldwin and Mitchell (2000) suggest that changes in wetting and drying cycles (flow history) can have a significant influence on the flux of carbon and nutrient between rivers and their adjacent floodplain. Thoms and McGinness (in press) calculate reductions of up to 85 percent in the potential supply of dissolved organic carbon from the lower Balonne floodplain due to changes in the wetting/drying regime associated with water resource in the Condamine Balonne.

Hydrological analyses of flows in the Condamine Balonne by Thoms and Sheldon (2000) also suggest that flow variability is a feature. This variability is important for the flora and fauna of these rivers. For example Walker et al., (1995) suggest that where floods are unpredictable in terms of their timing, species with flexible life cycles are likely to have a selective advantage (Baird et al., 1987). In contrast, sedentary organisms such as attached algae or attached aquatic macrophytes will be at a disadvantage in those environments that experience rapid rise and falls in water levels (a flood pulse parameter). Similarly increased rates of draw down due to water abstractions on the falling limb of the hydrograph have been reported to have increased rates of bank erosion in the Condamine Balonne.

In order to determine a suitable flow regime the hydrological character of a river system, to be managed, must be defined. Clausen and Biggs (1997), Hughes and James (1989), Poff (1997), Puckridge et al. (1998), Richter et al. (1996) and Toner and Keddy (1998) have all presented methods in which to define the key hydrological components of river systems. The Cap assumes that changes in flow will have a major influence on the health of the Condamine Balonne. River health, however, is a function of many factors (Norris and Thoms, 1999). Catchment conditions and in particular the nature of adjacent floodplain surfaces (Thoms et al., 1999) can also influence river health. Lateral connectivity where there is a periodic connection between the river channel and its floodplain is important for the transfer of materials and the resetting of river ecosystems.

Extensive floodplains are a feature of the Condamine Balonne. However, they have been subjected to large scale development resulting in substantial loss of natural surfaces (cf. Table 7.2). This can be expected to have a significant influence on the lateral transfer of carbon and nutrients between the floodplain and its river channel, an important feature in maintaining the integrity of river-floodplain systems. In the lower Balonne, Thoms and McGinness (in press) calculate reductions ranging from 8 to 40 percent in the potential supply of dissolved organic carbon from the lower Balonne floodplain due to the presence of developments on the floodplain for a range of floods (Figure 7.2).
Floodplain ecosystems are an important component in the overall health of river systems in the Murray Darling Basin. However, Cap compliance in the Condamine Balonne has only focused on instream issues – a major flaw in this part of Murray Darling Basin. Moreover, floodplain development still continues in the Condamine Balonne and current levels far exceed 1993/94 levels. Moreover, significant floodplain water harvesting is associated with these developments. These activities are not licensed and appear to continue unabated.

Continued floodplain water harvesting has the potential to significantly influence the long term ecologically sustainability of the lower Balonne floodplain system. A study by Sims et al., (1999) on the long term vegetation response to inundation in the lower Balonne has demonstrated that the vigour of floodplain vegetation increases dramatically during a 5 to 40 day period following a flood. However, between 1985 and 1999 there has been a slight but significant decline in the median Normalised Difference Vegetation Index (NDVI), a commonly used index of vegetation vigour, for the entire lower Balonne. This has resulted from increased water stress and is associated with significant water resource and floodplain development in the region. Indeed some floodplain regions experienced marked changes in NDVI with noticeable declines since 1993. The response of floodplain vegetation to environmental disturbances such as water stress, lags the onset of disturbance. Hence, if a Cap were to be implemented in Condamine Balonne under present conditions ecological degradation would still continue.

As outlined earlier river systems respond to three scales of hydrological behaviour: the flow regime; flow history and the flood pulse. It suggested here that the initial impact of water resource development will always be centred on a change in the nature of the flood pulse, and that continued change will result in a change in flow history leading eventually to change at the scale of the flow regime. The time scale of ecological change through this hierarchy from organism level responses, through population and community changes and finally ecosystem change will depend on the organism, or group of organisms or ecosystem component in question. This suggests that with any hydrological change there will be a 'lag time' before the ecological response can be detected, and the extent of this lag time will change with the
component in question. For many of the more familiar organisms (large fish, riparian trees) there would be a considerable 'lag-time', where recent hydrological development may take decades to be transferred into detectable environmental impact. For example, Thoms and Walker (1993) have demonstrated that the physical responses of the lower River Murray to weir construction are still incomplete after 70 years.

A major objective of the WAMP is to provide recommendations for ‘end of valley flows’ in the Condamine Balonne. Downstream of St George the Balonne bifurcates into six channels, the Culgoa, Balonne Minor, Briarie, Ballandool, Bokhara and Narran Rivers. The majority of these flows flow into the Barwon River in New South Wales. However, hydrological modelling and river assessment completed for the WAMP ceases at the Queensland – New South Wales border, some 100 kilometers from the Barwon confluence. Very little attention has been paid to the ecological downstream of the border crossings. This serves to illustrate that Cap compliance within the Murray Darling Basin appears to be focused at the sub catchment level. There is little emphasis at the Basin or whole catchment scale.

Catchment areas are highly variable in their physical, chemical or ecological character. For example, it is well known that some sub catchment areas are relatively more important that others in the supply of water at Menindee in the Barwon Darling catchment. Preliminary studies on dissolved organic carbon sources in the Barwon Darling Basin suggests that up to 73 percent of the potential supply at Bourke is derived from the Condamine Balonne catchment.

Further development in the Condamine Balonne catchment is likely to have a dramatic impact on ecological functions and eventually the sustainability of the river system downstream of Bourke. There is a serious risk that a Cap implemented in the Condamine Balonne (based on the WAMP) will fail to recognise the relative importance and potential impact of water resource development in this sub catchment on the ecological sustainability of the entire Basin.
10 References


Jones, GJ. Setting target river flows for the prevention of cyanobacterial blooms in weir pools. Final Report. LWRRDC, Canberra


RT Kingsford (ed.). 1999 *A free-flowing river: The ecology of the Paroo River*, NPWS, Sydney


Mullen, C 1998. Comparisons of biofilm growth on artificial substrata in static and fluctuating water levels in a weir pool in the Murray River. Honours Thesis, LaTrobe University, Wodonga


QDNR 1999. Border Rivers WAMP. New South Wales Department of Land and Water Conservation and Queensland Department of Natural Resources.


11 Appendix
11.1 Appendix 1: Summary of Government and CAC Submissions

Government and CAC Submissions to the Review of the Operation of the Cap addressing Ecological Sustainability of Rivers. Submissions are prefaced by a short description of that States implementation of the Cap.

<table>
<thead>
<tr>
<th>Submission</th>
<th>Summary of main points relevant to Ecological Sustainability of Rivers</th>
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<tbody>
<tr>
<td>Commonwealth Government</td>
<td>- The Commonwealth has supported the Murray Darling Basin Cap from its inception based on the need for immediate action to ensure the long-term health of this river system and to ensure agricultural industries and the rural communities they support have a viable and profitable future.</td>
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<td></td>
<td>- The MDB contains 30,000 wetlands, which include eight recognised under the Ramsar convention as wetlands of international importance.</td>
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<td>- There is little doubt that the health of the rivers of the MDB depends upon how much water is removed from them and when it is removed.</td>
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<td></td>
<td>- Probably the single biggest and most widespread effect of water harvested from the catchment of MDB for agriculture, urban or industrial purposes has been to reduce the number of small to mid-range floods in the river.</td>
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<td></td>
<td>- Wetlands have suffered from reduced flows with Macquarie Marshes 50% smaller in area, Victorias marshlands 70% smaller and the Lower Gwydir couch wetlands 90% of their original size.</td>
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<td></td>
<td>- Measuring the environmental benefit of the Cap is difficult because:</td>
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<td></td>
<td>- Long term baseline data on river health is limited or unavailable</td>
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<td></td>
<td>- Impacts of water regulation on river health are compounded by the impact of water regulation, and</td>
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<td></td>
<td>- Differentiating between the impact of the Cap from other water management strategies is difficult</td>
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<td></td>
<td>- As knowledge of environmental flow requirements improves, the provision of environmental allocations is likely to require adjustment to the level of the Cap to remain consistent with the COAG water reform requirements.</td>
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<td></td>
<td>- A list of future research projects is presented which includes:</td>
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<td></td>
<td>- Developing and implementing methods for assessing the effectiveness of the Cap in achieving ecological sustainability, including an assessment of existing databases</td>
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<td></td>
<td>- Determining the environmental costs including the value of ecosystem services provided by the riverine environment, and</td>
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<td></td>
<td>- An investigation to be undertaken of options for returning water to the environment from water savings paid by the Commonwealth.</td>
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<td></td>
<td>- The Cap must include increased diversions to private storages including farm dams.</td>
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<td></td>
<td>- The impacts of the Cap on groundwater abstractions must be identified so that groundwater sustainability is not jeopardised by tighter controls on surface water extraction. Water resource management should be holistic.</td>
</tr>
<tr>
<td>New South Wales Government</td>
<td>Cap compliance in New South Wales varied between valleys. The Cap was considered to be exceeded in four valleys, the Murumbidgee, Lachlan, Barwon-Darling and the Border Rivers.</td>
</tr>
</tbody>
</table>

114
Diversions in New South Wales regulated streams totalled 6579 GL in 1997/98.19

- “…the Cap is part of an evolving process that in combination with other water management initiatives will lead to improved long term environmental, economic and social outcomes for the Basin community.”
- In the Project Brief for the Review of the Operation of the Cap sustainability “infers the balance that our Basin community and Government seeks between supporting consumptive use for agricultural production and ensuring our rivers are resilient enough to maintain key ecological processes”. New South Wales submission argues that this definition is too narrow and ignores other aspects of sustainability. New South Wales's argues that the definition must include the principles of Ecologically Sustainable Development, which includes:
  * Precautionary principle.
  * Inter-generational equity,
  * Conservation of biodiversity and ecological processes
  * The improved valuation and pricing of environmental resources
- If the Cap is not maintained over time, hydrologic stress on our rivers will increase and the ecological improvements targeted by environmental flow rules and other initiatives will be diminished or not achieved.
- Paroo and Warego Rivers originating in Queensland are two Basin rivers in a relatively (hydrologically) undisturbed state, and have highest conservation priority. Queensland's non-compliance with the Cap threatens these systems with environmental values in New South Wales threatened by developments in Queensland.
- A list of indicators of ecological impacts of water diversions and river regulation presented. This includes rising salinity, loss in size and function of wetlands, impacts on riparian and floodplain vegetation, birds and fish, increases in algal blooms and a loss of connectivity between rivers, wetlands and their floodplains.
- Can not separate effects of Cap from other water reform currently occurring in New South Wales.

- Stressed river classification has been undertaken in New South Wales for unregulated rivers. These are rivers which do not have major rural dams, and where water users rely on natural flows for their supplies. However, the flows in these rivers can be affected by town water supply dams and weirs. Regulated rivers in New South Wales are considered as stressed.
- Past policies of allocating licences on unregulated streams have, in many cases, resulted in over-use of resources and damage to the riverine flora and fauna, including wetlands.
- New South Wales embargoed all further licence applications when the Cap was introduced in 1993/94.
- A key outcome of the stressed rivers analysis is the prioritisation of catchments for immediate attention.
- A index of hydrological Stress was developed for unregulated streams. The index was derived by proportioning water extraction to the 80th percentile flow (50th percentile in some ephemeral streams).
- Environmental stress was assessed separately by determining...
health indicators. These indicators included geomorphological, biological and chemical indicators.

- The results of the Stressed Rivers Assessment for New South Wales Unregulated streams in the MDB were that under existing conditions 85% of streams assessed indicated medium or high environmental stress with 49.6% of streams exhibiting a high degree of environmental stress. It is recognised that environmental stress reflects problems caused by factors other than water abstraction. Hydrological stress was however, one of the major stressors on the system. 32.5% of streams had a high level of hydrological stress (greater than 70% of 80th percentile flow extracted) and a further 24% with a moderate level of hydrological stress (between 40 and 60% extraction). This high proportion of streams exhibiting high hydrological and environmental stress has occurred under the current levels of diversions. The Cap does not reduce these levels of diversion.

- The stressed rivers classification was also undertaken assuming full water licence development scenario. Under these conditions the proportion of streams having a high level of hydrological stress increases from 32.5% to 52% and the number of low hydrological stress streams reduces from 43.7% to 25.8%. The Cap protects unregulated streams from unsuitable future development.

- This paper indicates that NSW embraces Cap and argues that the Cap is as an essential step in the process of sustainable water management.

- It also recognises that there is a fundamental limit to the level of diversions that can be sustained.

- The Cap is seen as providing 'breathing space' to allow the development of environmental flows etc.

- Water management plans will be the main vehicle for managing rivers. These plans will have clearly defined environmental objectives.
**Victorian Government Submission**

Victorian diversions were within Cap for 1997/98 for all valleys for which a Cap diversion target has been set. Total diversions were 3746 GL, 94.5% of the Cap diversion target of 3964 GL\(^\text{20}\).

- "Victoria, is very strongly committed to the Cap, …". A view endorsed by the newly elected government.
- Victoria recognises that water harvested by upper catchment farmers can have serious consequences for downstream users and environments.
- 200,000 ha of plantations in Victoria's NE will reduce inflows to the Murray by 400 GL, which is equivalent to 25% of Victoria's diversion from the Murray. This calculation assumes a reduction in runoff of 2 ML/ha when landuse is changed from annual pasture to plantation forestry. Submission argues that without downward adjustment of the Cap to account for lowered streamflows, the purpose of the Cap, to protect end of system flows, will be undermined.
- Anomaly of groundwater being outside the Cap, given that the resources are physically connected.
- Victoria has adopted the position that the Cap should be lowered to reflect any water returned to the Snowy.
- Bulk Water Entitlements account for 98% of water diverted from Murray tributaries in Victoria.
- Integrity of the Cap is threatened by if overuse in one year does not have to be "made good" in the following year.

**South Australian Government Submission**

Diversion for South Australia in 1997/98 was within Cap. Diversions (excluding Metro-Adelaide) totalled 478 GL, which was 85% of Cap diversion target. Metro-Adelaide's diversions were 153 GL.

- "The South Australian community is generally supportive of the Cap, …". The Cap has been widely identified and accepted, in South Australia, as a significant contributing factor in slowing the decline of the Basin water resources.
- South Australia proposes a complete sustainable rivers program to address flow regimes, timing and water quality issues in addition to the volumetric rationale of the Cap.
- The Cap does not effectively address ecological sustainability, although it has been effective in slowing its decline. Significant degradation of the riverine environment continues across the Basin. This indicates an inequity between consumptive users and the environment.
- Submission argues that there is a need to identify and address impacts of farm dams on river flows.
- The affects of all activities influencing flows, including all proposals for environmental enhancement, such as wetting and drying of wetlands and changes to flooding regime of floodplains, should be assessed form a whole-of-river perspective.
- Greater communication between States on the downstream effects of water management decisions is required.
- Degradation of strategic areas such as Chowilla floodplain, Coorong, Lower Lakes and Murray Mouth highlight the need to address flow management and timing through a whole-of-basin sustainable rivers program underpinned by the Cap.

\(^{20}\) This figure does not include diversions from the Wimmera-Mallee where Cap diversion target has not yet been set. MDBC 1999 Water Audit Monitoring Report 1997/98.
Determination of a Cap for Queensland has yet to be completed. Diversion\(^1\) of 741 GL were recorded for 1997/98, compared to 338 GL in 1993/94.

- Water management is currently being determined through the Water Allocation Management Planning (WAMP) and Water Management Planning (WMP) processes.
- Examples of how environmental water requirements are determined have been presented, for example the Condamine-Balonne Environmental Flows Technical Report and Current Ecological Condition of the Border Rivers (both reviewed later).
- As part of the WAMP process, the current condition of the riverine environment was determined, as were the effects of flow diversion on the hydrology of the river using an IQQM.

These reports present an appraisal of the current ecological condition of the Border Rivers using a combination of site inspection and rapid assessment techniques to produce an Index of Stream Condition, AUSRIVAS data from MRHI program and some existing fish community information collected as part of an NRMS project (Moffatt). They also report on the development of an Integrated Quality Quantity Model (IQQM) which is used to generate flow statistics for the Border Rivers for the 1991/92, 1993/94, 1998/99 and double the 1998/99 levels of abstraction. The salient points are:

- Abstractions continue to rise in this valley: Queensland and New South Wales on-farm storages have increased by >50% and 10% respectively, and capacity of Pindari Dam has increased from 37 GL to 312 GL since 1993/94. Mean annual diversions from the regulated system have increased from 264 GL to 350 GL (33%) since 1993/94. This has resulted in a significant decrease in a number of key flow statistics.
- The ecological data collected between 1996/99 indicates that the Border Rivers are currently in relatively good condition. However, ecological data collected after a run of four high flow years which have been favourable for river health.
- Reports emphasise the vulnerability of critical processes and ecological attributes of the Border Rivers to changes in flow regime (disappointingly does not point out the obvious temporal scale problem between very recent hydrological changes and longer term temporal changes).

The primary aim of this DRAFT report is to provide existing ecological condition assessment for the Condamine-Balonne river system and to establish the basis for assessing the flow related implications of any particular water resource development and flow management scenario for the Condamine-Balonne river system. Flow statistics for the river system were derived from an Integrated Quality Quantity Model (IQQM) which can simulate flows and abstractions over a long period of time. Ecological information was collected using rapid assessment techniques, AUSRIVAS data from MRHI program and some existing fish community information collected as part of an MDBC NRMS project (Moffatt).

Less than 30% of the Condamine-Balonne is regulated, however harvesting of overland flows has a considerable impact on the flow regime of this river. For the Condamine-Balonne river system to remain ecologically healthy it is

important that all of the features of the highly variable flow regime remain as 'natural' as possible.

- Considerable water resource development in the last 10 years has significantly altered hydrology of river system. The lag time before geomorphological or ecological response are measurable may be considerably longer than 10 years.
- The important ecological aspects of the Condamine-Balonne flow regime that need maintaining are:
  - The magnitude and duration of flow events
  - Rate of water level decline
  - The frequency of flow events, and antecedent conditions
  - The timing of flow events, and flow seasonality
  - Long term flow variability
- Environmental flow assessments indicated that the Upper and Lower Condamine and the Upper Balonne continue to have a fair to good flow regime, while the Lower Balonne has generally a poor flow regime.
- AUSRIVAS scores indicate a dramatic reduction in the number of expected macroinvertebrates downstream of Whyenbah (Lower-Balonne). Fish communities sampled at seven sites across the river system generally scored well, except for a site on the Culgoa River downstream of Whyenbah, which was routinely in poor condition. However, a convincing correlation between Index of Stream Condition Scores for hydrology, physical habitat, streamside zone and water quality with macroinvertebrate and fish scores was not found (pg 49).
- Water birds predominantly assemble to nest when the RAMSAR listed Narran Lakes reach 100% capacity, and birds abandon their nest when water level drops below 86% capacity. Increasing the period between filling the lakes and increasing the rate of draw-down threaten bird populations.

The social assessment for the Condamine-Balonne WAMP was undertaken to provide an assessment of the communities of the Condamine-Balonne Basin to assist in the evaluation of the social implications of different WAMP scenarios.

- A genuine desire to maintain or restore healthy rivers measured by maintenance of biodiversity and water quality
- Environmental water requirements need to be determined before significant water management decisions are taken.
- The ability of science to clearly explain and quantify river health is questioned. What is river health and can it be measured?

Australian Capital Territory Government Submission

A Cap process for the Australian Capital Territory has yet to be determined. Diversions for 1997/98 totalled 44 GL\textsuperscript{22}, compared to 1993/94 level of 29 GL\textsuperscript{23}.

- Australian Capital Territory's Water resources Act (1998) established a framework for the sustainable management of the water resource requiring that environmental flows are established and protected. The Act requires a Water Resources Management Plan which sets out Environmental Flow Guidelines guaranteeing an average of 63% of

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\textsuperscript{22} MDBC 1999 Water Audit Monitoring Report 1997/98.
\textsuperscript{23} Australian Capital Territory Government Submission to Review of Operation of Cap.
Australian Capital Territory's water resource is for the environment.

- Argued that this is a generous environmental allocation which protects the aquatic environment of the Murrumbidgee R.
- Much of the environmental flow left in-stream is used for irrigation further down the Murray and Murrumbidgee Rivers.
- Australian Capital Territory has adopted a 'bottom up' approach to setting environmental water requirements. The submission argues that current abstraction is below assessed environmental water requirements.
- Submission presents arguments, mostly on grounds of equity, for a Cap in excess of 1993/94 levels of diversions.

Community Advisory Committee of the MDBMC Submission

Summary comments from CAC of the Murray-Darling Basin Ministerial Council submission to the Review of the Operation of the Cap on Diversions.

**How should sustainability be defined for the purposes of the Cap?**

**SUMMARY** — Responses to this question range from the general, to the theoretical and quite specific in the case of unregulated streams.

**What does the science tell us about the suitability of the level at which the Cap is set?**

**SUMMARY** — Community feeling on this question is probably encapsulated by the response of “Not known yet” from the Lower Murray Darling Catchment Management Committee, New South Wales. Responses indicate that the community is unconvinced about the science, “science has really failed to tell us …” (Western Catchment Management Committee, New South Wales), and questions the ability of science to halt river health decline, the accuracy of information, and the rigour and scrutiny being applied to this side of the sustainability equation. If the intent of the Cap (ie. to achieve a balance between consumptive and instream uses of water) is to be valued and realised, considerable effort remains in convincing the community. This negativity is exacerbated by the inability to see any improvements in river health today. Importantly, it is recognised that sustainability cannot be based merely on the idea that less water extractions will make our rivers healthier (Murray Darling Association); and “… the Cap alone cannot deliver ecological sustainability for the Murray Darling… the Cap should be viewed as the first step…” (Australian Conservation Foundation).

**What aspects of the operation of the Cap constrain or support the sustainability of the river system?**

**SUMMARY** — There is support for the need for environmental flows for the rivers, but concern about management and accountability for that water and the need to monitor the effectiveness of environmental flows. Industry groups are not able to distinguish improvements in river health as resulting from the Cap or a combination of reform initiatives. Responses for unregulated rivers consider the Cap as too blunt an instrument for those systems and suggest instead that environmental flows be used for an appropriate end-of-valley flow regime or other appropriate differences in Cap arrangements; and also comment on a number of environmental issues that should be considered in an integrated way rather than focussing on irrigators. There is wide support for the need to consider groundwater resources in any discussion on the Cap. This inter-connectivity between surface and ground water has been recognised by the Community Advisory Committee for several years and has been provided in ongoing advice to the Ministerial Council. In considering aspects of the operation of the Cap for the sustainability of river health, an important question comes from South
Australia who “gave away the opportunity to use above entitlement flows. This must be the single greatest action to ensure sustainable ecosystems. Can all communities agree with this?” (Lower Murray Catchment, South Australia). A number of issues with Cap operation are also raised in relation to enforceability and relationship between the Cap and environmental flow rules. Comment is also made on the potential impact of the Snowy on River Murray environmental flows and the Cap. A suggestion worthy of further development is that there be a process for individuals to ‘donate’ water for environmental purposes and perhaps the use of incentives.

At a Basin scale assess the potential hazards and level of risk to the health of the riverine environment (including algal blooms and salinity) and comment on the role of the Cap in containing these hazards and reducing the level of risk to riverine health.

SUMMARY — Issues raised in response to this question include the urgent need for monitoring (without which the sustainability of the river will be known only in theory), the need to re-adjust flows in low flow periods to assist with salinity and algae control, bank erosion and water-logging due to high irrigation flows in summer, and the impact of river regulation and diversion of water resources. A separate issue is the impact of the Cap on event-based unregulated streams such as the Barwon-Darling where it is felt the Cap has done little to improve what is still a healthy river system but has impacted on sustainability of development. An issue that is raised on several occasions through this submission is the impact of forestry plantations on catchment yields, this is obviously an area of research which will be required for community awareness of trade-offs for the future of the Murray-Darling Basin.
### 11.2 Appendix 2: Submitters directly to the Review

Submissions of Basin stakeholders made directly to the Review of Operation of the Cap addressing Ecological Sustainability of Rivers.

<table>
<thead>
<tr>
<th>No.</th>
<th>State</th>
<th>From</th>
<th>Pages</th>
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<tr>
<td>1</td>
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<td>2</td>
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<td>Murray Irrigation Ltd</td>
<td>9</td>
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<td>Murrumbidgee Irrigation, Ricegrowers Assoc &amp; MIA Council Horticultural Associations</td>
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<td>Coleambally Community Action</td>
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<td>Toowoomba &amp; Region Greens</td>
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<tr>
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## 11.3 Appendix 3: Relevant Reports submitted

Reports provided by MDBC relevant to the Ecological Sustainability of Rivers component of the Review of the Operation of the Cap.

<table>
<thead>
<tr>
<th>REPORTS</th>
<th>SUMMARY OF MAIN POINTS RELEVANT TO CAP</th>
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<tbody>
<tr>
<td>An Audit of Water use in the Murray-Darling Basin. 1995. MDBMC, Canberra.</td>
<td>This document describes the water audit carried out in the Basin. This document clearly identifies surface water use in the Basin, the growth in water diversions and the likely implications of this on water users and the environment. The report details changes to the flow regime of a number of the Basins rivers including changed seasonality and reduced total flow. By providing descriptions of what the Cap aims to protect against (for example, declining river health with increasing algal blooms and salinity, decreased areas of wetland as well as issues of security of supply) the rationale for introducing the Cap is made clear.</td>
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<tr>
<td>Review of Cap implementation 1996/97 &amp; 1997/98 MDBMC Canberra.</td>
<td>These reports, prepared by the Independent Audit Group, provide a state by state assessment of Cap implementation for that water year. For each of the 22 valleys the reports provide details of diversions, and where available Cap targets. A description of water resource management and planning for the valleys are also given. The 1997/98 report contains responses by the four State Governments. These reports provide a valuable independent assessment of compliance with the Cap. However, these reports do not attempt to interpret the impact of the Cap, either on the environment or the community. The reports do not link the management of the Cap with the flow regime of the river systems. It is not possible to assess the effectiveness of the Cap without this information.</td>
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<tr>
<td>Water Audit Monitoring Reports 1996/97 &amp; 1997/98 MDBC, Canberra</td>
<td>The aim of the Water Audit Monitoring Reports is to ensure that the development, management and operation of the Cap is an open and transparent process. This is achieved by reporting water use in each State by region. This is reported against Cap target diversion when it was available. The reports include a summary of the climatic conditions in the Basin during the water year. Descriptions of water trading and water availability are also given. Actual flows are reported against modelled natural flows where available (currently only Victoria). The report also outlines States proposed water management activities. The Water Audit Monitoring Reports provide an overview of water usage and management across the Basin. The reports do not attempt to assess the ecological, social or economic impacts of the Cap. These reports provide the information necessary to get an overview of water use across the Basin. However, by not attempting to assess the Cap against what it is intended to achieve (eg healthy river environment and security of supply) it is not possible to assess the success of the Cap (over its life, or over a year).</td>
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<tr>
<td>River Murray Barrages Environmental Flows. 1998. Jensen A, Good M, Tucker P &amp; Long M. MDBC</td>
<td>Objective of this project was: to identify key environmental flow requirements in relation to management of flow through the barrages, as it relates to maintaining the ecosystem of the Lower Lakes, the Coorong estuary and Coorong Lagoons. The project identified changed water regimes of the lakes and river as being a key issue in driving the serious degradation of the environmental values in</td>
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</table>
the Lower Lakes and Coorong. Specific flow-related points include:

- Median flow the Coorong estuary is reduced by 80% and average flow is 37% of original flows with frequency of extended no-flow periods increased from 1 in 20 to 1 in 2. Minor to medium floods (up to 1 in 7 year) have been eliminated. (78)
- Without increased freshwater flows the Lower lakes (Lakes Alexanderina and Albert), the Coorong Lagoon and estuary are likely to further degrade (pg 79)
- Reduced through-flows are contributing to the unsustainability of the current operating system for the Lower Lakes
- Reduced freshwater inflows to the Coorong lagoons are allowing seawater to dominate conditions which has negative impacts on biota and fishing industry
- Low through-flows in the Lower Lakes have reduced the health of the aquatic plant communities and habitat diversity in the Lower Lakes
- The progressive restriction of the Coorong Lagoon and channels near the Murray mouth is related to the reduced median flows in the Murray, with the frequency of prolonged no-flow periods at the mouth increased from one in twenty to one in two years (pg 27)

The report makes specific recommendations which are relevant to the operation of the Cap:

- Controlling diversions from the Murray-Darling system is a key issue for the sustainability of the Coorong and Lower Lakes (pg 19)
- Flow management of the River Murray must consider the flow regimes and ecological needs of the remnant Coorong estuary, the Coorong, the mouth channel and the offshore zone
- Management aim is to increase environmental flows from the barrages through ongoing basin-wide water allocation reviews (pg 67)
- Management aim is to increase environmental flows to meet ecological needs of the Lower Lakes and Coorong through ongoing basin-wide water allocation reviews

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<tr>
<td>The major objective of the project was to: Identify changes in river operations for the River Murray and lower Darling River that should result in general improvements in the environmental condition of these river reaches whilst considering the current needs of existing water users,</td>
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</table>

- Prior to river regulation, the River Murray had a highly variable flow regime. The river channel and floodplain were configured to accommodate these flows and the plants and animals were adapted to this natural variation.
- Water resource development has imposed a more stable water regime (less variability over daily, seasonal and inter-annual scales) which is resulting in significant long term, detrimental ecological changes in the River Murray. Flow management activities that threaten ecosystem health include: constant flow for sustained periods, unseasonal flow patterns, increased minimum flow, decreased frequency of flooding periods, reduced duration of individual floods, rapid rates of rise or fall and the development of weir pools.
- A number of management recommendations to reduce the ecological impacts of regulation and abstraction are made in this report. Those that are likely to require a reduction in current abstraction include:
  * re-instate a flooding frequency of no less than 50% of what it was under natural conditions with a duration as close to possible as natural.

This project aimed to improve the management of the in-stream, floodplain and wetland habitats of the Lower Darling River by preventing and, where possible reversing, environmental deterioration resulting from the operation of the Menindee Lakes Storage Scheme. The study consisted of 3 main components, an analysis of wetland inundation by remote sensing, analysis of changes in the hydrologic regime using modelled and historic data and an analysis of the current status and flow requirements of the ecological components of the Lower Darling River. The project reports:

- Significant reductions have occurred in monthly flow volumes, flow duration and peak monthly flows (decreased 30-50%) for all except the very lowest flows.
- Under natural conditions, the Darling River at Burtundy would have ceased to flow 4% of the time in winter and 8% in summer. Under current conditions cease to flow occurs 2% of the time, or less for all months.
- Minimum flows of 2000 ML/day in winter and 5000 ML/day in summer are required to disperse an algal bloom at Weir 32.
- Flows of at least 7000 ML/day at Weir 32 are required to allow fish passage, which is critical to the ecology of native migratory fish.
- The flow required to fill 50% of the wetlands on the Lower Darling happens less frequently since river regulation. The time between filling events has doubled from 106 days to 236 days, with the maximum period between events increasing from 2.3 to 6.2 years. Floodplain vegetation, particularly river red gums and black box were in poor health which is likely to be a result of reduced flood frequency.
- Flooding frequency of benches in the Lower Darling has been reduced. While benches are a source of food for aquatic animals it remains unknown what the effect of reduced inundation on river health is.
- The report recommends a number of flow management changes which include increasing the frequency and height of flooding events on the Lower Darling River.


The objective of this study was to assess the condition of the in-stream ecosystem and determine its flow requirements. This provides a basis for interim flow rules for the Barwon-Darling River between Mungindi and Menindee to be formulated. The assessment was undertaken by an expert panel. The assessment included visiting 20 sites along the river and consultation with stakeholders. The study did not consider large out-of-channel flows.

Key findings relevant to the operation of the Cap are:

- Abstractions have had a significant impact on flows in the Barwon-Darling River. Diversions above Menindee, with 1994/5 levels of development, were equivalent to ~60% of the natural average annual flow at Menindee which translates to a reduction of average annual flow at Menindee of about 40%.
- Water abstraction has resulted in an increase in the rate of flood recession, decreases in the rate of flood rises, a decrease in flood

| * Introduce greater flow variability by allowing a passing flow through major storages during June to September as they fill. * Minimum base flows should not drop below 8000ML day through weir pools in the lower Murray for periods of greater than one to two weeks between November and April to reduce risk of blue-green algal blooms. |  |
duration and an increase in the time between floods.

- The Barwon-Darling riverine ecosystem responds to flows at several time scales; the long-term quantity of water, the pattern of individual flow events, and day-to-day variation in river heights.
  - In the long-term, floods and droughts have major ecological roles which should be protected
  - The maximum flow, duration, and rate of rise and fall are ecologically important characteristics of individual flow events
  - Short-term variability is significant in maximising aquatic biodiversity and productivity and in maximising bank stability and loss of habitat values.

- The time-lag between alterations in flow regime and a measurable change in the environment may be longer than the period between the onset of significant water abstraction and data collection for the report

- The report recommended a number of actions to maximise the environmental quality of the Barwon-Darling which included:
  - An immediate moratorium on additional abstractions and the transfer of licences upstream, and
  - No abstraction of water for irrigation below the 80th percentile flow (during low flow periods).

<table>
<thead>
<tr>
<th>Social Assessment Report for the Condamine Balonne Basin WAMP Process. 1998 QDNR.</th>
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</thead>
</table>
| The social assessment for the Condamine-Balonne WAMP was undertaken to provide an assessment of the communities of the Condamine-Balonne Basin to assist in the evaluation of the social implications of different WAMP scenarios.

- The environmental issues raised by the community include:
  - A genuine desire to maintain or restore healthy rivers measured by maintenance of biodiversity and water quality
  - Environmental water requirements need to be determined before significant water management decisions are taken.
  - The ability of science to clearly explain and quantify river health is questioned. What is river health and can it be measured? |

|---|
| DRFF state that a healthy riverine environment is a prerequisite for a healthy, sustainable irrigation industry.

- The Cap is a logical means of controlling over-development of water resources.
- Have concerns about the validity of the IQQM developed for the Barwon-Darling River valley.
- DRFF will support a Cap if it it could be scientifically established and that its eventual outcome had long-term environmental, social and economic gains. The areas developed for irrigation have increased by 14% (2000 ha) on the Darling and by 55% (6300 ha) since 1993/94, though this does not necessarily reflect a similar increase in water use.
- Annual extractions from the Darling River are now at about 120 GL.
- DRFF supports the Low flow rules for the Darling aimed to protect flows of less than 1000 ML/d from diversion.
- DRFF supports and end-of-valley flow based CAP, and is strongly against a diversion model based Cap. |

|---|
| DRFF vision statement is "Balancing river health and economic productivity for the Darling River such that we achieve both a sustainable river environment and long-term prosperity for the regional community"

- Argue for the Darling and Barwon to be considered separately in the formulation of flow management rules.
- Argue that the key issue is not so much the volume of water taken, but rather, when it is diverted. |
Major river health issues in the Darling River are:
* Changed flow regimes
* Fish management
* Water quality nutrients
* Poor knowledge base
* Riparian zone/floodplain management

Many of the environmental problems of the Darling River are inherited from upstream, where significant diversions occur in the headwater streams.

Ask the question "How far back towards natural do we have to go before the impacts on economic productivity be too great?"

Identify the lack of knowledge about the Barwon-Darling as limiting their confidence in the need for stringent flow management rules.

The Cap distorts water market when there is significant (50%) sleeper licences.

Water is a community asset and has economic, social and environmental values…. The way in which water is stored, extracted, delivered, used and disposed of can have profound ecological and economic effects.

The decline in water quality results largely from contaminants from agricultural and urban developments and high allocations to consumptive use resulting in inappropriate flow regimes in terms of both volumes and the seasonality and duration of flows.

Actions to improve the ecologically sustainable management of our rivers and water resources include (pg 54-55):
- Introduction of environmental flow regimes and other measures to improve the quality of water in streams and rivers...
- Understanding the role of groundwater in environmental flows
- Improved integration and understanding of questions associated with the conjunctive use of ground water and surface water
- Investigating and improving the valuation of water to improve allocation for environmental uses, including developing effective performance indicators for the management of environmental flows.
- Improve planning to support sustainable use of floodplains, wetlands and rivers
- Increased support for appropriately planned river restoration activities
- Further developing water trading markets

Management activities should not diminish our natural resources' ability to sustain ecological processes at the farm and regional levels (pg 79). Indicators that show whether the use of natural resources is sustainable at the regional and at the farm level should be developed (pg 80). These sustainability indicators should be capable of monitoring change in the condition of the natural resource base, other environmental values, net economic returns, and social well being.

Rivers sustain a large proportion of New South Wales total biodiversity but the State's degraded riverine ecosystems are rapidly losing their biodiversity. Evidence is especially clear in the Murray region, particularly in rivers regulated for water supply. The Darling ecological region produced nearly 10 times as many fish of the more heavily regulated Murray Region (which includes the Lachlan and Murrumbidgee systems) with nearly double the number of native fish per site in the Darling system than in the Murray system.

Carp are the most dominant fish of the Murray and Darling River systems. Their numbers are aided by human modifications of rivers especially flow regulation.
- An Index of Biotic Integrity (IBI) was developed as a river-health indicator for New South Wales rivers. The IBI rankings show that the Murray region rivers are in a degraded condition.
- Flow regulation generally had a negative impact on native fish abundance but had a positive effect on some alien species, including carp. It was concluded that flow regulation has reduced the resilience of New South Wales Rivers and native fish communities to invasion by alien fish.
- While rivers in the Darling region contained the highest numbers of alien species, the Murray region had the highest proportion of alien individuals with 57.5% of fish being alien in comparison to the Darling with 25.1%.
- Recommendation 1 pg xv. The primary recommendation from the Rivers Survey is to accept that our riverine heritage in New South Wales is in a generally degraded condition and in urgent need of restoration. River biota is reflecting problems of river habitats: aquatic biodiversity is rapidly being lost; productivity of natural resources is seriously declining, especially recreational and commercial fisheries; and the values and supply of the basic resource, fresh water, have been damaged. Restoration of river-ecosystem components is needed, especially flow regimes, thermal regimes and river catchments, particularly in the riparian zones. There is an urgent need to control carp and to restore fish passage at barriers such as dams and weirs.‘

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<tr>
<td>&quot;Rivers as Ecological Systems – the Murray-Darling Basin&quot;, in press.</td>
<td>Models of river function are presented that incorporate the key elements of the Basin's climate, geomorphology, and hydrology. The model explains how sediment and nutrient transport, and riverine productivity change with flow and position in the river system.</td>
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<td>The book argues that flow regime is central to controlling river form and function.</td>
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<td>When published, this book will provide a valuable reference on the functioning of the Murray-Darling basin's river system.</td>
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### 11.4 Appendix 4: Literature Search.

Results of a search of the *Streamline* database for articles about the Cap on diversions in the Murray-Darling Basin. *Streamline* is an Australian database that attempts to include published material from a broad base including LWRRDC and government publications.

<table>
<thead>
<tr>
<th>Title</th>
<th>Abstract (reprinted directly from Streamline)</th>
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<tbody>
<tr>
<td>Close A (Murray Darling Basin Commission) 1999. How does the Cap work? Australian Landcare, 1999-03, ISSN 14404397, p38-39, 1 photo.</td>
<td>In 1995, the Murray-Darling Basin Commission imposed a Cap on any further increase in water diversions throughout the Basin to reverse a perceived decline in water quality and riverine environments and to halt the continuing erosion of the security of supply to existing irrigators. This paper explains the way in which the Cap will be determined and applied in each state, how it will vary between wet and dry seasons and what it will mean for irrigators.</td>
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<td>Brennan D (University of Sydney, Department of Agricultural Economics); Scoccimarro M (Australian National University, Centre for Integrated Catchment Assessment and Management) 1999. Issues in defining property rights to improve Australian water markets. Australian journal of agricultural and resource economics, 1999-03, 43 (1), ISSN 1364985X, p68-89, 1 fig, refs.</td>
<td>With the announcement of the 'cap' that marked the end to the expansionary phase of the water industry in the Murray-Darling Basin, there is a need to address water market reform as a means of reallocating water between existing uses. This article discusses the key practical issues associated with defining property rights to water use, in the context of broadening the scope of the market for transferable water entitlements. In particular, the third party impacts of water trade and the need for improved water trading rules are discussed. Some of the issues associated with defining the reliability of water rights, including the design of appropriate dam management policies, are also discussed.</td>
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<tr>
<td>Currey A (Irrigation Association of Australia) 1999. More dams for NSW? Irrigation Australia, Autumn 1999, 14 (1), ISSN 08189447, p12-13.</td>
<td>A 'cap' limiting water use for irrigation at 1993-94 levels throughout the Murray-Darling Basin was agreed to by the four states who are members of the Murray-Darling Basin Commission, the Australian Capital Territory and the Federal Government, as a means of more sustainably managing the water in the basin. Some irrigator groups in New South Wales have seen the Cap as an obstruction to further irrigation development and have been vociferous in their opposition. The leader of the New South Wales National Party, Mr George Souris, promised more dams for the state, a review of the Murray-Darling Basin Cap and flagged the establishment of water property rights, which has been interpreted as a threat to pull out of the agreement on the cap. Reaction to these proposals is discussed.</td>
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<td>Whittington J; Hillman T; (Murray Darling Freshwater Research Centre) 1999. Sustainable rivers: the 'cap' and environmental flows. Cooperative Research Centre for Freshwater Ecology, Canberra ACT, 1999, 13p, figs, photos.</td>
<td>By the 1990s nearly half of the mean annual runoff from the Murray-Darling Basin was being diverted for urban, industrial and agricultural use. From July 1997, the Murray-Darling Basin Ministerial Council set an upper limit on the amount of water that could be taken from the river system (the 'cap'). This report justifies the 'cap' in terms of river health, water temperatures, ecosystems, environmental flows and sustainability.</td>
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<td>Connell D (Murray Darling Basin Commission); Sharley T (Primary Industries and Resources South Australia) 1998. Flow-on benefits: South Australia and the Murray-</td>
<td>The Murray-Darling Basin is an integrated approach by governments, agencies and communities to manage natural resources irrespective of State boundaries. The position of South Australia at the end of the Basin system has encouraged the State to take a whole of catchment approach to managing its part of the</td>
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<td>Darling Basin. Environment South Australia, 1998, 7 (2), ISSN 10379010, p19, 35, 1 photo.</td>
<td>Basin. The Salinity and Drainage strategy has reduced water salinity in the lower Murray and the Cap on further water diversions has pegged the decline in water volumes flowing to South Australia in years not dominated by major droughts or floods. Work has been undertaken in the upper catchments to reduce the impact of dryland salinity on streams and water quality and throughout the Basin to reduce the pollutants and nutrients entering the waterways, reducing the likelihood of algal blooms in the river and lower lakes. Development of environmental flow policies, cost sharing for dryland salinity works and increased funding programs are currently being urged.</td>
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<td>South Australia, Environment Protection Authority 1998. State of the Environment Report for South Australia 1998. South Australia, Department of Environment, Heritage and Aboriginal Affairs, 1998-10, ISBN 0730858529, 2 v, tables, figs, refs.</td>
<td>Since publication of the 1993 State of the Environment (SOE) Report some major achievements have been realized. Air quality is good and continues to improve and the Montreal Protocol targets for phasing out ozone depleting substances continue to be met. The creation of catchment management boards since 1995 has provided funding and mobilized community groups to initiate projects to progressively improve inland waterways and reduce stormwater pollution of coasts. A Cap has been placed on water diversions from the River Murray to prevent unsustainable growth in diversions and overuse of the resource. Environment Improvement Programs (EIP) have been negotiated to reduce the discharge of nutrients to the marine environment from four wastewater treatment plants. All soil conservation districts are now covered by soil conservation boards, most of which have published district management plans. National parks and wildlife reserves now cover 21.4% of the state, with 3.2% of coastal waters in marine protected waters. The release of the rabbit calicivirus led to a 80- 95% reduction in rabbit numbers in some areas of the arid zone and a consequent increase in natural regeneration of native plants. Recommendations for future actions to improve the South Australian environment are provided.</td>
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<td>Samaranayaka D; Freeman F; Short C; (Australian Bureau of Agricultural and Resource Economics) 1998. Water trading in the Murray-Darling Basin: some preliminary observations. Outlook '98, Proceedings of the National Agricultural and Resources Outlook Conference, 3-5 Feb 1998, Canberra ACT, Proceedings. Australian Bureau of Agricultural and Resource Economics, Canberra ACT, 1998, vol 1, ISBN 0642266182, p157-164, 13 tables, 1 fig, refs.</td>
<td>In the past five years, the Council of Australian Governments (COAG) has introduced water reforms, provided for environmental flows, implemented the Cap in the Murray-Darling Basin and, set a moratorium on groundwater licences and removed bans on sleeper licences (unused water licences) and doser licences (infrequently used water rights) in New South Wales. One objective of this reform was to encourage water use at its highest value among both consumptive and non-consumptive users, while ensuring that the use was ecologically sustainable. This was to be done by allowing for the movement of water to take place within and between consumptive and non-consumptive users through water markets. This paper reports the results of surveys in the Loxton SA, Sunraysia VIC, and Murrumbidgee NSW irrigation areas of water use and rights traded.</td>
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Canberra ACT, 1997-08, ISBN 1875209824, 26p, 5 tables, 1 fig. | healthy rivers and sustainable consumptive uses. This report reviews the performance of each State in progressing the implementation of the Cap during 1996-97 to ensure an accountable and transparent process is in place.

Dick A 1997. States work out water Cap ruling. Australian farm journal, 1997-12, 7 (10), ISSN 10366474, p26-29, 1 photo. | The rivers of the Murray-Darling Basin have become stressed from over use, resulting in a range of environmental, water supply and quality problems. Four State governments (Queensland, New South Wales, Victoria and South Australia) and the Federal Government are engaged in implementing a 1995 decision to Cap water extractions at 1993-1994 levels of development. However, implementation of this ruling must overcome a host of complexities, as each State has a different system of assigning water and each uses different terminology.

Connell D; (Murray Darling Basin Commission) 1997. What have we achieved in water management? Landcare Changing Australia: National Conference, 16-19 Sept 1997, Adelaide Convention Centre SA, Proceedings, Mathison, M (ed). Primary Industries South Australia, Adelaide SA, 1997-09, vol 1, ISBN 0730802051, p41-42. | Fundamental changes in the approach to water management in Australia have been coordinated through the Council of Australian Governments program for water reform. Aiming to promote increased economic efficiency, less waste, lower costs, fairer distribution of benefits and improved environmental management, the program concentrates on the institutional structure of the water industry, water allocation and pricing policy, water trading, environmental management and programs for improved public consultation and education about the need for change. The basic features are demonstrated by implementation in the Murray-Darling Basin and the Ministerial Council has introduced a wide ranging program of reforms including establishing a water business to operate the structures used in river regulation and water distribution system, billing for services, a water Cap on any further increase in water diversions from the Basin, encouragement of water trading and an integrated catchment management approach to water resource management.

Mussared D. 1995. Irrigation at the crossroads. ECOS, Spring 1995, 85, ISSN 03114546, p17-18, 3 | The three main problems which face the irrigation industry are shortage of water in some areas, excess of water in others and degradation of rivers and catchments in all areas. Sustainability needs to be improved, because excessive use of irrigation has mobilized salt, bringing saline water tables to the surface and feeding saline drainage water into creeks and rivers. In 1995, the Murray-Darling Ministerial Council agreed to an interim Cap on further increases in water diversions and identified as an urgent priority the definition of a balance between water for the consumptive uses of irrigation, domestic and industrial and the environmental flows needing to be left in rivers.
MURRAY-DARLING BASIN COMMISSION

REVIEW OF THE OPERATION OF THE CAP:

Economic & Social Impacts

2 March 2000
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EXECUTIVE SUMMARY

1. A limit on growth in diversions from the Murray-Darling Basin (the Basin) river system was introduced by the Ministerial Council in June 1995 and confirmed as a permanent cap with effect from 1 July 1997. As part of this agreement, the Ministerial Council agreed to undertake a review of the operation of the Cap in the year 2000.

2. The objective of the overall review is to establish a sustainable resource management outcome which achieves the optimal outcomes and balance between the three objectives of economic activity, social aspirations and ecological outcomes. The objectives of this consultancy are to:
   • review the aggregate social and economic impacts of the operation of the Cap on diversions from the Murray-Darling Basin (M-DB) river system; and
   • identify and describe the benefits and costs on different groups of enterprises, valleys and irrigation systems and resulting equity issues.

3. The consultancy brief envisaged the report as a desk review, sourced from relevant work already performed or currently underway, in particular the major submissions to be received from partner governments, the Community Advisory Committee (CAC) and other stakeholders across the Basin.

4. The main paradigm which underpins standard project appraisals is benefit cost analysis (CBA).

   In a standard economic analysis, the rights of subsequent generations are essentially ignored and discount rates are applied to establish the value of future costs and benefits to the current generation at the current day.

   The standard benefit cost framework needs to be extended when dealing with major environmental issues in order to recognise impacts on the value of natural capital. An important extension is to incorporate the “sustainability principle” which recognises that the resource base and environment do not exist purely for financial benefit and that there is a responsibility to pass natural capital intact from one generation to another, i.e. to achieve intergenerational equity.

   Use of the benefit cost paradigm does not imply that the impacts of the Cap can, or need be, described in terms of the net present value of dollar benefits and costs. The approach adopted in this review is to identify, describe and, where possible, indicate the order of magnitude of the benefits and costs associated with the announcement and implementation of the Cap.
5. To apply any benefit-cost framework requires clear distinction between the Cap and No Cap scenarios and careful attention to avoid double counting and ignoring offsetting benefits or costs. The paradigm applied in this Review observes these requirements.

ROLE OF THE CAP

6. A core question addressed by the consultancy was whether the Cap had played a central role in triggering the introduction of additional control measures across the Basin or had merely been just another element in a continuing process of responding to increasing resource scarcity.

7. Prior to the announcement of the Cap, individual governments had begun to change their water management policies. However, these initiatives were developed and implemented in an uneven way, with considerable variation both between and within States and with little recognition of Basin-wide implications. The situation pre-Cap contrasts sharply with the coordinated suite of measures and controls which are now in place across most of the Basin.

8. The 1995 Audit of Water Use in the Basin was clearly a watershed in the development of a common and agreed understanding of the issues of resource sustainability between members governments.

9. The subsequent decision of the Ministerial Council to introduce a Cap signalled, publicly, the need for a Basin-wide commitment to limit future growth in diversions. Discussions with water managers in each state confirm that the formal announcement of the Cap galvanised thinking and effort to achieve better and sustainable outcomes.

10. Therefore, rather than seeing the Cap as just another step in a series of responses to increasing resource scarcity, the more appropriate perspective is that the Audit and the Cap were essential pre-requisites to the suite of controls currently in place or being implemented by the individual states. In simple terms, the effects have been to:

• provide a Basin-wide framework to co-ordinate actions between states and catchments;
• strengthen and reinforce existing reform initiatives;
• provide a benchmark for future regulation of diversions; and
• ensure compliance, monitoring and publicity in all 22 major systems in the Basin.
DEFINING THE NO-CAP SCENARIO

11. In defining the No Cap scenario, a crucial question is what would have been the river flow and management objectives and, in turn, the impact of these on allowable diversions. The starting base for our assessment of Cap impacts is the No Cap scenario based on Full Development as specified in the 1995 Audit.

BENEFITS AND COSTS OF THE CAP

Impacts on the Agricultural Economy

12. The prime benefit of the Cap is the guaranteeing of security on a valley-by-valley basis. In the absence of the Cap there would be substantial erosion of security of entitlements across the Basin, but particularly in the major southern systems. The magnitude of the erosion is not widely perceived (Chart ES.1). The guaranteeing of this security through the introduction of the Cap provides a better and more certain climate for investment and jobs growth. Long term investment in high value agriculture and value-adding processing is dependent on the underlying security of the base resource.

13. Part of the benefit of guaranteeing this long term security is potentially offset by the reduction in development opportunities, i.e., costs associated with this guarantee of security are that development, particularly in less developed valleys, is – other things being equal – curtailed.

To date, there appears to be little firm evidence of aggregate reductions in development opportunities:

• in the northern systems, the Cap has not yet been fully implemented and development has continued apace;

• in the southern systems, allocations in recent seasons have been impacted by the resource availability rather than the Cap. The impact of lowered allocations due to resource scarcity/availability is most heavily felt by those whose enterprises are most reliant on high allocations, including the historic ability to utilise the unused allocations of other entitlement holders. The Cap, when it bites, will have a similar impact. However, while individual enterprises currently dependent on high allocations will be adversely affected, the industries and regions appear likely to continue to prosper;

• in other cases, development may have been displaced from one valley to another; and

• through water trade, new high-value developments can still take place, but at the expense of existing lower value activities.
14. Estimates provided in submissions of the costs of the Cap in terms of development that may be forgone in the future provide a partial picture only since these estimates are specific to particular locations and ignore the benefits of guaranteed security which are widespread and diverse. Overall, the guarantee of security in the longer term is a major net benefit to the Basin irrigation community.

15. Under the No Cap scenario, the growth of diversions towards full development would also increase the sensitivity of irrigated agriculture to changes in climate and rainfall. The impact of drought sequences on cash flow, the ability to access debt finance and fund existing commitments would worsen progressively. A benefit of the Cap, therefore, is to maintain the viability of irrigated agriculture in the Basin. In turn, this will prevent irrigators from unnecessarily being forced off their land due to the collapse in the security of diversions.

16. A further benefit of the Cap is the stimulus to codifying and improving property rights and entitlements to water. By definition, when the demands on the fixed pool of resources can be substantially expanded, then each property right risks erosion. Placing a finite limit on diversions across the Basin, therefore, gives a stronger property right by providing known and guaranteed security. The Cap has also stimulated the streamlining of property rights to better facilitate trading in water.

17. Water trade substantially reduces the economic cost of compliance with the Cap and with environmental flow rules. The impetus provided by the Cap to facilitate trade is
fostering better trading rules, third party protection and easier movement of water to high value activities. Trade would occur independently of the Cap but the Cap stimulated reforms will accelerate that trade.

The economic benefit of water trade in NSW alone is estimated to exceed $65 million annually with the benefit of trade across the Basin likely to exceed $100 million annually. The Cap initiated reforms to water trading will enhance these benefits.

18. As the No Cap scenario progresses to Full Development, there will be increasing tensions between irrigator groups and between regions as security declines and water trading becomes more aggressive. Individual irrigators, industry associations, local government and others initiate legal actions against partner governments and the MDBC for failing to provide adequate stewardship of the water resource and riverine environment. Other legal actions seek to either remove or improve constraints on water trade. In other words, there is a disorderly scramble and lack of process.

The benefit of the Cap is that it allows the valleys and states in the Basin to avoid the water wars that have typified developments in California and Colorado. These disputes have run for more than 60 years and are noted for their polarity, community tension and disruption and waste of community resources.

19. Concern over possible future impacts of the Cap on the social fabric of particular irrigation communities appears misplaced when the impact of potential water wars on the social fabric of the Basin as a whole is contemplated.

20. Within Australia, the metropolitan electorate would become increasingly out of patience with the irrigation community and the unwillingness of Governments to halt the degradation. The perceived division between country and city Australians would increase.

21. In summary, from the perspective of the agricultural economy, the Cap has produced major immediate benefits with little commensurate cost. The better investment climate created by certainty over water security, improved property rights and improved trading arrangements are attributable to the announcement of the Cap and are not dependent on the timing of its actual implementation – provided that implementation is in fact proceeding.

22. In principle, the capping of diversions means that some potential developments may be curtailed and benefits forgone. In fact, with the southern systems largely constrained by resource scarcity since 1995, the Cap has not had a physical impact on constraining diversions. Similarly, in the northern systems the Cap has not yet been fully applied. This combination of circumstances means that the immediate benefit cost ratio, i.e., for the first five years, is undoubtedly highly positive.
23. In the medium term, progression to Full Development would lead to the collapse of security in the southern valleys and a significant loss of security in the north. As a result, the annual benefits of the Cap increase over time. These benefits accrue to both existing and new enterprises.

24. By guaranteeing security of entitlement the Cap will help create and sustain viable communities thus promoting social outcomes such as employment, schools and community welfare and cohesion. The Cap also provides a mechanism whereby disputes and tensions over resource scarcity, between community groups within the Basin and divisions between country and city Australians, can be managed and resolved in an orderly way.

**Equity Issues**

25. Within the agricultural economy, the Cap has differential impacts between valleys and between irrigators.

26. Under the No Cap case, constraints imposed by resource availability will impact on both existing activities and potential new developments. The sharp falls in security, and resulting volatility, are likely to necessitate the winding back and adjustment of existing industries including the Victorian dairy industry, the NSW rice industry and, to a lesser extent, existing cotton growers. With the Cap, the security of existing development in aggregate – though not individual businesses – is guaranteed and the constraints imposed by scarcity borne primarily by forgoing potential new developments, particularly in upper reaches and tributaries.

Under the No Cap scenario the costs of adjusting to security are likely to be both higher and tangible. In contrast to the possible costs of losing potential development, the costs of winding back and restructuring existing enterprises, industries and towns are very real.

27. The tributaries and upper reaches are disadvantaged through timing and history in that development occurred earlier in the south and the impending resource constraints mean that it is cheaper for the Basin as a whole to halt development at existing levels – this raises inevitable equity issues but the issues of who bears the pain of increasing scarcity and who shares the gains of access to the resource arise under both scenarios.

28. The guaranteeing of security at the valley level defines the security of entitlement for individual irrigators, but has differential impacts among irrigators since some enterprises have grown through extensive use of off-allocation and allocations above 100% of entitlements.

29. A major equity concern hinges on the activation of sleepers/dozers issue and the view that the Cap is causing “a massive wealth transfer”. The activation of sleeper dozer licences is essential for increased development and facilitates the shift of water to
higher value activities, particularly in years of allocation resource scarcity and low allocation.

Two mutually reinforcing effects have led to the rapid expansion of trade, ie.:

- increasing trade of unused entitlements causes lower announced allocations; and
- lower announced allocations causes more irrigators to seek additional water pushing up the price of water and encouraging greater release of unused entitlements into the water market.

Introduction of the Cap may have advanced the activation of sleeper dozer licences but this is unclear. Indeed, the opposite view is that:

“While sleeper activation has had an impact, this level of impact would have been even worse in the absence of a Cap.”1

The issue of the wealth transfer is heavily felt but whether “wealth is transferred” or rather wealth already held is simply realised depends critically upon the perception of the relative merits of prior rights or history of use approaches.

Non-Agricultural Benefits and Costs

30. Confidence that the benefits associated with the Cap substantially outweigh the costs is increased when impacts outside the agricultural economy are considered.

31. First, there are direct economic benefits attributable to the natural capital stock. The rivers and lakes have direct economic benefits in terms of tourism, commercial and recreational fishing, duck shooting and real estate amenity. While no precise estimates appear to be available for the Murray-Darling Basin, indicative estimates from other catchments in eastern Australia confirm the hard financial benefit of a good environment and, therefore, the costs of losing it. For instance, the costs of the 1999 algal bloom on the Gippsland Lakes is estimated to be around $5 million comprising around $2 million for commercial fishing and $3 million for tourism for the six week bloom.2 Importantly, the adverse impacts appear to carry over from one year to another in terms of reduced tourism.

Nationwide, the recent Atech-CSIRO study puts “the current total cost of algal blooms of $180 million to $240 million…..a conservative order of magnitude estimate.”3 For the rural sector itself the estimated costs of algal blooms is $60 million per year.4

1 Australian Conservation Foundation, Submission (1999).
4 ibid, p.xi.
32. Second, the riverine environment has an intrinsic value to most Australians. This means that the high level of degradation of the river under the No Cap scenario is a cost, albeit intangible. In the absence of the Cap, continued development would lead to consequential reductions in river flows and accelerate the degradation of the riverine environment. With the Cap, degradation is slowed and this loss of capital value therefore reduced.

Conclusion on Net Benefits

33. Taken together, our assessment indicates that the Cap has already delivered significant benefits to the Basin community and that the net benefit will increase over time.

This strong positive conclusion will not accord with the perception of every stakeholder in the Basin. This gap in perceptions needs to be understood to remove unwarranted criticism and allow attention to be focussed on improvements to the future operation of the Cap.

34. A first step is to ensure that people understand what would happen if the Cap were to be removed.

IMPACT OF THE REMOVAL OF THE CAP

35. The removal of the Cap after five years of implementation would reverse many of the net benefits. Essentially, this is the No Cap scenario applying from the date of removal of the Cap. In summary, this comprises:

- in the absence of the formal announcement of the Cap on diversions, irrigation development would proceed – at least initially – in most valleys. As a result, resource sustainability would become a major issue;
- the increased development would lead to a steady erosion of security reducing the incentive for new entrants to begin irrigating but also undermining the security of existing entitlements and enterprises in all valleys. Security in lower valleys and reaches would fall significantly due to development in these lower valleys as well as development in upstream reaches and tributaries. For instance, reflecting the obligations of NSW and Victoria to South Australia under the Murray-Darling Basin Agreement, new developments on the Darling and tributaries would also impact on the security of supply for the Murray systems;
- by definition, the movement to Full Development under the No Cap scenario must entail activation of unused rights, entitlements and licences. This occurs through continued development by existing entitlement holders and/or by the sale of unused entitlements in the market to new entrants seeking to gain entitlements;
- not all unused entitlements would be activated since some are kept as insurance to ensure greater reliability and others are held in anticipation of future development;
• sleeper and dozer licences would also be purchased by existing users as they seek to restore their previous levels of security;

• the degradation of the riverine environment and water quality would proceed at an accelerating pace. Algal blooms would become a recurring feature of major reaches as dilution flows are reduced. Salinity, particularly in the lower reaches, would continue to rise. In the mid and lower sections of the river, the rise in water salinity would lead to increased salt accumulation and loss of the remaining bio-diversity;

• socio-demographic trends would continue to be driven by the major forces impacting on irrigated agriculture, ie., commodity prices, seasonal allocations and access to export markets. However, the collapse in security in the southern systems would undermine the viability of existing industries and towns;

• with the substantial reduction in security, the income and viability of irrigated enterprises and communities across the Basin, but particularly in the southern valleys, becomes increasingly sensitive to seasonal and climatic variation;

• there would be increasing tensions between irrigator groups and between regions as security declines and water trading becomes more aggressive.

Individual irrigators, industry associations, local government and others initiate legal actions against the State Governments and the MDBC for failing to provide adequate stewardship of the water resource and riverine environment. The recent announcement from Premier Olsen provides an example of this risk:

“If NSW just simply continue to ignore our calls for appropriate flows through the River Murray we will take retaliatory action.”

In the absence of the Cap these challenges become far more common and vociferous. Other legal actions seek to either remove or improve constraints on water trade. In other words, there is a disorderly scramble and lack of process;

• as resource availability and security deteriorate rapidly in the final stages of this full development scenario, incentives for water use efficiencies rise sharply, stimulating major investment late in the period. Major corporate farms will be better placed to fund those capital expenditures and benefit generally from the free for all situation;

• pressures and urgency also amount for changes in river and system management as discussions increase to Full Development levels. However, the ability of partner governments to respond is likely to be significantly constrained by counter injunctions;

• as end of valley flows continue to fall and the damage to the river environment becomes stark, the urban electorate loses patience with and sympathy for irrigators and Basin communities.

5 Premier Olsen (2000), as reported in The Sunday Mail, 20 February.
IMPROVING THE OPERATION OF THE CAP

36. A number of measures to improve the operation of the Cap which will both increase the benefits and reduce the costs were identified during the consultancy.

Closing the Perception Gap

37. The gap in perceptions and understanding regarding the Cap needs to be closed. Factors leading to a gap in perception of the impact of the Cap include:

- **the different starting points.** Many of the submissions do not compare the Cap with the No Cap scenario. Rather, they compare the Cap with the situation before resource constraints became apparent, i.e., the early 1990s;

- **the different understandings on the role of sleepers and dozers.** The rapid growth of trading and the activation of sleepers and dozers is a consequence of increasing development and resource scarcity and not of the introduction of the Cap. Full Development cannot proceed unless sleepers and dozers are activated; and

- **difficulty in separating the impacts of resource scarcity and the Cap.** Although reduced allocations in the southern systems coincide with the announcement of the Cap, they have in fact been driven by resource scarcity and the resultant increase in trading.

38. These different starting points mean that some stakeholders ascribe far more to the Cap and associated reforms than is warranted. This leads to an overestimate and misperception of the adverse impacts of the Cap and fear and anger about the future. This destroys the trust required for meaningful dialogue on how to improve the operation of the Cap.

A further gap in perception arises from the **impact on security.** The underwriting of long term security in each of the valleys – the major direct benefit to irrigated agriculture – appears not to be well understood. This knowledge, summarised in the simulation models, may be familiar to water managers and industry leaders but has not been readily available to, or known by, irrigators and local communities.

39. Closing the gap requires a tailored communication strategy.
Operational Improvements

40. Operational improvements to ensure that the administration of the Cap does not lead to a downward bias in diversions appear achievable. For instance, detailed analysis undertaken by Murray Irrigation identifies some scope to optimise NSW Murray resources through more timely and accurate reporting of tributary inflows and intervalley transfers.

Possible options for improved harmonisation of Murray-Darling Basin management include:

- improved interaction between the Murrumbidgee modelling (DLWC) and the Murray modelling (MDBC);
- centralised management – or at least better integration – of Murray-Darling Basin modelling may offer the best opportunity for improved management. (This may raise sovereignty and other issues);
- improved timeliness of streamflow reporting, particularly significant rainfall events and rainfall “rejections”;
- improved management of intervalley transfer accounting; and
- greater flexibility with on-route storage management – for example, Lake Victoria management will exacerbate the problems of harmonisation.6

Socio-demographic Impacts

41. The concern that the Cap is causing generally widespread adverse socio-demographic impacts is not supported by the findings of this consultancy. Nonetheless, the concern will need to be further addressed with better information and understanding through the assembly and analysis of key data and targeted case studies. These are not mutually exclusive.

42. The current socio-demographic profile of the Basin extends only up to 1996 and therefore will not capture many of the more recent impacts of the Cap. Because the 2001 and 2006 Censuses will provide new socio-demographic data on the Basin, other benchmark data should sensibly be assembled. The snapshots of 2001 and 2006 should therefore incorporate:

- the socio-demographic profile from the ABS Census;
- a better understanding of water use across the basin. This requires improved information on water use by crop type and application method;
- a better understanding of the drivers and benefits of water trades, both permanent and temporary. This requires source and destination information to be collected at

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time of trade showing enterprise/activity of the seller and intended use by the buyer. Such information is essential in demonstrating the magnitudes of the benefits derived from trading and to better understand the adjustment processes operating within the Basin; and

- a better understanding of the attitudes, concerns and knowledge of water and resource management issues. This benchmark survey would facilitate development of a more comprehensive and targeted communication strategy.

43. Finally, some of the concerns expressed by irrigation communities which are alleged to be adverse effects of the Cap, in practice relate to the rules for activation of sleepers and dozers. Where Cap compliance is not jeopardised, consideration could be given to allowing irrigation communities to opt out of the “prior right” approach and to adopt a “history of use” approach to Cap implementation. Proposals for such opting out must satisfy the State and the Independent Audit Group and command a high level of support, say 75%, in plebiscites of affected winners and losers.

SUMMARY

44. The Cap provided a clear signal to stakeholders, across the Basin, that there was increasing resource scarcity, that previous state by state arrangements had proved inadequate and that there was the political commitment to implement necessary additional controls.

45. The Cap has:
- provided a Basin-wide framework to coordinate actions between states and catchments;
- strengthened and reinforced existing reform initiatives;
- stimulated additional controls;
- provided a benchmark for future regulation of diversions; and
- ensured compliance, monitoring and publicity in all 22 major systems in the Basin.

46. The introduction of the Cap has generated significant economic and social benefits.

The prime benefit of the Cap is the guaranteeing of security on a valley-by-valley basis. This provides a better and more certain climate for investment and jobs growth. Long term investment in high value agriculture and value adding processing is dependent on the underlying security of the resource base. Under the No Cap scenario this is likely to be eroded in the short to medium term.
47. By guaranteeing security of entitlement, the Cap will help create and sustain viable communities. The benefits from this will flow through into social outcomes such as employment, schools and community welfare and cohesion.

48. The Cap also provides a mechanism whereby disputes and tensions over resource scarcity, between community groups within the Basin and divisions between country and city Australians, can be managed and resolved in an orderly way.

49. By slowing degradation of the riverine environment, the Cap reduces the loss of direct economic benefits attributable to this natural capital stock, i.e., it helps preserve the direct economic benefits of tourism, commercial and recreational fishing, duck shooting and real estate amenity. It also reduces the costs of deteriorating water quality, blue green algal blooms and salinity.

Finally, the Cap helps preserve the riverine environment itself a special form of natural capital with high intrinsic value to most Australians.

2 March 2000
1. INTRODUCTION

1.1. STUDY OBJECTIVES

A Cap on diversions from the Murray-Darling Basin (the Basin) river system was first introduced by the Ministerial Council in June 1995, in response to an Audit of water use across the Basin. This Cap was later confirmed as permanent with effect from 1 July 1997.

As part of this agreement, the Ministerial Council undertook to undertake a review of the operation of the Cap in the year 2000. This five year period, between the initial application of the temporary Cap and the year 2000, has allowed the Cap to begin to “bed-down” and trends in the long-run effect of the Cap are beginning to emerge.

The objective of the overall Review of the Operation of the Cap is to establish a sustainable resource management outcome which achieves the optimal outcomes and balance between the three objectives of:

- economic activity;
- social aspirations; and
- ecological outcomes.

The review will help identify whether the Cap could be operated in a way which more closely approximates to an optimal balance between these three objectives.

The five-year Review of the Operation of the Cap comprises four discrete assessments. These separate assessments relate to the:

- ecological sustainability of rivers;
- equity aspects of the application of a Cap;
- levels of implementation and compliance with the Cap; and
- economic and social consequences of the application of a Cap.

This consultancy is concerned with the last task, i.e., to:

- establish a clear framework/paradigm for assessing the social and economic impacts;
- review the aggregate social and economic impacts of the operation of the Cap on diversions from the Murray-Darling Basin river system;
- identify and describe the benefits and costs on different groups of enterprises, valleys and irrigation systems and resulting equity issues; and
- assess the implications for the agricultural economy.
The consultancy brief envisaged the report as a desk review of relevant work completed or underway, primarily sourced from the major submissions to be received from partner governments, the Community Advisory Committee (CAC) and other stakeholders across the Basin.

However, the submissions from partner governments, received in early December 1999, were not as comprehensive and substantial as envisaged. The submission from the CAC was supported by a significant number of direct submissions to the MDBC from irrigators and community groups, including catchment management committees and water user associations. Of the 25 direct submissions to the review on economic and social impacts, 24 were from NSW organisations. Attachment A provides a listing of the submissions made to the review of economic and social impacts, both via the CAC and direct to the MDBC.

At an early stage we therefore sought further assistance and advice from the partner governments and other stakeholders in the assembly of a comprehensive reference list of relevant articles, reports, research and consulting studies. Attachment B provides a listing of the references referred to in this review.

1.2. CAP OBJECTIVES AND DEFINITION

The objective of introducing the Cap on diversions was to:

- maintain and, where appropriate, improve existing flow regimes in the waterways of the Murray-Darling Basin to protect and enhance the riverine environment; and
- achieve sustainable consumptive use by developing and managing Basin water resources to meet ecological, commercial and social needs.

The MDBMC in its review of Cap implementation for 1998/99 summarised the Cap in the following words.

“The introduction of the Cap was seen as an essential first step in establishing management systems to achieve healthy rivers and sustainable consumptive uses. In other words, the Council determined that a balance needed to be struck between the significant economic and social benefits that have been obtained from the development of the Basin's water resources on the one hand, and the environmental uses of water in the rivers on the other.”

The Cap has signalled approaching resource constraints by bringing forward the time at which they will impact and providing a formal framework for sharing the benefits and costs of that limited resource.

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It is clear that the Cap was not intended to be an end in itself:

“The Cap per se, is only a means to an end. It is not the end in itself. The IAG [Independent Audit Group] recognises that the overall objectives can be achieved only by identifying environmental water requirements and flow regimes and by establishing a supporting management and institutional framework, including trading of water.”

As the Commonwealth submission states:

“When the Cap was introduced in 1995, it was intended to be a first step towards striking a balance between in-stream and consumptive use by limiting growth on diversions...Formal determination of water allocations, including water for the environment as a legitimate user of water, is the long-term mechanism by which the balance between consumptive and in-stream uses are to be achieved.”

The agreed mechanism is to limit diversions in each of the 22 valleys/systems to 1993/94 levels of development. The Ministerial Council agreed that the Cap be defined as:

"The volume of water that would have been diverted under 1993/94 levels of development. In unregulated rivers this Cap may be expressed as an end-of-valley flow regime."

Diversion at 1993/94 levels of development does not mean the volume of water that was used in 1993/94. Rather, the Cap in any year is the volume of water that would have been used with the infrastructure (pumps, dams, channels, areas developed for irrigation, management rules, etc.) that existed in 1993/94, assuming similar climatic and hydrologic conditions to those experienced in the year in question. Thus, the Cap provides scope for greater water use in certain years and lower use in other years.

This definition, therefore, does not define the Cap as a specified volumetric limit which will apply in every year. It allows for fluctuations in diversions to take account of variations in climatic conditions, provided that, in the longer term, the level of diversions does not increase.

This has been the way the Cap has been applied, with small variations, in New South Wales, Victoria and South Australia (who between them

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8 ibid, p viii.
extract 95% of the water diverted in the Basin). In Queensland and the Australian Capital Territory (total of 5% of Basin diversions), the final details of the Cap are yet to be determined.\(^{11}\)

Implementation of the Cap is a State responsibility with considerable variation occurring between the States. The method by which compliance is achieved is a matter for each state but all states have chosen to recognise prior rights rather than history of use and to ensure compliance primarily by reducing announced allocation levels.

The Cap itself does not attempt to reduce Basin diversions, merely prevent them from increasing. New developments are possible under the Cap provided that the water for them is obtained by improving water use efficiency or by purchasing water from existing developments.\(^{12}\)

1.3. BASIS FOR COMPARISON

There are two main steps to assess the effects of a policy change such as the announcement of a Cap on diversions

The first is simply descriptive, detailing the changes between the pre-Cap and post-Cap situation. A good descriptive analysis requires access to comprehensive and robust information to establish the facts and the main changes.\(^{13}\) A good description, however, does not necessarily distinguish the role of the Cap from the many other factors affecting economic and social behaviour in the Basin. A further step is required.

The second step is to attempt to separate out the impact of the Cap from the wide range of other factors. This is the familiar approach used in benefit cost analyses.

Conceptual clarity is best achieved by first specifying, and then comparing, the With Cap and No Cap situations/scenarios. The With Cap situation is observable and can be described based on a comprehensive collation of available information. The No Cap scenario is more difficult. Desirably, it should be derived independently of the With Cap scenario.

Such a comparison can be undertaken from a summary, all encompassing perspective or through an item-by-item comparison of the With and No Cap scenarios. Extreme care must be taken in any such comparisons to avoid double counting and the failure

\(^{11}\) ibid, p. 4.

\(^{12}\) ibid, p. 8.

\(^{13}\) An early insight of this review is as to the paucity of the data which is available on most aspects of the economic and social impacts of the Cap and the need for the MDBC and partner governments to collect and analyse further information.
to acknowledge offsetting impacts. This is particularly relevant when evaluating the impact of the Cap since the benefit to one irrigator community will be offset to some degree by costs to another and, probably, to the environment.\textsuperscript{14}

**The Benefit Cost Paradigm**

The main paradigm which underpins standard project appraisals is that of the benefit cost analysis (CBA). This standard framework needs to be extended when dealing with major environmental issues in order to recognise and incorporate the principles which underpin the concept of ecological sustainable development, ie.:

- **the sustainability principle** which recognises that the resource base and environment does not exist purely for financial benefit and that there is a responsibility to pass the resource and environment base intact from one generation to another. The sustainability principle is therefore closely intertwined with the principle of intergenerational equity, ie. the next generations should have access to at least the same resource base as the previous generation.\textsuperscript{15}

It follows that the need to sustain the resource base and environment is not an objective which must be justified in terms of net financial benefits, nor should the future of a major natural resource system be construed in terms of least cost outcomes. While the major rivers systems have been undeniably damaged, few Australians would wish the River to be operated as Murray Pipes Ltd. and Murray Drains Ltd;

- the principles of sustainability and intergenerational equity have important implications for the application of **discount rates** to derive discounted cash flows at present values. In a standard financial analysis, the rights of subsequent generations are essentially ignored and discount rates are applied to establish the value of future costs and benefits to the current generation at the current day;

- the intergenerational equity principle implies a distinction between natural capital and manmade capital. This cuts directly across the standard financial perspective and requires that zero or low discount rates be applied.\textsuperscript{16} Intergenerational equity also recognises that natural resources and the environment are multifunctional and vast store houses of economic value. To treat some of these functions and services as if they had zero value is to seriously risk overuse and destruction of the natural capital asset. It is, therefore, vitally important that the environment is valued correctly and that these values are integrated into economic evaluations and policy decisions.

\textsuperscript{14} Several submissions to the Review identified the impact of the Cap to their local community, but few identified offsetting costs or benefits to other irrigator communities or to the riverine environment.


\textsuperscript{16} The discount rate applied to a particular development proposal should be lower or zero where natural capital is subject to irreversible or reversibility is uncertain; see Pearce and Turner (1990), The Economics of Natural Resources and the Environment, Harvester Wheat Sheaf.
A range of techniques have been developed over the last twenty years to provide an approach to placing a dollar value on environmental goods. These include contingent valuation and choice modelling, representing the distinction between revealed preference, stated preference etc. In the water sector, there is also a growing appreciation of the real commercial value of non consumptive uses of water, such as tourism, fishing, duck-shooting etc. However, neither of these approaches ascribes any inherent value to the water itself; and

- inherent in the sustainability principle is the **precautionary principle** which states that where the total costs and benefits of a particular proposal or series of proposals are uncertain and there is risk of irreversible loss, then policy makers should err on the side of conservatism. The need for precaution is driven by information failure. Obviously, the sustainability principle would be violated if there were high and uncertain risks of catastrophic and irreversible loss.

These considerations require an extension of the standard benefit cost paradigm. They do not undermine it. The essential extension is to insert into the standard paradigm, the need to at least sustain, ie. hold constant or improve, the natural capital base.17

The benefit cost paradigm can be applied both to guide policy decisions and to evaluate their impacts. Many of the submissions to the review, made from community and catchment groups, argued strongly that until the socio-economics of the Cap and its implementation had been fully and publicly evaluated no change in policy should have occurred. The alternative of at least one partner government is that:

> “We’ve never tried to justify our reforms by benefit cost analyses or from social impacts. This is because we see the issues as a matter of rights – We don’t believe that rights should be altered just because the benefit cost ratio is positive or negative. But we do believe that rights are a tiered hierarchy as a result of security and maturity of development – and that we have a responsibility to ensure that when rights are changed that this occurs in an orderly and transparent way.”18

Use of the benefit cost paradigm does not imply that the impacts of the Cap can, or need to be, described in terms of the net present value of dollar benefits and costs. (Indeed, as outlined above, this will be rarely achievable when dealing with issues of resource sustainability and the avoidance of catastrophic and irreversible losses.) Rather, the approach to be adopted here is to identify, describe and, where possible, indicate the order of magnitude of the benefits and costs associated with the announcement and implementation of the Cap.


18 pers. comm., Victorian Department of Natural Resources and Environment, February 2000.
1.4. STRUCTURE OF REPORT

Chapter 2 provides background information on economic activity, water use and the development of trading within the Basin. It also explores the range of factors which impact on farming enterprises and communities and recognises the difficulties in distinguishing those outcomes which can be attributed solely to the impact of the Cap. This sets the Cap in the context of the wider reform agenda implemented by partner Governments across the Basin to respond to increasing resource scarcity which is outlined in Chapter 3.

Chapter 4 specifies the No Cap scenario. A critical choice is whether the specification of the No Cap scenario should be based on a full development scenario which assumes the absence of environmental flows, or on a full development scenario in the presence of environmental flow requirements. In either case it is necessary to analyse the full development scenario as a process of development, rather than simply as an end point.

Assessment of the impacts brought about by the introduction of the Cap are identified in Chapter 5. We examine the impacts which the Cap has had on yield and security and, therefore, on the agricultural economy. The effects of changes in security on water-use-efficiency and water-trading are also addressed, together with the equity issues associated with the introduction of the Cap. The chapter also examines the social and environmental impacts of the Cap.
2. **ECONOMIC ACTIVITY AND WATER USE IN THE BASIN**

The Murray-Darling Basin is defined geographically by its rivers and economically by irrigated agriculture. The changes to water management policies and water use associated with the Cap must, therefore, be seen in context.

Accordingly, this Chapter provides a descriptive overview of the Basin, its productive output and contribution to the Australian economy. The Chapter outlines the increasing development in water use which has taken place and the implications for water trading. Finally it identifies that farming across the Basin has been subject to powerful forces which have driven and continue to drive major changes in farming practice.

### 2.1. ECONOMIC & SOCIAL ACTIVITY

The Basin is home to 1.9 million people with over half living in small country towns and a significant proportion on farms. The Basin contains Australia's major inland urban centres, the largest of which are Canberra-Queanbeyan, Toowoomba, Bendigo, Albury-Wodonga and Wagga Wagga. Another million people who live elsewhere are dependent on the waters of the Basin. The River Murray is a major source of water for around one and a quarter million people living outside of the Basin in South Australia. The significance of the Basin extends well beyond its catchment boundaries and some towns and many agricultural and industrial enterprises would not exist without the waters of the Basin.

### 2.2. AGRICULTURE AND OTHER INDUSTRIES OF THE BASIN

The Basin contains 42 per cent of all Australian farms and produces wool, wheat, sheep, cotton, rice, vegetables, dairy produce, wine, fruit and oil seed. Half of Australia's crop land and sheep, and a quarter of the beef and dairy cattle are located in the Basin. The Basin also holds three-quarters of the nation's irrigated agriculture producing 90 per cent of Australia's irrigated crops. The Basin contributed to approximately 40 per cent (or $22.8 billion) of the total exports of Australia's agricultural production in 1997/98.

The Basin also has a significant manufacturing industry with ABS data indicating that there were some 3,280 manufacturing locations employing over 62,400 people, with a turnover producing 6.4 per cent of the Australian total in 1991/92. By far the biggest sector is food, beverages and tobacco, in which the Basin accounts for 17.2 per cent of the Australian total. The Basin also accounts for 16.8 per cent of the total Australian production of textiles. Other important industries in the Basin include tourism and recreation contributing $3.5 billion pa and mining which is valued at over $1.5 billion pa. Many of these industries both support and depend on communities in their region.
and on local agricultural production. A reliable and good quality water resource is fundamental to the long-term survival and sustainability of many of these industries.

2.3. WATER USE IN THE BASIN

Total water use in the Basin and its component valleys is now well documented as a result of the Audit of Water Use which led to the introduction of the Cap on diversions and are recorded in the annual reports from the Independent Audit Group. The original audit provided a clear picture of the extent to which water previously flowing to the river mouth was diverted overwhelmingly for the purposes of irrigated agriculture.

**CHART 2.1 GROWTH IN DIVERSIONS ACROSS THE BASIN**

![Chart 2.1](chart.png)


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Salient features of water use in the Basin include:

- the substantial addition to the value of agricultural production achieved by irrigated agriculture in comparison with the opportunities available to traditional dryland farming and the further scope to shift irrigated production into high value water uses with consequent benefits to the Basin’s economy and communities;

- the different pattern of irrigated crop and enterprise types across valleys within each State. Within NSW, cotton is the dominant enterprise in all the northern valleys with rice playing a major role in the southern systems. The Lachlan retains a broader mix of crop type and obtains less benefit from irrigation (Chart 2.2);

**Chart 2.2 : Value of Irrigated Output by NSW Catchment, 1997**

<table>
<thead>
<tr>
<th>Catchment</th>
<th>Value $M</th>
<th>% of Ag Output</th>
<th>Major Crops &amp; % of Irrigated Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Border (inc. Qld)</td>
<td>271.3</td>
<td>33</td>
<td>Cotton, 62%</td>
</tr>
<tr>
<td>Darling</td>
<td>74.4</td>
<td>37</td>
<td>Cotton, 79%</td>
</tr>
<tr>
<td>Gwydir</td>
<td>245.1</td>
<td>41</td>
<td>Cotton, 90%</td>
</tr>
<tr>
<td>Namoi</td>
<td>292.2</td>
<td>30</td>
<td>Cotton, 83%</td>
</tr>
<tr>
<td>Macquarie</td>
<td>263.1</td>
<td>22</td>
<td>Cotton, 42%</td>
</tr>
<tr>
<td>Lachlan</td>
<td>165.3</td>
<td>17</td>
<td>Grain, 29%, canola, 17%, fruit, 14%, livestock 16%</td>
</tr>
<tr>
<td>Murray</td>
<td>388.8</td>
<td>40</td>
<td>Rice 44%, grapes, 12%, fruit 11%</td>
</tr>
<tr>
<td>Murrumbidgee</td>
<td>475.7</td>
<td>42</td>
<td>Fruit 27%, rice 26%</td>
</tr>
</tbody>
</table>


- the different pattern of irrigated crop and enterprise types across the four States reflecting primarily the different policies of the State Governments towards development and security.

In South Australia, where horticultural crops predominate, entitlements are effectively 100% secure. In Victoria, irrigator entitlements are divided into water rights which are very secure and less secure ‘sales water’. Complementary to the more conservative policies of the two southern States, NSW has promoted more opportunistic water use. Queensland’s policies have developed to serve an expanding irrigated sector, where there is considerable reliance on water harvesting for irrigated cotton growing, largely outside the licensing controls of the current legislation. Recent proposals will create a more structured and comprehensive regime;

- reflecting these policies, NSW diversions accounted for some 57% of total diversions within the Basin during the Audit period (1989 to 1994). NSW allocation and development strategies have been to take advantage of the unused
water available in most years. The advantages of such a strategy are enhanced by the more conservative policies adopted, particularly by Victoria. This complementarity is evidenced both by different crop enterprise types and the much higher diversions recorded by NSW compared to that State’s entitlement under the Murray-Darling Basin Agreement. Whereas NSW and Victoria are each entitled to 50% of water remaining in the Murray after the South Australian guarantee amount has been supplied, NSW took 53% of total diversions in the audit period compared with 47% for Victoria;

- the very rapid growth of diversions between 1988 and 1994 and the consequent effects on river flows, particularly in the lower reaches.

  “Water taken out of the rivers and streams of the Murray-Darling Basin has grown to over 10,000 GL a year, or 80% of the water that used to flow out of the mouth before irrigation began;”\(^{20}\)

- the continuing decline in river health including increasing salinity, growing frequency of algal blooms, the declining biodiversity in the riverine corridor and the decreasing frequency of beneficial flooding of the floodplain and ephemeral streams – all as a result of the increasing demand for water from the system.

  “This has reduced the bottom end of the Murray to a pond for most of the time. Stress on the riverine environment has showed up in rising salinity, more algal blooms, a reduction in native animal and plant life, and contraction of redgum forests and other wetland habitats.”\(^{21}\);

- the rapidly approaching date of full development of the water resources available for consumptive uses, the resulting reduction in system reliability and the need to anticipate how the gains from existing water use and the pain of resource scarcity should be shared.

  “It is worth noting that most irrigators’ perceptions of their rights are based on their experience over the last two or three decades, when resources have generally not been constrained.

  “Looking back over the types of weather patterns that have occurred over the last 100 years has been a salutary experience, and has reinforced the urgency of bringing the growth in water use to a halt.”;\(^{22}\)

- the dramatic growth in water trade since 1994/95, especially in the temporary, (ie., leasehold) market within the southern systems. This growth was stimulated by a combination of factors including increased resource scarcity, a reduction in


\(^{21}\) ibid

\(^{22}\) ibid
announced allocations as a result of the recognition of the property rights of sleepers and dozers in the water market, and possibly the announcement of the Cap; and

- the ability to access the water market varies markedly across the Basin with much greater opportunities in the inter-linked southern systems than in northern systems or in unregulated rivers where trading rules and environmental flow regimes are less well established.

### 2.4. DEVELOPMENT OF WATER TRADING

The volume of water traded in the Basin has exploded since the 1994/95 season. For instance, the volume of water traded in the Goulburn-Murray system since 1994/95 onwards has been seven times greater than the volumes traded in the preceding five years (Chart 2.3).

The period since the Cap has also seen the development of interstate trade in water. This has been facilitated by the pilot interstate water trading project which was approved by the Ministerial Council in November 1997. During the 1998/99 financial year there were twenty trades totaling 3,546 ML – with trades almost universally downstream from NSW to SA. The volumes concerned are still very small in comparison to the volumes involved in intra-state trade.

This section provides an initial description of the changes in water trading which have taken place over the Cap period. Section 5.4 then provides an in-depth analysis of the relationship between the Cap, increasing resource scarcity and water trade.
Similar dramatic increases in the volume of water traded from 1994-95 onwards have also occurred in New South Wales\textsuperscript{23} (Chart 2.4).

\textsuperscript{23} Marsden Jacob Associates (1999), “Water Trading Development and Monitoring”, report prepared for the NSW Department of Land and Water Conservation, Chart 3.4, p. 3.7.
During the 1997-98 irrigation season, some 863,145 ML\textsuperscript{24} of water was traded in NSW, comprising 832,149 ML of sales within the State, 16,282 ML of purchases from Victoria and South Australia and 14,714 ML of sales to those States. Total sales (intrastate trade and exports of water) represented 11\% of the total water entitlement.

This trade occurred solely within the regulated river systems. The partial information available on the volume of water traded in previous years suggests that the volume of trade has increased over thirteenfold since the 1988/89 season, with most of this increase occurring since 1993/94. Indeed, the volume of water traded in NSW between licence holders rose 50\% between 1996/97 and 1997/98, to reach 585,091 ML.

Across the Basin, the great bulk of water transferred is through temporary transfers. For instance, in NSW more than 95\% of the 863 GL of water traded in the 1997-98 season occurred as temporary trade. In comparison, permanent trades in the same year were 39 GL.

The growth in temporary trade in NSW and Victoria, since 1994, has been driven by a series of factors:

- the reduction in the level of announced allocations, and access to off-allocation water;
- resource scarcity at the end of an El Niño sequence;
- a reduction in the availability of unused water, through the activation of sleeper and dozer licences (stimulated by trading opportunities); and
- the announcement of the Cap on diversions.

The level of announced allocations and off-allocation flows appears to be the most powerful driver of temporary trade (Charts 2.5 and 2.6).

\textsuperscript{24} Trading includes transfers between landholders in Murray Irrigation, Murrumbidgee Irrigation, Coleambally Irrigation, Western Murray Irrigation and Jemalong Irrigation; transfers between licence holders recorded by DLWC in NSW; and transfers between licence holders in NSW and organisations in Victoria and South Australia.
This shows that the volume of trade increases as the level of off-allocation decreases.

In northern Victoria, lower allocations has increased the pressure for greater temporary trade.
2.5. FACTORS IMPACTING ON AGRICULTURE

A major suite of factors has impacted on farming over the past decade across Australia. Key elements include:

- changes in international commodity prices. Australia is a price taker, rather than a price maker in many of its export markets for agricultural products. This exposes it to risk from movements in international commodity prices, eg:

  "higher production in most States is partly offsetting the effects of lower export prices for key farm commodities such as wheat, canola, sugar and cotton.";25

- a long-term downward trend in farmers’ terms of trade (ie, the ratio of prices received to prices paid). In the mid 1950s this ratio was four times higher than it is today;26

- exchange and interest rates;

- weather and droughts through the patterns of El Niño and La Niña and larger scale changes over the past eighty years.27,28 The period since the Cap has seen a sequence of particularly dry years;

- environmental pressures: salinity, waterlogging, erosion, nutrient pollution:

  “Preliminary results for farms growing rice in the southern Murray-Darling Basin show that spatial patterns in farm productivity are consistent with a number of degradation problems in the area…These results suggest that there is a clear relationship between farm productivity and resource condition.”29;

- introduction of environmental flow rules;

- COAG: pricing reform, water allocations and water trading;

- industry de-regulation;

- changes in consumption and demographic changes;

- pressures for productivity and efficiency improvements; and

- moves to corporatised and mechanised farming.

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The impact of these forces has been confirmed in the recent Productivity Commission report on Rural and Regional Australia:

“Forces affecting the fortunes of country Australia include:

- a downward trend in the world prices for agricultural and mineral commodities, which has been reflected in a decline in producers’ terms of trade;
- technological advances, such as increased mechanisation of farming, agronomic developments, adoption of new mining techniques and improved telecommunications;
- changes in consumer tastes, such as the decline in the demand for wool and increased expenditure on tourism;
- changes in lifestyle, such as an increase in internal migration to coastal areas; and
- government policy changes, such as lowering trade barriers, deregulating the financial system and increased regulation to protect the environment.”

In response to these longer term forces, increases in agricultural productivity have resulted in fewer, but larger, farms.”

The Productivity Commission Report also identified that there have been some marked shifts in the location of populations outside the capital cities. In country Australia there has been a movement to ‘sponge cities’, i.e., provincial centres which have grown largely at the expense of their surrounding districts. Good examples of these in the Basin, include Dubbo, Wagga Wagga, Albury-Wodonga and Mildura.

Current socio-demographic information on rural Australia, including the Basin, paints a picture of people experiencing some social disadvantage and having to make individual, family and community adjustments which together add up to major structural change. Across Australia the overall picture is one of:

- continuing demands for increased productivity to respond to cost pressures from declining terms of trade;
- stable or declining rural populations; and
- increase in average age for active farmers.

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31 ibid p. 27.
The Basin has faced many of the same pressures. It is important, however, to recognise the areas where irrigated agriculture in the Basin differs:

- it faces different commodity price trends – with a greater potential for irrigators to move into higher value products such as horticulture or to exit farming through realising the value of their water entitlement;
- it faces clearer resource definition than other non-irrigated areas;
- it is subject to environmental degradation and adverse impacts which are more apparent and extreme than many dryland enterprises; and
- it has experienced differential rises in key input costs, such as government charges for water.

The following pointers from the Bureau of Rural Sciences’ *Country matters: Social atlas of rural and regional Australia, 1999,* highlight some features of the changes and pressures which the Basin’s population has faced over the past ten years.

- average age is increasing with an overall 10-20% increase in people 65 years or older in most Statistical Local Areas (SLAs) over the period 1991-96;
- median age of farm managers in the Basin is generally 43 years old or more and increased over the period 1991-96;
- population is decreasing overall (many SLAs in the Basin showed either a 0-5% or a 5-20% decrease in population over the period 1991-96) – the only major exception relates to indigenous people, whose population increased by up to 20% in some SLAs over the same period;
- there is net out-migration of youth (most SLAs showed losses in the proportion of the population aged 15-24 years over the period 1991-96) – the only gains tended to be in areas where there are tertiary education institutions;
- unemployment rates in 1996 are generally above those of metropolitan areas by up to 40% in some SLAs;
- employment in agricultural industries is generally declining (the percentage decline in employment in this sector was between 0 and 20% or greater in most SLAs between 1991 and 1996) – this is seen as being part of a long-term pattern of structural change in the Australian economy in which technological improvements are lessening the need for human labour;
- generally an increasing percentage of the population is employed in service industries and in manufacturing (percentage increase in employment in these sectors varied between 0% and 20% or greater in most SLAs between 1991 and 1996); and
- mean taxable incomes in the Basin are generally below those in metropolitan areas (by up to 20% in some SLAs).
These aggregate trends mask significant variations between regions, industries and individual farms, according to a whole range of environmental, financial and social factors. For example, in the rice, cotton and wheat growing industries, the age of the grower operator is showing a consistent downward trend, whereas in the wool industry the average age of farmers is rising and is now well above sixty.

This analysis applies more widely to the overall review of economic and social impacts where the assessment has identified widely differing outcomes for different groups, regions and types of enterprise.

It should be noted that the majority of the data in the Bureau’s report extends only up to 1996 and therefore will not capture many of the more recent impacts of the Cap and related water reforms. The forthcoming census in 2001 will provide an invaluable opportunity for member States to source key data to enable a more comprehensive assessment of the Cap to be undertaken.

A recommendation from the review is that full opportunity should be taken of the 2001 census to develop a data base which will allow key issues from the overall review of the Operation of the Cap to be analysed further.

2.6. PRODUCTIVITY AND FARM ECONOMICS

As we have seen there are strong pressures across Australia to drive change in agriculture in the same way as the rest of the economy:

- pressure to reduce labour costs;
- the need to increase productivity;
- a trend to an increase in farm size;
- an increase in capitalisation; and
- shifts in crop type.

This has seen the traditional one family farm being transformed with an inexorable drive towards larger, more professionally managed enterprises with increased use of labour and contract services. This is particularly true of the irrigated sector.

The opportunities available for meeting these pressures in each sector differ and so do the strategies available for implementing structural change and adjustment. In many cases higher productivity has been the pre-requisite to continued business existence – not a route to increased profitability.

- Dairy: the main route to increased productivity has been an increase in the size of the production unit. This movement has been particularly noted with the aggregation of farms in northern Victoria although there is also some movement to the creation of greenfield dairy enterprises in southern NSW.
Productivity is driven by increasing the area of permanent pasture subject to irrigation. This change has been dependent on water trading. There is a limit to size of a farm which can be run by one family, normally estimated at a maximum of 200 cows. Beyond this size there is a move from the individual dairy farmer (plus son or brother) to employing 1 labour unit per 100 additional cows. Dairying has also provided the maximum opportunity for industries with added value.

Future levels of investment and output are uncertain with the phasing out of the Domestic Market Support Scheme for manufactured milk by the end of June 2000 and further de-regulation of farmgate pricing and supply of market milk. However, dairy farms within the Basin should retain a competitive advantage over dryland dairy farms given their relative financial position and the continued growth in the export market for dairy products.

**Rice:** there has been significant growth in the total area under cultivation over the past twenty years. This has centred on the southern valleys of NSW and is most notable in the Murray, which overtook Murrumbidgee in output in 1990. Overall production in NSW has increased from an average of 600,000 tonnes pa in the early 1980s to the figure of 1.38 million tonnes recorded for 1989/99. Future levels of rice production are forecast to decline from this high level in response to a fall in world prices.

The main change in farming practice has been an increase in the size of the enterprise. This has required easy access to surplus water, initially from off-allocation supplies and more recently from the temporary trading market. This trade has not necessarily led to an increase in the gross margins from the water use – but has allowed an increase in total enterprise surplus.

**Horticulture:** the term horticulture covers both permanent plantings such as citrus or vines on the one hand and annual cash crops such as vegetables on the other. Both have seen substantial growth in the period since the Cap and are the major success story of the irrigated sector. Permanent horticulture requires considerable certainty and security in its future water allocation. They have been the main purchasers in the permanent water market. Vegetable growers can be more opportunistic in their access to water markets.

The Australian wine industry, in particular, has grown dramatically over the past decade, with a 56% increase in the area under cultivation since 1996. The industry is now predominantly export led and so will be increasingly exposed to world economic conditions. Once again a distinction has to be drawn between vineyards in the traditional irrigated areas around say Mildura and the Riverland.

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32 Ricegrowers Association of Australia, Yanco Avenue (PO Box 561), Leeton, NSW 2705.
33 ABARE (1999), “Commodity Notes: Agriculture”.
and new entrants in cooler climates in the southern highlands of NSW. The two sectors have experienced different impacts from the Cap with the new entrants often struggling to obtain water allocations in upper catchments due to tighter controls on new diversions and poorly defined trading rules for unregulated streams.

Horticulture has always employed more labour than other sectors as it is reliant on seasonal labour for picking etc. It is also more highly capital-intensive with average investment rates of between $25-35,000 per hectare for vineyards or orchards. This sector has become an entry point both for corporate entities seeking to control the full value chain in the vertically integrated wine market, and also, at the other end of the spectrum, for small scale enterprises able to build up the scale of their output over time.

- **Cotton**: cotton production has nearly doubled in Australia over the last ten years, from 370 kt in 1990 to 716 kt in 1998/99.\(^{35}\) The large majority is exported and so exposed to shifts in international commodity prices. The last five years has seen significant growth in production in southern Queensland and northern NSW valleys, including the upper Darling, and a gradual southwards expansion down into the Macquarie and, to a lesser extent the Lachlan, as new varieties become established.

Cotton now dominates all NSW valleys other than the Lachlan, Murrumbidgee and the Murray. This growth and movement has been dependent on the availability of water through trading. Cotton provides a far higher gross margin in these valleys (around $300/ML) than the traditional mixed farming enterprises ($70 to $100/ML). However, water trades may involve a shift in the predominant flows from a winter/spring cycle to a summer flow.

The area of dryland cotton planted is forecast to drop over the coming seasons in response to lower prices and less favourable soil moisture. However, the area of irrigated cotton is forecast to remain largely unchanged as the returns relative to other crops remain attractive.\(^{36}\) This demonstrates the relative robustness of the irrigated sector in the Basin over traditional dryland farming which is less resilient in markets exposed to commodity price effects.

Cotton is a family farm based enterprise, but it relies on large players supporting regional development and on personal entrepreneurs rather than government endorsement.

- **Mixed Farming**: the traditional mixed farm of livestock and cereals has found it less easy to find a route into higher productivity. This sector has therefore tended to fall behind – especially where faced by intractable environmental problems, and has given way to more specialised sectors identified above.

\(^{35}\) Cotton Australia, Level 2, 490 Crown St, Surrey Hills, NSW 2010.

\(^{36}\) ABARE (1999), Australian Commodities, December Quarter, p. 624.
“Success for Australian Farmers depends…on their ability to manage in a constantly changing business environment. Political, social and economic change impacts daily on the business environment and hence, individuals and communities. These changes, for the most part, are outside the control of any individual, business, or domestic government. To manage and succeed, individuals and businesses must be adaptable and adept at assessing and managing their risks.”

This review of irrigated agriculture in the Basin raises several important issues for the subsequent analysis of the Cap impacts:

- irrigated agriculture has demonstrated that it is a dynamic sector of the economy over the past ten years with evidence of major changes in crop type, farm size and practice, productivity and capitalisation, in response to external pressures;
- changes in water management and the Cap specifically are, therefore, clearly only one small subset of the wide range of factors which impact on farming;
- it will be difficult to disaggregate the impact of the Cap from other factors:
  
  “…it is impossible to separate…the cumulative impacts that have flowed from the Cap, the introduction of the Environmental Flow Rules and the impact of the temporary transfer market.”;  

- the relative impact of the Cap is likely to be small in comparison with other factors, such as changes in commodity prices; however
- the Cap will be a focus of attention as it is a clearly identified factor which results from deliberate government action.

This Chapter has provided a snap-shot of key aspects of the Basin’s economy and social structure. It has emphasised the dynamic characteristics of farming within the Basin and has confirmed the increasingly active role of water trading as a response to resource scarcity. The overview therefore provides the context for an appreciation of the role and impact which the MDBC Cap has played since its announcement in 1995.

3. **THE CAP : CONTEXT AND STATE RESPONSES**

To understand the impact of the Cap we must have a clear picture of precisely what the Cap does and does not involve. This chapter therefore provides an understanding of the context and objectives of the decision to introduce a Cap and the actions taken by partner governments to ensure compliance.

### 3.1. ASSESSING THE ROLE OF THE CAP

From one perspective, the Cap can be seen as just another element in an expanding suite of controls adopted by the States across the Basin, over a period of twenty-five years, reflecting a growing recognition of the increased scarcity of water as an essential resource.

An alternative perspective would cast the Cap as the essential precursor and stimulus for the decisions and controls which have been implemented since 1995.

It is clear that the formal MDBC Cap (which has a very specific timeline, definition and application) is in many ways just the focus of a broader commitment to “capping” which can be seen to have a longer history and wider application. While the political decision to Cap diversions was not formally made until 1996, the need to do so became evident several years before then (it was formalised by the Basin water audit). The bureaucratic processes were under way in many States to put a Cap in place well before the formal decision was made. Were that not the case, the political decision would not have been possible.

The following analysis adopts this wider definition of “capping”.

### 3.2. PRE-CAP INITIATIVES

This section provides a review of the controls and arrangements implemented by the different States prior to the introduction of the Cap. This allows an analysis of the extent to which the Cap can be seen merely as part of a continuum of developing arrangements or whether, in practice it triggered a far more rigorous suite of controls.

The specific policies and arrangements adopted by the different States pre-Cap were determined by a range of factors, including the history of development and the nature of the major irrigated sectors and crop types involved. Examples of these initiatives include:

- controls on overall diversions established in South Australia in 1968, due to the high security required for the permanent plantings;
• conversion of licences to a volume basis on the regulated rivers in NSW in the late 1970s and early 1980s, as part of the volumetric allocation schemes. This defined the entitlements of the individual irrigators and the relative availability of resources;

• cessation of dam building in the southern systems on completion of Dartmouth in the early 1980s. This reflected a recognition of the limitations of the remaining available flows and dam sites;

• actions in NSW, from the mid 1980s, to set water quality objectives for all waterways, which became part of the National Water Quality Management Strategy in the early 1990s;

• establishment of environmental flows for the Macquarie Marshes in 1986, as an early example of minimum environmental flow rules in regulated systems;

• introduction of the Water Act in Victoria in 1989. The objective of this Act was “to promote the orderly, equitable and efficient use of water resources ...[and] to make sure that water resources are conserved and properly managed for sustainable use for the benefit of present and future Victorians.”;\(^{39}\)

• the change, in 1989, from annual to continuous accounting for the allocation of diversions for Victoria and NSW from the Murray. Prior to this, NSW benefited each year from the conservative approach adopted by Victoria, as any water remaining in the dam at year end was shared equally between the two parties in the following year;

• decisions to cease awarding further entitlements in the regulated southern systems in the late 1980s in Victoria (when the last diversion licences were auctioned for the Loddon, Goulburn and Broken catchments) and in NSW from the early 1990s;

• confirmation of property rights in Victoria through Bulk Entitlements (BEs) under the Water Act. BEs for the Goulburn system, representing a third of Victoria’s water usage, were mostly issued in 1995, prior to the Cap. These BEs clearly delineated existing rights to water in terms of both volume and security;

• introduction of a moratorium on the issue of new licences within Queensland, in 1995; and

• introduction of the NSW water reform program in 1995 with the objective to better share the available water, enhance support to the rural sector and reshape how water management was delivered.

Overall there were a range of initiatives and controls in place across all States. However, these were uneven in their application both within States and across the Basin more widely. The decision to restrict the level of any further diversions was a

\(^{39}\) Water Act 1989, Victoria, Section 1.
major step-change in the degree of the control introduced, in the creation of a Basin-wide coordinated approach and in its focus on outcomes to be achieved rather than input controls.

This conclusion is reinforced through the following analysis of the controls implemented by each of the States, both pre and post Cap.

3.3. NEW SOUTH WALES RESPONSE TO CAP

Pre-Cap
Prior to the formal announcement of the Cap, NSW established a suite of controls for water resource management covering both consumptive use and environmental objectives.

The flow rules for the Macquarie Marshes, which were first introduced in 1986, are an example of early implementation of environmental flow rules. Equally, access rules have been in place since the early 1980s, with diversion licences on most regulated systems converted to a volumetric basis in the late 1970s and early 1980s.

However, the application of these rules was uneven and despite their application it became evident that the growth in diversions was unsustainable and, in some valleys, probably already beyond the level of environmental sustainability.

Response to Cap
The NSW Government, therefore, strongly supported the introduction of the Cap, as evidenced by the major program of water reforms introduced in 1995 and reinforced in 1997 and 1999.40

The 1995 reforms started the comprehensive process of developing river flow and water quality objectives for the State’s waters and provided water for the environment in the Macquarie and Gwydir River systems. Institutional reforms included setting up the Healthy Rivers Commission and the Water Advisory Council and separating out responsibility for operation, regulation and licence management.

The 1997 reforms extended these initiatives identifying stressed unregulated rivers and involving local management committees in developing management plans for environmental flow rules.

The Cap is applied on a valley-by-valley basis with compliance assessed through computer simulation models of river flows.

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NSW’s response to the Cap involves two major aspects:

- Access Rules which are the primary tool to ensure compliance with the Cap; and
- Environmental Flow Rules, which seek to achieve optimal environmental outcomes within the available water.

These are explored further below.

**Access Rules**

Access rules were substantially strengthened to ensure Cap compliance. The primary mechanisms employed were:

- reduced announced allocation levels or limits;
- controls on off-allocation diversions: eg. either as a volumetric limit or raising ‘commence-to-pump’ levels or reduced rate of extraction limits; and
- changes in ownership and use of water through carryover and continuous accounting of water.

The following specific steps were taken in regulated systems to ensure Cap compliance: 41

- from 1995, announced allocations were reduced to reflect the recognition that unused sleeper and dozer entitlements, in any year, could no longer be automatically re-allocated to high volume users, as the owners of those entitlements could now trade the unused allocation;
- announced allocations in the Murray and Murrumbidgee valleys have been limited, since 1995, to 100%, down from their previous 130% and 120% limits respectively;
- in some valleys (such as the Macquarie) off-allocation access has been refused, since 1997, to any licence holder without a previous history of use of off-allocation;
- off-allocation volumetric limits have been halved in both the Murray and Murrumbidgee valleys since 1997;
- high security licence holders have had no access to off-allocation flows since 1997;
- equally allowance to borrow from next year’s resources has been eliminated or reduced since 1997 (with no waiving of this policy when the dam spills);

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• carryover has been introduced to reduce the ‘use-it’ or ‘lose-it’ behaviour engendered by annual allocations. This policy has been introduced progressively across NSW from 1995; and

• late season trades have not been approved in some instances in order to reduce incentives for growth in diversions based on irrigating larger areas.

A parallel work program was initiated in 1998 to quantify and control unregulated usage:

• conversion of licences from an area-based to volumetric limits;
• embargoes on new entitlements;
• limitations on trade, especially in sleepers; and,
• restrictions on the growth in farm dams, with the introduction of the farm dams policy which ensures that 90% of runoff continues to reach the rivers.

Environmental Flow Rules

With a Cap on diversions in place, enforced by access rules, it was possible for the first time to set realistic environmental (water quality and river flow) objectives for waterways and to introduce environmental flow rules to manage river flows so as to optimise environmental benefits. Environmental flow regimes have been determined for each valley to achieve specific environmental outcomes.

Decisions on these objectives are taken by locally based management committees which are best able to balance the competing objectives of consumptive and environmental outcomes. Any reduction on consumptive use is limited to a maximum of a 10% reduction in diversions to irrigators from Cap levels. These controls have been guaranteed for a period of five years to give additional security.

Integration

Although the two sets of controls (access rules and environmental flow regimes) have different immediate objectives, both are designed to contribute towards delivery of the environmental objectives which the Cap has enabled NSW to set for the first time. Their implementation has been integrated to ensure effective coordination.

In some valleys, where historical usage has been relatively low, the Cap may ensure the minimum required for environmental flows. For most rivers, however, it has been evident that access controls, based on achieving the Cap, will not be sufficient to meet the river-flow and water-quality objectives required. In these circumstances additional controls have been introduced, through the access rules, to further reduce diversions, eg:

• end-of-system flows have been increased; and
• storage reserves have been increased, limiting annual allocations to allow for future environmental contingencies.

Equally, if the outcome of a valley’s long-term model indicates that the present access rules, in combination with environmental flows and the irrigator behaviour, do not maintain diversions within the Cap, then adjustments are made to the access rules. This is an iterative process with the magnitude of the adjustment chosen so that the long-term diversions resulting from the change falls back within the long-term valley cap.

These rules and controls are still in the early stages of implementation. Environmental objectives for river systems were only agreed by the NSW Cabinet in mid 1999 and the access and flow rules are still being refined by the local River Management Committees. In practice, the process is only just beginning to take effect, as serious resource constraints in the southern systems have limited diversions over the past five years while full implementation has taken longer to achieve in some of the northern valleys.

The latest IAG report suggests that these controls are not yet fully effective in controlling diversions within Cap limits, especially on the Barwon Darling.

Summary

The Cap provided a clear signal to stakeholders across the Basin that there was increasing resource scarcity, that previous arrangements were insufficient and that there was the political commitment to implement necessary controls.

Moreover, the Cap set a benchmark against which future regulation of diversions could be measured and resulted in a tightening of access rules and other measures to ensure Cap compliance. In turn, the policy initiatives facilitated the introduction of environmental flow rules to manage river flows to produce environmental benefits. Benefits attributable to the Cap therefore include advanced timing and wider scope of such initiatives, if not the initiatives themselves. As for Victoria, the Cap has had strong publicity effects and promoted trade and hence resource use efficiency.
3.4. VICTORIA’S RESPONSE TO CAP

The MDBC Cap was a powerful agent for additional reforms in the water sector. The following are an indication of the actions undertaken by Victoria following its introduction:

Initial Actions

- within weeks there was a moratorium on diversions:
  - Victoria had not issued standard diversion licences in the northern systems since a final auction in February 1994. However it had still issued new winter-fill licences;
  - it now only issued new licences as a result of trade;
- new constraints were imposed on trade on unregulated systems:
  - trade was only allowed downstream & a 20% levy was imposed on all trades;
- no trade was allowed in sales water;
- 100% limit was imposed on sales allocations; and
- seasonal allocation policy was adjusted to ensure:
  - a higher reserve, and a higher utilisation factor.

Later Framework

Following extensive consultation summarised in the publication “Sharing the Murray” 42, the Victorian Government in 1997 introduced a series of further reforms to make controls over diversions more effective. These included:

- constraint of trade in sales above 30%;
- limiting off-allocation to 20% of Water Right;
- tightening the allocation methodology for setting Urban Bulk Entitlements (BEs);
- introducing more rigorous criteria for setting BEs on the Murray than had been followed for the Goulburn/Broken catchment:
  - there was a greater community acceptance of the importance of recognising the needs of the environment eg as for the Barmah Millewa Forest,
  - entitlements for Urbans were far more restrictive,
  - the rules for over and under use were more stringent; and
- introducing bulk metering to FMIT to control and manage diversions.

42 Murray Water Entitlement Committee (2997), “Sharing the Murray – Proposal for defining people’s entitlements to Victoria’s water from the Murray”.
Summary

The introduction of the Cap led to changes in Victorian rules on the issues of entitlements, seasonal allocations and water trading.

For instance, additional controls were included in the Murray BEs beyond those present in the Goulburn Broken BEs, which had been finalised prior to the Cap. Goulburn urban water users were allocated an entitlement based on the design capacity of their works (some 20% - 40% greater than past use) and at 99% reliability. In contrast, urban authorities on the Murray accepted an entitlement capped at past use, and at the same reliability as that of irrigators, ie 96% reliability.

The Cap has also had a powerful publicity or announcement effect. It was recognised as a high profile statement of future policy and practice. This stimulated change in perception across the range of water users and facilitated the introduction of more rigorous controls.

However, in practice, in the time period since 1996, the Cap has had little direct impact in Victoria because resource scarcity has acted as the primary constraint on development. The River Murray models do not yet have climate adjusted monitoring simulation. However, the frameworks and behaviour developed over this period will extend beyond the period of the drought.

The Cap can, therefore, be seen to have had benefits through:

- publicity value (acceptance of change and appreciation of the impact of your actions/ preferences on others);
- discipline value (better and clearer definition of agreements); and
- acceleration of outcomes.

3.5. SOUTH AUSTRALIA’S RESPONSE TO CAP

Reflecting the predominant use of water for horticulture, SA has adopted a conservative and prudent approach to allocations and diversions. As it is located at the end of the Basin, SA is vulnerable to reductions in the volume and quality of its water resources as development occurs up-stream. Adelaide residents are particularly aware of their dependence on the Murray as their source of drinking water.

These concerns were critical in driving the commitment in the Murray-Darling Basin Agreement to guarantee SA minimum passing flows at the border of 1,850 GL.
Pre-Cap
SA has had an effective limit on entitlements since 1968. This level has been reduced twice, since then, to ensure maintenance of a high level of security for irrigators.

The limit was set at the maximum level of entitlements, not at the level of use or diversion. On average, diversions have only represented 80% of those entitlements in any year. The level was set at the total volume which SA would take from the Murray, irrespective of rainfall, and with reference to the level of diversion which was environmentally sustainable during minimum drought flows (entitlements represent approximately 40% of minimum flows). During average to wet years a much higher volume is made available to the environment. Traditionally, SA has not made use of opportunistic, annual off-allocations.

Rehabilitation of irrigation areas also started at an earlier stage in SA than in other States and led to savings which were returned to the environment.

Response to Cap
The SA Government was one of the key early proponents of the Cap. The paper from Minister Klunder to the Ministerial Council in June 1993 was a central stimulus for the Audit which led to the introduction of the Cap. This paper argued that “there be no further regulation and diversion arrangements which would exacerbate deteriorating flow regimes” throughout the Basin.43

SA, therefore, welcomed the introduction of the Cap as protecting its future resources and minimising risks from, for example, increased salinisation.

In negotiating the introduction of the Cap, SA argued that its future level of diversions should be set by reference to the limit of entitlements, not by reference to the actual level of diversions in 1993/94. This involved a potential increase in total diversions of 69 GL, over 1993/94 levels, if diversions increased to 90% of entitlement (approved by the Ministerial Council). SA also renounced any future access to above-entitlement flows as part of the negotiation over the Cap.

Summary
Announcement of the Cap had little impact on existing water management procedures and practice, as SA had implemented an effective cap since 1968. Moreover, as the Cap was set at a level above 1994 levels of usage, it has not been an immediate constraint on diversions, having the potential to increase from an average of 80% pre-Cap to 90% post-Cap. Implementation of the Cap, however, has involved development and refinement of monitoring tools and climate adjusted models.

3.6. QUEENSLAND RESPONSE TO CAP

Prior to the announcement of the Cap, Queensland had recognised the need for coordinated resource management controls:

“The need for basin wide planning to support the management of water became evident in the Queensland section of the Murray-Darling Basin prior to the decision ...to introduce a Cap on water diversions ... Queensland had therefore effectively introduced its own cap in advance of the Murray-Darling decision in 1995.”

The major mechanism introduced by Queensland, pre-Cap, was a moratorium on the issue of new licences. However, this failed to place a restriction on future growth in diversions, as full activation of licence entitlement was allowed. Equally it had no effect on floodplain harvesting. The Cap, by distinction, focuses on the output to be achieved, ie no growth in total diversions.

Queensland’s approach to ensuring Cap compliance was based on:

“Its Water Allocation Management Planning (WAMP) process to set end of river flow objectives based on limiting consumptive water use to sustainable levels.”

The IAG and Ministerial Council endorsed this approach in 1996, subject to independent audit of the results of the WAMP process. Queensland’s original compliance strategy was based on completion of the necessary WAMPs and Water Management Plans (WMPs) by 1997. In practice, progress has been slower than expected, due to the complexity of the catchment-wide models required, the hydrologic and scientific issues raised and the need to consult with community representatives and water-use stakeholders.

Major Actions

In late 1999, the Queensland Government adopted a streamlined WAMP process to reduce the time required to produce draft plans.

One of the intended outcomes of the WAMP process is to establish minimum performance measures for various types of water entitlements (Water Entitlement Security Objectives or WESOs) in each basin. WESOs will specify the minimum benchmarks of performance, either in terms of the monthly and/or annual reliabilities for regulated water allocations, or in terms of a range of simulated diversions (in days per year for various percentiles of years) for water harvesting entitlements.

Other initiatives include:

- confirmation of the moratorium on the issue of new licences, pending completion of the WAMPs, which will provide a framework for decisions on individual applications;

- abandonment of proposals to construct the Beardmore Dam Western Cell which would have provided additional water to the St George Irrigation Area. The reliability of allocations to farms in the area will be enhanced through the introduction of capacity sharing in the storage and an offer to buy back allocations;\(^46\) and

- the joint Queensland and NSW report on the Border Rivers which establishes an outer envelope for flow management planning.\(^47\) This makes two policy commitments:\(^48\)
  - it establishes an end of flow regime for the rivers, at Mungindi, and commits to prevent any worsening of this flow, currently at 60% of natural mean annual flow;
  - it restricts any further increase in total diversions within regulated systems which feed into the main stem. In time this will reduce the average security of all licence holders as sleepers are progressively activated. Trading will provide a mechanism to minimise this impact. However, operational arrangements will take eighteen months to implement.

Coincident with these initiatives there has been:

- major growth in the harvesting of over-land flows and number and volume of off-stream storages. For instance, the IAG reports that harvesting in the upper Condamine is currently estimated at 120 GL compared to 44 GL in 1993/94.\(^49\) This harvesting has the potential to impact on existing water allocations and on environmental values both within and outside the riverine environment;

- Growth in capacity of on-farm storages for both licensed water-harvesting and non-licensed overland flow diversions; and

- a negative trend in key flow statistics for the Border Rivers and other streams.\(^50\)

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\(^{46}\) Hon Rod Welford, MLA, letter to all holders of Nominal Allocation in the St George Irrigation Area and Project, 21 December 1999.


The substantial expansion of diversions above 1993/94 levels does not constitute a breach of the Cap as Queensland’s Cap is still to be determined following completion of the WAMPs. The increase in water-harvesting falls within the terms of the existing licences which specify the threshold flow, diversion rate and timing of diversions. In addition, the harvesting of overland flow is not currently subject to any of the State’s allocation systems.

**New overarching legislation** will be in place, from later in 2000, in line with the recently published draft Water (Allocation and Management) Bill,\(^{51}\) to provide a framework which should ensure adequate controls across the broad field of water allocation and management. The proposed new allocation system will provide a statutory basis for the WAMP process and provide controls for the harvesting of overland flows.

**Summary**

The impact of the Cap, and related external audit and reporting mechanisms, has been to galvanise Government and landholder thinking on the need to advance and extend the WAMP and water management frameworks. On the other hand, it has also spurred some landholders to develop their water use to the maximum possible ahead of formal application of a Cap to diversions in Queensland catchments. As with other States, the Cap has had announcement benefits particularly in terms of providing a Basin-wide perspective on Queensland water management and development particularly the impact of Queensland developments on the security of entitlements on the Border Rivers and northern NSW and the impact on the security of Queensland entitlements.

### 3.7. ACT ACTIONS TO IMPLEMENT CAP

“A formal Cap has yet to be determined for the ACT. It is expected that the ACT will shortly bring forward to the Council a proposal for a Cap covering the territory together with proposed management rules.”\(^{52}\)

Key issues to be addressed will include defining the entitlement for ACTEW and establishing rules for water trade with NSW.

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3.8. SUMMARY

In summary, prior to the announcement of the decision to limit growth in diversions, individual governments had begun to change their water management policies. However, these initiatives were developed and implemented in an uneven way, with considerable variation both between and within States and with little recognition of Basin-wide implications. The initiatives compare powerfully with the coordinated suite of measures and controls now in place across most of the Basin.

The 1995 Audit of Water Use in the Basin was a watershed in terms of developing a common and agreed understanding of the issues of resource sustainability between member governments.

It identified and documented:

- the extremely rapid growth of diversions between the 1988 and 1994 seasons;
- the rapidly advancing limits to further growth;
- the dramatic decline in scarcity of access that would result under a No Cap/full development scenario in, say, the Victorian Murray;
- the continuing fall in end of river flows and the decline in the environmental health of the river system; and
- the need for co-ordinated basin-wide action.

The subsequent decision of the Ministerial Council signalled publicly the need for Basin-wide commitment to limit future growth in diversions.

Discussions with water managers in each State confirm that the formal announcement of the Cap galvanised thinking and effort to achieve better and sustainable outcomes.

Rather than seeing the Cap as just one step in a series of responses to increasing resource scarcity, the more appropriate perspective is that the Audit and the Cap were essential precursors of the suite of controls currently in place or being implemented by the individual States.

In simple terms the effects were:

- to strengthen and reinforce existing reform initiatives;
- to stimulate additional controls;
- to act as a benchmark for future regulation of diversions;
- to provide a Basin-wide framework and so coordinate actions between catchments and States; and
- to ensure compliance monitoring and publicity at the sub-state level.
4. **NO CAP SCENARIO**

As noted, the impact of the Cap should be appropriately assessed by comparing the With Cap situation against the benchmark set by the No Cap scenario. This Chapter assesses the possible options for defining the No Cap scenario and sets out the preferred approach.

### 4.1. CHOICE OF NO CAP SCENARIO

In terms of specifying the detail of the No Cap scenario, there are several choices. The most important of these concern the impact of the environmental flow regimes, particularly in NSW and the judgement made on whether these flow regimes would have been introduced in a timely manner in the absence of a Cap.

Our review of the State responses to the Cap and the preceding changes to water management indicates that while environmental flow regimes and water management plans were evident prior to the announcement of the Cap, that announcement stimulated and galvanised action in these areas. The result has been to initiate a much more comprehensive and integrated application of environmental flow and water management regimes.

The preferred No Cap scenario adopted for this review is “No Cap and the absence of environmental flows”. We note, however, that some environmental flows would have been established.

Within the preferred scenario of No Cap and the absence of environmental flows, there are several possible variants, but they do not alter the qualitative description of the No Cap scenario.

### 4.2. NO CAP IN THE ABSENCE OF ENVIRONMENTAL FLOWS

The No Cap scenario would demonstrate the following characteristics:

- in the absence of the formal announcement of the Cap on diversions, irrigation development would proceed — at least initially — in most valleys. As a result, resource sustainability would become a major issue;
- the increased development would lead to a steady erosion of security reducing the incentive for new entrants to begin irrigating but also undermining the security of existing entitlements and enterprises in all valleys.

Security in lower valleys and reaches would fall significantly due to development in these lower valleys as well as development in upstream reaches and tributaries. For instance, reflecting the obligations of NSW and Victoria to South Australia under the Murray-Darling Basin Agreement, new developments on the Darling and tributaries would also impact on the security of supply for the Murray system;
by definition, the movement to full development must entail activation of unused rights, entitlements and licences. This occurs through continued development by existing entitlement holders and/or by the sale of unused entitlements in the market to new entrants seeking to gain entitlements;

not all unused entitlements would be activated since some are kept as insurance to ensure greater reliability and others are held in anticipation of future development;

sleeper and dozer licences would also be purchased by existing users as they seek to restore their previous level of security;

the degradation of the riverine environment and water quality would proceed at an accelerating pace. Algal blooms would become a recurring feature of major reaches as dilution flows are reduced. Salinity, particularly in the lower reaches, would continue to rise. In the mid and lower sections of the river, the rise in water salinity would lead to increased salt accumulation and loss of the remaining bio-diversity;

socio-demographic trends would continue to be driven by the major forces impacting on irrigated agriculture, ie., commodity prices, seasonal allocations and access to export markets;

there would be increasing tensions between irrigator groups and between regions as security declines and water trading becomes more aggressive.

Individual irrigators, industry associations, local government and others initiate legal actions against the State Governments and the MDBC for failing to provide adequate stewardship of the water resource and riverine environment. The recent announcement from Premier Olsen provides an example of this risk:

“If NSW just simply continues to ignore our calls for appropriate flows through the River Murray we will take retaliatory action.”

In the absence of a cap these challenges would have been far more common and vociferous. Other legal actions seek to either remove or improve constraints on water trade. In other words, there is a disorderly scramble and lack of process;

as resource availability and security deteriorate rapidly in the final stages of this full development scenario, incentives for water use efficiencies rise sharply, stimulating major investment late in the period. Major corporate farms will be better placed to fund those capital expenditures;

changes in river and system operation would tend to occur progressively but predominately in the full development scenario as the pressures and urgency mount;

53 Premier Olsen (2000), as reported in The Sunday Mail, 20 February.
• as end of valley flows continue to fall and the damage to the river environment becomes stark, the urban electorate loses patience and sympathy with irrigators and basin communities; and

• with the substantial reduction in security, the income and viability of irrigated enterprises and communities across the Basin becomes increasingly sensitive to seasonal and climatic variation.

By way of comparison, the No Cap scenario involves some of the same features observed in the Cap situation:

• the activation of sleeper and dozer licences is an essential feature of increasing development;

• the availability of sleeper/dozer licences would be reduced as water becomes more valuable;

• holders of sleeper and dozer licences – like all holders of entitlement – would enjoy a progressive appreciation in value of their entitlements/licences;

• existing irrigators would be forced to buy additional water in order to preserve security;

• some water would normally be under-used in any year due to need to maintain security insurance;

• new entrants would need to buy entitlement in order to establish irrigation operations; and

• irrigators previously reliant on benefiting from off-allocation or sales water would be faced with rapidly diminishing availability of such sources of water.

The important distinction to draw is that in the With Cap scenario these changes and challenges are presented within a coordinated framework where competing and conflicting interests can be addressed and resolved. This contrasts with the disorder and scramble for decreasing resources which characterises the No-Cap scenario. As the Victorians put it:

“If the Cap hadn’t been deliberately set, the physical limitations of the system would have imposed one on us anyway. This would have been a lot less orderly and more painful than the Cap we’re now grappling with.”54

4.3. VARIANTS OF NO CAP SCENARIO

The qualitative description of the No Cap scenario in the absence of environmental flows is consistent with several variants of this scenario including:

- the progression to “Full Development” as specified by the 1995 Audit Report;
- scenarios consistent with the concept of optimal development of the Basin or of individual valleys; and
- scenarios which recognise the close inter-relationship of development and allocations across the river systems of the Basin.

Full Development: The Audit Report’s interpretation of the Full Development scenario suggests substantial scope for expansion above the 1993-94 development levels (Chart 4.1) but at a cost of very substantial reductions in security. Whether development would proceed to the level of “Full Development” in the face of the dramatic decline in water security across the Basin, is an economic issue not addressed by the hydrological analysis of the 1995 Audit.

CHART 4.1 : FULL DEVELOPMENT SCENARIO SPECIFIED BY 1995 AUDIT

<table>
<thead>
<tr>
<th>RIVER SYSTEM</th>
<th>1994 DEVELOPMENT DIVERSION</th>
<th>AUDIT SCENARIO</th>
<th>CHANGE FROM 1994</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FULL DEVELOPMENT OF EXISTING ENTITLEMENTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSW</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Darling and tributaries u/s</td>
<td>1,445</td>
<td>1,976</td>
<td>531</td>
</tr>
<tr>
<td>Menindee</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Darling</td>
<td>139</td>
<td>183</td>
<td>44</td>
</tr>
<tr>
<td>Murrumbidgee</td>
<td>2,300</td>
<td>2,670</td>
<td>370</td>
</tr>
<tr>
<td>Murray</td>
<td>1,977</td>
<td>2,039</td>
<td>62</td>
</tr>
<tr>
<td>Total NSW</td>
<td>5,861</td>
<td>6,868</td>
<td>1,007</td>
</tr>
<tr>
<td>Victoria</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Murray</td>
<td>1,725</td>
<td>1,910</td>
<td>185</td>
</tr>
<tr>
<td>Goulburn/Broken/Campaspe/Loddon</td>
<td>2,094</td>
<td>2,100</td>
<td>6</td>
</tr>
<tr>
<td>Total Victoria</td>
<td>3,819</td>
<td>4,010</td>
<td>191</td>
</tr>
<tr>
<td>South Australia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumped Diversions</td>
<td>506</td>
<td>731</td>
<td>225</td>
</tr>
<tr>
<td>Reclaimed Swamps</td>
<td>104</td>
<td>104</td>
<td>–</td>
</tr>
<tr>
<td>Total South Australia</td>
<td>610</td>
<td>835</td>
<td>225</td>
</tr>
<tr>
<td>Queensland</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Border Rivers</td>
<td>135</td>
<td>156</td>
<td>21</td>
</tr>
<tr>
<td>Condamine/Balonne</td>
<td>291</td>
<td>400</td>
<td>109</td>
</tr>
<tr>
<td>Total Queensland</td>
<td>426</td>
<td>556</td>
<td>130</td>
</tr>
<tr>
<td>ACT</td>
<td>65</td>
<td>75</td>
<td>10</td>
</tr>
<tr>
<td>Total for Basin</td>
<td>10,781</td>
<td>12,344</td>
<td>1,563</td>
</tr>
</tbody>
</table>

Optimal Development: An alternative concept is, therefore, “optimal development”, defined in terms of optimising the financial outcomes at either the Basin or individual valley levels. This concept is now being embodied in the IQQM models which recognise the need for irrigators to pay the full costs of any additional infrastructure investments – whether on-river or on-farm – required to achieve increased levels of development.

From a Basin perspective, levels of “optimal development” (in the absence of a Cap and environmental flow rules) can only be established by reference to simulations of yet to be constructed IQQM and linear programming models which integrate the decision process across all major catchments/systems.

Levels of optimal development may be greater than Full Development as envisaged in the 1995 Audit, although in general they appear likely to be lower. They are likely to be lower because, while individual landholders may choose to ignore the impact of their development on the security of others, these impacts would be recognised in any decision process leading to the definition of optimal levels of development in a valley.

Physically Possible Development: The need to take a Basin-wide view on the definition of the No Cap scenario is further emphasised by recent hydrological advice from DLWC. This indicates that it may not be physically possible for all valleys to develop full entitlement simultaneously. Integration of the Basin means that full development in upper tributaries will impact on yield in lower tributaries.

For instance, full development on northern tributary rivers in NSW is likely to result in reduced allocations within the Murray, viz.:

- full development in the unregulated streams above storages in the northern NSW rivers will reduce the ability of those storages (such as the Keepit Dam) to guarantee security to licence holders in the regulated systems;

- some further development in the regulated tributaries of the Barwon Darling such as the Namoi, would still be possible. However, such development would be predicated on harvesting flood-flows thus requiring construction of further farm storages. Clearly a point would be reached whereby the cost of additional storages would be greater than the returns achieved from the incremental flows able to be harvested. As a result, there is an economic limit to full development in an unconstrained system;

- full development in these tributary rivers would severely affect the normal flows in the Barwon Darling. This would limit further diversions and development in

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this system to very large flood events. The physical and economic scope to capture such flows is likely to be severely limited; and

- if normal flows from the Darling are reduced significantly, then the southern systems sourced from Hume and Dartmouth will carry greater responsibility to meet the commitment to deliver minimum passing flows to South Australia. This, in turn, will result in a reduction in available allocations within the Murray.

Conclusion

For the sake of clarity of exposition and consistency with the Audit Reports, we begin our assessment of Cap impacts, in Chapter 5, from the starting base of the No Cap based on Full Development as specified in the 1995 Audit.
5. ASSESSMENT OF CAP IMPACTS

5.1. IDENTIFICATION OF IMPACTS

Impacts from the announcement of a limit to diversions across the Murray-Darling Basin and the subsequent and on-going introduction of management regimes to achieve Cap compliance include:

- changes in yield and security which affect the viability of individual enterprises, employment opportunities and the social fabric of the broader agricultural economy;
- equity issues arising from differential impacts;
- the stimulus to water use efficiency and to trade water to high value uses;
- improvements in the institutional framework for property rights, third party impacts and trading arrangements; and
- as a catalyst for advancing and broadening environmental flow regimes, reducing adverse environmental impacts and slowing of long term degradation.

Each of these impacts is examined in turn in the sections below.

In examining these impacts, several distinctions need to be drawn. First, while many of the submissions focused on the impact of the Cap compared to the pre-Cap situation, the impact of the Cap is more accurately assessed against the yardstick of the No Cap scenario.

Second, because the limit to diversions applies on a valley by valley basis, these impacts vary accordingly. However, impacts on individual irrigators also vary – particularly between conservative and opportunistic water users – and need to be explicitly considered.

Third, in identifying and describing the impacts of the Cap, we need to distinguish between direct impacts – potentially observable in the 1995/96 to 1999/2000 seasons and longer run – and second round flow-on effects. The need to distinguish between the potential short-run and longer run effects has been accentuated by the succession of dry seasons since the announcement of the Cap. These have meant that in the southern systems resource scarcity, rather than the Cap, has been the dominant constraint. Similarly in Queensland, the Cap has not been a constraint since it has not been formally implemented pending completion of the WAMP processes, now projected for completion by end 2000. In NSW the Independent Audit Group Report for 1998/99 notes that the Cap has not been fully implemented in the Gwydir and Border Rivers as the models for monitoring compliance are not yet complete.
This chapter provides an assessment of the Cap impacts on the agricultural economy and the Basin community in general, drawing on the available information from the submissions to the Review from partner governments and from community groups, as well as data not previously assembled.

5.2. CHANGES IN YIELD, SECURITY AND THE AGRICULTURAL ECONOMY

Limitation of the growth of diversions has several potentially major impacts on the security of allocations across the Basin. These impacts move in opposite directions.

“The introduction of transfer schemes, particularly temporary transfer schemes, and the subsequent introduction of the extractive Cap:

− has increased the reliability of a reduced minimum level of water availability, and at the same time
− has accelerated the reduction in reliability of water supplies in excess of the minimum reliable quantity.”

These two impacts are observable in the short term, ie., now. In the longer term as the No Cap scenario progresses towards Full Development, the impact of the Cap in guaranteeing the reliability of supply becomes increasingly important.

The twin impacts of seasonal allocations below minimum reliable quantity are observable, for instance, in the NSW Murray Valley where allocations in a normal year will be around 87% of entitlement. Similarly, Victorian dairy farmers within the boundaries of Goulburn-Murray Water (G-MW) are adjusting to the reduced availability of sales water. The fact that the seasonal allocations have been reduced primarily because of the drought sequence and resource scarcity rather than the Cap does not prevent these twin impacts from being observed.

In the medium to long term as the No Cap scenario progresses to Full Development, high allocations will become a rare event in the major southern valleys with smaller, but significant, reductions in reliability in the northern valleys of NSW and in Queensland. Consistent with these differences in reliability impacts, the irrigators and community groups in the southern regulated systems are much more strongly supportive of the Cap than are counterpart groups in the northern regulated and unregulated systems.

“Responses are clearly divided by location in the Basin. Regulated systems, particularly at the bottom of the River, are very positive about the Cap in providing security of supply, encouraging irrigation efficiencies and ongoing reform to high value crops. It is also recognised that the Cap

56 Combined submission from Murrumbidgee Irrigation, MIA Council of Horticultural Associations and Ricegrowers Association of Australia.
will have positive economic and social impacts by providing great security for irrigation allocations.

Conversely, there are regulated areas which consider there would be benefits if the Cap were removed and that the impact on development has been too severe. This is also the view of unregulated systems which consider the Cap to have had major negative impacts, and the introduction of environmental flows or payback under Schedule F would cause economic collapse." 57

The magnitude of the ultimate reductions in reliability needs to be fully appreciated. The prime tool for assessing the security/reliability of water supplies are the “reliability/exceedence” curves which summarise the probability (or number of years in 100) of different levels of supply being available. 58

These reliability curves are based on hydrological simulation models under specified assumptions relating to levels of development, climate patterns and stream flows. Consistent with the assessment framework specified to assess the impact of the Cap in Chapter 1, reliability/exceedence curves are required for several obvious scenarios. These are:

- a baseline curve for historic use as at, say, 1988;
- the reliability of supply at 1993/94 levels of development, i.e., under the Cap scenario; and

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57 Community Advisory Committee (1999), Submission, p.17.
58 Reliability/exceedence curves are typically defined in regulated systems in terms of the reliability of different levels of allocations. In unregulated systems (and in regulated systems where there is substantial off or out-of-allocation harvesting), the reliability/exceedence curves need to be defined in terms of, say, the percentage of peak diversions.

In both cases the underlying concept is the same. Single summary measures, such as “mean annual diversions” can be derived from the information contained in the reliability/exceedence curves provided these are comprehensively defined.

The reliability/exceedence curves are preferred to single summary measures such as mean annual diversions because mean or median measures do not adequately describe the situation in drought sequences “when the chips are down.”

For instance, while “mean annual diversions” may increase as development proceeds, the level of possible diversions will become (much) more variable.

As a result, more development by some may mean lower utilisation of infrastructure and other assets by others.

Reliability/exceedence curves allow water users and managers to assess individually risk and reliability.
• the reliability of supply under the No Cap scenario, ie., Full Development in the absence of environmental flow rules.\textsuperscript{59}

The prime focus must be on the change in reliability between the Cap, ie., 1993/94 levels of development and the No Cap scenario.

The available hydrological evidence indicates that unconstrained growth in diversions would lead to a fundamental change in yield/security relationships. In the major systems and other valleys, these changes are sufficiently large to undermine existing irrigation enterprises and communities.

Simply put, there is a limited amount of water. Users can either take a high annual volume, at a low level of reliability, or a low volume at high reliability. If annual diversions are allowed to rise, the reserves for the following year are eroded and the reliability drops. Although the precise situation and security impacts vary between valleys and type of entitlement, this qualitative conclusion applies uniformly.

Valley by valley examination of these impacts illustrates both the magnitude of the changes in yield and security and the potential consequences.

**Valley by Valley**

In the **NSW Murray** as the No Cap scenario progresses to Full Development, the security of allocations progressively collapses (Chart 5.1). At the completion of the development process high allocations have become an infrequent event:

• whereas under 1993/94 levels of development, allocations of 100% or more could be achieved in almost 75% of years, under Full Development this is achieved in only 45% of years; and

• under the 1993/94 levels of development, allocations of 80% or more could be achieved in almost 85% of years, under Full Development this would be achieved in little more than 50% of years.

It should be noted that the above scenario is based on both the level of development and the allocation rules which were in place in 1993/94. It is also the outcome of MDBC modelling dating from 1995.

\textsuperscript{59} Full Development as specified in the 1995 Audit need have no direct counterpart under the more sophisticated IQQM models developed more recently.
In the **NSW Murray** the sharp reduction in level of security between the 1993/94 level of development and the Full Development scenario implies highly adverse impacts on general security irrigators and the wider agricultural economy. For instance:

- individual irrigators would face more volatile water supply, output and income requiring increased cashflow and funds in order to service existing debt levels;
- the rice industry would have difficulty in achieving a high and stable level of production leading to a lower proportion of the crop being marketed through long-term contracts; and
- attempts to offset the loss of security by building on-farm storages would involve not only high capital investment and pumping costs but localised high water tables and land salinisation.

In terms of timing, the greater part of the development phase is likely to occur in the early years with the rate of development slowing as Full Development is approached. This implies that the decline in security would be especially fast in the first five to ten years before slowing as the development phase runs its course.
In the **Victorian Murray** and **Goulburn systems** similar contrasts between security under the Cap and No Cap scenarios are observed (Charts 5.2 and 5.3). Again, as the No Cap scenario progresses to Full Development high allocations become a rare event:

- in the Victorian Murray, whereas under the 1993/94 levels of development, an allocation of 220% would be received in 75% of years, under Full Development this falls to around 27% of years; and
- in the case of the Goulburn system, the comparable reduction is from 55% to 5% of years, respectively.

A feature of current water use within North East Victoria is the reliance of dairy farms on ‘sales water’ which is only available at times of relative resource abundance:

> “Dairy farms are more reliant on high sales allocations than mixed farms or horticulture (close to Water Right plus 100% sales in the record delivery year).”\(^\text{60}\)

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These dairy farms have been impacted by changes in water management policy in recent years – particularly the decision to restrict sales allocations. Nonetheless, a comprehensive process of surveys, analyses and workshops confirms that while some individual farms would be adversely affected, the dairy industry as a whole would continue to prosper and expand under the Cap:

“Dairy Processors should be confident that the Industry can maintain and continue to expand production under the MDBC Cap.” 61

The sharp decline in security and the rarity of high allocation years under the Full Development scenario raises a different and more severe set of implications. At a minimum, the No Cap scenario implies for the northern Victorian dairy industry:

- increased purchase of grain and fodder;
- purchases of water entitlement; and/or
- a reduction in stock numbers.

61 ibid. p. 7.
The underwriting of security in the Victorian Murray and Goulburn systems by the Cap is substantial and well recognised by Victorian irrigators and investors.

“The MDB Cap has generated significant economic and social benefit as it has complemented the water management regime in Victoria, which is based on both quantity and reliability. Together, these two factors have resulted in effective and sustainable management of this finite resource. This has encouraged long term investment and the investment is providing identifiable and sustainable economic and social benefits.”

“In the Goulburn Valley alone, in the last five years in excess of $800 million has been invested in irrigated agriculture. An estimated additional $800 million has been invested in value added agribusiness industry. As detailed above, this investment would not have occurred without water resource management that assured reliability, adequate volumes and sustainability.”

On the Murrumbidgee, implementation of the Cap has had immediate impact in increasing the reliability of minimum reliable quantities and reducing the reliability of water supplies in excess of that minimum. As a result, irrigators previously heavily reliant on high allocations lose access and must recoup the security where possible. With the progression of the No Cap scenario towards Full Development, security is progressively eroded exacerbating the previous concerns of Murrumbidgee irrigators over security. For instance in 1991 the Department had proposed the release of an additional 300 GL of water for further development in the Murrumbidgee. For security and other reasons this offer was rejected by Murrumbidgee irrigators.

In the Macquarie, there is evidence of progressive reduction in security of irrigators’ allocations, over a twenty year period, as riparian licences are extended and environmental flow rules introduced:

“In 1995 simulations studies by the Department showed that as a result of water transferability and because of the huge increase in construction of farm water storages, the reliability of water supply on the Macquarie had declined even further (from around 80% at the time our allocation was first granted) to 28%.”

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63 ibid, p.3.
64 Cummings BA (1996), “Removing Barriers: Helping irrigators to become more Competitive”.
In the Lachlan Valley, the progressive divergence between the security levels guaranteed under the Cap and the progression toward Full Development appear less extreme (Chart 5.4). This partly reflects the lower percentage which the irrigated sector comprises within the agriculture of the catchment.

Nonetheless, any development beyond 1993-94 levels will lead to a reduction in security of supply for both new and existing entitlement holders.66

On the Barwon-Darling the Cap has not yet been formally applied and development is following the No Cap scenario. There is continued growth in irrigation infrastructure, with an increase of around 30% in the irrigated crop area since 1993/94,67 accounting for increased diversions of an additional 77 GL of water in the past two seasons.68 The Independent Audit Group, therefore, reports that NSW is in breach of its Cap obligations for the Barwon-Darling.


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66 “Extended development” is DLWC’s best estimate of further growth in each valley taking account of crop type, irrigation practices, and the declining investment on on-farm storages. However, this level of development should not be construed as an optimum level of development.


Macquarie and Warego). These developments eliminate the smaller flood peaks making water-harvesting on the Barwon-Darling dependent on the major peaks. This undermines the economics of new on-farm storages and increases the duration of drought with resultant adverse impacts on the cash flow of the farms.

The income stability provided by irrigation is eroded and income volatility increases reducing the ability to service debt and so on.

In the Northern Valleys, ie., the Namoi and other tributaries of the Barwon-Darling, the Cap has not yet been fully implemented, as valley based IQQM models are still being developed. For example:

“As the Cap has never been implemented in the Gwydir Valley, there are no economic or social impacts, good or bad, …”

As a result, development has continued to proceed at a rapid level. The levels of existing development in these cotton dominated valleys (Chart 5.5) suggests that the erosion of underlying security due to ongoing development may be greater than observed in the case of the Lachlan.

The resulting loss of security in cotton intensive irrigation leads to pressure on marketing and contract selling arrangements. The importance of these marketing and contractual issues was recognised in submissions:

69 Gwydir Valley irrigators Association (1999), Submission, p.2.
“There has been no consideration of the impacts of loss of access and security of supply of water on the marketing strategies that are required for successful and profitable cropping in the region.”

In the Border Rivers, the Cap has not been implemented pending agreement on end-of-river flows and completion of a joint Flow Management Plan (FMP) by the NSW and Queensland Governments. NSW is finalising its Cap separate to the FMP. However, as noted, the November 1999 Agreement by the NSW and Queensland Governments effectively caps the Border Rivers’ end-of-flow regime at Mungindi:

- further growth in diversions in regulated streams will not be allowed; and
- increases in water use in the Border Rivers Catchment that lead to further deterioration in the end of system flow regime will not be supported.

Since 1995, development has proceeded within the NSW and Queensland sectors of the Border Rivers. Part of this increase reflects growth in diversions from the Pindari Dam, which was endorsed by the Ministerial Council, and part a growth in on-farm storages. In the Queensland sections of the Rivers the capacity of on-farm dams increased from 210 to 230 GL from 1997/98 to 1998/99. Equally, estimates of projected diversions in a No-Cap scenario indicate a 50% growth from 1993/94 levels of diversion.

In the Condamine-Balonne, considerable growth in on-farm storages has taken place even since 1997, when environmental flow reports indicated that many parts of the lower Balonne were impacted.

Projections on mean annual diversions without the WAMP or Cap again demonstrate major future growth, particularly in water harvesting and unregulated supplies. These have risen from 257 GL in 1993/94 to 500 GL in mid 1999 with further growth projected to reach 706 GL in due course.

A conclusion on the impact of this growth, in the Border Rivers and Condamine-Balonne, on the reliability of supply to existing licence holders cannot be made until the FMP and WAMPs are complete.

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70 Namoi Water Users Association (1999), Submission to CAC, p.2.
72 DNR Queensland (2000), Submission.
74 DNR Queensland (2000), Submission.
5.3. EQUITY ISSUES

While there is substantial agreement across Basin communities on the need of a Cap to halt the growth of diversions and to sustain river health and consumptive use, there is considerable disquiet over equity and implementation issues.

The key concerns in the community submissions, which were overwhelmingly from NSW, relate to the unequal distribution of the adverse impacts of the introduction of the Cap between different individuals and communities. The main areas of concern and disquiet relate to:

- the wealth transfer resulting from the activation of sleeper and dozer licences and from the preferential treatment accorded irrigators with high security entitlement vis-à-vis those with general security entitlement; and
- the perceived inequities in the implementation of the Cap between highly developed and less developed valleys, i.e., the limitation of further development in valleys where 1994 levels of water diversions are seen to be low.

Sleeper Activation and Wealth Transfer

Among NSW communities there is broad concern over the “massive transfer of wealth from active productive irrigators to sleepers and dozers.”75

“... in NSW some water users have been allowed to increase water use at the direct expense of water users with a demonstrated history of use and dependence, such as the 2000 shareholders of Murray Irrigation Limited .... As the Cap currently stands, water users that have historically used less than their entitlement are receiving significant benefits through greater demand and price for their tradeable surplus. Above average water users have experienced no benefit from the introduction of the Cap.”76

The basis of this concern is well summarised by the following extract:

“By its very nature the CAP limit is set by the history of use for the valley as a whole.

Whilst the total volume of water available for extraction is based on history of use, individual rights to access water are still based on licensed entitlement, regardless of individual history of use. As water trading has become well established within the valley, irrigators who previously under utilised their entitlement are now fully activating their entitlements through the temporary and permanent transfer markets.

75 Hay Water Users Association (1999), Submission to CAC, p.3.
76 Murray Irrigation Limited (1999), Submission.
“As activation of sleeper and dozer licences continues at a pace, the general security allocation must be continually reduced in order to limit valley extraction to the Cap limit. This situation creates serious inequities between irrigators with a high history of use and those with low history of use. High history of use irrigators must now purchase water on the temporary transfer market, at between $30 and $60/ML in an attempt to secure water supplies to maintain their farm programs.

“It must be remembered that irrigators with a high history of use have invested massive amounts of capital in irrigation infrastructure, in order to achieve a return on that capital they must now purchase water from irrigators that have made little or no investment in irrigation infrastructure of production. There is a massive transfer of wealth from active productive irrigators to sleepers and dozers.”

In the case of the NSW Murray Valley, concerns over the resulting wealth transfer are exacerbated because:

i) compliance with the Cap in the Murray Valley requires that allocations are generally not greater than 100% of entitlement in a normal year;

ii) the Barmah-Millewa choke, which restricts water availability downstream, is seen to provide a clear demarcation between those irrigators who in general must buy additional water and those downstream who in general have water entitlement and allocation in excess of existing production requirements;

iii) the magnitude of water that must be purchased (whether annually or permanently) is very substantial, especially for those irrigators who have pursued high levels of development relative to their level of entitlement.

“Individual impacts resulting from Cap implementations vary across valleys and regions, however, reductions of up to 40% in the Murray and 30% in the Murrumbidgee are not uncommon.”

As a result, there are clear and strongly held opinions within the NSW Murray Valley on the magnitude of the total water in excess of production requirements, the levels which are available for trade and which groups hold what water.

The estimated magnitudes of the annual “wealth transfers” are substantial. For instance, Murray Irrigation advises that $50-$60 million is paid annually by their shareholders to other irrigators holding unused allocations. Around Hay, the net cost is estimated at almost $10 million a year.

77 ibid.
79 Murray Irrigation Limited (1999), Submission.
80 Hay Water Users Association (1999), Submission.
However, in analysing these allegations of ‘wealth transfers”, it is also relevant to note that:

- every dollar paid, to regain previous levels of water availability, is a dollar received by another irrigator in the same location or elsewhere in the Basin who holds sleeper/dozer licences;
- the purchaser gains the value of using the purchased water; and
- although water must now be purchased in the market place, the prior position depended on high users accessing water in excess of entitlement, at delivery cost only.

On the issue of whether wealth is “transferred” or rather wealth, already held, is simply “realised”, depends, critically, upon the perception of the relative merits of prior rights or history of use approaches.

Arguments/concerns that there are major wealth transfers from existing water users to holders of unused entitlements are strongly felt, but fail to recognise that the activation of sleeper and dozer licences is an inevitable result of increasing resource scarcity. Importantly, the activation of sleeper and dozer licences would have occurred, with at least equal impact, under the Full Development scenario in the absence of the Cap.

The formal announcement of the Cap has signalled approaching resource constraints and has accelerated the activation of sleeper and dozen licences. This activation could only have been prevented if the Cap had been implemented for individual irrigators or sub groups on the basis of “history of use” rather than “prior right”. This would not have been impossible, although very difficult to validate and implement. It would also have required ceding additional power to the MDBC to audit diversions at a farm level.

Our review of approaches to resource allocation indicates that a “prior right” has typically been preferred over “history of use” arguments, except in extreme cases where the community of rights holders and users agrees voluntarily to adopt history of use in order to reduce adjustment costs.

Where Cap compliance is not jeopardised, consideration could be given to allowing irrigation communities to opt out of the “prior right” approach and to adopt a “history of use” approach to Cap implementation. Proposals for such opting out must satisfy the State and the Independent Audit Group and command a high level of support, say 75%, in plebiscites of affected winners and losers.
Trading by High Security Holders

Similar equity concerns arise from the treatment of high security entitlements under the Cap and the ability of persons holding these entitlements to trade.

“This situation [of wealth transfer] is further exacerbated by the situation with high security water, which can now be traded on the temporary transfer market.

High security entitlements have not been impacted by any of the water reform processes, however calculation of the Cap only included approximately half of the high security entitlement for the valley. As more and more of this water is mobilised on the temporary transfer market, it bites deeper and deeper into general security allocation announcements.

Once again general security irrigators with a high history of use are transferring massive amounts of capital to high security irrigators, insulated from the water reform process and making free fall gains from water trading.”  

The original objective of High Security licences was to provide horticultural growers, reliant on permanent plantings, with a water allocation which would not be restricted. This protected their investment which would, otherwise, be vulnerable to seasonal variations in allocation. However, it would clearly be inequitable if holders of those licences were able to claim that water, at the expense of general security licences, not for use on vulnerable permanent plantings (as intended) but only to sell it to those lower security licence holders whose own allocations had been reduced to provide the high security allocation in the first instance.

This concern is recognised in the NSW Government’s White Paper:

“High security share allocations will be tradeable but only to the level of announced general security supply. There must be equity between high security and other entitlement holders in trading opportunities. High security entitlement holders will not be entitled to receive or purchase “off-allocation” water.”

81 Hay Water Users Association (1999), Submission, p.3.

Levels of Development

The Cap limits diversions in each valley to the 1993-94 level of development. Valleys such as the Darling, Macquarie, Lachlan and Cudgegong had much lower levels of development than in the southern systems. For instance,

“For historical reasons, including water trading restrictions, communities along the unregulated Barwon and Darling Rivers had not developed to the same extent that communities on regulated rivers had developed when the 1993-94 benchmark was set.”83

As a result of the differences in development levels, it is inevitable that as an across-the-board initiative, the Cap has different impacts in terms of the potential level of development foregone in the individual valley or river reach.

The Cudgegong submission summarises the position as:

“Although we can appreciate the reasoning behind the Cap, we believe the Cudgegong Valley Irrigators have been disadvantaged far greater than what was intended by the Cap.

At the time of imposition of the Cap the valley was on the verge of a substantial increase in the area of vineyards ... an enormous area of plantings which were planned for the valley were moved to Victoria and South Australia where ironically water was freely available ... the development which would have taken place has been permanently lost with the jobs which would have been created now being available in other states.”84

Implicit behind these particular concerns is the belief that rather than adopting an approach to setting caps for each valley based on “history of use”, some alternative based on “potential” or “intended use” should have been employed – as occurred with the area below the newly completed Pindari Dam in the Border Rivers.

On the other hand, the southern valleys tend to take a different view:

“Murray Irrigation Limited endorses the continued implementation of the MDBC Cap on a valley by valley basis. In the case of interstate rivers the MDBC Cap should continue to be implemented as water use, equivalent to the 1993/94 level of development in each state. ...”

84 Macquarie/Cudgegong River Management Committee, Submission to CAC.
Murray Irrigation Limited consider further questioning of this approach by other valleys or jurisdictions would be a retrograde action.

As a principle, all states and valleys should comply with the requirement to limit diversions to the 93/94 level of development.”85

Ironically the concerns of the irrigators on the Cudgegong are not shared by their colleagues further down the catchment:

“If the Cap were removed it would allow full development of all rivers in the Basin. As most of these rivers were originally over allocated the effects would be disastrous for both industry and the environment.”86

5.4. RESPONSE TO SCARCITY

The impact of increasing scarcity of water resources is to increase water use efficiency by both irrigators and system managers and to stimulate trade in water. Recognition of the scarcity of water is reflected in its price which had been relatively stable up to and including the 1995/6 season (Chart 5.6).

**CHART 5.6 : PRICES OF PERMANENT WATER – NORTHERN VICTORIA**

Source: MDBC/ Planright Australasia Pty Ltd, Victoria.

85 Murray Irrigation Limited, Submission.
86 Macquarie/Cudgegong River Management Committee, Submission to CAC.
5.4.1. **WATER USE EFFICIENCY**

Water use efficiency is generally thought to be improving across the Basin as a result of a number of pressures, including:

- increasing scarcity of water brought about by a combination of factors such as the Cap and related changes in allocation and environmental flow policies;
- implementation of land and water management plan initiatives such as on-farm storages and recycling systems with a resultant reduction in drainage flows; and
- desire to reduce irrigation labour inputs. Examples of such initiatives include changes in irrigation systems away from furrow to automated micro or drip irrigation systems in horticulture and use of automated devices on border check systems.

Not only is it difficult to attribute with any degree of accuracy the relative importance of these different pressures on improvements in water efficiency, the submissions to this Review made little or no useful mention of the subject.

Nonetheless, logic suggests that increasing scarcity will act as a powerful incentive mechanism to achieve on-going improvements in water use efficiency.

> "The greatest economic benefit of the cap is to create more efficient use of water." 87

One submission, however, did raise the issue that not only should the focus on water-use efficiency be directed at farm use but also at system efficiency.

> "A reduction in river system losses of only 2.3% would allow another 400 GL to reach the Barrages in South Australia. State Authorities must be obliged to improve their water management and water use efficiency in the same way that irrigators have responded to the continual on-farm and off-farm pressures to improve efficiency. The same improvement of 2.3%, if taken from irrigators rather than the State’s delivery system, would mean a cost to the nation of around $160 million per annum in lost production." 88

5.4.2. **STIMULUS TO WATER TRADE**

Increasing scarcity and falling reliability provides existing irrigators with a strong motivation to purchase additional water to maintain water security. Demand for water from new developments must also be satisfied by activating previously unused

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87 Murray Darling Association Submission.
88 Twynam Submission.
entitlements or by purchasing water that is currently used in lower returning enterprises.

Supplementing the increasing scarcity of water in the long run has been the reduction in allocations due to the sequence of dry years since the introduction of the Cap.

In addition, water managers have recognised that with approaching scarcity they would no longer be able to announce allocations at levels which pre-suppose that a high proportion of irrigators would not use their full entitlement.

Two mutually reinforcing effects which lead to a rapid expansion of trade in water are:

• increasing trade of unused entitlements causes lower announced allocations; and
• lower announced allocations causes more irrigators to seek additional water pushing up the price of water and encouraging greater release of unused entitlements into the water market.

5.4.3. REALISED BENEFITS

Water Trading Lowers Costs

The rapid growth of regional, intervalley and interstate trade has dramatically lowered the cost of compliance with the Cap and adjustment to other changes in water management policies. Equivalent restrictions on diversions and levels of restriction to environmental flows and protection can now be achieved at substantially lower cost to private water users as a result of access to water markets.

For instance, in the relatively less secure Murray Valley, trade is estimated to reduce the impact of increased environmental flows by between a third and a half depending upon the flow scenario.89

A worked case-study, on the Macquarie, is provided below to indicate the practical benefits which water trading can provide when an irrigated area faces the challenge to reduce the total level of its water diversions (Chart 5.7).

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The impact of water trading in reducing the cost of the Cap or environmental flow regimes on individual farmers is readily demonstrated. Consider the imaginary case of two irrigators in the Macquarie, each with an entitlement of 1,000 ML, growing cotton and wheat respectively. Cotton generates a gross margin of $350/ML whilst wheat only creates $65/ML. The total annual gross value of their combined output therefore equals $415,000.

Without Trade (Scenario A) each farmer must reduce diversions by 20% in order to restore environmental flows. The two irrigators now each have an entitlement of 800 ML. In the absence of trading opportunities, this reduces their combined annual gross value by 20% (i.e., down by $83,000) to $332,000.

With Trade (Scenario B) the reduction of 20% in diversions can be achieved at dramatically lower cost. In this case Irrigator A, who grows cotton, buys 200 ML, on the temporary market, from Irrigator B, who grows wheat. This augments Irrigator A’s allocation to 1,000 ML and reduces Irrigator B’s allocation to 600 ML. The reduction of combined annual gross value, under this scenario, is merely $26,000 or 6.3%.

The impact of trade is therefore to reduce the potential loss of income due to the introduction of a Cap or higher environmental flows to the combined irrigation enterprises.

<table>
<thead>
<tr>
<th>Entitlement</th>
<th>Gross Margin</th>
<th>Gross Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CURRENT POSITION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigator A Cotton</td>
<td>1000 ML</td>
<td>$350/ML</td>
</tr>
<tr>
<td>Irrigator B Wheat</td>
<td>1000 ML</td>
<td>$65/ML</td>
</tr>
<tr>
<td>Total Gross Value</td>
<td></td>
<td>$415,000</td>
</tr>
<tr>
<td>SCENARIO A: 20% REDUCTION IN ENTITLEMENT: NO TRADE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigator A: Cotton</td>
<td>800 ML</td>
<td>$350/ML</td>
</tr>
<tr>
<td>Irrigator B: Wheat</td>
<td>800 ML</td>
<td>$65/ML</td>
</tr>
<tr>
<td>Total Gross Value</td>
<td></td>
<td>$332,000</td>
</tr>
<tr>
<td>Loss in Gross Value</td>
<td>($415,000 - $332,000) =</td>
<td>$83,000</td>
</tr>
<tr>
<td>SCENARIO B: 20% REDUCTION + TRADING ALLOWED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigator A: Cotton</td>
<td>800 ML</td>
<td>$350/ML</td>
</tr>
<tr>
<td>+ 200 ML bought from Irrigator B @ $90/ML</td>
<td>200 ML</td>
<td>$260/ML</td>
</tr>
<tr>
<td>Total Gross Value: Irrigator A</td>
<td>$332,000</td>
<td></td>
</tr>
<tr>
<td>Irrigator B Wheat</td>
<td>600 ML</td>
<td>$65/ML</td>
</tr>
<tr>
<td>+ 200 ML sold @ $90/ML</td>
<td>200 ML</td>
<td>$90/ML</td>
</tr>
<tr>
<td>Total Gross Value: Irrigator B</td>
<td>$57,000</td>
<td></td>
</tr>
<tr>
<td>Total Gross Value: Irrigators A + B ($332,000 + $57,000) =</td>
<td>$389,000</td>
<td></td>
</tr>
<tr>
<td>Loss in Gross Value</td>
<td>($415,000 – $389,000) =</td>
<td>$26,000</td>
</tr>
<tr>
<td>BENEFIT FROM ALLOWING TRADE ($83,000 - $26,000) =</td>
<td>$57,000</td>
<td></td>
</tr>
</tbody>
</table>
Gains From Water Trade In the Basin

There is strong evidence that trade in water is allowing irrigation activities within the Murray Darling Basin to move to higher value enterprises. The directions are well documented in SA and Victoria through extensive surveys and interviews with the buyers and sellers in studies of all permanent trades in the period 1994 to 1996.90

Permanent trade in SA in the 1994-96 period transferred water from low margin activities, generally in the lower reaches of the Murray, to high value activities upstream. Almost half the water sold had previously been used in lucerne and grain production with 81% of water purchased being applied to the higher value horticultural enterprises such as vines and vegetables (Chart 5.8).

Marsden Jacob Associates (1999) calculated that the productivity of water permanently transferred in SA between 1994-96 increased between six to ten times as a result of the trade, depending on assumed gross margins. The average gross margin of the water prior to trade was $80-100/ML but post trade increased to between $480 and $900 plus/ML.91

### Chart 5.8: Source & Destination of Permanent Trades in SA 1987-93

<table>
<thead>
<tr>
<th>South Australia</th>
<th>% of Sellers</th>
<th>% of Buyers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vines</td>
<td>6.4</td>
<td>26.9</td>
</tr>
<tr>
<td>Citrus</td>
<td>0.9</td>
<td>8.7</td>
</tr>
<tr>
<td>Stone Fruit</td>
<td>4.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Other Horticulture</td>
<td>1.7</td>
<td>38.1</td>
</tr>
<tr>
<td>Vegetables</td>
<td>13.6</td>
<td>16.4</td>
</tr>
<tr>
<td>Dairy Pastures</td>
<td>12.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Lucerne &amp; Grain</td>
<td>49.3</td>
<td>6.9</td>
</tr>
<tr>
<td>Other Purposes</td>
<td>11.4</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


Similarly, permanent transfers in Victoria between 1994 and 1996 (Chart 5.9) are estimated to have increased the productivity of that water by around four times.92

**CHART 5.9 : SOURCE & DESTINATION OF PERMANENT TRADES IN VICTORIA 1992-94**

<table>
<thead>
<tr>
<th>VICTORIA</th>
<th>% OF SELLERS</th>
<th>% OF BUYERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>6.8</td>
<td>79.3</td>
</tr>
<tr>
<td>Cattle</td>
<td>37.9</td>
<td>9.8</td>
</tr>
<tr>
<td>Sheep</td>
<td>39.9</td>
<td>1.6</td>
</tr>
<tr>
<td>Horticulture</td>
<td>2.8</td>
<td>5.8</td>
</tr>
<tr>
<td>Other Crops</td>
<td>6.7</td>
<td>3.5</td>
</tr>
<tr>
<td>No Crop</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


The available information strongly suggests that the same process is occurring in NSW and that the benefits to that State from the existing trade are substantial. An order of magnitude estimate for the annual benefits to NSW is around $65 million a year. These magnitudes were described as indicative and likely minimums. 93

A rather crude indication of the magnitude of the benefits of water trade – both permanent and temporary, in Goulburn-Murray Water, can be obtained by simply pro-rata-ing the estimates for NSW. As noted, the first round benefits of both permanent and temporary trade were estimated at around $65 million for NSW and that temporary trade accounted for around half of these benefits. On a simple pro rata basis, this suggests that the benefits to Victoria from trade involving G-MW irrigators might be around $20 million per year.

**Wider Benefits of Water Trade**

As noted, water trading offers practical opportunities to realise substantial benefits for the Basin economy and individual water users. These benefits arise from a wide variety of sources including by:

- providing a financial incentive for investments in efficiency savings in water use;
- allowing new water users to invest in higher value activities – whether mines or higher value horticulture – and to acquire water without jeopardising each

92 *ibid.*

93 *ibid.,* pp. 3.16 – 3.24.
State’s responsibilities for adherence to sustainable environmental flow regimes and associated caps on consumptive use;

• allowing rice, cotton and other profitable annual crops to use the surplus water allocations which are available in most years from permanent plantings;

• allowing greater flexibility in land use, particularly by transferring water from less to more sustainable land use practices, eg. transferring the water use away from sandy soil areas, where rising watertables are a problem;

• gaining fuller advantage of the physical interconnections in the river and delivery systems (such as the inter-linking of the Murray, Murrumbidgee, Lower Darling and Goulburn-Murray systems through shared headworks in the Snowy and Lake Hume and the interstate obligations to South Australia under the River Murray Agreement). The potential benefits of trade in these interconnected systems extend to more efficient production and use of both water and electricity;

• allowing businesses to adjust their water supply security to the long-term reliability of the water source. Current security levels will decline as inactive licences are used. The market allows businesses to obtain additional water to maintain required security levels;

• allowing more efficient consumptive use of water without further depletion of minimum flow regimes for fish breeding, river health and other environmental needs;

• allowing landholders seeking to retire, restructure or exit to realise their assets at full value through efficient and, desirably, equitable markets. While the “drying” of heavily-watered and irrigated properties may reduce income flows within some regions, the sale of water is usually a major cash injection into the local community;

• by reducing the economic cost of achieving Cap compliance and/or environmental flows. The increased ability to trade interstate will further reduce the economic impact and adjustment required to accommodate increased environmental flows in NSW valleys and elsewhere; and

• creating economic benefits to the States in the Basin through driving water to higher value uses. Detailed surveys have been completed for Victoria and South Australia on the nature and pattern of permanent trades, and information is emerging on temporary trades. These allow broad order of magnitude estimates of the aggregate benefits to the States in the Basin for water trade to be derived.

Simply put, trade allows the Basin’s water resources to be used more productively within a sustainable framework. However, for these benefits to be realised, partner governments need to provide players in this market with clearly defined property rights, within well structured and robust markets and explicit and flexible trading rules.
5.5. INSTITUTIONAL CHANGE

The Cap has helped accelerate controls over water diversions. However, those controls have been only one element of a wider framework of institutional change which has been implemented over the past five years, much of which can be attributed to the Cap.

These changes include:

• property right definitions;
• planning and licensing procedures;
• water allocation procedures;
• water trading rules and markets; and
• community involvement in decision making.

Property Right Definitions And Allocation

One of the major initiatives has been the development of clearer property rights to water. This also implements the requirements of NCP/COAG in the Strategic Framework for the Water Industry. This is a developing position with uneven application by States and across regions:

• in Victoria bulk entitlements (BEs) have been defined and implemented in all catchments in the Basin. This has clarified and confirmed the rights not only of Authorities but also of high security licences;
• the terms and rigour of those BEs has been directly influenced by the Cap;
• Retail Entitlement Reform (RER) is also progressing which will convert ill-defined Sales allocations into medium reliability property rights;
• in NSW the volumetric basis of regulated entitlements is now more clearly defined. Although more still needs to be done to provide clarity to irrigators in western and northern valleys as to probable future yields;
• in all States there has been a recognition of the superior position of prior right over history of use:
  – as in the allocation of sales water as part of the Victorian retail entitlement reform; and
  – in the recognition of the rights of sleepers and dozers in NSW over those of historical high-users;
• in all States there is increasing separation of property rights over water from its traditional linkage to land. This will facilitate water trading; and
there is universal conversion of licences from an area definition to a volumetric measure. This process has furthest to go on unregulated streams where there are complex issues to resolve in codifying diversion rights.

**Water Trading Rules and Markets**

One of the most substantial developments since 1994 has been the growth in water trading and markets. The key elements are:

- substantial growth in trade, particularly in the temporary market in the southern systems. This reflects a reduction in announced allocations and the need of users with a high history-of-use to restore their previous level of diversion;
- all States are removing barriers to the more effective development of that trade through the drafting of trading rules and conversion rates particularly for inter-valley trade;
- as a result of this growth in trade there has been a development in the institutional arrangements to facilitate that trade. There are now a number of different and inter-linked markets across the Basin run by SRIDC, the Northern Victorian Water Exchange and the MIA. These employ a range of different market mechanisms to ensure transparency, disclosure, speed of dispatch and efficiency;
- parallel to these markets within each State, there has also been a pilot interstate project to encourage and control trade between States. This was formally commenced in January 1998 and the first trade took place in September. During 1998/99 financial year there were twenty trades totaling 3,546 ML – with trades almost universally downstream and the large majority from NSW to SA. This has increased river-flows; and
- these market developments are also stimulating the development of more sophisticated market instruments to allow for longer term leases.

**Community Involvement**

One of the most notable changes across the Basin has been the increased involvement of local communities in decision making about resource use and allocation:

- in Queensland the water allocation and management planning (WAMP) process involves community and stakeholder consultation to identify issues associated with the allocation and management of water resources within the study area. As part of the process, community and stakeholder input is sought when determining the acceptable balance between competing water uses and for specifying water entitlement in terms of tenure, access and transferability;
- in NSW, Water Management Committees have been appointed in all major regulated unregulated and groundwater districts to provide a structure to identify and resolve competing objectives and to advise on allocation and management
issues. The Committees have also been tasked with considering socio-economic factors in those deliberations; and

- in Victoria, existing consultative arrangements for the allocation of resources from the Murray were formalised through the creation of the Murray Water Entitlement Committee involving more than 30 members representing water users, irrigation industry groups, water authorities, environmental groups and government departments. The major outcome of that Committee was the publication of the booklet “Sharing the Murray” which provided a forum for the resolution of allocation issues.

Looking further ahead, both NSW and Queensland have major proposals at a final stage to further codify and implement these institutional changes.

**New South Wales**

NSW has recently published a White Paper setting out proposals for a new legislative framework for water management across the State:

> “The Act will promote the best use of water and support ecosystems, public health, town water, industry, agriculture and recreation.”

The White Paper provides updated and consolidated legislation to replace the current Water Act which dates from 1912. The proposals extend the key elements of the water reform process in NSW, which has seen major policy announcements and initiatives since the 1980s, with major programs introduced in 1995 and 1997. The Water Sharing Access & Use policy document, published in 1998, raised many of the central issues about the principles and practice of water allocation.

The White Paper covers the full suite of institutional issues:

- legal standing for entitlements for the environment: introduction of mechanisms for defining and managing extractable limits for water;
- clarification of water rights: clearer specification of different categories of entitlement and segmented licensing to reflect the different components of that entitlement;
- integrated planning: a revised approvals system will be simpler, more transparent and less costly – complementing the integrated development approvals system in planning. A revised appeals procedure to the Land and Environment Court will be provided;

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• water management planning and the community: involvement of local water management committees in advising on water management plans and clarity on the processes which DLWC will follow in implementing those plans;
• enhanced water trading: clarity on trading rules and process; and
• enforcement: new and additional explicit powers to monitor and ensure compliance across the range of licence functions.

Queensland
Queensland has recently published an Exposure Draft Bill on water allocation and management.95 This updates water resource management arrangements across the State and provides a generic system for future water allocation and management. The arrangements will ensure Basin-wide planning and provide mechanisms to control harvesting of overland flows.

The Bill will provide a statutory base for water resource planning and coordinate all current tools such as WAMPs and WMPs within a coherent scheme. It will make formal provision for environmental flow requirements, define resources available for future consumptive development and formalise trading rules.

A revised licensing system will establish transferable water allocations through a two stage process involving WAMPs and Resource Operations Plans. Those licences will be recorded in a Water Entitlements Register which will facilitate financing through recording of encumbrances.

5.6. SOCIAL IMPACTS

Broader Social Pressures
As noted in Chapter 2, farming communities have had to respond to a wide spectrum of external factors and risks over the five years of the Cap, since 1995/96. These include:
• shifts in international commodity prices and declining producer terms of trade;
• demographic shifts in population from rural communities to major regional centres;
• a reduction in the number and increase in the size of farms;
• wider pressures for increases in productivity; and
• wide ranging water reforms.

Any possible social impacts of the Cap need to be assessed within this broader setting.

Risks of Social Outcomes

Several of the submissions referred to probable social outcomes of any down-turn in economic activity, eg. the Country Women’s Association has expressed concerns on potential impacts on the family – in particular women and children – community health and community infrastructure and service, such as:

“….the stress and strain on human relationships from stress related illnesses to suicide….schools are staffed by (reference to the) number of students. The fewer the number of students, the fewer the number of teachers and the fewer the subjects can be offered, so our children will be deprived of the best education….a downturn in the farm economy...could lead to further alcohol abuse, drug abuse and worse still a rise in the crime rate.”

A report for Darling River Food and Fibre provides a review of the economic and social impacts which might arise from future changes to the diversion and flow rules on the Darling River for the irrigation industry and township of Bourke. This is one of the few available reports which undertakes a structured and comprehensive review of possible social impacts of the Cap.

Concerns identified included the possible downsizing and closure of operations of local businesses and a loss of trained/skilled workforce. In turn, this could reduce revenues for the Shire council, threaten the viability of health services and reduce funding for local schools. A final outcome would be a smaller township, with less community infrastructure and services whilst being more reliant on social welfare.

Social Benefits from the Cap

It is clearly difficult to ascribe particular social outcomes to the suite of water reforms or to attribute specific impacts to the Cap within that broader suite.

“The tempo of reform underway within the Basin is such that for practical purposes it is not possible to definitively distinguish between the impacts of the Cap, the Water Reform process of the NSW Government and the general on-going structural change within rural areas.”

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96 Coleambally-Argoon branch of the Country Women’s Association Submission.
98 Moira Private Irrigation Board (1999), Submission.
However, the review has identified a series of major positive benefits to the social fabric which can be linked to the introduction of the Cap:

- the economic benefits identified earlier will create positive flow-on effects within the social environment; and
- the Cap has created a structured framework for future resource allocation. This has prevented the disorderly scramble for resources and the social tensions which would have arisen from a No Cap scenario.

The positive economic benefits created by the Cap centre on guaranteeing the security of water entitlements on a valley-by-valley basis. Long-term investment in high value agriculture is dependent on the underlying security of the resource base. In the absence of the Cap there would be substantial erosion of this security. The Cap provides that security and also has stimulated the development of clearer property rights and water markets.

From this perspective, estimates provided in submissions on the costs of the Cap, in terms of development that may be forgone, provide only a partial picture since these estimates are specific to particular locations and ignore the benefits of guaranteed security which are widespread and diverse.

These benefits of additional certainty and security will generate positive social outcomes by ensuring a sustainable local economy. That will provide the basis for the improved education, housing and health which are the reasonable concerns and objectives of all communities.

These social benefits also arise from a reduction in the social tensions which would have been the inevitable consequence of the No Cap scenario. In the absence of the Cap on growth in diversions there would have been a relentless reduction in the security of water entitlements. This would have created increasing tensions between irrigator groups and regions as competition for increasingly scarce resources became more extreme. This would have led to a disorderly scramble and conflict which would have torn at the social fabric.

The recent announcement from Premier Olsen provides an example of this risk:

“If NSW just simply continues to ignore our calls for appropriate flows through the River Murray we will take retaliatory action.”99

In the absence of the Cap these challenges would have been far more common, vociferous and extreme. The risk of water wars as seen in the USA100 and other countries is not an overstated scenario.

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99 Premier Olsen (2000), as reported in The Sunday Mail, 20 February.
Concern over possible future impacts of the Cap on the social fabric of particular irrigation communities appears misplaced when the impact of potential water wars on the social fabric of the Basin as a whole is contemplated.

It also seems probable that smaller family farms would have lost out, in that competitive scramble, to the larger corporate entities who would have had greater access to the financial backing required to acquire those scarce resources.

Through water trading, the Cap has also created social benefits, by allowing innovative and entrepreneurial farmers to move into higher value enterprises and by providing a mechanism to allow farmers in poorer economic and environmental settings to realise the value of their assets and exit the industry.

The Cap has also helped prevent further division between country and city Australia. Continued growth in diversions would have seen inexorable degradation of the environment of the Basin. Without the Cap, the metropolitan electorate would have become increasingly out of patience with the irrigation community and Governments’ failure to halt this continued degradation:

"river health is used as a measure by which irrigators will be judged by the wider community."\(^{101}\)

In summary, by guaranteeing security of entitlement the Cap will help create economically sustainable communities. The benefits from this will flow through into social outcomes such as employment, schools and community welfare. The Cap also provides a mechanism whereby disputes and tensions over resource scarcity, between community groups within the Basin and divisions between country and city Australians, can be managed and resolved in an orderly way.

5.6.1. **STATE GOVERNMENT APPROACHES**

The various States have adopted different approaches in dealing with social impacts, associated with major policy change such as the Cap. In general terms, Victoria and South Australia have relied on social consultative processes whilst NSW favours technical assessment criteria and guidelines.

Under the former approach, the State establishes a social process to create local ownership of the process and decisions by key stakeholders whilst at the same time ensuring that those decisions are based on robust and professionally valid data and

\(^{100}\) These disputes have run for more than 60 years and are noted for their polarity, community tension and disruption and waste of community resources.

analysis. The mix of the two elements adopted in any individual case will reflect the history of water management in the particular valley and State concerned.

In contrast, NSW has recently adopted a more structured approach involving the established guidelines drawn-up for the NSW water management committees. These provide guidance to water management committees, given the responsibility of developing water management plans, on how to assess the socio-economic implications of their decisions. The objective of the approach is to promote community involvement and progressive feedback.

The guidelines are detailed and comprehensive and involve a ten step process founded on the collation and review of data on a range of indices. Even the initial step, of creating a “community water profile”, requires a substantial process including:

- brief description of the socio-economic characteristics of the catchment and how they have changed over time. This may include:
  - brief history of region
  - population within each catchment
  - age structure and education level
  - employment and income levels
  - major industries and sources of employment

- profile of water use in the catchment. This could include:
  - information on water resources
  - types of water use in the catchment
  - perspectives on water use by major water use groups
  - information on water users and the social and economic contributions to locality and region.”

There is some concern that the very comprehensive approach recommended may prove problematic for the lay committees to deliver in practice, eg:

“Valley groups in NSW have been charged with the job of assessing the socio-economic effects of the Cap and other policy initiatives themselves.

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103 ibid. p. 4.
The guidelines for these assessments are far too onerous for voluntary committees with limited resources.” 104

Queensland also has set out a formal methodology which it proposes for assessing social impacts as part of the second stage implementation of its wider Water Allocation and Management Planning process. This proposed approach, which follows an equivalent methodology to that recommended in NSW, requires three main stages:

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Scoping:
- stakeholder issues, aspirations and expectations

Profiling:
- Town resource Cluster identification
- Social profiles and Indicators
- GIS modelling and Integration

Prediction:
- data modelling
- scenario development
- use of focus groups for impact prediction and mitigation strategy development'',105
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Again there is a question to the complexity of the exercise which is sustainable through a lay process and the degree to which the assessment will require input from a more technical group and leadership from within the political arena.

These formalised approaches contrast to that of Victoria which has had a history of successfully involving the full scope of interested parties in the area of water management. Recent decisions on allocating resources from the River Murray were taken by the Murray Water Entitlement Committee which comprised water users and irrigation industry groups, urban water authorities, environment and catchment management groups and Government.

This group worked over an eighteen month period to assess and review a variety of options and scenarios for the future allocation of water from the River Murray. Technical data on the various options and their implications was developed and submitted to the Committee as the debate developed. The outcome was a publication

104 Twynam Pastoral Company Submission, p. 9.
which won the support and confidence of all parties involved in the area.\textsuperscript{106} It is interesting to note that the Committee took a fairly high-level approach to assessing the social and economic impacts of different options, with less detail on specific scenarios than might have been generated by application of the NSW or Queensland methodologies.

Victoria has the advantage of a history of such interaction and cooperation between the relevant stakeholders. It also has a relatively limited set of rivers and catchments to deal with and a predominantly well-developed irrigation sector. In this regard it is fairly similar to the situation in South Australia which has also managed to create inclusive debate on resource allocation.

NSW faces different circumstances, without the same history of mutual cooperation between parties and a more complex set of catchments, at different levels of development. That creates a more conflicting set of incentives for the different players. This is reflected in some of the submissions, as in the comments from irrigators on the Namoi:

\begin{quote}
“The process that the NSW government has embarked upon in setting and managing the Cap in the Namoi and other valleys has not in any way been satisfactorily reviewed with regard to socio economic impacts of the changes involved.

“The “Expert Panel” and the Ministers own “Socio Economic Task Force” were unable to come up with a consensus position of processes that would satisfy the requirements of COAG, and so now the government has determined that politically correct laymen will do the studies that should be done by people that have expertise in this very imprecise field.”\textsuperscript{107}
\end{quote}

However the River Namoi itself has been the location of successful negotiation within a community over the re-distribution of over-allocated groundwater supplies. This has required general community agreement on the process for sharing the pain.

The examples identified above confirm the relative importance of creating effective social processes over the comprehensiveness of the technical assessment involved.

\textbf{5.7. ENVIRONMENTAL IMPACTS}

A further benefit from imposing the Cap is environmental. This benefit may arise from either an improvement in environmental values in the riverine environment and

\textsuperscript{106} Murray Water Entitlement Committee (1997), “Sharing the Murray – Proposal for defining people’s entitlements to Victoria’s water from the Murray”.

\textsuperscript{107} Namoi Valley Water Users’ Association Submission, p. 2.
ecology of the Basin and its numerous valleys, or from a slowing of longer term
degradation of these values.

A comparison of the With Cap case against that of the No Cap case needs to take into
account the non-private or public benefits and costs that arise from each case. In turn
these relate to the different environmental outcomes that result.

As for the private benefits and costs, none of the submissions provided detailed
information on the environmental outcomes under either of the two cases. However,
we set out below some broad observations:

**River Health : Intrinsic Values**

This category includes both intrinsic valuation of ecosystems, and the “existence
values” placed by the public on the continued survival of species.

The values for these approaches can be obtained from standard revealed and stated
preference techniques, such as contingent valuation and choice modeling. Choice
modelling is a well-developed technique from marketing and areas such as transport.
It has also been used in Australia more recently to measure eg. the willingness of
customers to pay for environmental benefits related to water supply, and was trialed
in a case-study involving the allocation of water between agriculture and wetlands in
the Macquarie and Gwydir Rivers in NSW.

These approaches are also being investigated by the National Land and Water
Resources Audit and the NSW Independent Advisory Committee on Socio-Economic
Analysis. CSIRO is currently developing a program to assess the Nature and Value of
Australian Ecosystems Services.

The riverine environment has an intrinsic value to most Australians. This means that
the high level of degradation of the river under the No Cap scenario is a cost, albeit
intangible. With the Cap, degradation is slowed and this loss of capital value
therefore reduced.

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Harvester Wheatsheaf.

109 Centre for International Economics (1999), “A study to assess environmental values associated
with water supply options”, prepared for ACTEW, May.


111 Whitten S. and Bennett, J., “Private and Social Values of Wetlands Research”, School of
Economics and Management, University of New South Wales.

using choice modelling”, Research Report No 6, Choice Modelling Research Reports, University
of NSW.
River Health: Direct Benefits

River health generates direct benefits with an attributable commercial value in terms of agriculture, tourism, commercial and recreational fishing and river state amenity.

In terms of agricultural impacts:

“Irrigators are aware that their own-farm viability and profitability is affected by declining water quality and that this is directly affected by river health.”

Blue-green algal blooms are conservatively estimated to cost rural industries across Australia some $60 million per year. The recent estimates suggest that more than half of this cost is likely to be incurred in the Murray-Darling Basin.

In addition increasing salinity adversely affects citrus growing and a wide range of other irrigated enterprises. Better river health reduces these costs and provides benefits in pest control, pollination of crops and re-cycling of nutrients.

Maintenance of high quality rivers, lakes and wetlands creates major commercial benefits from other active uses. These include:

- duck shooters, who spend $40 million on equipment in Victoria each year;
- recreational and commercial fisheries, and
- tourism, recreation and real estate amenity.

While no precise estimates of these economic values appear to be available for the Basin, indicative estimates from other catchments in eastern Australia confirm the hard financial benefit of a good environment and, therefore, the costs of losing it, eg. it was estimated that restoring 28% flows in the Snowy might result in an additional 136,000 visitor days to the area (associated with rafting, canoeing and fishing) generating benefits between $51 and $84 million, capitalised over thirty years. In addition there would be regional economic impacts from that tourist activity which would lead to higher employment and wider activity of at least the same order.

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113 SRIDC Submission.
117 Australian Conservation Foundation, Submission.
In terms of the costs of losing a good environment, blue-green algal blooms provide prominent examples:

- the cost of the 1999 algal bloom on the Gippsland Lakes is estimated to be around $5 million comprising around $2 million for commercial fishing and $3 million for tourism for the six week bloom.\(^\text{119}\) Importantly, the adverse impacts appear to carry over from one year to another in terms of reduced tourism; and
- nationwide, the recent Atech-CSIRO study puts “the current total cost of algal blooms of $180 million to $240 million.....a conservative order of magnitude estimate.”\(^\text{120}\) As noted, for the rural sector itself the estimated costs of algal blooms is $60 million per year.

**Salinity and Drinking Water**

A particular issue in valuing the quality of the River Murray in South Australia is that it provides the major source of drinking water for Adelaide. The recent MDB report on salinity confirms the success which has been achieved in reducing the trends in increasing salinity at Morgan. This should defer the date at which it becomes necessary to treat Adelaide’s drinking water for salinity by around fifty years. That will have significant economic benefits.

It must be assumed that any continued increased diversions, which might have been associated with a No Cap Scenario, would have reduced the levels of dilution available in the Murray in South Australia thereby increasing the salinity.

By stimulating water use efficiency the Cap will assist in reducing the rapid growth of salinity in the Basin.

**Concluding Comment**

The step-by-step assessment of the impacts of the Cap compared with the No Cap scenario reported in this chapter provide the basis for assessing the overall benefits and costs of the announcement and implementation of the Cap. This is reported in the following chapter.

\(^\text{119}\) **pers. comm.** Rob Molloy, Project Co-ordinator, CSIRO, 22 February 2000.

6. SUMMARY AND OVERVIEW

6.1. PERSPECTIVES ON THE CAP

As noted, the decision to implement the Cap was made with the objective:

“1) to maintain and, where appropriate, improve existing flow regimes in the waterways of the Murray-Darling Basin to protect and enhance the riverine environment; and
2) to achieve sustainable consumptive use by developing and managing Basin water resources to meet ecological, commercial and social needs”

Process

The introduction of the Cap followed a deliberative and transparent process leading to final agreement by the partner governments. Importantly, the Cap was introduced following an audit of water use in the basin and extensive discussion between representative governments following a broad consideration of relevant issues relating to the economic, social and environmental impacts.

Following the introduction of the Cap, some States have facilitated the broader consideration of how the gains from use of water resources and the pain resulting from the increasing scarcity of the water resource should be shared.121

In summary, the 1995 decision to introduce a Cap on diversions, ahead of reaching absolute full development of existing entitlements, reflected a judgement that the resulting environmental, social and economic benefits of a Cap outweighed, in aggregate, the corresponding costs.

Partner governments uniformly endorse the need for the Cap and to make it work effectively. Similarly, with the important exception of northern NSW, submissions to this Review from community groups provided strong and uniform support for the concept and introduction of the Cap.

“Sustainability in an ecological sense is inseparably linked to the economic sustainability of those industries and communities which the river system supports.”122

“...recognises the need for the implementation of a tool such as a cap on diversions ... the Cap will in some instances provide the necessary

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121 Murray Water Entitlement Committee, (1997), Sharing the Murray, Proposal for defining peoples’ entitlements to Victoria’s water from the Murray, October.

122 Murray Valley Diverters, Submission.
security of resources to enable our region a sustainable and long term future.\textsuperscript{123}

“The greatest economic benefit of the cap is to create more efficient use of water”\textsuperscript{124}

“In principle supports the implementation of a MDB Cap on diversions as a means of protecting the security of irrigators in the Murray Valley and to ensure the continued health of our rivers systems.”\textsuperscript{125}

“The Cap’s value comes from the restraints it imposes upon unbridled use of our finite supply of water in the interests of one sector of our community, the irrigators, at the expense of the rest.”\textsuperscript{126}

As the specification of the No Cap scenario has clearly demonstrated, the activation of sleeper and dozer licences is an essential feature of continuing development and encroaching resource scarcity. It is in no way a unique feature of the Cap. Nonetheless, the formal signal of encroaching resource scarcity provided by the Cap may have brought forward sleeper/dozer activation and trading.

Despite these concerns, there is on balance a \textit{prima facie} case for concluding that the Cap has produced public and private benefits to the Basin community and Australia more generally.

\textbf{Cap Effectiveness}

A central question for the review is whether the Cap has played a central role in triggering the introduction of additional control measures across the Basin or has merely been just another in a continuing process of responding to increasing resource scarcity.

Prior to the announcement of the Cap individual governments had begun to change their water management policies. However, these initiatives were developed and implemented in an uneven way, with considerable variation both between and within States and with little recognition of Basin-wide implications. These compare strongly with the coordinated suite of measures and controls which are now in place across most of the Basin.

\textsuperscript{123} Murray Valley Voice, Submission.
\textsuperscript{124} Murray Darling Association, Submission.
\textsuperscript{125} SRIDC, Submission.
\textsuperscript{126} Tumut River Landowners, Submission
The 1995 Audit of Water Use in the Basin was a watershed in terms of developing a common and agreed understanding of the issues of resource sustainability between members governments. It identified and documented:

- the extremely rapid growth of diversions between the 1988 and 1994 seasons;
- the rapidly advancing limits to further growth;
- the dramatic decline in scarcity of access that would result under a No Cap/full development scenario in, say, the Victorian Murray;
- the continuing fall in end of river flows and the decline in the environmental health of the river system; and
- the need for coordinated basin-wide action.

The subsequent decision of the Ministerial Council to introduce the Cap, signalled publicly the need for a Basin wide commitment to limit future growth in diversions. Discussions with water managers in each state confirm that the formal announcement of the Cap galvanised thinking and effort to achieve better and sustainable outcomes.

Therefore, rather than seeing the Cap as just another step in a series of responses to increasing resource scarcity, the more appropriate perspective is that the Audit and the Cap were essential pre-cursors of the suite of controls currently in place or being implemented by the individual states.

Their effects have been:

- to strengthen and reinforce existing reform initiatives;
- to stimulate additional controls;
- to act as a benchmark for future regulation of diversions;
- to provide a Basin wide framework and so coordinate actions between catchments and States; and
- to ensure compliance monitoring and publicity at the sub-state level.

### 6.2. THE BENEFITS AND COSTS OF THE CAP

The impacts of the Cap must be evaluated against the clearly specified No Cap scenario. Based on the analysis presented in Chapter 5, the component benefits and costs of introducing the Cap are summarised in terms of:

- the agricultural economy and social fabric;
- tourism, fishing and the non-agricultural economy generally; and
- the natural resource base including the riverine environment.
Impacts on the Agricultural Economy

The prime benefit of the Cap is the guaranteeing of security on a valley-by-valley basis. In the absence of the Cap there would be substantial erosion of security of entitlements across the Basin, but particularly in the major southern systems. The guaranteeing of this security through the introduction of the Cap provides a better and more certain climate for investment and jobs growth. Long term investment in high value agriculture and value-adding processing is dependent on the underlying security of the base resource. Under the No Cap scenario this is likely to be eroded in the short to medium term.

Part of guaranteeing this long term security is potentially offset by the reduction in development opportunities, ie., costs associated with this guarantee of security are that development, particularly in less developed valleys, is – other things being equal – curtailed.

To date, there appears to be little firm evidence of reductions in development opportunities:

- in the northern systems the Cap has not yet been fully implemented and development has continued apace;
- in the southern systems allocation in recent seasons have been impacted by the resource availability rather than the Cap.

Lowered allocations due to resource availability have greatest impact via those whose enterprises are most reliant on high allocations including the historic ability to utilise the unused allocations of other entitlement holders.

The Cap, when it bites, will have a similar impact. However, while individual high allocation enterprises will be adversely affected, the industries and regions appear likely to continue to prosper.

“Dairy processors should be confident that the industry can maintain and continue to expand production under the MDPC Cap.”

- in other cases, development may have been displaced from one valley to another; and
- through water trade, new high-value developments can still take place, merely at the expense of existing lower value activities.

Estimates provided in submissions of the costs of the Cap in terms of development that may be forgone provide a partial picture only since these estimates are specific to particular locations and ignore the benefits of guaranteed security, which are

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widespread and diverse. Overall, the guarantee of security in the longer term is a major net benefit to the Basin irrigation community;

Second, under a No Cap scenario, the growth of diversions towards full development would increase the sensitivity of irrigated agriculture to changes in climate and rainfall. The impact of drought sequences on cash flow, the ability to access debt finance and fund existing commitments would progressively worsen. A benefit of the Cap, therefore, is to maintain the viability of irrigated agriculture in the Basin and to prevent irrigators from unnecessarily being forced off the land due to the collapse of security and their finances in the absence of the Cap.

A third benefit of the Cap is the stimulus to codifying and improving property rights and entitlements to water. By definition, when the demands on the fixed pool of resources can be substantially expanded, then each property right risks erosion. Placing a finite limit on diversions across the Basin, therefore, gives a stronger property right by providing known and guaranteed security. The Cap has also stimulated the streamlining of property rights to better facilitate trading in water.

Fourth, water trade substantially reduces the economic cost of compliance with the Cap and with environmental flow rules. The impetus provided by the Cap to facilitate trade is fostering better trading rules, third party protection and easier movement of water to high value activities. Trade would occur independently of the Cap but the Cap stimulated reforms are contributing to the early acceleration of that trade and will increase the associated benefits from trade.

The economic benefit of water trade in NSW is estimated to exceed $65 million with the benefit of trade across the Basin likely to exceed $100 million annually. The Cap initiated reforms to water trading will enhance these benefits.

Fifth, as the No Cap scenario progresses to Full Development there will be increasing tensions between irrigator groups and between regions as security declines and water trading becomes more aggressive. Individual irrigators, industry associations, local government and others initiate legal actions against the State Governments and the MDBA for failing to provide adequate stewardship of the water resource and riverine environment. Other legal actions seek to either remove or improve constraints on water trade. In other words, there is a disorderly scramble and lack of process.

The benefit of the Cap is that it allows the valleys and states in the Basin to avoid the water wars that have typified developments in California and Colorado. These disputes have run for more than 60 years and are noted for their polarity, community tension and disruption and waste of community resources.
Concern over possible future impacts of the Cap on the social fabric of particular irrigation communities appears misplaced when the impact of potential water wars on the social fabric of the Basin as a whole is contemplated.

Sixth, in the absence of the Cap, continued development would lead to consequential reductions in river flows and accelerate the degradation of the riverine environment.

“Careful consideration of the impacts of river flows is required, since river health is used as a measure by which irrigators will be judged by the wider community.”

Within Australia, the metropolitan electorate would become increasingly out of patience with the irrigation community and the unwillingness of Governments to halt the degradation. The perceived division between country and city Australians would increase.

In summary, from the perspective of the agricultural economy, the Cap has produced major immediate benefits with little commensurate cost. The better investment climate created by certainty over water security, improved property rights and improved trading arrangements are attributable to the announcement of the Cap and are not dependent on the timing of its actual implementation – provided that implementation is in fact proceeding.

In principle, the capping of diversions means that some potential developments may be curtailed and benefits forgone. In fact, with the southern systems largely constrained by resource scarcity since 1995, the Cap has not had a physical impact on constraining diversions. Similarly, in the northern systems the Cap has not yet been fully applied. This combination of circumstances means that the immediate benefit cost ratio, ie., for the first five years, is undoubtedly highly positive.

In the medium term, progression to Full Development would lead to the collapse of security in the southern valleys and a significant loss of security in the north. As a result, the annual benefits of the Cap increase over time. These benefits occur to both existing and new enterprises.

**Equity Issues**

With the agricultural economy, the Cap induces some important differences in impact between valleys and between irrigators:

- under the No Cap case, constraints imposed by security will impact on both existing activities and potential new developments. The sharp falls in security –
and resulting volatility – are likely to necessitate the winding back and adjustment of existing industries including the Victorian dairy industry, the NSW rice industry and, to a lesser extent, existing cotton growers. With the Cap, the security of existing development in aggregate – though not individual businesses – is guaranteed and the constraints imposed by scarcity borne primarily by forgoing potential new developments, particularly in upper reaches and tributaries.

Under the No Cap scenario the adjustment costs are likely to be both higher and tangible. In contrast to the possible costs of losing potential development, the costs of winding back and restructuring existing enterprises and industries are very real.

The tributaries and upper reaches are disadvantaged through timing and history in that development occurred earlier in the south and the impending resource constraints mean that it is cheaper for the Basin as a whole to halt development at existing levels – this raises inevitable equity issues but such issues arise under both scenarios; and

- the guaranteeing of security at the valley level defines the security of entitlement for individual irrigators, but has differential impacts among irrigators since some enterprises have grown through extensive use of off-allocation and allocations above 100% of entitlements.

A major equity issue hinges on the activation of sleepers/dozers issue and the view that the Cap is causing “a massive wealth transfer”. The activation of sleeper dozer licences is essential for increased development and facilitates the shift of water to higher value activities particularly in years of low allocation due to resource scarcity.

Two mutually reinforcing effects have led to the rapid expansion of trade, ie.:

- increasing trade of unused entitlements causes lower announced allocations; and

- lower announced allocations causes more irrigators to seek additional water pushing up the price of water and encouraging greater release of unused entitlements into the water market.

Introduction of the Cap may have advanced the activation of sleeper dozer licences but this is unclear. Indeed, the opposite view is that:

“While sleeper activation has had an impact, this level of impact would have been even worse in the absence of a Cap.”\(^{129}\)

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\(^{129}\) Australian Conservation Foundation, Submission (1999).
The issue of the wealth transfer is heavily felt but whether “wealth is transferred” or rather wealth already held is simply realised depends critically upon the perception of the relative merits of prior rights or history of use approaches.

**Social Impacts and Benefits**

As noted above, the Cap has created positive social impacts. By guaranteeing security of entitlement the Cap will help create economically sustainable communities. The benefits from this will flow through into social outcomes such as employment, schools and community welfare.

The Cap also provides a mechanism whereby disputes and tensions over resource scarcity, between community groups within the Basin and divisions between country and city Australians, can be largely avoided.

**Non-Agricultural Benefits and Costs**

Confidence that the benefits associated with the Cap substantially outweigh the costs is increased when impacts outside the agricultural economy are considered.

First, there are direct economic benefits attributable to the natural capital stock. The rivers and lakes have direct economic benefits in terms of tourism, commercial and recreational fishing, duck shooting and real estate amenity. While no precise estimates appear to be available for the Murray-Darling Basin, indicative estimates from other catchments in eastern Australia confirm the hard financial benefit of a good environment and, therefore, the costs of losing it. For instance, the costs of the 1999 algal bloom on the Gippsland Lakes is estimated to be around $5 million comprising around $2 million for commercial fishing and $3 million for tourism for the six week bloom. Importantly, the adverse impacts appear to carry over from one year to another in terms of reduced tourism.

Nationwide, the recent Atech-CSIRO study puts “the current total cost of algal blooms of $180 million to $240 million…..a conservative order of magnitude estimate.” For the rural sector itself the estimated costs of algal blooms is $60 million per year.

Second, the riverine environment has an intrinsic value to most Australians. This means that the high level of degradation of the river under the No Cap scenario is a cost, albeit intangible. With the Cap, degradation is slowed and this loss of capital value therefore reduced.

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132 *ibid*, p.xi.
Conclusion on Net Benefits

Taken together, our assessment indicates that the Cap has already delivered significant benefits to the Basin community and that the net benefit will increase over time.

This strong positive conclusion will not accord with the perception of every stakeholder in the Basin. This gap in perceptions needs to be understood to remove unwarranted criticism and allow attention to be focussed on improvements to the future operation of the Cap.

A first step is to ensure that people understand what would happen if the Cap were to be removed (see Section 6.3 below).

6.3. IMPROVING THE OPERATION OF THE CAP

Our review has identified a number of measures to improve the operation of the Cap which will both increase the benefits and reduce the costs. We consider each of these in turn.

First, the gap in perceptions and understanding regarding the Cap needs to be closed. Factors leading to a gap in perception of the impact of the Cap include:

- **the different starting points.** Many of the submissions do not compare the Cap with the No Cap scenario. Rather, they compare the Cap with the situation before resource constraints became apparent, ie., the early 1990s;

- **the different understandings on the role of sleepers and dozers.** The rapid growth of trading and the activation of sleepers and dozers is a consequence of increasing development and resource scarcity and not of the introduction of the Cap. Full Development cannot proceed unless sleepers and dozers are activated; and

- **difficulty in separating the impacts of resource scarcity and the Cap.** Although reduced allocations in the southern systems coincide with the announcement of the Cap, they have in fact been driven by resource scarcity and resultant increase in trading.

These different starting points mean that some stakeholders ascribe far more to the Cap and associated reforms than is warranted. This leads to an overestimate and misperception of the adverse impacts of the Cap and fear and anger about the future.

*There is a lack of discussion with affected parties, whether or not they happen to be water users or residents of country towns whose lifestyle is*
being affected not only by changes which have occurred but also because of the fears being generated as a result of proposed changes.\textsuperscript{133}

This destroys the trust required for meaningful dialogue on how to improve the operation of the Cap.

A further gap in perception arises from the impact on security. The underwriting of long term security in each of the valleys – the major direct benefit to irrigated agriculture – appears not to be well understood. This knowledge, summarised in the simulation models, may be familiar to water managers and industry leaders but has not been readily available to, or known by, irrigators and local communities.

Closing the gap requires a tailored communication strategy.

Second, operational improvements to ensure that the administration of the Cap does not lead to a downward bias in diversions appears achievable. For instance, detailed analysis undertaken by Murray Irrigation identifies some scope to optimise NSW Murray resources through more timely and accurate reporting of tributary inflows and intervalley transfers.

Possible options for improved harmonisation of Murray-Darling Basin management include:

- improved interaction between the Murrumbidgee modelling (DLWC) and the Murray modelling (MDBC);
- centralised management – or at least better integration – of Murray-Darling Basin modelling may offer the best opportunity for improved management. (This may raise sovereignty and other issues);
- improved timeliness of streamflow reporting, particularly significant rainfall events and rainfall “rejections”;
- improved management of intervalley transfer accounting; and
- greater flexibility with on-route storage management – for example, Lake Victoria management will exacerbate the problems of harmonisation.\textsuperscript{134}

Third, the concern that the Cap is causing generally widespread adverse socio-demographic impacts is not supported by this first review. Nonetheless, the concern will need to be further addressed with better information and understanding through the assembly and analysis of key data and targeted case studies. These are not mutually exclusive.

\textsuperscript{133} Western Catchment Management Committee (1999), Submission.

The 1996 socio-demographic profile of the Basin is now dated and does not provide insights into more recent effects of the Cap. Because the 2001 and 2006 Censuses will provide new socio-demographic data on the Basin, other benchmark data should sensibly be assembled. The snapshots of 2001 and 2006 should therefore incorporate:

- the socio-demographic profile from the ABS Census;
- a better understanding of water use across the basin. This requires improved information on water use by crop type and application method;
- a better understanding of the drivers and benefits of water trades, both permanent and temporary. This requires source and destination information to be collected at time of trade showing enterprise activity of the seller and intended use by the buyer. Such information is essential in demonstrating the magnitudes of the benefits derived from trading and to better understand the adjustment processes operating within the Basin; and
- a better understanding of the attitudes, concerns and knowledge of water and resource management issues. This benchmark survey would facilitate development of a more comprehensive and targeted communication strategy.

Finally, some of the concerns expressed by irrigation communities which are alleged to be adverse effects of the Cap, in practice relate to the rules for activation of sleepers and dozers.

Where Cap compliance is not jeopardised, consideration could be given to allowing irrigation communities to opt out of the “prior right” approach and to adopt a “history of use” approach to Cap implementation. Proposals for such opting out must satisfy the State and the Independent Audit Group and command a high level of support, say 75%, in plebiscites of affected winners and losers.

**6.4. PROJECT BRIEF QUESTIONS**

Given the nature of the exercise the review has addressed issues at a generic level, as in the discussion above. The Contract Brief included an explicit set of questions where the Cap Project Board sought particular insights.

This Section demonstrates how that analysis has provided answers to the specific questions in the original project brief.

The Contract Brief for this Review posed an explicit set of questions. Recognising the overlap of these questions, our responses to these questions are summarised below:
i) **How suitable is the benefit cost paradigm for assessing the Cap?**

The standard benefit cost framework needs to be extended when dealing with major environmental issues to recognise impacts on the value of natural capital. This extension does not undermine the standard framework.

To apply any benefit cost framework requires clear distinction between the Cap and No Cap scenarios and careful attention to avoid double counting and ignoring offsetting benefits or costs.

The paradigm applied in this Review observes these requirements. We conclude that the paradigm is appropriate and has been followed (Section 1.3).

ii) **What is the aggregate value of the Cap to the economic and social welfare of the Basin?**

Taking all components and impacts together, our assessment indicates that the Cap has already delivered significant benefits to the Basin community and that the net benefit will increase over time.

To date, the Cap has had little “cost”, because it not yet been fully implemented in Queensland and the northern valleys of NSW and the southern valleys have been resource constrained.

This strong positive conclusion will not accord with the perception of every stakeholder in the Basin. There is clear concern and misunderstanding over what the Cap means and this has created apprehension and anger amongst irrigators in some valleys, especially in NSW.

This gap in perceptions needs to be understood to remove unwarranted criticism and allow attention to be focussed on improvements to the future operation of the Cap.

iii) **What has been the impact on the agricultural economy?**

The prime benefit of the Cap is the guaranteeing of security on a valley-by-valley basis. In the absence of the Cap there would be substantial erosion of security of entitlements across the basin, but particularly in the major southern systems. The guaranteeing of this security through the introduction of the Cap provides a better and more certain climate for investment and jobs growth. Long term investment in high value agriculture and value-adding processing is dependent on the underlying security of the base resource. Under the No Cap scenario this is likely to be eroded in the short to medium term.

This increased security and its consequences will also generate significant social benefits. Other economic and social benefits include:
by comparison with the No Cap scenario, a benefit is the maintenance of the viability of irrigated agriculture in the Basin and to prevent irrigators from unnecessarily being forced off the land due to the collapse of security and their finances in the absence of the Cap; and

water trade substantially reduces the economic cost of compliance with the Cap and with environmental flow rules. The impetus provided by the Cap to facilitate trade is fostering better trading rules, third party protection and easier movement of water to high value activities. Trade would occur independently of the Cap but the Cap stimulated reforms are contributing to the early acceleration of that trade and will increase the associated benefits from trade;

reduced tension between irrigator groups and between the irrigation community and the city.

iv) **Have we seen other major positive or negative economic and social impacts of the Cap?**

In addition to the impacts on the agricultural economy noted above, the Cap has major positive impacts on independent activities such as tourism, recreational and commercial fishing and real estate amenity and water quality for urban consumption.

Moreover, the Cap has stimulated institutional reform which will lead to better appreciation of property rights to water, more effective rules for water markets including interstate trade and strengthened and more comprehensive river management and environmental flow regimes. These will also be reflected in positive social outcomes.

v) **To what extent have there been public and/or private gains or losses throughout the Basin under the Cap?**

In terms of private gains and losses, the Cap provides major gains in terms of underwriting resource security on a valley-by-valley basis. The benefits of this underwriting are greatest for the highly developed valleys and for irrigators whose use is relative to their entitlement has been conservative.

Conversely, there is a loss of development potential in less developed valleys and adverse impacts from the adjustment required by irrigators whose use has been high relative to their formal entitlement.

Despite these differential impacts, the Cap provides net benefits to the Basin compared with the No Cap scenario.
vi) **What have been the benefits of water markets in the context of the Cap?**

As noted, benefits attributable to the Cap include:

- a stimulus to codifying and improving property rights and entitlements to water. By definition, when the demands on the fixed pool of resources can be substantially expanded, then each property right risks erosion. Placing a finite limit on diversions across the Basin, therefore, gives a stronger property right by providing known and guaranteed security. The Cap has also stimulated the streamlining of property rights to better facilitate trading in water;

- a reduction in the economic cost of compliance with the Cap and with environmental flow rules. The impetus provided by the Cap to facilitate trade is fostering better trading rules, third party protection and easier movement of water to high value activities. Trade would occur independently of the Cap but the Cap stimulated reforms are contributing to the early acceleration of that trade and will increase the associated benefits from trade.

vii) **What would be the impact if the Cap were to be removed (especially through the erosion of security of supply to existing users)?**

Essentially, this is the No Cap scenario applying from the date of removal of the Cap. In summary, this comprises:

- in the absence of the formal announcement of the Cap on diversions, irrigation development would proceed – at least initially – in most valleys. As a result, resource sustainability would become a major issue;

- the increased development would lead to a steady erosion of security reducing the incentive for new entrants to begin irrigating but also undermining the security of existing entitlements and enterprises in all valleys.

- security in lower valleys and reaches would fall significantly due to development in these lower valleys as well as development in upstream reaches and tributaries. For instance, reflecting the obligations of NSW and Victoria to South Australia under the Murray-Darling Basin Agreement, new developments on the Darling and tributaries would also impact on the security of supply for the Murray systems;

- by definition, the movement to full development must entail activation of unused rights, entitlements and licences. This occurs through continued development by existing entitlement holders and/or by the sale of unused entitlements in the market to new entrants seeking to gain entitlements;
• not all unused entitlements would be activated since some are kept as insurance to ensure greater reliability and others are held in anticipation of future development;

• sleeper and dozer licences would also be purchased by existing users as they seek to restore their previous level of security;

• the degradation of the riverine environment and water quality would proceed at an accelerating pace. Algal blooms would become a recurring feature of major reaches as dilution flows are reduced. Salinity, particularly in the lower reaches, would continue to rise. In the mid and lower sections of the river, the rise in water salinity would lead to increased salt accumulation and loss of the remaining bio-diversity;

• socio-demographic trends would continue to be driven by the major forces impacting on irrigated agriculture, ie., commodity prices, seasonal allocations and access to export markets;

• there would be increasing tensions between irrigator groups and between regions as security declines and water trading becomes more aggressive.

• individual irrigators, industry associations, local government and others initiate legal actions against the State Governments and the MDBC for failing to provide adequate stewardship of the water resource and riverine environment. The recent announcement from Premier Olsen provides an example of this risk:

  “If NSW just simply continue to ignore our calls for appropriate flows through the River Murray we will take retaliatory action.”

  In the absence of a cap these challenges would have been far more common and vociferous. Other legal actions seek to either remove or improve constraints on water trade. In other words, there is a disorderly scramble and lack of process;

• as resource availability and security deteriorate rapidly in the final stages of this full development scenario, incentives for water use efficiencies rise sharply, stimulating major investment late in the period. Major corporate farms will be better placed to fund those capital expenditures;

• changes in river and system operation would tend to occur progressively but predominately in the full development scenario as the pressures and urgency mount;

• as end of valley flows continue to fall and the damage to the river environment becomes stark, the urban electorate loses patience and sympathy with irrigators and basin communities; and

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135 Premier Olsen (2000), as reported in The Sunday Mail, 20 February.
• with the substantial reduction in security, the income and viability of irrigated enterprises and communities across the Basin becomes increasingly sensitive to seasonal and climatic variation.

SUMMARY

The Cap provided a clear signal to stakeholders, across the Basin, that there was increasing resource scarcity, that previous arrangements had proved inadequate and that there was the political commitment to implement necessary additional controls.

The Cap has:
• strengthened and reinforced existing reform initiatives;
• stimulated additional controls;
• provided a benchmark for future regulation of diversions;
• provided a Basin-wide framework to coordinate actions between catchments and States; and
• ensured compliance, monitoring and publicity at the sub-state level.

The introduction of the Cap has generated significant economic and social benefits. The prime benefit is the guaranteeing of security on a valley-by-valley basis. This provides a better and more certain climate for investment and jobs growth. Long term investment in high value agriculture and value adding processing is dependent on the underlying security of the resource base. Under the No Cap scenario this is likely to be eroded in the short to medium term.

By guaranteeing security of entitlement, the Cap will help create economically sustainable communities. The benefits from this will flow through into social outcomes such as employment, schools and community welfare and cohesion. The Cap also provides a mechanism whereby disputes and tensions over resource scarcity, between community groups within the Basin and divisions between country and city Australians, can be managed and resolved in an orderly way.

Finally, the Cap creates significant environmental benefits. These are realised both as direct benefits attributable to the natural capital stock – such as from increased tourism, recreation and real estate amenity – and in slowing further degradation of the riverine environment which has intrinsic value to most Australians.
ATTACHMENT A

Review of the Operation of the Cap: Economic and Social Impacts

a) Submissions made to the Community Advisory Committee

New South Wales
Western Catchment Management Committee
Central West Catchment
Lower Murray Darling Catchment
Murrumbidgee Irrigation
Ricegrowers Association
Batlow Unregulated Streams
Tumut River Landowner
MIA Council of Horticultural Associations
Yanco Creek and Tributaries
North West Catchment Management Committee
Macquarie/Cudgegong River Management Committee (individual members)

Victoria
Joint CAC members
North East Catchment
Mallee Catchment

South Australia
Riverland
Lower Murray Catchment

Queensland
Maranoa-Balonne Catchment

Murray Darling Association
Cotton Australia

b) Other Community Submissions Provided Directly to the Review

Berrigan Shire
Bourke Chamber of Commerce
Bourke Cotton Growers Association
Bourke Shire Council
Brewarrina Shire Council
Coleambally Community Action
(incl. Dr Robert Byrne, Country Women’s Assoc., Barry Hogan and St Peter’s Primary School)

Darling River Food & Fibre
Goulburn – North East – Water for Agriculture – Ministerial Committee
Gwydir Valley Irrigators Association
Hay Water Users Association
Hume Shire Council
Lachlan Valley Water
MIA Council of Horticultural Associations
Moira Private Irrigation District
Murray Irrigation Limited
Murray Valley Voice
Murray Valley Water Diverters Advisory Association
Murrumbidgee Irrigation
Namoi Valley Water Users’ Association
Narromine Irrigation Board of Management
Ricegrowers Association
Southern Riverina Irrigation Districts Council
Tumbarumba Shire Council
Twynam Pastoral Company
West Corurgan Private Irrigation District

c) State Submissions

The review of economic and social impacts received formal submissions from each of the member States and from the Commonwealth Government. The review team would also like to place on record their appreciation of the contribution made by members of staff within the respective Departments of those member states, who generated original unpublished data for key aspects of the consultancy and provided invaluable comments and insights.
ATTACHMENT B

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Review of the Operation of the Cap

Equity

Report of the Independent Audit Group

February 2000
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A number of equity issues were identified in the IAG’s Setting the Cap report. This Review has highlighted to the IAG that there has been progress in clarifying the outstanding State and ACT equity issues.

**Queensland** argued in 1996 when the Cap was introduced that there was still scope for development and that water for diversion would be determined following a Water Allocation and Management Planning (WAMP) process. Queensland has advised that draft plans will be available for community consultation from mid March with advice presented to Council on Queensland’s preferred valley Cap limits for most valleys in July 2000. This process will enable a Cap to be established for Queensland.

Queensland also propose to introduce legislation to manage the State’s water resources including floodplain (overland) flows in line with COAG principles and Cap requirements.

In the case of **New South Wales** the Pindari Dam equity issue is expected to be finalised by June 2000.

**Victoria** is addressing its outstanding Lake Mokoan equity issue as part of its work on Bulk Entitlements for the Broken Valley. This will not be completed until June 2001.

The **South Australian** equity issue was addressed and resolved as a result of the IAG 1996 report ‘Setting the Cap’.

The **ACT** commenced participation in the MDBC under a Memorandum of Understanding in 1998 and a Cap has yet to be established. The ACT argues that on equity grounds it is entitled to more water than that associated with the 1993/94 level of development used to define the Cap.

No major new interjurisdictional equity issues were raised during the Review.

Specific equity issues considered included farm dams, both for floodplain (overland) diversions and upper catchments. These are inter-jurisdictional and intra valley equity issues with downstream users impacted by lower security, reduced ability to manage environmental issues and the principle of whether extra use from dams should be included within Caps.

An emerging issue in some catchments is the increase in tree plantations. These reduce runoff and have similar impacts as upper catchment farm dams.

A number of stakeholders in their submissions raised equity issues. The vast majority related to New South Wales and intra-valley issues particularly lack of emphasis on history of use in distributing available resources under the Cap and the concurrent environmental flows initiative. These issues are outside the jurisdiction of the Commission.

The IAG have made a number of recommendations:

i) the MDBC note that the Cap component for Lake Mokoan is expected to be finalised by Victoria by June 2001.

ii) floodplain and overland flows and diversions (where significant) be measured and included in the valley Cap;

iii) a statutory basis for the management of floodplain and overland flows be provided in all jurisdictions with significant flows;

iv) as a matter of principle, jurisdictions include farm dam water use in their Caps;

v) each jurisdiction with significant growth in farm dams survey use and report on the expected quantum of use, cost of metering and reporting;

vi) the MDBC in cooperation with member States and the ACT ascertain the extent of proposed tree plantation planting;

vii) if tree plantations are expected to become significant, develop a strategy to manage the impacts on water flow, allocation, diversion and river health;

viii) the MDBC note that the Cap component for Pindari Dam is expected to be finalised by New South Wales by June 2000;

ix) the MDBC note that Council can expect to receive advice from Queensland on its proposed Cap limits for most valleys within the Basin by July 2000;

x) the MDBC note that the Environmental Flows Technical Report for the Condamine-Balonne will be assessed by the Queensland EPA in line with terms of reference agreed between the EPA and the IAG;

xi) the MDBC note that the Queensland government has proposed legislation to provide a statutory framework for water resource management that includes floodplain (overland) diversions and is consistent with the COAG and Cap principles;

xii) the ACT submit to Council a firm proposal for a Cap for the ACT during the finalisation of the five-year Review of the Operation of the Cap;

xiii) the ACT proposal, in addition to testing against the six principles established by the IAG, consider downstream impacts on river health and diversions;

xiv) the ACT finalise negotiations on trading rules with New South Wales; and

xv) the individual stakeholder submissions and that of the CAC be referred to the appropriate State Governments for consideration.
The Murray-Darling Basin Ministerial Council at its June 1995 meeting made the strategic decision to introduce a Cap upon diversions of water from the Murray-Darling Basin.

A Cap on the volume of diversions associated with the 1993/94 level of development was seen as an essential first step in establishing management systems to achieve healthy rivers and sustainable consumptive uses.

The Council in resolving to cap diversions, saw the need to take account of any special circumstances and equity issues in examining the establishment of a Cap.

The IAG were appointed in 1996 and were required to examine ‘the special circumstances and equity issues previously noted by the Ministerial Council and advise on reasonable approaches to the Cap to take these into account’.

The particular equity issues addressed by the IAG included:

- a South Australian proposal to include an estimated 69 GL per annum of allocated but unutilised irrigation water and 50 GL for economic development within the South Australian Cap;
- Queensland’s proposals for further development;
- New South Wales proposals to include the enlarged Pindari Dam within the Cap limits for NSW;
- Victoria’s request for the consideration of the Lake Mokoan situation.

Following the participation of the ACT in the Murray-Darling Basin Commission in March 1998 there is also a need to consider an appropriate Cap for the ACT.

This report covers the status of each of these equity issues and additional strategic issues arising from the submissions. Intra-valley equity issues have been referred to the respective State Government as they are beyond the role of the Murray-Darling Basin Commission.
2. Terms of Reference

The Murray-Darling Basin Commission (MDBC) provided the following terms of reference for the five-year Review of the Operation of the Cap:

To review the operation of the Cap (and, importantly, not the Cap itself) and provide suggestions for the more effective future operation of the Cap through obtaining independent assessments (involving the Independent Audit Group and partner governments to the initiative as appropriate) in each of the following areas:

**Equity**

By addressing issues of equity that have arisen in the process of implementing the Cap (between river valleys within States and between States).

Main tasks:

1. Partner governments, and the CAC, are asked to identify any outstanding equity issues arising from the implementation of the Cap and may put at risk its future management:
   i) at a jurisdictional level (equity issues between jurisdictions that have arisen since the 1996 ‘Setting the Cap’ report of the IAG);
   ii) within jurisdictions (equity issues between valleys that have now come to light);
   iii) between groups within valleys; and
   iv) in any other way that is relevant to the Cap.

2. The Independent Audit Group (IAG) will be engaged to review submissions received in this component of the Review, meet with partner Government representatives to discuss the submissions and providing independent advice on the equity issues raised.

3. Review Process

The IAG has developed an open and accountable process in the conduct of its annual audits. A similar approach was utilised for this Review.

The IAG met with representatives of Commonwealth, States, the ACT and representatives of the Murrumbidgee irrigation area to discuss their respective submissions as they relate to the equity term of reference during the period 31 January to 3 February 2000. The IAG has also analysed the Community Advisory Committee’s and individual stakeholder submissions for equity issues and possible options for addressing the issues.

Where equity issues raised were the clear responsibility of any one jurisdiction and outside the terms of reference for the IAG, the IAG has suggested the issue be addressed by that jurisdiction.

Following the meetings and review of submissions a draft report was prepared and circulated to the Commonwealth, States and ACT for comments on factual issues and preliminary findings. Such comments were considered by the IAG however all of the final findings and recommendations are solely those of the IAG.
4. Equity Issues

4.1 Ministerial Council Decisions

The Murray-Darling Basin Ministerial Council at its 6 December 1996 meeting addressed a number of equity issues and agreed on the following:

South Australia
i) the South Australian proposal to allocate an additional 50 GL per year for economic use not be approved as it is not compatible with water quality and river flow objectives;
ii) the 69 GL per year increase in diversions expected from the uptake of water allocated for irrigation and previously used be included in the Cap.

Victoria — Lake Mokoan
i) the Lake Mokoan system qualifies for inclusion in the 1993/94 Cap;
ii) the Cap be increased by the net consumptive use determined by an appropriate water allocation study;
iii) on an interim basis, the Victorian Cap include 22 GL per year for Lake Mokoan.

New South Wales — Pindari Dam
i) in principle Pindari Dam qualifies for inclusion in the Cap; and
ii) the Cap be increased by a net consumptive use determined by an appropriate water allocation study.

Queensland
i) agree, in consideration of the equity issues that the definition of the Cap allow for certain additional developments which have occurred since 1993/94 or which may occur and which are more fully discussed in ‘Setting the Cap’ report;
ii) the Cap for Queensland be determined after the WAMP process is completed.

4.2 Progress in Implementation (including New Issues)

4.2.1 South Australia

The South Australian equity issue has been finalised with 69 GL of water previously allocated for pumped allocation but not utilised included in the Cap. The only issue is the appropriate absolute definition for the pumped irrigation component which has historically been described as 90 percent of 489.6 GL. The 1998/99 IAG report recommended that this be set at 440.6 GL.

No new significant equity issues have been raised.

4.2.2 Victoria

The Victorian submission raised a number of new issues including farm dams, and plantations.

Lake Mokoan
Victoria argued successfully that the net consumptive use determined by a water allocation study be included in the Cap. On an interim basis 22 GL per year was included in the Victorian Cap.

The water allocation study is not yet complete but will be incorporated into the development of models and bulk entitlements for the Broken Valley. These are not expected to be completed before June 2001 as this has not been a priority as it accounts for less than one percent of the available resource.

Recommendation:

i) it is recommended that the MDBC note that the Cap component for Lake Mokoan is expected to be finalised by Victoria by June 2001.

Farm Dams

The farm dam issue was raised by a number of Victorian and New South Wales stakeholders. Particular issues raised included the perceived need for similar rules between States and the need to incorporate on-farm dam storage use in the Cap.

The IAG considers that there are two separate farm dam issues. The first relates to dams or tanks to harvest water from floodplain (or overland) flows. This is a common situation in the unregulated river valleys of New South Wales and Queensland. The second refers to farm dams in the upper catchments of a number...
of valleys. Traditionally these have been used for domestic and stock water but increasingly are being constructed for irrigated agriculture.

Floodplain Harvesting

There has been significant growth in floodplain harvesting in a number of Queensland and New South Wales river valleys since 1993/94. As the floodplain and river are contiguous, any increase in water harvesting from the floodplain reduces stream flow and the security of supply to environmental users. Floodplain harvesting in Queensland and New South Wales has not previously been recorded as a diversion and as a consequence is not part of the valley Caps. It also has historically not been measured or reported. This issue has been recognised by both New South Wales and Queensland and there are proposals to include the floodplain flows and diversions into the models and allocation plans. Provision is also being made to provide a statutory basis for the allocation and management of floodplain flows. A similar case can be made for overland flows.

Recommendations:

- As a matter of principle, jurisdictions include farm dam water use in their Caps;
- Each jurisdiction with significant growth in farm dams survey use and report on the expected quantum of use, cost of metering and reporting.

Farm Dams

The equity issue arising from increased diversions into farm dams upstream in catchments is the reduced runoff and flow to lower parts of the catchment. This reduces the level of security to downstream users and the ability to achieve environmental outcomes. This issue affects all States and the ACT but is of greatest interest to New South Wales and Victoria. Both States have either introduced legislation (New South Wales) or propose to provide a statutory basis for the allocation of water to off stream dams. While it may be preferable to have uniform rules within each State and the ACT this is difficult to achieve. The issue of principle however for the Murray-Darling Basin Commission is that any increased use from farm dam diversions be included in the Cap limits. Implementation of the principle should however be dependent on the significance or otherwise of increased use as measurement and monitoring of use across a number of dams within valleys would be resource intensive. It would appear to the IAG appropriate for the MDB to accept the principle of water use being included within the Cap, to recognise that this may have downstream impacts and to encourage each jurisdiction to report on the magnitude of use from farm dams.

Recommendations:

- As a matter of principle, jurisdictions include farm dam water use in their Caps;
- Each jurisdiction with significant growth in farm dams survey use and report on the expected quantum of use, cost of metering and reporting.

Plantations

An emerging equity issue raised in submissions with the same implications as farm dams is the trend towards increased plantations. This trend follows a shift from native hardwoods to plantations and is generally focused on the higher rainfall component of catchments. It is generally accepted that plantations of most tree types significantly increase evapotranspiration compared to annual pasture with a reduction in runoff and accretion to groundwater. This could be seen as a beneficial impact in the control of salinity particularly dryland salinity or as significantly reducing riverflow thereby reducing security for downstream users and the ability to address river health issues. It has been estimated that 200,000 ha of plantations could reduce runoff by 400 GL per year. It would be appropriate for the MDB in cooperation with member States and the ACT to ascertain the extent of proposed planting and to develop a strategy to manage the impacts (if significant) including decisions on water allocation for plantations and Cap inclusion.

Recommendations:

- It is recommended that the MDB in cooperation with member States and the ACT ascertain the extent of proposed tree plantation planting;
- If tree plantations are expected to become significant, develop a strategy to manage the impacts on water flow, allocation, diversion and river health.
4.2.3 New South Wales

Pindari Dam
The Ministerial Council agreed in principle to include Pindari Dam in the New South Wales Cap for the Border Rivers with the specific quantum to be determined following a water allocation study. This issue has not been a high priority to date but has now been included in the IQQM model being developed for the Border Rivers. The ability to finalise the model follows agreement between the governments of Queensland and New South Wales that further growth in diversions in regulated streams of the Border Rivers will not be allowed.

It is expected that a specific Cap component for Pindari will be finalised by June 2000.

Recommendation:
i) it is recommended that the MDB note that the Cap component for Pindari Dam is expected to be finalised by New South Wales by June 2000.

Environmental Flows
New South Wales has raised the issue of equity between States arising from increased environmental flows. The IAG have discussed this issue in the report on ‘Implementation and Compliance’.

4.2.4 Queensland

Following the Murray-Darling Basin Ministerial Council’s earlier decisions the Cap is to be established following completion of the various water resource planning studies that will provide the basis for decisions on the balance between diversions and environmental needs.

These studies include a Flow Management Plan for the Border Rivers (in cooperation with New South Wales), a Water Allocation and Management Plan for the Condamine-Balonne and Water Management Plans for the Moonie and Warrego/Paroo/Nebine.

A comprehensive update of the status of these processes was provided as of September 1999 in the ‘Review of Cap Implementation 1998/99’. In this report an update of the status of the various processes is provided.

Border Rivers
The Border Rivers IQQM has been completed as has a report on ‘Current Ecological Condition of the Border Rivers’.

New South Wales and Queensland have assessed water use and flow performance. This work indicated that the current level of water use may result in unacceptable long term ecological impact at the end-of-system at Mungindi.

As a result the governments of New South Wales and Queensland agreed in November 1999 that further growth in water use that leads to deterioration of the end-of-system flows would not be supported.

The draft Flow Management Plan is expected to be released for public consultation in late 2000 with a Queensland position available for Council’s consideration by July 2001.

Condamine-Balonne
There has been significant progress in developing the Condamine-Balonne draft WAMP. The report of the Technical Advisory Panel has been finalised — ‘Environmental Flows Technical Report’. The report indicated that while the Upper Condamine was generally in good to fair condition the lower Balonne was in poor to fair condition.

The draft WAMP is expected to be released in mid March for public consultation with advice to Council on this component of the Queensland Cap by July 2000.

Moonie and Paroo/Warrego/Nebine
As previously advised in the 1998/99 Review of Cap Implementation the Water Management Plans are expected to be sufficiently advanced by June 2000 to provide estimates of sustainable diversions. Refinement may be required once detailed hydrological models are available.

Advice on this component of the Queensland Cap is also expected to be available for Council in July 2000.

Audit of the WAMP, WMP’s and FMP
Council agreed that the planning process and its outcomes be audited by the IAG. The IAG has agreed with the Queensland EPA on terms of reference for a review of one key component of the Condamine-Balonne WAMP. The review of the Environmental Flows Report will be conducted by the Queensland EPA with a copy of the review provided to the IAG. The IAG also expects to comment on the finalised plans as part of the process leading to Council consideration of the Queensland Cap components.

The IAG has previously supported the WAMP and associated processes as an appropriate basis for balancing diversions and environment.
In doing so the IAG noted that it must include:

- in-stream use in Queensland and downstream;
- licensed diversions from streams and the currently unlicensed floodplain and overland unlicensed water harvesting;
- a management regime that includes pricing, property rights, measurement (metering) and reporting;
- assessment of downstream flows and diversion impacts;
- application of the precautionary principle.

The Queensland Government has released an exposure draft bill which will provide a comprehensive statutory framework for the management of the State’s water resources including proposals to license floodplain and overland diversions.

While WAMP and other plans will establish the proposed limits to diversion and end of valley flows operationalising of these plans will be via Resource Operation Plans and full implementation could take up to a further 18 months.

Conclusions

Substantial progress within the last 12 months is expected to result in the draft WAMP for the Condamine-Balonne being released for public consultation in April, the draft Water Management Plans for the Moonie in March and Warrego/Paroo/Nebine by mid May and the draft Flow Management Plan for the Border Rivers by late 2000.

Council can expect to receive advice from Queensland on its proposed Cap limits for most valleys within the Basin by July 2000.

The test that will need to be applied is whether the proposed Cap provides a balance between diversion and environmental objectives and downstream impacts. Proposed legislation will provide the statutory basis for the management of the State’s water resources in line with COAG principles.

The perceived slow rate in completing WAMP and the other planning studies and the growth in storages and diversions was of major concern to a number of stakeholders as reflected in submissions from throughout the Basin.

Recommendations:

It is recommended that the MDBC note that:

i) Council can expect to receive advice from Queensland on its proposed Cap limits for most valleys within the Basin by July 2000;

ii) the Environmental Flows Technical Report for the Condamine-Balonne will be assessed by the Queensland EPA in line with terms of reference agreed between the EPA and the IAG;

iii) the Queensland government has proposed legislation to provide a statutory framework for water resource management that includes floodplain (overland) diversions and is consistent with the COAG and Cap principles.

4.2.5 Australian Capital Territory

The ACT became a participant in the Murray-Darling Basin Commission under a Memorandum of Understanding in March 1998. At that time the ACT Government undertook to participate in the Cap initiative. There has been no decision on the ACT’s Cap.

The IAG in its ‘Review of Cap Implementation 1998/99’ examined four options for the Cap under consideration by the ACT. At that time the IAG considered that two options — 29 GL per year representing the 1993/94 level of water use in the ACT; and 172 GL per year which was the residual water available after allowing for environmental flows were not appropriate options when compared with the principles and procedures arising from Cap decisions for other urban centres.

In turn the IAG recommended that:

i) the ACT bring forward a considered proposal on the Cap in the context of six principles used to set the Cap in other jurisdictions as part of the five-year Review of the Operation of the Cap.

ii) For a Cap to be effective in the ACT, the ACT must have access to a broader water trading environment and that arrangements for water trading between the ACT and NSW be agreed as part of the Cap finalisation process.

The ACT in their submission to the Review analysed four options against the six principles or ‘tests’ used to set the Cap in other jurisdictions. The ACT has argued that by establishing a Water Resource Management Plan, water has been allocated to the environment as a first priority as opposed to other constituencies where there has been a need to ‘claw back’ diversions for environmental purposes.
The ACT also argues that it would be inequitable for the surplus net volume of some 138 GL to be utilised downstream for irrigation while requiring the ACT to acquire additional water from trade with NSW. It is estimated that some 53 percent of the Murrumbidgee River average annual Cap flow at Wagga Wagga is used for irrigation.

The IAG was not required as part of its terms of reference to address setting of an ACT Cap. The IAG notes however that implementation has progressed sufficiently in each State for a modified Schedule F to be finalised. This would then provide the basis for ongoing Cap management including monitoring, reporting, auditing and remedial action (if appropriate).

In this context it would be appropriate for the ACT to submit a detailed proposal including its preferred option while the five-year Review of Operation of the Cap is finalised. This would enable Council to consider the proposed ACT Cap at the same time as Schedule F and the Queensland Cap proposals.

In view of the ACT submission to the Review the IAG recommends that any such proposal consider the downstream instream and diversion impacts of their proposal and that the previous basis for setting Cap limits for other urban centres be considered.

Conclusions

Net ACT consumption is only 0.3 percent of overall Basin water use. Despite this it is important that a Cap be established for the ACT.

The ACT has to date considered four options ranging from 29 to 172 GL per year.

The ACT has commenced negotiations with NSW over a possible framework for trading between the ACT and NSW although these have not progressed to the extent that would provide the ACT with the necessary confidence to establish Cap limits.

Recommendations:

It is recommended that the:

i) ACT submit to Council a firm proposal for a Cap for the ACT during the finalisation of the five-year Review of the Operation of the Cap;

ii) ACT proposal, in addition to testing against the six principles established by the IAG, consider downstream impacts on river health and diversions;

iii) ACT finalise negotiations on trading rules with New South Wales.

Stakeholder Submissions

In addition to specific jurisdictional equity issues arising from the Commonwealth, State and ACT submissions (see Table 1) a number of submissions were received from a range of stakeholders.

The Community Advisory Committee (CAC) of the Murray-Darling Basin Ministerial Council presented a detailed submission incorporating many of the comments made by individual stakeholders.

The CAC has provided a summary of the equity issues raised in these submissions and these are attached as Appendix 1.

The IAG reviewed all submissions and in addition met on 1 February with representatives of the Ricegrowers’ Association of Australia, the MIA Council of Horticultural Associations and Murrumbidgee Irrigation.

The vast majority of submissions were from NSW stakeholders and the most common issue raised was that of intra-valley equity particularly the failure to take account of history of use in distributing available resources.

This issue and others have been referred to the respective State Government for consideration in the context of their water industry reform programs.

One strategic principle comes out of the submissions and that is the need for appropriate public involvement and communication in implementing major change.

Implementation of the Cap across a range of valleys has been a particularly complex and resource intensive task. In the case of NSW the IAG has in a number of its reports identified the need for additional resources to develop the models and implement the changes including consultation with affected stakeholders. Concurrent implementation of environmental flow rules has added further complexity.

The need for improved public participation and communication with stakeholders has been recognised in a number of jurisdictions and has resulted in changes in communication with stakeholders.

Conclusion

A number of intra-valley equity issues remain that lie outside of the Murray-Darling Basin Commission’s jurisdiction.

The general principle that can be drawn from these is the need for public participation and communication in introducing major change programs such as the Cap.
TABLE 1 — Equity Issues Raised by the Commonwealth, States and ACT

<table>
<thead>
<tr>
<th>Issue</th>
<th>Commonwealth</th>
<th>NSW</th>
<th>VIC</th>
<th>SA</th>
<th>QLD</th>
<th>ACT</th>
<th>Where dealt with:</th>
</tr>
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<tbody>
<tr>
<td>Private Storage/Farm Dams</td>
<td>x</td>
<td></td>
<td></td>
<td>X</td>
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<td>Section 4.2.2</td>
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<tr>
<td>Cap arrangements in Queensland</td>
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<td>X</td>
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<td>X</td>
<td></td>
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<td>Section 4.2.4</td>
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<tr>
<td>Lake Mokoan</td>
<td>X</td>
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<td></td>
<td></td>
<td></td>
<td>Section 4.2.2</td>
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<tr>
<td>Land use changes (effect on runoff)</td>
<td>X</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Section 4.2.2</td>
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<tr>
<td>ACT Cap/Urban Use</td>
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<td>X</td>
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<td>Section 4.2.5</td>
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<tr>
<td>Groundwater</td>
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<td>I&amp;C Report 5.1</td>
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<tr>
<td>Accounting for Environmental Flows</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
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<td>I&amp;C Report 5.1</td>
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<tr>
<td>• Savings to the environment</td>
<td>X</td>
<td></td>
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<td>and 5.2</td>
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<tr>
<td>• Consumptive use included in Cap</td>
<td>X</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>• Consumptive use separate to Cap</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Snowy River (reduced transfers matched by reduced Cap or losses)</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<td>I&amp;C Report 5.1</td>
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<tr>
<td>Lower Murray Swamps</td>
<td>X</td>
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<td>I&amp;C Report 5.1</td>
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<tr>
<td>Water Trading</td>
<td>X</td>
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<td></td>
<td>X</td>
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<td>I&amp;C Report 5.1</td>
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<tr>
<td>Scientific research (relationship between diversion and environment)</td>
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<td></td>
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<td>I&amp;C Report 5.2</td>
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</tbody>
</table>

Recommendation:

i) it is recommended that the individual stakeholder submissions and that of the CAC be referred to the appropriate State Governments for consideration.
5. Conclusions and Recommendations

5.1 Conclusions

The outstanding equity issues raised in the IAG’s 1996 report “Setting the Cap” have progressed to the stage where Queensland can be expected to provide advice on most of its valley by valley Cap targets to Council in July 2000.

The outstanding finalisation of Cap provisions for Pindari Dam and Lake Mokoan can be expected to be resolved by June 2000 and 2001 respectively.

No major new inter-jurisdictional Cap equity issues have been raised during the Review.

There were a number of subsidiary equity issues raised including the impact of farm dams including those for floodplain (overland) and upper catchment diversions and use. The concern related to equity between upstream and downstream users and the principle of whether increased water use from these dams should be included within valley Caps. Similarly the impact of increased tree plantations in upper catchments was seen as having a possible impact on downstream users.

Intra-valley equity issues were of concern to a number of New South Wales stakeholders who considered that inadequate attention had been paid to history of use in establishing valley Caps and distributing available resources. The submissions in the view of the IAG were symptomatic of inadequate public consultation in managing the introduction of the Cap and the concurrent initiative of environmental flows.

These issues are however outside the jurisdiction of the Commission (and this consultancy) and can best be directed to the appropriate state jurisdiction with a recommendation that the issues be considered.

5.2 Recommendations

The IAG have made a number of recommendations:

i) the MDBC note that the Cap component for Lake Mokoan is expected to be finalised by Victoria by June 2001.

ii) floodplain and overland flows and diversions (where significant) be measured and included in the valley Cap;

iii) a statutory basis for the management of floodplain and overland flows be provided in all jurisdictions with significant flows;

iv) as a matter of principle, jurisdictions include farm dam water use in their Caps;

v) each jurisdiction with significant growth in farm dams survey use and report on the expected quantum of use, cost of metering and reporting;

vi) the MDBC in cooperation with member States and the ACT ascertain the extent of proposed tree plantation planting;

vii) if tree plantations are expected to become significant, develop a strategy to manage the impacts on water flow, allocation, diversion and river health;

viii) the MDBC note that the Cap component for Pindari Dam is expected to be finalised by New South Wales by June 2000;

ix) the MDBC note that Council can expect to receive advice from Queensland on its proposed Cap limits for most valleys within the Basin by July 2000;

x) the MDBC note that the Environmental Flows Technical Report for the Condamine-Balonne will be assessed by the Queensland EPA in line with terms of reference agreed between the EPA and the IAG;

xi) the MDBC note that the Queensland government has proposed legislation to provide a statutory framework for water resource management that includes floodplain (overland) diversions and is consistent with COAG and Cap principles;

xii) the ACT submit to Council a firm proposal for a Cap for the ACT during the finalisation of the five-year Review of the Operation of the Cap;

xiii) the ACT proposal, in addition to testing against the six principles established by the IAG, consider downstream impacts on river health and diversions;

xiv) the ACT finalise negotiations on trading rules with New South Wales and

xv) the individual stakeholder submissions and that of the CAC be referred to the appropriate State Governments for consideration.
6. Further Reading

- Setting the Cap, Report of the Independent Audit Group, November 1996;
Appendix 1 — Summary of CAC Equity Issues

Summary of CAC Submission on Equity

A summary of the Equity issues raised in the submission of the Community Advisory Committee (CAC) is provided below:

Who: Australian Conservation Foundation
What: consumptive users have resource security and priority of supply, the environment has neither
Why: anomalous
Options: —

Who: Australian Conservation Foundation
What: off-allocation use should be abolished
Why: it should be available to the environment as a natural flow
Options: all water used for irrigation must come from allocation

Who: Australian Conservation Foundation
What: ‘high’ security water should be subject to ‘skeleton’ water regimes in extremely dry years
Why: high security water should not be 100% secure. Activation of high security sleepers means the Cap has failed to safeguard the interests of the environment
Options: ‘skeleton’ water regimes, and environmental flow assessments

Who: Australian Conservation Foundation
What: volumetric conversions of standard and high security water are overly generous and have compounded the impact of sleeper activation
Why: —
Options: volumetric conversions should be based on a combination of soil types and recognised standards of best practice

Who: Australian Conservation Foundation
What: water trade between States and over long distances
Why: lack of adequate conversion factors (and loss factors) will create equity problems and further erode the environment’s share
Options: —

Who: Australian Conservation Foundation
What: security of supply for urban areas
Why: drought restrictions should equate to standard security annual announcements
Options: water for gardens should be standard security

Who: Australian Conservation Foundation
What: capping of urban centres at 1993/94 levels
Why: urban centres should purchase water like any other user if population or consumption increases
Options: Cap for urban centres and water trading

Who: Australian Conservation Foundation
What: public funding of water efficiency savings
Why: —
Options: savings should be taken from the Cap and added to the environment’s share

Who: Batlow Unregulated Streams Water Users Committee NSW
What: unregulated streams have no final information on where they stand as part of water reform
Why: —
Options: not specified

Who: Central West Catchment Management Committee NSW
What: start date for Cap reporting in Macquarie River
Why: dry year, in combination with a carryover and wildlife allocation
Options: not specified

Who: Coleambally Irrigation NSW
What: reduction in allocation from 94% to 85% and access to less than 50% of off-allocation (also being phased out), plus further reductions for environmental flows and potentially the Snowy
Why: significant change implemented too quickly, impacting on ability to fund and implement the Coleambally Land and Water Management Plan
Options: need access to COAG structural adjustment mechanisms

Who: Coleambally Irrigation NSW
What: history of use has not been considered in the Murrumbidgee Valley. Plus activation of sleeper and dozer water results in a lower allocation for history of use water
Why: activation of sleeper/dozers is facilitated by water markets, ignores economic benefits of existing infrastructure and also has environmental impacts
Options: —

Who: Coleambally Irrigation NSW
What: 248 GL of high security not accounted in the Cap (detail provided within this chapter)
Why: 120 GL was set as High security in the Cap. Why has this fundamental inequity not been addressed in four years of discussion?
Options: not specified

Who: Coleambally Irrigation NSW
What: continuous accounting model is not suited to the Murrumbidgee valley and is inequitable in its effect, and also does not recognise history of use
Why: continuous accounting works where the total Dam volume is many times the total water allocation, this is not the case in the Murrumbidgee. If introduced, some users will receive more access and Coleambally will get reduced access.

Options: capacity sharing

Who: Condamine Catchment, Qld
What: sharing of overland flow between irrigators and the environment
Why: growth in storage capacity will impact on the Cap’s goals and legitimacy of the Cap and WAMP

Options: regulatory regime

Who: Cotton Australia
What: changes in Queensland Government priorities and view of river health, particularly for the Condamine-Balonne
Why: changed view from pro-development (Developmental Incentive Scheme providing grants for irrigation infrastructure) to stressed catchment (DIS on hold, licensed entitlement may need reduction). Paucity of understanding of inland rivers makes appraisal of river health difficult. Queensland Government is using questionable and inadequate base information for environmental assessment and lack of rigour to ensure rural livelihoods and viability of communities is safeguarded

Options: more cogent and rigorous scientific assessment

Who: Hay Water Users Association NSW
What: dependence on off allocation flows as part of private diverters allocation was encouraged by NSW Government during introduction of the Cap. Ignoring history of use and now transferring capital from efficient irrigators to inefficient irrigators
Why: use of off allocation flows required capital expenditure and now water must be purchased on the temporary market

Options: application of the Cap needs to be modified to ensure fair and reasonable equity between all irrigators

Who: Lower Murray Darling Catchment Management Committee NSW
What: increasing water use in Queensland
Why: impact on lower States and potentially the Murray-Darling Basin Agreement

Options: not specified

Who: Lower Murray Darling Catchment Management Committee NSW
What: accounting of permanent trade between valleys

Why: trading between States with different allocation methods, which allocation applies to the traded water?

Options: not specified (Editor: greater community awareness of the accounting rules; exchange rates, environmental clearance requirements, etc would be of benefit)

Who: Lower Murray Darling Catchment Management Committee NSW
What: lack of volumetric measurement of all water usage
Why: inequities

Options: measure all water usage

Who: Macquarie/Cudgegong River Management Committee NSW (individual members)
What: joint consideration of the Macquarie valley and Cudgegong valley
Why: differences in level of water use and level of development make this joint consideration unworkable, as the Cudgegong valley is capable of 100% allocation each year, compared to the Macquarie where licences exceed average flow

Options: administer the Cudgegong valley under separate rules from the Macquarie

Who: Macquarie/Cudgegong River Management Committee NSW (individual members)
What: Cap of 2 500 ML representing only 12% of prior licensed entitlement
Why: investments made based on prior security of supply

Options: —

Who: Macquarie/Cudgegong River Management Committee NSW (individual members)
What: definitions of active, sleeper, dozer licences and their rights
Why: very high level of sleeper licences in the Cudgegong valley

Options: not specified

Who: Mallee Catchment Management Authority, Victoria
What: access to the new tradeable sales product by irrigators downstream of Nyah
Why: to accommodate those who wish to use sales

Options: needs to be made available as soon as possible

Who: Maranoa-Balonne Catchment Management Association, Qld
What: undeveloped areas in northern catchment may not be able to equitably develop
Why: through having to compensate for an over committed southern area and to maintain sustainability of the system at their cost

Options: not specified

Who: Murray Darling Association
What: illegal works on river systems; unregulated catchments versus downstream users; not all water is volumetrically measured and concerns re accuracy of measurement; sleeper and dozer licenses and inequity of benefits; storages for recycling water may be used to store water
Why: —
Options: —

Who: MIA Council of Horticultural Associations NSW
What: trading (or capacity to trade) existing prior to 1993/94 should be included in Cap
Why: the Murray valley was the recipient of the water and obtained an increased Cap; the Murrumbidgee was disadvantaged due to the water not being activated in the 1993/94 year due to it being a wet season
Options: adjust the Cap upwards for the Murrumbidgee

Who: MIA Council of Horticultural Associations NSW
What: the Cap did not fully take into account DLWC “fixed commitments” (ie. system losses, town water, stock and domestic, etc), instead relying on level of development
Why: DLWC takes this water out of the available resource as a contingent liability
Options: the full amount of fixed commitments existing in the 1993/94 year should either be fully included in a larger Cap or left completely outside the Cap

Who: MIA Council of Horticultural Associations NSW
What: Murrumbidgee Cap structure is unclear, especially in construction of the Cap for high security entitlement
Why: high security allocation was not recognised in the Cap construction; “total volume of high security and other sleeper and dozer licences was in fact included in the Cap”
Options: needs to be reviewed

Who: MIA Council of Horticultural Associations NSW
What: high security water users have never had access to of allocation flows or system savings; present restriction on trade is a hollow argument
Why: —
Options: —

Who: MIA Council of Horticultural Associations NSW
What: high flow licences have not been taken into account in Cap
Why: — these can be activated under certain circumstances and may or may not be metered
Options: need separate Caps for high flow licences, conjunctive licences, Lowbidgee and groundwater

Who: MIA Council of Horticultural Associations NSW
What: unregulated rivers and streams
Why: licences on unregulated sections of rivers are not currently under the Cap
Options: a separate Cap or the current Cap be expanded to include them

Who: MIA Council of Horticultural Associations NSW
What: farm dams
Why: extractions and use should have a separate Cap and should be metered if used for other than stock and domestic
Options: a separate Cap

Who: MIA Council of Horticultural Associations NSW
What: multiple valley Caps — a Cap including two or more valleys where an average could be established may resolve some of the current difficulties
Why: would provide more flexibility in valley compliance
Options: multiple valley caps

Who: MIA Council of Horticultural Associations NSW
What: water trading restrictions involving a discount between buyer and seller have been introduced as it is affecting the management of the Cap. Also has impact on income production.
Why: this is of concern because it does not follow COAG principles and may discourage efficiency improvements
Options: the Cap should not impede development of a properly functioning water transfer market; and compensation should be paid to those impacted by water reform processes

Who: MIA Council of Horticultural Associations NSW
What: those who did not participate in permanent water trade now have a penalty for complying with Government reforms
Why: —
Options: —

Who: MIA Council of Horticultural Associations NSW
What: development, particularly on unregulated rivers, and new farm dams policy and how this will be considered in the Cap
Why: these developments should not have been allowed to extract water if they had never previously extracted water
Options: all water should be sourced from the market

Who: MIA Council of Horticultural Associations NSW
What: restructuring package needs to be developed to address equity issues, including resources and a licence buy back for over committed rivers
Why: the Government issued the licences and therefore enabled their market value
Options: Government to be responsible for reducing the extractive capacity of licences and to recognise the inherent capital value

Who: Murrumbidgee Irrigation NSW
What: potential for inter valley transfers in 1993/94 was not included in the Cap. 100,000 ML was approved for transfer from Murrumbidgee to the Murray in 1993/94
Why: did not occur due to climatic conditions
Options: —

Who: Murrumbidgee Irrigation NSW
What: impact of high security activation on general security availability not included in the Cap and will impact general security users
Why: because the full high security commitment was not included in the Cap, any activation over 53% by high security is at the expense of general security availability. Reforms have not been included in the Cap, impacting on security.
Options: not specified

Who: Murrumbidgee Irrigation NSW
What: EC credits resulting from water reforms have not gone to those who earned them.
Why: —
Options: —

Who: North East Catchment Management Authority, Victoria
What: entitlement to sales water
Why: creation of ‘medium security right’ for irrigators will eliminate potential development in areas other than amongst existing irrigators
Options: not specified

Who: North-West Catchment Management Committee, NSW
What: water should not be traded outside the Namoi valley, also transfer between regulated and unregulated streams
Why: long term equity problems
Options: —

Who: Ricegrowers Association of Australia
What: fixed water commitments were not included in the Cap (only 160 GL of fixed commitment allocation of 311 GL was included in the Cap)
Why: this places an inequitable burden on general security users
Options: not specified

Who: Ricegrowers Association of Australia
What: ability of high security users to use/trade 100% of entitlement results in a potential 100-200 GL reduction in general security resource set. Failure to include capacity for inter-valley trade creates further inequities
Why: —
Options: not specified

Who: Ricegrowers Association of Australia
What: NSW Government action to issue licences to capture/extract water post Cap implementation and cumulative effect of farm dams policy is not understood
Why: to treat these developments as being outside Cap creates further inequities
Options: treat outside the Cap or increase the Cap volume

Who: Ricegrowers Association of Australia
What: history of use has not been recognised as part of a nominal property right
Why: HOU should be recognised due to encouragement by Governments and investment in capital infrastructure
Options: recognise HOU within current rights through access to off allocation flows and creation of a separate right for off allocation in development of definitive property rights. The Independent Audit Group established a key principle that history of use of entitlement must take precedence over no history of use of entitlement

Who: Riverland, SA
What: adherence to Cap by upriver States
Why: suspicions
Options: ongoing audit system to be open and comprehensive

Who: Tumut River Landowners Association NSW
What: Snowy scheme impact on conduit rivers
Why: loss of soil, water logging, high watertables, and landowners are limited to primitive forms of agriculture
Options: Cap is one measure to control this inequity, and part of measures taken to rationalise water use in Australia

Who: Western Catchment Management Committee NSW
What: Barwon-Darling inflexible approach to Cap; economic and social impacts; active and inactive licences; variation in definition of Cap; impact of Queensland Cap
Why: socio-economic impacts unknown; Cap for Queensland is unknown and 37% of water comes from that State
Options: not specified

Who: Yanco Creek and Tributaries Advisory Council

What: inequities between those who have invested in irrigation development and those activating sleeper/dozer licences. Also concerns in restricting access to off allocation to those with a history of use.
Why: those who have invested are being penalised
Options: not specified. Consistent guidelines for determining and announcing off allocation needs to be developed

Who: Yanco Creek and Tributaries Advisory Council

What: amount of the Cap
Why: should be increased by 100 GL to reflect the high security activation that did not take place in 1993/94 due to seasonal conditions
Options: increase volume of the Cap by 100 GL
Review of the Operation of the Cap

Implementation and Compliance

Report of the Independent Audit Group

FEBRUARY 2000
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Implementation and compliance issues are matters which evoke a wide range of comments. Some of the issues raised by stakeholders in particular, reflect concern about action being taken in neighbouring jurisdictions and concern that others are somehow being given better treatment because of a lack of adequate action to ensure satisfactory implementation and compliance in other jurisdictions. Of particular concern has been the time taken to complete the water planning processing in Queensland and the perception that diversions have been allowed to grow significantly in that State. The current lack of a satisfactory Cap for the north western NSW rivers has also been cited as further evidence of the lack of satisfactory implementation and compliance.

The IAG has been particularly conscious of the delays that have been experienced in the full implementation of the Council’s 1995 decision to introduce a ‘Cap’ on further diversions within the Basin. However, the IAG has also been pleased with the progress made across the Basin in general, notwithstanding delays in finalising Cap definitions and compliance arrangements in some places. The IAG notes that with the completion of the Queensland WAMP and WMP programs by mid 2000 and progress made on the Border Rivers in NSW that it should be possible to introduce a more formal compliance program using Commission accredited simulation models as part of the 2000/01 water year. This will not conclude the implementation process and introduction of formal compliance arrangements across all valleys. However, it will represent a significant stage in the process of implementing the Cap and is likely to be seen by the Basin community as a demonstration of the commitment that the IAG has seen within all partner governments, towards the implementation of the Cap.

Having reached this important and significant milestone, the IAG is conscious that this represents only part of the objectives of the Council as contained in its 1996 report to introduce the Cap. There are clearly wider issues to do with the future allocation of instream water for environmental purposes which are not currently addressed by the implementation of compliance rules for the Cap. Thus, while not part of the IAG’s terms of reference, the opportunity has been taken to reflect some of the questions raised by partner governments and stakeholders about how these environmental flow decisions and priorities might be made. This represents the ‘Next Step’ which is only possible having reached the position whereby mid 2000, the IAG expects each jurisdiction to have clear Cap definitions for its major diversions and workable compliance arrangements.

In addressing the specific terms of reference given to the IAG, a number of recommendations for Council consideration have arisen. These are:

It is recommended that:

i) the Commission’s office give consideration to the preparation of a register of Cap definitions as agreed by the partner governments as they finalise their monitoring and compliance programs;

ii) within the spirit of the Cap, jurisdictions should be encouraged to consider groundwater usage and allocation rules on an integrated basis with surface water diversions;

iii) jurisdictions should be asked to advise on likely implications of groundwater usage on the integrity of the Cap and downstream river health;

iv) MDBC should consider its policy position in relation to groundwater usage and rules if the likely impact as advised by the jurisdictions is significant;

v) MDBC note general compliance with Cap requirements in South Australia, Victoria, and the ACT;

vi) MDBC note that there has been a breach of the draft Schedule F requirements for the Barwon-Darling and high individual year exceedence of the Cap diversion target for the Lachlan and Murrumbidgee;

vii) MDBC note the substantial growth in storages and by implication diversions in Queensland;

viii) each jurisdiction puts in place an appropriate quality management system for the management of metering, monitoring and reporting data;

ix) the States and ACT through the MDBC establish a set of trading rules to enable free trade within and between valleys, within and between States (and the ACT);

x) models for the major valleys be completed and forwarded to the MDBC for assessment and endorsement in time for the finalisation of Schedule F in September 2000;

xi) the definition of the Cap be modified to delete reference to “in unregulated rivers this Cap may be expressed as an end-of-valley flow regime”;

xii) Schedule F be modified to delete the end-of-valley flow option;
(iii) Clause 17 in Schedule F be modified to read:

**Advice to Council on remedial actions**

17. (1) The Government of a State referred to in paragraph 16(a) must:

(a) report to the next Ministerial Council after a declaration is made under that paragraph, setting out:

(i) the reasons why diversions exceeded the Murray-Darling Basin diversion cap; and

(ii) action taken, or proposed to be taken by it to ensure that cumulative diversions are brought back into balance with the cap; and

(iii) the valley model predictions of the period within which it is predicted that the cumulative diversions will meet the long term diversion Cap; and

(b) report to each subsequent meeting of the Ministerial Council on action taken, or proposed to be taken by it to ensure that cumulative diversions are brought back into balance with the cap in accordance with paragraph 17(1)(a), until the Commission revokes a declaration pursuant to sub-clause 17(2).

(2) When the Commission is satisfied that a State in respect of which a declaration has been made under paragraph 16(a) has brought the cumulative diversions back into balance with the cap and is once more complying with the Murray-Darling Basin diversion cap in all respects, it must:

(a) revoke the declaration; and

(b) report that fact to the next meeting of the Ministerial Council.

and

(xiv) Clause 11(8)(a) in Schedule F be modified to read “include information about every water year concluding after 1 November 2000”.

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The Independent Audit Group (IAG) has been asked to undertake a review of the Cap implementation and compliance. This forms part of a wider review of the operation of the Cap and how it can be further refined to meet the needs of the communities within the Murray-Darling Basin being undertaken by the Murray-Darling Basin Ministerial Council.

The IAG in its initial report to the Murray-Darling Basin Ministerial Council placed some emphasis upon issues surrounding the implementation and compliance arrangements for the Cap. The IAG recognised that without widely held confidence in the physical operational aspects of the Cap, the Ministerial Council's objective of a better balance between consumptive and in-stream use of water would not be achieved.

As part of its review of the implementation and compliance issues associated with the operation of the Cap, the IAG has again referred to the six equity and consistency principles that it established as 'tests' for assessing proposals and submissions as part of its initial report on 'Setting the Cap'. Of specific relevance to this aspect of the current Review of the Operation of the Cap has been two of those principles, namely that:

- water management processes be transparent and auditable; and
- a system of administration be implemented which is easily understood and which minimises time and costs (administrative efficiency).

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1. Introduction

2. Terms of Reference

The Murray-Darling Basin Commission (MDBC) provided the following terms of reference for the five-year Review of the Operation of the Cap:

“To review the operation of the Cap (and, importantly, not the Cap itself) and provide suggestions for the more effective future operation of the Cap through obtaining independent assessments (involving the Independent Audit Group and partner governments to the initiative as appropriate) in each of the following areas:

Implementation and Compliance

By assessing progress in implementing the Cap including impediments and constraints to full implementation and addressing issues associated with ensuring Cap compliance covering the methodology adopted including the proposed Schedule F.”

Main tasks:

1. Partner governments, the CAC and the office of the Murray-Darling Basin Commission are asked to make a submission to the Review on the following issues:

   (i) the implementation of the Cap including impediments and constraints to its full implementation;
   (ii) ensuring Cap compliance;
   (iii) the form and content of a permanent Schedule F; and
   (iv) any outstanding implementation or compliance issues that may put at risk the future management of the Cap.

2. The Independent Audit Group (IAG) will be engaged to review submissions received in this component of the Review, meeting with partner government representatives to discuss their submission and providing independent advice on the following issues:

   (i) has compliance been achieved at jurisdictional level?
   (ii) are there any impediments to achieving compliance?
   (iii) how has compliance, or otherwise, of different jurisdictions affected the implementation of the Cap in other jurisdictions;
   (iv) are the arrangements in place sufficient to ensure confidence in the Cap by governments and the community?
   (v) has the confidence of governments and community in the Cap been enhanced by the level of compliance to the Cap?
   (vi) have effective compliance tools (computer simulation models) been developed?
   (vii) the form and content of a Schedule F for Council consideration.

By way of clarification, the IAG was provided with additional advice that the Review of the operation of the Cap should cover:

“(a) the clear areas of responsibility of the Ministerial Council/Commission (using the Murray-Darling Basin Agreement as a guide as necessary);
(b) those intra State issues that:
   (i) have been covered through the IAG process to date (eg, the Queensland WAMP process);
   (ii) are appropriate given arrangements in Schedule F (where Cap implementation is defined at a sub-State level);
   (iii) have inter-jurisdictional implications and/or repercussions.

And where issues have been raised in the submissions that fall outside these instructions, recognising the impact of intra-valley issues on the operation of the Cap, the IAG should:

(c) raise the issues in their report and make recommendations about appropriate action/response;
(d) where appropriate, use the opportunity to highlight outstanding issues (including education, communication) in the States.

However, the IAG should focus on the principles raised and not become involved in particular cases.”
3. Review Process

The IAG has developed an open and accountable process in the conduct of its annual audits. A similar approach was utilised for this Review.

The IAG met with representatives of Commonwealth, States, and the ACT to discuss their respective submissions as they relate to the implementation and compliance term of reference during the period 31 January to 3 February 2000. The IAG has also analysed the Community Advisory Committee’s and individual stakeholder submissions for implementation and compliance issues and possible options for addressing the issues. In addition the IAG met on 1 February with representatives of the Ricegrowers’ Association of Australia, the MIA Council of Horticultural Associations and Murrumbidgee Irrigation.

Where implementation and compliance issues raised were the clear responsibility of any one jurisdiction and outside the terms of reference for the IAG, the IAG has suggested the issue be addressed by that jurisdiction.

Following the meetings and review of submissions, a draft report was prepared and circulated to the Commonwealth, States and ACT partner governments for comments on factual issues and preliminary findings. Such comments were considered by the IAG, however all of the final findings and recommendations are solely those of the IAG.
4. Implementation and Compliance

Under the arrangements for this Review, community and other interest groups were invited to submit written proposals to the Review. Partner governments were asked to incorporate aspects of community views and comment in their own submissions. The IAG met with representatives of all partner governments and the following provides an overview of their comments and views on implementation and compliance issues.

4.1 South Australia

South Australia raised several matters in relation to implementation and compliance with the Cap. The matters raised by South Australia broadly reflected their concern that, being at the bottom end of the Basin, decisions taken by partner governments upstream of South Australia have a significant impact upon the quality and quantity of water that is available for consumptive and instream uses within South Australia.

Issues requiring further action raised by South Australia were:

- the need to reinforce the culture and commitment to the implementation of the Cap across the whole Basin;
  - community concern is heightened by loose statements from some industry, community and political groups which imply that the Cap should be abandoned;
  - South Australia is particularly conscious of the initiatives it has taken within its jurisdiction to cap consumptive use from the Basin at a specific volumetric level while some other partner governments are still to determine what is the definition of the Cap in their respective jurisdiction;
- the need for further improvement in the monitoring and reporting of water taken for consumptive use, with specific issues requiring further considering being:
  - the extent of unmetered diversion of water across the Basin;
  - the need for independent assessment and continuing dialogue on the use of models to determine compliance within the Cap;
  - the introduction of penalties for non-compliance with the Cap limits on diversions;
  - a periodic (every five years) more comprehensive audit of water usage across the Basin.

South Australia also raised the wider issue of the allocation of water flows to meet competing environmental enhancement objectives within the Basin. Although within the Cap and consistent with the overall objectives of the Ministerial Council to achieve a better balance between consumptive and instream uses, environmental enhancement activities upstream from South Australia can have important implications for flows passing through South Australia.

4.2 Victoria

Victoria has progressed its implementation of the Cap through the implementation of its bulk water entitlements system. When fully implemented, bulk water entitlements will cover 98 percent of all diversions in the Victoria component of the Basin. The remainder of diversions are by private diverters under licences from unregulated streams. Growth of these diversions is controlled by trading rules that are being progressively reviewed and through formal stream flow management plans. It is expected that these plans will be put in place over an extended number of years.

Specific issues raised by Victoria in relation to Cap implementation and compliance were:

- the need to finalise the compliance reporting arrangements under Schedule F and to implement Schedule F on a permanent and ongoing basis;
- the need for some form of requirement within the compliance arrangement to ‘make good’ any use that was deemed to exceed the specified river valley Cap;
- while fully supporting the use of climate adjusted models to establish compliance with the Cap, concern about the cost associated with preparing and maintaining these models for smaller regulated systems;
- concern with the level of compliance and operating rules adopted by other partner governments, particularly where it appears that diversions are exceeding the Cap (or the spirit of the Cap where the ‘Cap’ has yet to be determined);
- the need for wider community awareness and understanding of what is happening in other partner government jurisdictions to allay concerns about apparent differences in approaches adopted throughout the Basin.

4.3 New South Wales

New South Wales has been progressively implementing a program of water reform as part of its Ecologically Sustainable Development (ESD) program. The development of environmental flow rules has been integral to this program,
along with implementing the Cap on diversions. While the environmental flow rules may influence diversions, they are not designed or targeted at achieving Cap compliance. Maintaining Cap, however, is fundamental to achieving the benefits targeted by the environmental flow rules. For Cap management purposes, NSW has introduced various strategies such as controlling access to off-allocation water and reducing on-allocation levels as part of its control on water diversions. In addition, various levels of carry-over now operate across the State and continuous accounting is being trialed in the north western valleys.

All interest groups in NSW are in general agreement that the Cap is an essential measure to protect water rights, security of supply and business investment. However, NSW has concern about the problems of using annual comparisons of diversions against Cap volumes as the only measure of performance. NSW will use its allocation (both on- and off-) rules as tools to meet the Cap requirements. NSW notes however that:

- there is an expectation that rule changes will occur immediately following the reading of water meters whereas in fact this process takes about one year; and
- because of the inter-annual variation in valley flows, these rules will be more effective in some years and less in others;
- thus it may be some years before conditions are such that access rules ‘bite’ and bring the usage back to the Cap.

In these circumstances, NSW wants to ensure that there is recognition in the monitoring and enforcement arrangements for the climatic pattern of river flows.

NSW endorses the use of long term climate adjusted simulation models such as the Integrated Quantity Quality Model (IQQM). However, in order to redress the backlog in preparing these models, NSW is seeking endorsement of some form of simplified draft models which may be used for compliance purposes. This would require some clear guidance on interim interpretation of the Schedule F provisions if draft models were to be used on some minor streams for a number of years.

Formal approval and endorsement of models under the proposals outlined in the draft Schedule F is supported by NSW who is ready to submit its first model for formal assessment. A clear start date for Cap compliance enforcement is supported by NSW.

4.4 Queensland

Queensland has noted that it effectively introduced a ‘cap’ on its section of the Basin prior to the Council’s decision in 1995 by way of a direction to hold any new applications for diversions. Having obtained Council agreement to a modified interim Cap to allow ongoing planning and management until a final Cap could be determined, Queensland embarked on an extensive evaluation and review program under the framework of Water Allocation and Management Planning (WAMP) and Water Management Planning (WMP) initiatives.

This WAMP and WMP program is now nearing completion and it is expected that outcomes will be available by mid 2000. This will coincide with the introduction of new legislation which will give Queensland the power to control diversion of water from flows that are not contained within the ‘bed and banks’ of a watercourse.

With the completion of the WAMP and WMP process, Queensland will be in a position to agree a Cap and to develop appropriate modelling and monitoring arrangements against which compliance with the Cap can be measured.

On Schedule F, Queensland’s views is that its finalisation should be deferred until water management plans are finalised for the Queensland section of the Basin and the Queensland long term Cap defined. Management of diversions into ‘on-stream’ storages is recognised as being an important element of the water management plans currently being developed in Queensland. They will also need to be reflected in the Schedule F reporting arrangements and the management response to exceedence of the Cap once it is determined.

4.5 Australian Capital Territory

A Cap has yet to be determined for the ACT. It is expected that the ACT will shortly bring forward to the Council a proposal for a Cap covering the Territory together with proposed management rules.

One of the outstanding issues for the ACT is the trading rules to be applied to water being traded up or down the Basin from the ACT. This issue was addressed by the IAG in its November 1999 Report2. Negotiations between the ACT and NSW have yet to be concluded to resolve this issue.

From an implementation and compliance perspective, the ACT maintains a system of

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volumetric licensing of diversions. ACTEW is the primary ‘user’ and the provider of reticulated water for domestic and industrial use throughout Canberra.

Reporting of water diversions under the Schedule F proposal does not present a difficulty for the ACT, although special consideration may need to be given to the ACT’s participation in the MDBMC under a Memorandum of Understanding when formalising the legal arrangements for the operation of Schedule F.

4.6 Stakeholder Submissions

Submissions were invited from other stakeholders across the Basin. These submissions identified a range of issues relating to implementation and compliance (see Appendix 1). Not all of the issues raised are matters for resolution at Ministerial Council level, but rather reflect individual State jurisdictional issues, primarily to do with the implementation of Cap in that State. Nevertheless, there are a number of matters which were reflected in comments from the other stakeholders. They include:

- a level of mistrust in the commitment by NSW and Queensland to the implementation of the Cap, particularly in the light of increased diversions in certain valleys and delays in completing the WAMP/WMP program;
- concern about aspects of the recovery of exceedence of Cap provisions as proposed within the draft Schedule F;
- implications of climatic conditions on the operation of the Cap;
- the inter-relationship between the Cap on surface water and the allocation and management of groundwater resources;
- the monitoring and quantification of farm dams and their treatment under the Cap;
- the need for tightening of allocation arrangements for inter-valley transfer of water.
5. Discussion of Issues

5.1 Response to the Terms of Reference

The terms of reference provide a list of issues that the IAG is to consider. For purposes of this report, each of these issues has been addressed in turn below.

1(i) the implementation of the Cap including impediments and constraints to its full implementation.

The issues raised in submissions from the partner governments and stakeholders cover a range of Basin wide and inter-jurisdictional issues. These issues include:

- the need for agreement on the final form of Schedule F (see discussion under 2(vii) below);
- the completion followed by the auditing and Commission approval of the computer models to be used to define the Cap (see discussion under 2(vi) below);
- completion of an agreed register of Cap definitions for designated river valleys throughout the Basin including definitions of what constitutes a diversion in each case;
- improved monitoring and reporting of all forms of diversions (see discussion under 2(vi) below);
- agreement on the definition and quantification of savings through changed management practices, infrastructure maintenance or improved management facilities; and
- provision of adequate resources for the implementation of the Cap.

Register of Cap Definitions

Preparation of an agreed register of Cap definitions represents a practical measure which would contribute to the implementation of the Cap, and in particular the broad acceptance of the operation of the Cap within the Basin community. The IAG has on previous occasions highlighted the need for action at a jurisdictional level to promote wider understanding and acceptance of the Cap and its operation. The individual jurisdictions are in the best position to present these arguments to their relevant constituencies. However, to the extent that the Commission can assist in this marketing exercise, it should be encouraged to do so.

One of the difficulties encountered at an individual constituency level is misunderstanding regarding aspects of the Cap and its application in other jurisdictions. To the extent that an agreed set of Cap definitions would contribute to a better understanding by stakeholders, the Commission’s office could usefully assist in the preparation of a list of Cap definitions which could be widely published.

Recommendation:

i) It is recommended that the Commission’s office give consideration to the preparation of a register of Cap definitions as agreed by the partner governments as they finalise their monitoring and compliance programs.

Definition and Quantification of Savings

Agreement on the definition and quantification of savings in diversions will assist in the operation of the Cap. However, it is not essential to the implementation of the Cap itself. Rather, it will contribute to a greater understanding of the potential for allocation of water for in-stream purposes, and thus can be expected to become of greater importance as the implementation process proceeds and further consideration is given to improving existing flow regimes or utilising water for consumptive purposes within the Cap.

Inter-jurisdictional issues requiring completion are:

- agreement on interstate trading rules between NSW and the ACT (see discussion under 2(ii) below);
- the resolution of accounting rules for water use in the Barmah-Millewa forest (see discussion under section 5.2 below);
- agreement on the way that environmental savings and environmental losses are treated under the Cap (see discussion under section 5.2 below);
- agreement on the way that any reductions in transfer from the Snowy River will be treated under the Cap; and
- the treatment of groundwater under the Cap.

Snowy River Diversions

The treatment of Snowy River transfers is a matter which the IAG believes should more appropriately be considered by the individual participating States, namely NSW and Victoria. Victoria has indicated that its preference in returning flow to the Snowy River is to utilise savings achieved from operation of the Murray system. NSW has not indicated how it might allocate water for this purpose should it decide to redirect flows.
From a Cap implementation and compliance perspective, any decision to redirect water into the Snowy River is not a matter requiring consideration as part of this Report. However, the IAG notes that to the extent that water is diverted into the Snowy River it effectively has an impact upon the ultimate flows through the Murray-Darling system and thus should either be considered within the Cap, or as an allocation for environmental purposes which would need to be considered as having higher priority than the in-stream health of the Murray-Darling system itself. An allocation from savings achieved from within the Murray-Darling Basin would be consistent with the Council’s 1995 decision to maintain existing flow requirements in the Basin, but would not contribute to any improvement in those flows (see also discussion under section 5.2).

Treatment of Groundwater

Studies indicate that about 50 percent of the base load of streams can be fed by groundwater, although this proportion varies significantly. For example, in some locations, streams contribute significantly to the recharge of groundwater.

The Cap on surface water use has resulted in some increased pressure on groundwater, although at this time it is unclear as to what extent this is a problem. Victoria has advised that it is currently implementing a program to ensure that groundwater resources are allocated on a sustainable basis.

Currently groundwater is not included within the Cap. The IAG is of the view that in principle, despite the exclusion of groundwater from the Cap, the total water resource should be managed sustainably. Should there be substantial leakages between streams and groundwater aquifers there could be important implications for the Cap. For example, by having groundwater outside of the Cap could encourage greater usage of this resource which, if the aquifer is directly fed by local streams, could contribute to reduced downstream flows and associated river health problems and increased salinity.

The extent to which this problem exists or is likely to arise will more likely be a jurisdictional issue. However, there could be important river health problems for downstream users and raising inter-jurisdictional concerns. Thus, the IAG is of the view that further consideration needs to be given to this issue following appropriate analysis of available information.

Recommendations:

It is recommended that:

i) within the spirit of the Cap, jurisdictions should be encouraged to consider groundwater usage and allocation rules on an integrated basis with surface water diversions;

ii) jurisdictions should be asked to advise on likely implications of groundwater usage on the integrity of the Cap and downstream river health;

iii) MDB should consider its policy position in relation to groundwater usage and rules if the likely impact as advised by the jurisdictions is significant.

1(ii) ensuring Cap compliance.

See discussion under 2(i), (ii), (iii) and (vi) below.

1(iii) the form and content of a permanent Schedule F.

See discussion under 2(vii) below.

1(iv) any outstanding implications or compliance issues that may put at risk the future arrangement of the Cap.

See discussion under 1(i) above and 2(i) and (ii) below.

2(i) has compliance been achieved at a jurisdictional level.

Cap compliance has been assessed annually by the IAG and reported on. A State by State and ACT summary is:

South Australia
Fully compliant in all years.

ACT
No Cap has yet been established but consumption to date is likely to be below any Cap agreed on.

Victoria
The 1996/97 report suggested that diversions from the Murray Goulburn system could have exceeded the Cap although at that time no climate adjusted Cap was available.

In all other years diversions were below the climate adjusted Cap targets.
New South Wales

In 1996/97 consumption on the Murrumbidgee and Lachlan appeared to exceed the Cap. Other valleys were within Cap limits.

Similar concerns were expressed in 1997/98 and the Barwon-Darling and Border Rivers also appeared to have high levels of diversions although no climate adjusted models were available for definitive comparisons.

In 1998/99 the IAG advised that using the provisions of draft Schedule F the Barwon-Darling was clearly in breach. A similar comment was made about the Lachlan although following the provision of additional information by New South Wales this proved not to be the case.

The 1998/99 report also indicated that diversions exceeded the climate adjusted Cap for the Murrumbidgee but that the cumulative differences were not in breach of draft Schedule F.

Queensland

No Cap has yet been established for Queensland. Council agreed to base a decision on the outcome of proposed FMP, WAMP and WMP processes for the Border Rivers, Condamine-Balonne and Moonie and Paroo/Nebine/Warrego respectively. Those were originally expected to be completed by July 1997 but recent advice is that details on Queensland’s position on most valleys will be available to Council in July 2000.

In the interim there has been an increase in storages and probably diversions. Since 1993/94 there has been:

• an increase from 360 GL to 1,050 GL in on-farm storages for river diversions;
• an increase from 44 GL to 120 GL in floodplain storages. There are no constraints on water diversion from floodplains as it remains unlicensed; and
• an increase in total diversions from 338 GL to 608 GL in 1998/99 although no direct valid comparisons are available due to differences in rainfall and flow conditions.

It is difficult however, not to conclude that there has been significant growth in storages and diversions and as a consequence the IAG recommended that a moratorium be placed on further diversions in their 1997/98 and 1998/99 reports.

This growth is likely to constrain the outcome of the present planning studies in terms of achieving a balance between diversions and river health including downstream impacts.

Recommendations

It is recommended that:

i) MDBC note general compliance with Cap requirements in South Australia, Victoria, and the ACT;

ii) MDBC note that there has been a breach of the draft Schedule F requirements for the Barwon-Darling and high individual year exceedence of the Cap diversion target for the Lachlan and Murrumbidgee;

iii) MDBC note the substantial growth in storages and by implication diversions in Queensland.

2(ii) are there any impediments to achieving compliance.

The implementation of the Cap on diversions in the Murray-Darling Basin is still progressing. The major delay in implementing Council’s 1995 decisions is the availability of resources within Government agencies, particularly New South Wales, Queensland and Victoria, to develop suitable models to determine Cap limits and ensure future compliance.

An equally important factor has been to manage the change process in consultation with the community. To provide adequate information to stakeholders and to ensure opportunities for meaningful involvement is also resource intensive.

Despite this considerable progress has been made but there are a number of outstanding issues that need to be addressed before the Cap can be fully operationalised. These include:

Basin-wide Issues

The following aspects of Cap implementation need to be addressed throughout the Basin:

• agreement upon the permanent form of Schedule F — Cap on Diversions to the Murray-Darling Basin Agreement (see 2(vii));

• completion, auditing and Commission approval of the computer models to be used to define the climate adjusted Cap target for each water year (see under 2(vii));

• improved monitoring and reporting of all forms of diversion including diversion on unregulated streams, from farm dam (all
jurisdictions) and floodplain harvesting diversions (New South Wales and Queensland).

**Inter-jurisdictional Issues**

The following aspects of Cap implementation which require completion are of an inter-jurisdictional nature:

- agreement on interstate trading rules;
- the resolution of accounting rules for water use in the Barmah-Millewa forest, including the options for borrowing, paying back and trading from this account by NSW and/or Victoria;
- agreement on the way that any reductions in transfers from the Snowy River will be treated under the Cap.

Outstanding Cap implementation tasks by jurisdiction are:

**New South Wales**

- resolution of the Cap definition for the Border Rivers taking into account the equity issue associated with the enlargement of Pindari Dam;
- development of Cap arrangements for the Barwon-Darling, Lower Darling and the Lowbidgee District.

**Victoria**

- resolution of the Cap definition for the Goulburn/Broken/Loddon designated river valley to account for the equity issue associated with the operation of Lake Mokoan.

**South Australia**

- provision of reports on the Cap for country towns supplied from the River Murray and subsequent determination of an appropriate Cap for this use;
- the completion of the installation of meters within the Reclaimed Swamps to more accurately monitor diversions and from this develop an appropriate Cap and arrangements for trading of this water; and
- the revision of the Cap for pumped irrigation in South Australia, which should be set at the absolute number of 440.6 GL, rather than 90 percent of 489.6 GL.

**Queensland**

- the completion, auditing and Council consideration of the Water Allocation Management Plans (WAMPs) and Water Management Plans (WMPs) (as appropriate) which will be used to define the Cap target diversions;
- the introduction of an effective moratorium on further growth in diversions while the WAMP and WMP process are completed.

**Australian Capital Territory**

- the resolution of a Cap for the ACT, which is within the range of the options proposed in the paper — 'Options for Implementing the Murray-Darling Basin Water Cap in the ACT' (July 1999).

A number of these issues have been addressed in other parts of this report or the Equity report. Two issues will be dealt with in this section. These are:

i) need for quality management systems for collection of metering, monitoring and reporting data;

ii) finalisation of interstate trading rules.

**Quality Management Systems**

The proposed Schedule F is the vehicle to administer the Cap monitoring and reporting on key components for ensuring Cap compliance. This reliance however is heavily dependent on the information obtained from metering, monitoring and reports being reliable and verifiable. This can only be achieved if each jurisdiction puts in place an appropriate quality management system that outlines the processes and checks required for the handling of data. The IAG audit is only as good as the information supplied to it.

**Recommendation:**

It is recommended that:

i) each jurisdiction puts in place an appropriate quality management system for the management of metering, monitoring and reporting data.

**Finalisation of Interstate Trading Rules**

One key element of the Cap was the vision that water would move from areas of low value to high value. This would enable individual growers to make decisions to optimise their returns. While rules have been established within valleys and a pilot interstate trading program has been trialled there is now a need to remove the barriers perceived in a number of the submissions to increased movement within and between valleys, and within and between States.
**Recommendation:**  
It is recommended that:  
i) the States and ACT through the MDBC establish a set of trading rules to enable free trade within and between valleys, within and between States (and the ACT).

2(iii) how has the compliance, or otherwise, of different jurisdictions affected the implementation of the Cap in other jurisdictions.

A number of submissions addressed the perceived non-compliance by Queensland, and in the case of the Barwon-Darling what appears to be a slow down in the finalisation of a River Management Plan that ensures its own compliance.

Queensland is not in breach of the Cap as Council agreed to consider an equity adjusted Cap following the completion of WAMP studies. Delays in completing the WAMPs and growth in storages and diversions during this period has resulted in a number of critical comments in the submissions. This has also been a matter which the IAG has commented upon in previous reports.

In the main, individual jurisdictions have progressed the Cap in their own jurisdiction. It is mainly within the farming community that there is concern about the equity of accepting a Cap within their valley while there is real or perceived growth in others. This issue will principally be addressed when the Queensland, Barwon-Darling and Border Rivers (NSW) Caps are finalised. However, there will continue to be a need for improved, coordinated release of information on compliance arrangements across the Basin (see 1(i) above and 2(iv) below).

2(iv) are the arrangements in place sufficient to ensure confidence in the Cap by governments and the community.

The IAG on the basis of the submissions from the Commonwealth, States, ACT and stakeholders and discussions with a number of representatives of the above is of the view that there continues to be support for the Cap within the Commonwealth, States and ACT. Confidence in implementation of the Cap is likely to further increase when implementation is finalised and there is agreement to Schedule F. Concern has been expressed at the time taken for the completion of the Queensland planning studies and confidence is likely to increase further when these studies are finalised and provide an acceptable balance between diversions and river health including downstream impacts.

Confidence in the Cap has been assisted by annual audits by the Independent Audit Group. The reports of these audits are a public document and are readily available to the public.

Community confidence is not at the same level. The level of confidence varies within States depending on how the implementation has been handled, the number of equity issues and the degree of impact on individual irrigators. On the basis of the individual submissions received and the Community Advisory Committee report one can only conclude that while confidence is high in South Australia, Victoria and the ACT, similar high levels do not exist in New South Wales.

There is also still considerable uncertainty in the Queensland portion of the Basin pending the finalisation of the Border Rivers Flow Management Plan, the Condamine-Balonne WAMP and the WMP’s for the Moonie and Warrego/Paroo/Nebine.

2(v) has the confidence of governments and community in the Cap been enhanced by the level of compliance to the Cap.

This issue has been addressed variously in sections 2(i) — (iv) and (vi).

2(vi) have effective compliance tools (computer simulation models) been developed?

As individual jurisdictions developed Cap implementation strategies it quickly became evident that computer simulation models were required for the major valleys to determine river flows and diversions over a range of climatic conditions. Advice received from the Office of the Murray-Darling Basin Commission indicates that following the division of the Basin into ‘Designated River Valleys’ for Cap compliance under Schedule 1 of Schedule F, some 22 compliance tools are required throughout the Basin. On a jurisdictional level the progress with the development of these compliance tools is summarised in Table 1.

There are currently no models endorsed by the MDBC as required under Schedule F for the determination of the Cap in the Murray-Darling Basin. The IAG was advised during the review that the model for the Macquarie River Valley would be submitted to the MDBC in February 2000 and that Victoria had already submitted two completed models.
The Office of the MDBC advised that it had responsibility for three of the incomplete models namely:

- the lower Darling from the furthest upstream reach of Menindee Lakes to the furthest upstream reach of the Wentworth Weir Pool;
- the New South Wales portion of the Murray Valley including the portion of the Lower Darling influenced by the Wentworth Weir Pool; and
- the Victorian portion of the Murray Valley including the Kiewa and Ovens.

It is critical that models for each of the valleys be completed and that the priority be for the major valleys accounting for the highest diversions and those where non compliance is a high risk.

Recommendation:

It is recommended that:

i) models for the major valleys be completed and forwarded to the MDBC for assessment and endorsement in time for the finalisation of Schedule F in September 2000.

Submissions from stakeholders also raised a number of other issues which are considered in this report.

End of Valley Flow Targets

Following advice from the IAG, Council agreed to a Cap definition (leaving aside equity issues) of:

- "the Cap is the volume of water that would have been diverted under 1993/94 levels of development."
- "In unregulated rivers this Cap may be expressed as an end-of-valley flow regime."

The IAG was persuaded to this view on the basis of information provided on the variability in flow patterns in unregulated rivers and the benefits of identifying end of system flow regimes to achieve environmental outcomes. The latter argument still holds but the IAG on the basis of submissions received during the review including those from New South Wales and Queensland suggests that the Cap definition should delete "In unregulated rivers this Cap may be expressed as an end-of-valley flow regime". This change is supported on the basis of the difficulty in measuring end-of-valley flows where there are multiple channels and where a substantial portion of the flows are on the floodplain or overland. In contrast the reliability of measuring diversion is much higher particularly with a move to metering of all diversions.

This position is also supported by the fact that end-of-valley flow targets do not protect the security of supply in a valley from reduced inflows from either unregulated parts of the valley or upstream valleys.
**Recommendations:**

It is recommended that:

i) the definition of the Cap be modified to delete reference to "in unregulated rivers this Cap may be expressed as an end-of-valley flow regime";

ii) Schedule F be modified to delete the end-of-valley flow option.

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**Compliance to Cap Targets**

Clause 17 of Schedule F deals with “Advice to Council on remedial actions”.

The focus to date has been on payback provisions and a number of the stakeholder submissions including advice from the Community Advisory Committee of the Murray-Darling Basin Ministerial Council is strongly supportive of remedial action to bring diversions back in control where cumulative above average diversions have exceeded 20 percent of the average annual diversion. Much of the debate to date is based on semantics. Every jurisdiction supports compliance to the Cap which is defined as the long term average diversion. Climate adjusted models identify annual Cap targets. A long term average implies that if there has been a period of above average use then by definition there has to be a period of below average use to achieve the long term average. The complication is that in a fully regulated environment it is possible for the responsible jurisdiction to modify management rules to bring diversions back in line with the Cap. This is more difficult to guarantee in the short term in highly variable unregulated systems. For such valleys there should be a requirement by the appropriate jurisdiction to identify remedial measures and to provide advice from models as to the likely impact of these measures. The exact time to achieve correction however is dependent on the flow regime in future years. For example, if the rule change is to reduce diversions in high flow years this decision is followed by a number of dry low flow years, correction to the long term average will not occur until the next high flow cycle. The model results, provided the model is accredited, should provide the Commission, Council and the community with the necessary assurances that appropriate remedial action has taken place.

A number of changes to Clause 17 of Schedule F are proposed to accommodate the above.

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**Recommendation:**

It is recommended that:

i) Clause 17 in Schedule F be modified to read:

**Advice to Council on remedial actions**

17. (1) The Government of a State referred to in paragraph 16(a) must:

(a) report to the next Ministerial Council after a declaration is made under that paragraph, setting out:

(i) the reasons why diversions exceeded the Murray-Darling Basin diversion cap; and

(ii) action taken, or proposed to be taken by it to ensure that cumulative diversions are brought back into balance with the cap; and

(iii) the valley model predictions of the period within which it is predicted that the cumulative diversions will meet the long term diversion Cap; and

(b) report to each subsequent meeting of the Ministerial Council on action taken, or proposed to be taken by it to ensure that cumulative diversions are brought back into balance with the cap in accordance with paragraph 17(1)(a), until the Commission revokes a declaration pursuant to sub-clause 17(2).

(2) When the Commission is satisfied that a State in respect of which a declaration has been made under paragraph 16(a) has brought the cumulative diversions back into balance with the cap and is once more complying with the Murray-Darling Basin diversion cap in all respects, it must:

(a) revoke the declaration; and

(b) report that fact to the next meeting of the Ministerial Council.

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**Date for Finalisation of Schedule F**

It is expected that the majority of equity issues, and certainly the major equity issues, will have been addressed by July 2000. With those models that have been developed it would be appropriate to commence implementation of the full Schedule F in September 2000 in time for the 2000/01 water year. This date would enable Queensland, ACT and a number of valleys in New South Wales to be included from the commencement of Schedule F.
A change to clause 11(8) is proposed to accommodate the above.

**Recommendation:**

It is recommended that:

i) Clause 11(8)(a) in Schedule F be modified to read “include information about every water year concluding after 1 November 2000”.

**Other Proposals**

A number of other proposals for further refinement of Schedule F were received in submissions. The IAG sees these as improvements which can be considered over time as the Commission and Council consider additional issues that may impact on flows, diversions and river health.

**5.2 The Next Step**

A number of the submissions highlighted the need for balance between water for diversions and river health. Some questioned whether the Cap per se could address environmental degradation that has occurred in parts of the Basin.

The Murray-Darling Basin Ministerial Council in its landmark 1995 decision to establish the Cap recognised that the two primary objectives driving the decisions to implement the Cap were:

1. to maintain and, where appropriate, improve existing flow regimes in the waterways of the Murray-Darling Basin to protect and enhance the riverine environment; and

2. to achieve sustainable consumptive use by developing and managing Basin water resources to meet ecological, commercial and social needs.

This review indicates that there has been significant progress in implementing the Cap, and that by mid 2000 most States and the ACT should be in a position to agree to a modified Schedule F which provides a quality assured framework for Cap implementation, monitoring, reporting, auditing and corrective action. By 2001 Council’s objective of limiting diversions, equity adjusted, to those equating to 1993/94 levels of development should be achievable.

The challenge for the Commonwealth, States and ACT through the Ministerial Council is to identify the next step in achieving its objective of “to protect and enhance the riverine environment”. Although not part of its terms of reference the IAG, based on its audits over the period 1996/97 to 1998/99 and on analysis of the submissions received, suggests a framework for improving environmental outcomes.
6. Conclusions and Recommendations

6.1 Conclusions

The IAG has concluded that while implementation and compliance arrangements for the operation of the Cap have not been concluded, there has been important progress across the Basin. While some jurisdictions are further advanced than others in terms of implementation and compliance issues, this in part reflects the complexity faced by the States concerned in implementing the Cap. There is general support for the Cap and the achievement of the Council's objectives being to improve existing flow regimes and achieve sustainable consumptive use.

With the completion of the Queensland WAMP and WMP process and recent developments in relation to the management of the Border Rivers, a number of the more significant shortfalls in terms of implementation will have been addressed. It is expected that this will then allow completion of Schedule F in a final form to take effect from the 2000/01 water year.

Some interim arrangements will still be required for monitoring of those streams for which Commission endorsed models will not be available for a number of years. However, there is a willingness and goodwill from all jurisdictions towards the adoption of interim arrangements for those valleys and streams for which a formally endorsed model will not exist from the 2000/01 water year. The existing goodwill shown towards the auditing program of the IAG over the last four years, if continued should contribute to an acceptable enforcement process until such time as final models are prepared for all valleys and streams.

The IAG has identified a number of matters which should be considered by the Council as arising out of this Review. The IAG has also highlighted a possible framework for considering what might be the 'Next Step' now that Cap implementation is nearing completion. These 'Next Step' options are drawn to the attention of Council for its long term consideration.

6.2 Recommendations

It is recommended that:

i) the Commission’s office give consideration to the preparation of a register of Cap definitions as agreed by the partner governments as they finalise their monitoring and compliance programs;

ii) within the spirit of the Cap, jurisdictions should be encouraged to consider groundwater usage and allocation rules on an integrated basis with surface water diversions;

iii) jurisdictions should be asked to advise on likely implications of groundwater usage on the integrity of the Cap and downstream river health;

iv) MDBC should consider its policy position in relation to groundwater usage and rules if the likely impact as advised by the jurisdictions is significant;

v) MDBC note general compliance with Cap requirements in South Australia, Victoria, and the ACT;

vi) MDBC note that there has been a breach of the draft Schedule F requirements for the Barwon-Darling and high individual year exceedence of the Cap diversion target for the Lachlan and Murrumbidgee;

vii) MDBC note the substantial growth in storages and by implication diversions in Queensland;

viii) each jurisdiction puts in place an appropriate quality management system for the management of metering, monitoring and reporting data;

ix) the States and ACT through the MDBC establish a set of trading rules to enable free trade within and between valleys, within and between States (and the ACT);

x) models for the major valleys be completed and forwarded to the MDBC for assessment and endorsement in time for the finalisation of Schedule F in September 2000;

xi) the definition of the Cap be modified to delete reference to "in unregulated rivers this Cap may be expressed as an end-of-valley flow regime";

xii) Schedule F be modified to delete the end-of-valley flow option;
xiii) Clause 17 in Schedule F be modified to read:

**Advice to Council on remedial actions**

17. (1) The Government of a State referred to in paragraph 16(a) must:
   (a) report to the next Ministerial Council after a declaration is made under that paragraph, setting out:
      (i) the reasons why diversions exceeded the Murray-Darling Basin diversion cap; and
      (ii) action taken, or proposed to be taken by it to ensure that cumulative diversions are brought back into balance with the cap; and
      (iii) the valley model predictions of the period within which it is predicted that the cumulative diversions will meet the long term diversion Cap; and
   (b) report to each subsequent meeting of the Ministerial Council on action taken, or proposed to be taken by it to ensure that cumulative diversions are brought back into balance with the cap in accordance with paragraph 17(1)(a), until the Commission revokes a declaration pursuant to sub-clause 17(2).

(2) When the Commission is satisfied that a State in respect of which a declaration has been made under paragraph 16(a) has brought the cumulative diversions back into balance with the cap and is once more complying with the Murray-Darling Basin diversion cap in all respects, it must:
   (a) revoke the declaration; and
   (b) report that fact to the next meeting of the Ministerial Council.

xiv) Clause 11(8)(a) in Schedule F be modified to read “include information about every water year concluding after 1 November 2000”.
7. Further Reading

- Setting the Cap, Report of the Independent Audit Group, November 1996;
## Appendix 1 — Summary of Submissions

The issues tabulated below are discussed in Sections 4 and 5 of this Report.

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| Commonwealth Government | X | X | X | X | X | X | X |
| NSW Government | X | X | X | X | X | X | X |
| VIC Government | X | X | X | X | X |
| SA Government | X | X | X | X | X | X |
| QLD Government | X | X | X | X | X |
| ACT Government | | | | | | | |
| CAC | X | X | X | X | X | X | X |
| MDBC Office | X | X | X | X | X | X | X |

### STAKEHOLDERS

1. NSW Murray Catchment Management Committee
2. NSW Murray Irrigation Ltd
3. NSW Southern Riverina Irrig. Districts Council
5. NSW Murrumbidgee Irrig., RGA & MIA CHA
6. NSW MIA Council of Horticultural Associations
7. NSW Hay Water Users
8. NSW Murrumbidgee Valley Lic. Pumps' Assoc.
10. NSW Coleambally Community Action
11. NSW Lachlan Valley Water
12. NSW Lachlan Shire Council
13. NSW R Caldwell
14. NSW Narromine Irrigation Board of Management
15. NSW Namoi Valley Water Users’ Association
16. NSW Namoi Groundwater M C (incl. W L Weakley)
17. NSW Gwydir Valley Irrigators Assoc.
18. NSW Twynam Pastoral Co
19. NSW Barwon-Darling River Management Committee
20. NSW Darling River Food & Fibre
21. NSW Bourke Shire Council
22. NSW Bourke Chamber of Commerce
23. NSW Brewarrina Shire Council
24. NSW Bourke Cotton Growers Association
25. NSW Walgett Water Users Association
26. NSW Inland Rivers Network
27. NSW National Parks Association
28. VIC Goulburn-Murray Water
29. VIC Victorian Farmers Federation
31. QLD Toowoomba & Region Greens
32. VIC Australian Dried Fruits Association