

Improving water-use efficiency in irrigation conveyance systems

A study of institutional arrangements

Marsden Jacob Associates



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The **National Rivers Consortium** is a consortium of policy makers, river managers and scientists. Its vision is to achieve continuous improvement in the Management of Australia's rivers.

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ABBREVIATIONS

ABARE	Australian Bureau of Agricultural and Resource Economics
AFFA	Agriculture, Forestry and Fisheries – Australia (C'wlth)
ANCID	Australian National Committee on Irrigation and Drainage
BRS	Bureau of Rural Sciences (C'wlth)
CIT	Central Irrigation Trust (SA)
CMA	catchment management authority
COAG	Council of Australian Governments
DLWC	Department of Land and Water Conservation (NSW)
DNRE	Department of Natural Resources and Environment (Victoria) (now DSE)
DSE	Department of Sustainability and Environment (Victoria) (formerly DNRE)
EMS(s)	environmental management system(s)
EPA	Environment Protection Authority (NSW and SA)
GL	gigalitre (1,000 million litres)
G–MW	Goulburn–Murray Water (Victoria)
IC(s)	irrigation corporation(s)
IDMP(s)	irrigation and drainage management plans
IPART	Independent Pricing and Review Tribunal (NSW)
IWP(s)	irrigation water provider(s)
LMRIA	Lower Murray Reclaimed Irrigation Area
LWMP(s)	land and water management plan(s)
MDB	Murray–Darling Basin
MDBC	Murray–Darling Basin Commission
MIL	Murray Irrigation Limited (NSW)
ML	megalitre (million litres)
NCC	National Competition Council
NCP	National Competition Policy
NRM	natural resource management
pers. comm.	personal communication
PIC(s)	private irrigation corporation(s)
PID(s)	private irrigation district(s)
PIRSA	Primary Industries and Resources South Australia (now Department of Land and Water)
SCADA	supervisory control and data acquisition
SRIDC	Southern Riverina Irrigators District Council
UNE	University of New England
WSCs	water service committee(s)
WSP(s)	Water Sharing Plans (NSW)
WUE	water-use efficiency

Executive summary

Background

1. The reform of the Australian water industry has led to significant changes over the period since the COAG meeting in 1995. A primary tool for this change, and one of its main achievements, has been the adoption of greater efficiency in delivering water and drainage services through the corporatisation or privatisation of the main irrigation businesses.
2. One of the primary objectives of the reform program was to safeguard the environmental need for water. This was to be achieved by ensuring that environmental requirements were clearly identified as a clear entitlement with first claim on the available resources.
3. Some progress has been made towards achieving that goal. However, it is clear that current levels of diversions from Australia's major systems are still unsustainable in terms of the health of the riverine or groundwater ecology. A further reduction in our current level of diversions will be required if that sustainability is to be achieved.
4. Any such reduction would have major implications for production in the agricultural sector which is the main user of that water. The reduction would be facilitated and its adverse effects ameliorated if that water were used more efficiently. Moreover, irrigators need to be assured that before any water is retrieved from them that all alternatives have been explored.
5. The scope and practical opportunity to increase efficiency in irrigation water use on farm offers specific benefits of:
 - freeing water for on-farm expansion or to generate capital for investment on farm;
 - generating surplus water to provide additional flows for rivers and wetlands;
 - reducing adverse environmental impacts, both locally, through reduced recharge, and more widely through reduced saline discharge to rivers; and
 - providing a powerful means to facilitate adjustment and minimise the impacts of any buyback of current entitlements in order to restore environmental flows.

6. The purpose of this report is to understand how the irrigation water providers (IWPs) that deliver water to the bulk of Australia's irrigators promote or impede improved water-use efficiency (WUE) on farm, and to identify principles, strategies and options that might be adopted to promote efficiency and sustainable water use.
7. In addition to agreements or contracts to deliver water which can set expectations and obligations on both parties, the IWPs set tariffs for water delivery and use, provide ancillary services, and set, or at least strongly influence, local rules for water trading. In most States the IWPs are licensed, and in NSW and WA compliance with these licences requires compliant behaviour from individual irrigators. More broadly, the IWPs act as an interface between their irrigators and government and the wider community.

Thus, the IWPs have a potentially critical role in influencing and channelling irrigator attitudes and behaviour, including promoting the adoption of greater WUE.

Terms of reference

8. Given the primary role that IWPs have in the use of water resources, and their (potential) roles in influencing on-farm behaviour and WUE, Land & Water Australia commissioned Marsden Jacob Associates to:
 - i. report on the policy, legal and other institutional factors under which irrigation water agencies are established, and which operate to promote or impede greater efficiency and sustainable use;
 - ii. report how the internal policies, capacity and influence of water agencies operate to drive improvements in WUE and sustainable water use or impede such improvements;
 - iii. report the scale of WUE that can be achieved through improvements in the policy, legal and other institutional frameworks;
 - iv. develop a set of principles which may be applied by governments to existing government-owned, privatised or corporatised water agencies to ensure

that there are sufficient drivers for improving WUE and sustainable water use;

- v. identify policy options that could be adopted by governments and water agencies to improve the efficiency of water use and to relieve any major impediments to sustainable water use; and
- vi. suggest options for improved institutional arrangements whereby WUE can be made available for reallocation to environmental or consumptive uses and drive ongoing improvements in sustainability.

Clarity of objectives

9. Water-use efficiency is a means to achieve other objectives. It is not an end in itself. As a result, blanket promotion of WUE for its own sake may not uniformly achieve more fundamental objectives including increasing the quality and health of Australian rivers. Policies on WUE must be assessed and tailored to particular circumstances.
10. Water rights and entitlements held by irrigators in Australia are defined in gross terms. This means that the losses are irrigator owned. The promotion of WUE on farm should result in high income for the secure volume of available water, but it does not result in increased water for the environment — unless separate purchase or gains-sharing arrangements are in place.
11. Policy responses on WUE must recognise that inefficiency in water delivery and use is not uniformly bad. It has always been known that some delivery losses flow back to rivers to boost environmental flows. The notion that inefficient use of water is not uniformly bad appears to be more broadly relevant. Recent research by ABARE/BRS indicates that, more broadly, efficient water delivery and water use in the Murray above Nangiloc–Colignan increases return flows to the river. Though these return flows are saline, they serve to dilute higher salinity levels downstream, with the result that economic losses due to salinity overall are reduced.
12. This insight from applying the logic of the total water cycle is uncomfortable because it means that a simple policy view that WUE should be pursued in all situations may be simplistic and indeed wrong. It also implies that:
 - where the objective of improving WUE is to promote higher production income the focus on policy and action may need to be location specific; and
 - the progressive pressure to eliminate inefficient use, if successful, will over time directly reduce water flowing back to the rivers. The policy implication is that offsetting actions will be required.

A technical concept ...

13. WUE is a technical concept or, at best, an economic measure of partial economic productivity. Demonstrated gaps in WUE performance do not necessarily imply that it is profitable or desirable for an individual irrigator to improve his level of WUE. For the irrigator, there is a fundamental distinction between what is physically possible and what is profitable, reduces risk and reduces labour input.
14. There are further gaps between what actions on WUE are desirable for the individual irrigator, the district and region, and the nation. These gaps arise because the benefits and costs for the private individual do not necessarily match those of other parties and the environment in the region, or those of the nation and public as a whole.
15. The policy task is to close these gaps (ie. ‘internalise the externalities’) in the most effective manner, ie. at least cost and risk to the longer term objectives.

Mechanisms

16. Mechanisms to increase WUE can operate in three main ways:
 - narrowing the dispersion of efficiency within each of the major industries and activities. This entails ‘pulling up the tail’ towards best practice;
 - shifting the frontier of best practice in WUE in each industry; and
 - shifting water and activity from low WUE industries/activities such as flood irrigation of pasture, to high WUE industries such as drip-irrigated horticulture.
17. Simple technological solutions such as ‘all irrigation water should be supplied by pipe’, cannot be applied in all circumstances, physically, eg. cotton on grey cracking clays, and is unlikely to be economic for much of broad-acre irrigation. A case-by-case approach must be followed. Moreover, on-farm behaviour is critical in determining actual WUE, regardless of the technologies applied.

Focus instruments on the drivers

18. Instruments to align private incentives and action with the more fundamental public objectives relating to water use and management should impact on all drivers of on farm action to improve WUE. These drivers include: profitability, cash flow, risk and labour input. Focusing on or leveraging any one of these in isolation will not achieve the desired improvements. All need to be addressed if irrigators are to have the incentive to invest in improved WUE.
19. The IWPs have the potential to have critical impacts on behaviour on farm. These impacts arise because the importance of delivery and drainage allows the IWPs to influence, both positively and negatively, on-

farm behaviour in terms of promoting greater profitability, more environmentally responsible behaviour and other objectives.

20. The primary instruments for achieving any change in WUE and, indeed, farm behaviour generally, include:
 - **information provision** and attitude changes;
 - **the price mechanism**, including the level and structure of water tariffs, subsidy, incentive and penalty mechanisms, salinity credits and other market-based instruments;
 - **self regulation** to achieve common purposes at the industry or district level; and
 - **regulation and licensing**, including the conditions attached to water licences, EPA licences and site-use licences.
21. These instruments can be applied singly to individual irrigators, but they can also be applied as a package and collectively.
22. Since WUE improvement aims to facilitate several fundamental objectives and faces multiple constraints, a package of instruments can be expected to be superior, indeed required, in achieving the objectives. Moreover, the ability to capture local externalities suggests that collective responses will be supported and be effective in many cases.
23. IWPs are strongly placed to execute these roles. However, the IWPs hold no automatic right to these instruments. First, legislation must be facilitative. Second, in regional monocultures, such as rice, cotton and dairying, the processing companies/co-operatives, for example, are also well placed through their programs for environmental management systems (EMS) to play either separate or reinforcing roles.

External framework

24. The external framework of legislative and administrative arrangements is set by the State, although the Commonwealth's taxation legislation and administration also impact on the IWPs. This is especially the case with the move to a national tax regime for government enterprises.
25. The States have interpreted — and enabled — the roles of the IWPs very differently. Some of these differences have little direct impact on the extent to which the IWP influence on-farm WUE. Thus, whether or not the IWP is purely retail or also undertakes the wholesale function of headworks is not, in principle, a material issue.
26. Potentially more relevant differences in the legislative and institutional frameworks established by the States include:
 - ownership and legal structures;
 - the ease with which conditions can be placed on water use;
 - whether the IWP has any role beyond the point of water delivery to the irrigator;
 - the comprehensiveness and rigour of the arrangements for licensing the IWP;
 - the role of the IWP in implementing land and water management plans (LWMPs);
 - the nature of the bulk entitlement/bulk licence in relation to individual entitlements; and
 - the ease with which conditions can be placed on water use.
27. The IWPs are established under different ownership and legal structures. These differences do not appear to be especially material when compared with the more pervasive and powerful effect of comprehensive licensing of IWP activities.
28. At one extreme, the comprehensive licences of the NSW irrigation corporations require that compliance with the licence conditions by the individual irrigator behaviour be demonstrated to the licensing authority by the IWP. At the other extreme, Queensland has interpreted the requirements of national competition policy, particularly competitive neutrality, as requiring that SunWater, the State-wide IWP, be established with no role or responsibility for on-farm behaviour.
29. The point of principle here is not necessarily that there should be uniformity between the States, but rather that the critical roles potentially exercisable by an IWP be recognised and explicitly assigned to a specific responsible entity. (The fact that two or more entities can both do the same task does not ensure that either one of them will actually do so.)
30. As a matter of principle, comprehensive licensing of IWP activities has the advantage of providing a disciplined and certain framework for both governments and the IWPs, while allowing governments to amend the conditions of the licences at periodic reviews.
31. The IWPs have variable roles in terms of implementing LWMPs. Closely related arrangements apply as for licensing. In Victoria, the IWPs are part of the community developing the LWMPs, may undertake under contract some of the development and implementation tasks but are not the entity responsible for implementation.
32. Again, the point of principle here is that the need for regional plans must be recognised and the responsibility explicitly allocated to a body to ensure that the functions are fulfilled. The evidence on comparative merits of the different models is at this stage not conclusive.
33. The water licences held by the IWP vary materially, with the bulk entitlements of the Victorian IWPs being essentially an aggregate of the individual licences and therefore a statement of liabilities/responsibilities for delivery. The Victorian bulk water entitlements are not tradeable in any normal sense. In

contrast, the NSW bulk licences held by the irrigation corporations are licences in the normal sense and these licences replaced the licences held by the individual irrigators who are members of these corporations.

Internal policies

34. IWPs potentially have multiple policies and decisions which can influence on-farm behaviour, and WUE in particular. These include price levels and tariffs, service standards and deliver infrastructure, policies on external pressures such as licensing requirements, trading rules and the promotion of trade through exchanges.
35. In terms of **tariff structures**, there is increasing recognition of the need to unbundle the tariffs and therefore move to a more sophisticated version of the two-part tariff to reflect basic service requirements and cost drivers.
36. The IWPs have considerable scope to advance or retard changes in WUE through responsiveness or otherwise in changing service standards and delivery infrastructure. (This is so because **service standards and delivery infrastructure** have a direct and critical impact on the choice of technology for applying water and, therefore, the choice of irrigation enterprise.) On the other hand, where infrastructure is not readily changed, attempts to modify service standards can lead to inefficiencies in the delivery system and increased costs, particularly from servicing the more intensive enterprises. **Water trade** is a vital tool to promote adoption of greater WUE, to transfer water to higher-value uses and to minimise the adverse impacts of any reduction in overall levels of diversion. There are many constraints on the extent and

arrangements for that trade. The main initiatives which could be adopted to promote greater trade are:

- the further development of effective and robust water exchanges. This breeds confidence and assurance to landholders, and a culture where trade is supported;
 - the full separation of rights of ownership over land and water as distinct assets. This will broaden the market and allow a more commercial approach to the ownership of water as a factor input to production;
 - introduction of some form of exit fees to facilitate trade out of areas where there are significant sunk costs in existing irrigation infrastructure. On the other hand, there will be some areas where government will need to step in to facilitate structural adjustment to assist the withdrawal of water from an area;
 - the provision of consistent effective measures to ensure that trade does not lead to adverse environmental outcomes. The current disparity between the controls over high impact zones in Sunraysia and the equivalent controls in SA act to constrain the further extension of interstate trade; and
 - reduction in the barriers to trade imposed by individual IWPs. The provision of fair exit fees and good controls over environmental outcomes should reduce the grounds for retention of these controls.
37. Implementation of the principles and strategic options developed in this review needs to be carefully considered and planned. This consideration needs to ensure that the existing achievements and motivation of the IWPs is recognised and that they contribute to the process of enhancing their positive roles.

1 Introduction

The purpose of this report is to understand how the irrigation water providers (IWPs) that deliver water to the bulk of Australia's irrigators, promote or impede improved water-use efficiency (WUE) on farm, and to identify principles, strategies and options, that might be adopted to promote efficiency and sustainable water use.

1.1 Background

Australia's water resources are substantially committed to irrigated agriculture which is significantly more profitable and stable than dryland agriculture. However, there is increasingly widespread recognition that many of Australia's major water resources have been allocated for consumptive use at levels that are inconsistent with the sustainability of the resource and the wider environment.

As a result, the growth of diversions of water for consumptive purposes has been capped in virtually all major river systems in southern Australia, and governments are considering how to retrieve water to boost the levels of environmental flows. For irrigators, there is an increasing incentive to use what water is available more profitably.

The scope and practical opportunity to increase efficiency in irrigation water use on farm offers specific benefits of:

- freeing water for on-farm expansion or to generate capital for on-farm investment;
- generating surplus water to provide additional flows for rivers and wetlands;
- reducing adverse environmental impacts, both locally, through reduced recharge, and more widely through reduced saline discharge to rivers; and
- providing a powerful means to facilitate adjustment and minimise the impacts of any buyback of current entitlements in order to restore environmental flows.

In addition to agreements or contracts to deliver water which can set expectations and obligations on both parties, the IWPs set tariffs for water delivery and use, provide ancillary services, and set, or at least strongly influence, local rules for water trading. In most States the IWPs are licensed, and compliance with these licences

may require compliant behaviour from individual irrigators. More broadly, the IWPs act as an interface between their irrigators and government and the wider community.

Thus, the IWPs have a potentially critical role in influencing and channelling irrigator attitudes and behaviour, including in promoting the adoption of greater WUE.

The IWPs can be major agents for change across a range of natural-resource-management (NRM) outcomes. Indeed, most IWPs list the promotion of sustainable water use by their customers or members among their material achievements.

However, the impact and effectiveness of the IWPs in promoting or impeding WUE is influenced by the policy, legislative and institutional frameworks under which they operate, and also by their own internal policies, capacities and influence.

The overwhelming proportion of water used by irrigators in Australia involves the IWPs¹ who provide the essential service of retail delivery and, typically, drainage. Thus, across the southern Murray–Darling Basin (MDB), more than half of all irrigation water is used within the areas and districts served by Goulburn–Murray Water (GMW), Murray Irrigation, Murrumbidgee Irrigation and other IWPs. The comparative shares of water delivered and drained by the IWPs are similarly high outside the MDB, for instance in Western Australia and Queensland.

¹ The ownership and legal form of these IWPs differ significantly, as does the range of functions, roles and size (Table 1). The smallest IWP in Australia operates a single water supply system with fewer than 50 customers, while the largest, Goulburn–Murray Water (GMW), has 16,000 customers and covers seven water supply systems. Annex A provides a fuller listing. For a more detailed description of Australian IWPs, see ANCID (2001), *Australian irrigation water provider benchmarking report for 1999/2000*, an ANCID initiative funded by Land & Water Australia and Agriculture, Fisheries and Forestry – Australia.

Table 1. Data on Australian irrigation water providers

Irrigation water provider	Number of irrigation customers	Number of irrigation systems	Irrigation deliveries 1999–2000 (ML)	Legal structure
New South Wales				
Coleambally Irrigation	411	1	316,000	Private co-operative
Jemalong	108	1	42,000	Private company
Murray Irrigation Ltd	2,425	1	724,000	Company limited by guarantee
Murrumbidgee Irrigation	2,668	1	633,000	Private company
West Corugan	295	1	34,000	Private co-operative
Western-Murray	470	1	24,000	Private company
Queensland				
Sun Water	6,323	17	940,000	Government -owned corporation
South Australia				
Central Irrigation Trust	1,436	7	84,000	Company plus trusts
Renmark Irrigation Trust	65		7,000	Private trust
Lower-Murray (SA Water)	90		56,000	Government owned and private trusts
Sunlands	65		8,000	Private trust
Tasmania				
River and Water Supply Commission	300	3	16,000	State-owned corporation
Clyde Water Trust				Trusts
Victoria				
First Mildura Irrigation Trust	1317	1	49,000	Statutory rural water authority
Goulburn–Murray Water	16,447	7	1,780,000	Statutory rural water authority
Southern Rural Water	1,307	3	130,000	Statutory rural water authority
Sunraysia Rural Water	226	1	68,000	Statutory rural water authority
Wimmera–Mallee Water ^a	6,912	1	30,000	Statutory rural water authority
Western Australia				
Gascoyne Irrigation	192	1	2,000	Co-operative (as at 1 July 02)
Ord Irrigation	63	1	170,000	Co-operative (as at 1 July 02)
South West Irrigation Co-op	558	1	77,000	Private co-operative
Harvey Water				Two stage co-operative

^a Includes stock and domestic water

Sources:

1. ANCID (2001). *Australian irrigation water provider benchmarking report for 1999/2000*, An ANCID initiative funded by Land & Water Australia, and Agriculture, Fisheries and Forestry – Australia.
2. Updating by Marsden Jacob Associates, particularly details of legal structures.

Depending on the jurisdiction, physical location and other circumstances, some IWPs also own and operate storages and are responsible for the transmission of bulk water (see Table 2).

The focus of this report is on the retail or local delivery functions of the IWPs. The report therefore excludes the functions of ownership and/or operation of dams and headworks — although the larger IWPs which are government-owned typically harvest and store water as part of an integrated operation.

The report also focuses solely on on-farm WUE. It does not address the related issue of efficiency gains in transmission. The potential for savings from this route has been dealt with in a parallel report by Marsden Jacob Associates for Land & Water Australia, which looks at the opportunities from savings from different elements of the storage and transmission system, and the options for financing those savings.²

² Marsden Jacob Associates (2002). *Improving water use efficiency in irrigation conveyance systems: a study of investment strategies*. Land & Water Australia.

Table 2. Roles and functions of selected irrigation water providers

	Goulburn –Murray Water	Sunraysia	Central Irrigation Trust	Murray Irrigation Ltd	Murrum- bidgee Irrigation	NSW State Water	Sun Water	Harvey Water
Storage, ownership and management	✓	✗	✗	✗	✗	✓	✓	✗
Storage and operation	✓	✗	✗	✗	✗	✓	✓	✓
Large-scale transmission	✓	✗	✗	✓	✓	✗	✓	✗
Delivery system operation and maintenance	✓	✓	✓	✓	✓	✓	✓	✓
Customer service function	✓	✓	✓	✓	✓	✓	✓	✓
Return drainage operation and maintenance	✓	✓	✓	✓	✓	✗	✓	✓
Land and water management plan implementation including	✗	✗	?	✓	✓	✗	✗	✗
• codes of practice	✗	✗	?	✓	✓	✗	✗	?
• WUE initiatives on farm	✗	✗	✓	✓	✓	?	✗	✓

Source: Marsden Jacob Associates

1.2 Terms of reference

Given the primary role that IWPs have in the use of water resources, and their (potential) roles in influencing on-farm behaviour and WUE, Land and Water Australia commissioned Marsden Jacob Associates to:

1. report on the policy, legal and other institutional factors under which irrigation water agencies are established, and which operate to promote or impede greater efficiency and sustainable use;
2. report how the internal policies, capacity and influence of water agencies operate to drive improvements in WUE and sustainable water use or impede such improvements;
3. report the scale of water use efficiencies that can be achieved through improvements in the policy, legal and other institutional frameworks;
4. develop a set of principles which may be applied by governments to existing government-owned, privatised or corporatised water agencies to ensure that there are sufficient drivers for improving WUE and sustainable water use;
5. identify policy options that could be adopted by governments and water agencies to improve the efficiency of water use and to relieve any major impediments to sustainable water use; and
6. suggest options for improved institutional arrangements whereby water-use efficiencies can be made available for reallocation to environmental or consumptive uses and drive ongoing improvements in sustainability.

The terms of reference also included case studies describing the framework and policies of three IWPs (Murray Irrigation, Goulburn–Murray Water, and Central Irrigation Trust). The focus of the analysis is therefore

predominantly on the three major south-eastern states. However, the study has also drawn upon Marsden Jacob Associates' wider experience in advising on privatisation and corporatisation of the IWPs in several States and in establishing licensing and land and water management plan (LWMP) frameworks.

We have sought to update our knowledge with extensive discussions with the senior officers of the IWPs and industry leaders. Our thinking and understanding has also benefited from discussions with officers in AFFA and Land & Water Australia.

1.3 Structure of report

The structure of the report follows directly from the terms of reference.

Chapter 1 confirms the background to the inception of the project and confirms the terms of reference.

Chapter 2 assesses the objectives and metrics of promoting WUE. This confirms the complexity in using improved WUE to achieve environmental outcomes.

Chapter 3 assesses the primary drivers of greater WUE and identifies continuing barriers to their adoption. This provides a context for the analysis of the institutional and legal parameters of the irrigation entities and their significance for promoting greater WUE. Chapter 3 also examines the factors which have driven water savings in three key sectors (rice, wine grape and dairy) and

assesses the potential available from increased WUE. This review establishes that *prima facie* there are very large potential gains but that they are likely to be achievable only if the investment and effort required is worthwhile for the landholder.

- Chapter 4 examines the external framework for irrigation water providers and reviews the policy, legislation and institutional arrangements within which the IWPs operate. This chapter confirms the substantial variation in this external framework across the States and scope to extend the lessons on best practice from one State to another.
- Chapter 5 examines the internal policies, capacity and influence within the IWPs. Once again, a wide spectrum of approaches is evident, with similar conclusions.
- Chapter 6 pulls together the insights and lessons from the preceding chapters and identifies some emerging principles, options and strategies, to enable best practice from differing locations and circumstances to be generalised to help promote greater WUE more widely across the irrigation sector.

The remainder of this chapter deals with the critical issue of interaction of WUE and environmental flows.

1.4 Improving water-use efficiency and river health

In response to the continued decline of the health of many of Australia's major rivers, governments have moved to cap growth in consumptive diversions and have begun to consider how to retrieve water to provide increased environmental flows.

WUE has a critical role in reducing the economic and social costs of these responses. Improved WUE reduces the magnitude of any loss of potential income and:

- increases the income that can be obtained from a reduced volume of water;
- frees water for on-trading to other irrigators who need additional water to rebalance their enterprise; and
- provides opportunities for governments to cost and gains share in order to obtain additional volumes for environmental flows.

Ownership of inefficiencies

Improved WUE cannot directly provide additional water for the rivers, but since the access right/entitlement to the

inefficiencies and water losses is held by owners of the access right:

It needs to be appreciated that under current property right arrangements savings realised by increasing water use efficiency belong to irrigators.³

As a result, promoting WUE will not benefit the environment by providing greater environmental flows unless separate arrangements are put in place for governments to purchase the savings gained via sharing initiatives or purchase in the market.

Thus, to resolve this particular issue:

- governments can provide the capital required for the investment to create the savings. This would then allow government to appropriate those savings for the environment. This is the route proposed by Murrumbidgee Irrigation whereby the NSW Government would invest in upgrading of water supply infrastructure to generate savings which could contribute to the return flows for the Snowy River.⁴

This approach has the advantage that government may be able to identify areas for investment that will generate multiple benefits, i.e., not only generating additional flows for the environment but at the same time reducing local environmental impacts or providing targeted funding to facilitate structural adjustment in areas suffering from decline in an industry sector.⁵

However, under this approach, government will be exposed to risk in the execution of the project and achievement of the predicted outcomes. These identifiable projects may also not be the cheapest way to acquire large volumes of additional water. There is also possible political risk from the perception that farmers have received handouts from government; or

- alternatively, government may intervene directly in the market to purchase entitlement.

This approach has the advantage that, in the short term, the prices paid are likely to be lower. However, this may be a limited benefit and will depend on the effect of announcement of any government decision on market behaviour. This approach will be scatter

³ CSIRO (2002). *A preliminary assessment of the economic and social implications of environmental flow scenarios for the Murray River System*, Mike Young *et al.*, p. 15.

⁴ The MDBC's water management and accounting arrangements are currently being extended to guarantee that any investments to promote greater WUE intended to benefit the environment will create additional flows to the river.

⁵ A current example would be the reform of the Lower Murray Swamps where government purchase of water entitlement would facilitate the exit of uncommercial farms.

gun in its impact and may lead to water being withdrawn from prime development areas or result in the stranding of key infrastructure.

Inefficiency and losses in the total water cycle

A further issue is that it now appears possible that increased WUE not only might not directly lead to an increase in river flows, but also might in some cases actually lead to a reduction in environmental flows.

It is important to understand the steps in this deduction.

As water shifts to high-value uses, WUE increases not simply in terms of gross margins. It also raises the WUE in physical terms. This is so because higher value activities, such as irrigated horticulture, tend to have piped delivery and more sophisticated application systems such as drip or microjets.

There is some evidence that water losses and inefficiencies can actually benefit the river. This is most obvious in the case of channel outfalls which typically result in water being returned to the rivers via creeks and tributaries. However, recent work by ABARE/BRS makes the proposition that watering inefficiencies may be good for the rivers.

If, at present, irrigators are relatively inefficient, then a significant percentage of their watering will return to waterways or wetlands to provide environmental flows or water for consumptive use downstream. ABARE indicates that this inefficiency is particularly beneficial

where it occurs in the upper catchments, and in the Murray above Nangiloc–Colignan, as it provides important dilution flows (Figure 1).⁶

For the objective of increasing environmental flows, it is critical that any surplus generated through the introduction of greater WUE be returned to the environment rather than used to increase the area under cultivation.

It is common to all Australian States that their water licences/allocations to the IWPs have been set to include allowances for conveyance losses and that the volumetric water entitlements held by individual growers make no reference to WUE. Thus, as noted above, the property right to losses, whether in conveyance or on farm, rests with either the IWP or the individual irrigator.

Without significant exception, all Australian water rights/entitlements held by individual irrigators are defined in gross terms, so that any reductions in drainage flow due to WUE improvements are held by the irrigator holding the right/entitlement.

This fundamental assignment is not challenged by any changes or reforms in recent water legislation.

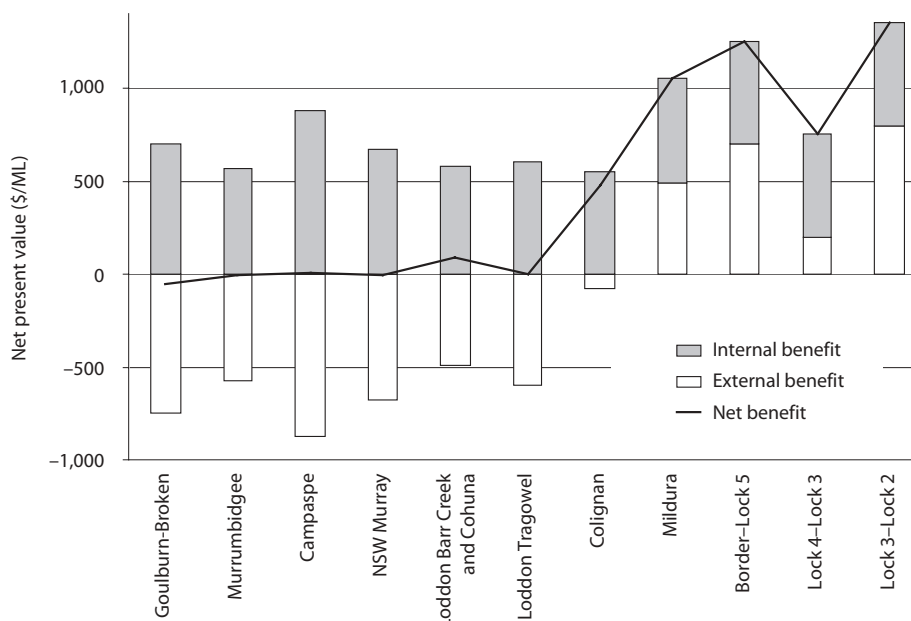


Figure 1. Sources of commercial benefits and costs due to transmission losses along the River Murray. Source: ABARE.

⁶ ABARE (2001) *Irrigation, water quality and water rights in the Murray Darling Basin*, Stephen Beare and Anna Heaney, ABARE project 1704, p. 18.

However, to the extent that return flows to the rivers as a result of inefficient watering — whether direct via drainage to tributaries or via the watertable — benefit the river, then the combination of trade and differential levels of water-use inefficiency may lead over time to a reduction in river flows.

This is a critical issue, as it makes clear that a simple focus on driving the adoption of greater WUE may not achieve the specific objectives sought. Greater WUE may reduce localised adverse environmental effects and increase financial incomes but, at the same time, may increase effective overall diversions and reduce environmental flows.

The judgement on whether inefficient watering is ‘good’ or ‘bad’ is very locationally specific — and doubly so, since whether a loss is good or bad depends not only on the quality of the resulting water flowing into the river, but also on the quality of water in the river without that inflow.

In these situations, and in the absence of other, offsetting policy initiatives, driving a universal policy of greater WUE may, in practice, reduce dilution flows to the river, increase its salinity, reduce environmental flows and increase total aggregate diversions as any savings are used elsewhere on the same property or are sold for use elsewhere.

Any policy initiative must therefore take account of the practical outcomes that will materialise in a specific setting. In addition, the policy must assess the impact of externalities and their interaction with the rights/entitlements regime. When governments seek both to promote adoption of greater WUE and to increase environmental flows then they will need either to amend policies on the ownership of the savings or be willing to purchase the water directly whether by gains sharing or standing in the market.

2 Understanding water-use efficiency

2.1 Introduction

A first point is that all measures of WUE are essentially physical, referring to either technical efficiency or to, at best, partial measures of economic efficiency.

Second, there are multiple measures of WUE each focusing upon a particular issue and objective. Different irrigation industries tend to focus on different measures because the issues differ. For instance, storage efficiency is a particular concern in the cotton industry because “one man’s ring tank is another man’s evaporation basin”. In contrast, the rice industry focuses heavily on hydraulic loadings and therefore the measure of ML/ha.

Third, while irrigators are price and cost conscious, ultimately whether or not an irrigator seeks to increase their WUE depends on whether doing so will improve income, lower risks or reduce labour input, or improve the trade-offs between these.

An excellent summary and rationalisation of technical measures is provided in *Determining a framework, terms and definitions for water use efficiency in irrigation*, prepared by Barrett Purcell and Associates for the National Program for Irrigation Research and Development, and published in September 1999.

2.2 Objectives and metrics of greater water-use efficiency

Greater WUE is promoted to achieve a number of objectives, ie. to:

- minimise adverse local effects such as waterlogging on the environment and third parties;
- minimise regional adverse effects from eg. salinity discharge to the river;
- provide a new source of water that could be shared or purchased by governments to reduce system-wide diversions and so enhance environmental flows;
- increase economic value; and/or
- facilitate structural adjustment and response to reductions in licensed diversions.

However, the concept and relevant measure of WUE tends to differ between each objective and it is necessary

to clarify the links between different objectives, measures and actions.

2.2.1 Adverse Local and regional effects

Excessive water application to irrigated properties may lead to localised adverse effects such as waterlogging. It may also result in increased accession to groundwater, resulting in perched watertables and increased salinisation of land both locally and at a distance. Close to waterways, high drainage flows may create adverse impacts either through discharge directly to the river or through increased pressure which may drive higher salt loads to the river from saline groundwater. Those higher salt loads may create adverse impacts both to the river and to third parties locally and at a greater distance.

These effects can be generated at a number of points in the irrigation pathway from storage to paddock. The focus of this report is on the effect that the policies and framework of IWPs have on adoption of WUE on farm. There is a suite of activities which can result in losses, including on-farm distribution systems, application efficiency, and leakage and evaporation from on-farm storages, which are particularly critical for cotton growing.

The objective of increased WUE in this case is to minimise direct adverse impacts to land and water, and to third parties. This objective may be achieved even though the total volume diverted within a region remains static or even grows. This is because any water savings achieved within an individual property are likely to be used by that landholder to increase the area under cultivation, rather than be returned to the environment. This is, in practice, what has occurred generally over the past 10 years in the southern Murray–Darling Basin as more efficient watering systems and controls have been introduced.

For this objective the key metrics will be:

- **ML/ha:** this is the base level, coarse measure of WUE and gives a first estimate of relative efficiency. It allows a comparison between sectors and is a useful predictor of gross effects at the local level. Within a sector it is a reasonable basis for setting targets, such

as the rice industry standard that limits application levels to 11 ML/ha;

- **Percentage efficiency:** this records the extent to which the level of watering exceeds the optimal crop requirement, ie. it is a measure of how much water will travel beyond the root zone of the relevant crop, is lost to evaporation, or runs off at the bottom end of the paddock. This measure takes account of the particular requirements of different crops, at different stages of growth and soil conditions. For example, it is the basis of the standards set by the South Australian River Murray Catchment & Water Management Board where:

15. From 30 June 2005 water shall only be taken and used for irrigation so that the use of that water achieves a water-use efficiency of no less than 85%.⁷

2.2.2 Maximise economic value

A second objective in promoting greater WUE is to increase the financial return from the available water. Here the concern is that the resource is not generating the potential return to the economy that it could realise. Promoting the shift of water to highest value uses can occur both within and between sectors.

There is a suite of measures for assessing the relative efficiency of water usage related to productive output:

- **\$/ML:** the simplest measure is the gross margin generated. This is measured in terms of dollars gross margin/ML. It provides a useful indicator of relative productive capacity both within and between sectors.

The limitation of this measure is that it does not take account of the relative capital intensity of the activity, eg. moving from flood irrigation of pasture for fattening lambs to viticulture would require an investment of \$35,000/ha, or moving from grazing to horticulture could require investment in a centre pivot at \$250,000 per unit. There is no equivalent measure to gross margin/ML which takes account of capital investment, given the variance in the cost of debt and depreciation policy between enterprises; and

- **kg/ML:** an alternative measure is the productive output per ML, defined in terms of either the mass or value of the product, ie. kg of butter fat/ML, kg of cotton lint /ML, or dollar value of output/ML of water applied. This measure is obviously limited to comparisons within the same industry.

Between sectors: there is substantial variation in the return for water used between industry sectors, with pasture irrigation for fattening lambs traditionally

generating between \$30–\$120 gross margin/ML while viticulture should generate returns between \$600–\$2,000/ML gross margin (Table 3).

Table 3. Comparative financial returns on water usage

Commodity	Gross margin (\$/ML)	
	Low	High
Pasture (livestock)	30	120
Rice	50	200
Dairy	90	550
Cereal	70	200
Annual row crops	150	300
Vegetables	400	1800
Vine & tree fruit	200	700
Viticulture	600	2,000
Mining (gold in NSW)	3,000	5,000

Source: Marsden Jacob Associates, from sources listed in Annex B.

Within sectors: within each sector there is also significant variance in terms of WUE, so, for example, in wine grape there is a tenfold variation in the yield of grapes per ML of water used, from 1.07 to 10.15 tonnes/ML,⁸ while in dairy there is a factor of three in terms of kg of dairy fat generated per ML.⁹ Table 3 confirms the dispersion in terms of gross margin within each sector.

Whether within or between sectors, the objective is to set up mechanisms to promote the transfer of water to higher value uses. This may involve either:

- increasing WUE within the same sector, to generate a higher return for the same volume applied, ie. to move lower performers towards a performance frontier for that sector; or
- transferring water to an alternative sector with a higher gross margin, at the same level of water application.

2.2.3 Facilitating adjustment

The potential availability of WUE gains also provides a route to minimise adjustment costs if reductions are sought in overall licensed diversions. The introduction of greater WUE may allow the maintenance of the same overall irrigated area at a lower irrigation rate and therefore lower level of total diversions.

Alternatively, with the availability of water trading, it will allow the transfer of water from lower to higher-value activities, and so retain the economic value of the output within a reduced overall level of diversion.

⁷ River Murray Catchment Water Management Board (2002). *Water allocation plan for the River Murray prescribed water-course*, Section 5.4, p. 28.

⁸ PIRSA (1997). *Irrigation benchmarks and best management practice for wine grapes*, Fig. 3, p. 16.

⁹ DNRE (1998) *Water use efficiency on irrigated dairy farms* [Armstrong, Knee, Doyle, Pritchard and Gyles]

2.3 Mechanism for increasing on-farm water-use efficiency

Regardless of the particular definition of WUE chosen, all measures confirm that there is wide variation both between and within industries. In each case, the specific numbers are not the critical issue. The point of interest is the dispersion of the data — indicative of a range of current performance and approach and also, therefore, of the potential for substantial savings from improving WUE.

In order to promote WUE, there are three main mechanisms:

- **to narrow the range** of WUE performance in each sector within the current technology by moving average practice toward the ‘best practice’. This is sometimes referred to as ‘pulling up the tail’;
- **to promote improved varieties** and techniques of application and practice to establish a new level of best practice; and
- **to encourage the movement of water** to sectors that use water more efficiently.

Each of these mechanisms may improve the technical, cash flow, and risk efficiency with which water is used. On the farm, however, WUE is not an end in itself. The challenge is to ensure that potential improvements in the technical efficiency of water use are matched by improvements in economic efficiency of water use. That is, to integrate and match sustainable, responsible, environmental outcomes with commercially profitable, practical outcomes and commensurate rates of adoption of better practice and technologies in new enterprises.

Despite growing national and public interest in WUE in irrigation, the fact is that WUE is determined by decisions, practices and behaviour on farm. Action to lift

WUE must therefore ultimately focus on, and be relevant to, the farm. (The drivers and constraints on the adoption of better practice are reviewed in Chapter 3.)

a) Narrow the range

A first mechanism to promote WUE is to narrow the range of WUE performance in each sector within the current technology. Within each sector of irrigation, WUE — like profitability and commercial viability — varies substantially. That is, there are typically wide gaps between the best and worst average performance. Figure 2 shows the variation in tonnes of citrus grown per ML of water applied, from 39 sites located in the South Australian Riverland, and NSW and Victorian Sunraysia. Since the better-performing growers are using known techniques and practices, their distribution indicates the scope of gains that would be achieved if the bottom performing ‘tail’ were to increase WUE up to, say, first quartile.

Improving efficiency will result in the dispersion frequency distribution being narrowed as the tail and average move moved towards best practice (Figure 3).

It is estimated that it would, conceptually, be possible to reduce aggregate water use across the Murray–Darling Basin by some 1,000 GL per annum by raising the average level of WUE in each sector by one standard deviation (Table 4). These gains are, by definition, achievable with existing technology.

These savings do not take account of the potential savings which would be generated through the transfer of water from a low-value, high-application rate to a higher value sector with greater WUE.

The reality is that the rate of adoption of best practices and new application technologies is often naturally slow.

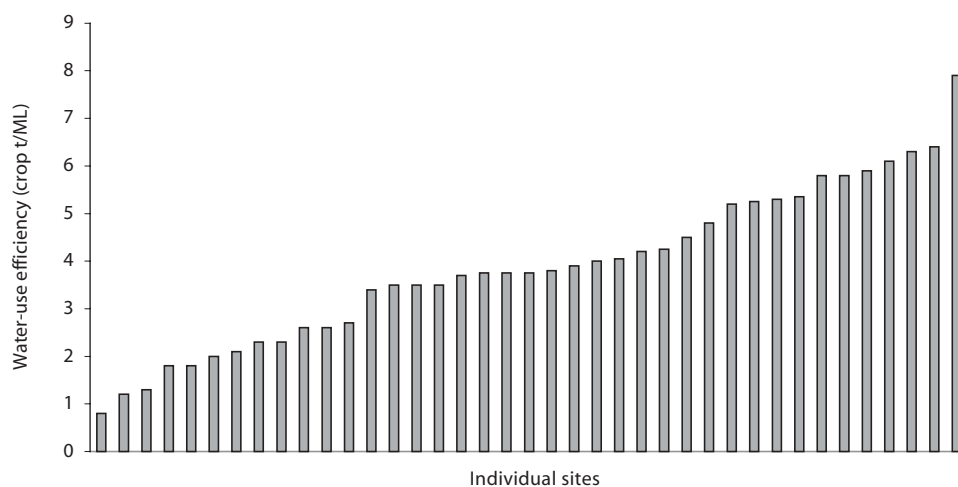


Figure 2: Citrus – water-use efficiency by site. Source: Mark Skewes & Tony Meisner (1997). *Irrigation benchmarks for citrus*, Fig.3.

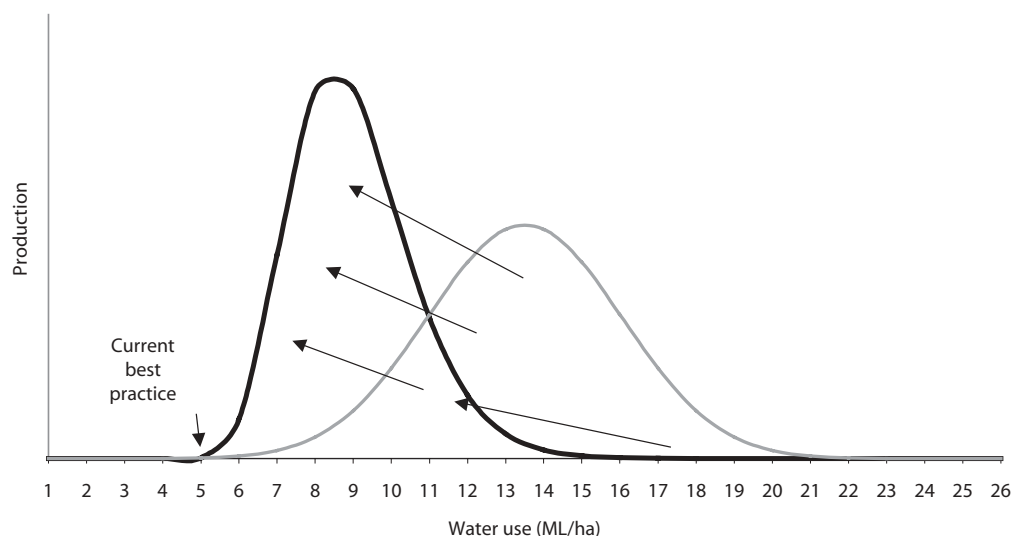


Figure 3. Better water-use efficiency with existing technology

Table 4. Broad-brush indications of existing efficiency of field application of water in the Murray–Darling Basin and conceptualised potential savings

Industry	Indicative total water use (GL)	Conceptualised average application efficiency	Conceptualised mean plus one standard deviation	Initial benchmark (rounded to avoid false precisions)	Potential savings at conceptualised mean plus one S.D. (GL)
Dairying	2,000	0.40	0.51	0.50	200
Rice	2,000	0.60	0.67	0.70	200
Cotton	2,000	0.75	0.82	0.80	100
Horticulture	1,000	0.60	0.86	0.85	150
Speciality — contract row crops	500	0.75	0.82	0.80	25
Other flood/furrow	2,500	0.30	0.44	0.45	75
Indicative Basin total	10,000				1,050

Source: Cummins, T. (1998). *Developing implementation pathways for more efficiency irrigation technology*. Scoping study prepared for MDBC, March.

As an illustration, the simulation modelling undertaken by ABARE for CSIRO’s base-case modelling on environmental flows in the Murray assumed improvements in WUE of between 5% and 10% only over a 20-year period¹⁰ and this rate was increased by the assumption that increased environmental flows would raise the opportunity cost of water and stimulate higher rates of improvement in WUE.

The traditional approach to promoting more rapid adoption of best practice is to provide information, demonstration farms and encouragement. The limitations of this model are now widely recognised.¹¹

b) Improved WUE from innovation

The second broad mechanism to achieve greater WUE is to promote improved varieties and techniques of application. This shifts the entire curve of WUE as it sets a new benchmark of what represents best practice (Figure 4).

In certain sectors, the investment in research and development on new species, application techniques, measurement and monitoring has yielded a string of innovations that redefines the frontier of best practice. For instance, the best practice frontier for wine grapes was significantly advanced by the development of partial root zone drying (PRD) and its first commercial application in 1998.

c) Move water to higher efficiency sectors

The third broad mechanism to promote WUE is to encourage the movement of water to sectors which use water more efficiently. At present some 12% of water in

¹⁰ CSIRO (2002). *A preliminary assessment of the economic and social implications of environmental flow scenarios for the River Murray system*, report for the MDBC, February, p. 11.

¹¹ Neil Barr & John Cary (2000). *Influencing improved natural resource management on farms*, prepared for BRS.

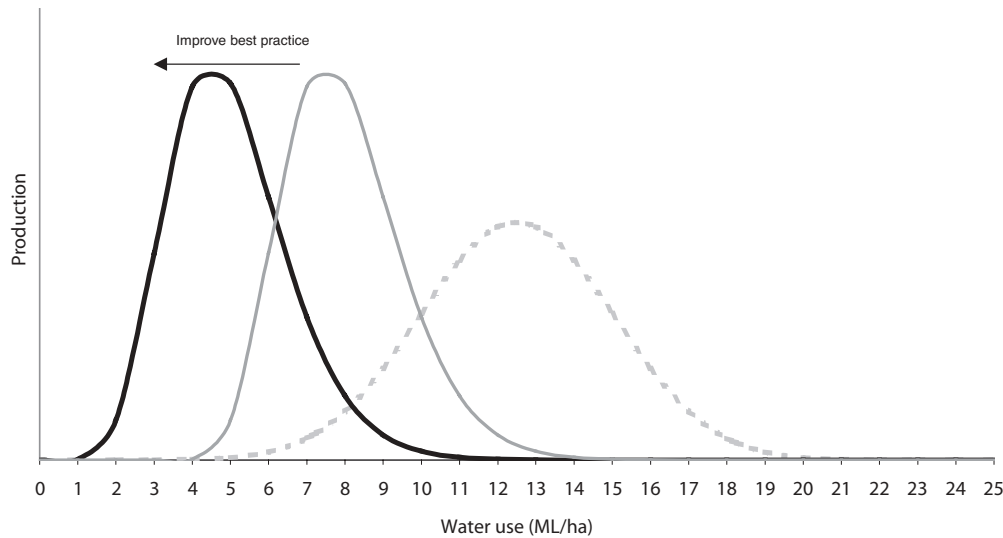


Figure 4. Shift in the water-use efficiency distribution curve consequent on adoption of improved best practice

the southern Murray–Darling Basin is used to irrigate pasture to fatten livestock. In most seasons, this returns only a low gross margin. Transferring some of that water to higher-value uses could generate both higher economic returns and potentially release additional flows for the environment.

This transfer to higher-value activities can take place either within the same property or between properties. It depends, among other things, on the changing profitability and attractiveness of each activity, particularly from the perspective of the family farm. Trade is driven by an expansion of more-profitable and a contraction of less-profitable activities.

There have been substantial transfers of water to higher-value activities on the same property. Examples include:

- the redevelopment of Murrumbidgee rice properties to include horticulture; and
- the removal of plums and apricots from SA Riverland properties in favour of vines.

However, the scope for internal transfers depends on the characteristics of the property and location.

Murrumbidgee Irrigation reports that some 60,000 ML have been transferred internally from growing rice to higher value crops in the past five years.¹² In

Coleambally, on the other hand, horticulture is less developed, and Coleambally Irrigation is seeking to diversify into a range of products such as sorghum, sunflower, lupins, citrus and vegetables. Coleambally has

also exploited changes in dairy practice within Victoria, by growing more fodder.

The internal transfer of water to higher-value uses is also constrained by the practical and financial limitations of the relevant enterprise. As noted, the gross margin curves do not provide information on the capital required in, say, switching from rice growing to a new viticultural enterprise on the same property. These activities all involve significantly higher labour costs and levels of capital investment than for rice and so may not generate higher returns for the individual farm as a productive unit. These alternative sectors will also involve different and potentially greater risks.

Transfer of water use within a property will be driven by a perception that water is scarce and is likely to become less available and more expensive in future. There are, therefore, incentives to obtain a greater return on the available supply. This perception also drives investment in greater WUE, with the objective to generate additional and more reliable supply. The ability to achieve higher returns is also the primary incentive to shift water to higher-value uses through permanent trade.

2.4 Discussion of mechanisms and sectors

In assessing the opportunities to promote greater WUE efficiency, and the factors that promote or constrain that objective, it is important to focus on those areas that have the potential to drive the greatest reductions in terms of total water usage.

If the objective is to establish additional environmental flows from savings generated through the adoption of greater WUE, then the initial focus should clearly be on four major sectors, ie. rice, dairy, cotton and pasture.

¹² Dick Thompson, Chairman, Murrumbidgee Irrigation, pers. comm., March 2002.

Although viticulture is a growth area and innovative in WUE, the total volumes involved are still marginal in terms of total diversions.

Consideration of the three mechanisms for lifting WUE suggests the following priorities:

- **rice:** there is currently fairly tight dispersion within the sector in terms of ML/ha, so the priority should be to seek alternative, higher-value and lower-volume uses for that water and to promote research into innovative approaches such as new strains of rice that require less frost protection and hence lower water application rates;
- **dairy:** there is still significant dispersion in WUE across the sector. The priority should be to narrow the range of performance across the sector. This requires a concerted program involving all stakeholders in the sector. The dairy-processing companies have a major role to play in helping drive adoption of higher standards through an accreditation scheme;
- **cotton:** there is a narrow dispersion in WUE in field application, but there are continuing high evaporation losses from local, property-based storages. The tightly

knit industry should help promote the development of innovative approaches to this issue;

- **pasture:** there may be little value in looking for major improvements in WUE within the sector as the returns are not available to merit the investment. Equally, the sector is very fragmented and lacks the cohesive identity to drive development and implementation of innovative approaches. Here the focus should be on promoting the transfer of water to higher-value uses that involve lower rates of watering. One way to promote this outcome will be through charging policy, where raising the level of water charges would provide the most effective stimulus to shift water to higher-value sectors.

In summary, there appear to be significant savings possible across the major sectors, reflecting the substantial dispersion apparent in current performance, and the possibilities available to transfer water between sectors. Further gains are obviously possible through ongoing innovation. The realisation of these gains in WUE depends, however, on how the investment and effort required is seen on farm.

3 Drivers and instruments for water-use efficiency

3.1 Introduction

This chapter examines:

- the main drivers promoting or constraining the adoption of greater WUE by irrigated landholders;
- the conditions which favour effective and concerted action on WUE;
- the instruments available to affect on-farm behaviour in order to accelerate adoption and improvement; and
- industry experience and approaches to WUE.

This examination provides a contextual base for assessing the relative significance of institutional factors in driving future improvements in WUE.

There are several groups of drivers for the adoption of WUE measures. These reflect the drivers for the individual decision-makers. Individual WUE measures will have characteristics that mean that the benefits accrue either to individual farms or across a number of farms (including, say, a region).

Where a WUE measure can be implemented by a farm, the drivers reflect on-farm issues such as:

- financial aspects of the investment including profit and loss, cash flow and risk; and
- organisational and lifestyle issues, particularly leisure trade-offs and labour requirements.

However, while the benefits of some WUE measures can be captured by a farm, economies of scale mean that there is a minimum size required before the investment will be undertaken. Such scale issues may also promote action at the level of broader institutions such as industry associations, or the water supplier.

Finally, the benefits of WUE measures may not be able to be captured by the farm. Where there are external benefits, such as for the environment, there is an incentive for governments to provide carrots and sticks to promote action to generate these benefits. The actual response may be licensing or requirements under LWMPs, or a pro-

active role by business organisations to circumvent explicit government controls — this may take the form of industry self-regulation or preferential buying schemes

3.2 On-farm drivers of water-use efficiency

The primary incentives for the adoption of greater WUE, at the level of the individual enterprise, are the commercial drivers to reduce labour costs and time, improve quality, expand the area which can be cultivated and so increase the return to the enterprise.

Rates of adoption and adaptation reflect individual appraisals and decisions, are cash flow dependent and therefore vary with abilities to finance necessary investments. However, improved profitability in itself is insufficient to stimulate rapid adoption. Australian studies of adoption of best practice in farming activities also emphasise that a positive decision to adopt best practice requires not just that it is profitable to do so, but that it should also lower, or at least not worsen risk, and must be consistent with the available labour units.

For example, a family business can normally only manage an irrigation property of around 8 ha for citrus, when irrigated through flood and furrow. This irrigation technology requires extensive labour input, involving three-hourly intervention for a period of three days and two nights every fortnight. This is a heavy workload, which is costly in terms of paid labour, or demanding and antisocial in terms of self-employment.

By contrast, a family business can manage a 40-ha citrus property if it is irrigated through a pressurised system with spray or drip irrigation, as this can be activated and monitored through an automated control system. This substantially increases the productive capacity of the enterprise.¹³

¹³ Jeff Parish, CIT, pers. comm., June 2002.

The strengths of these drivers are confirmed in a recent MDBC study into the factors which drive adoption of best-practice irrigation techniques in the wine grape sector.¹⁴ This found that:

...the key factors driving the change from furrow irrigation to pressure irrigation in the grape industry were:

- a desire to spend less time irrigating and to increase flexibility in managing activities in the vineyard,
- a need to redevelop vineyards to longer rows to save time irrigating and harvesting grapes, increasing flexibility in managing activities in the vineyard, and changing grape varieties,
- the topography and soils of the vineyard were not suitable for furrow irrigation, and
- a desire to improve grape and bunch quality.

As identified in the quote above, another factor that has driven adoption of lower watering rates has been to improve the quality of the product. A good example is the adoption of partial root-zone drying in wine-grape cultivation.

A further, and critical commercial driver is the objective to generate surplus water to allow expansion of the area under irrigation. In almost all irrigation areas, the primary factor limiting production is the availability of water, rather than limits on suitable, available land.

In both Victoria and central NSW, an early incentive for water trading was to provide a mechanism whereby landholders could realise some of the financial value of any water savings that would be generated following conversion from flood/furrow to more water-efficient irrigation technologies.¹⁵ This approach would allow a landholder partially to fund that conversion from the capital value of the water savings realised. However, analysis of water trades in the southern MDB has identified few cases of landholders following this approach in practice.¹⁶

In this review of the circumstances that drive adoption of greater WUE, it is also worth considering those factors that tend to constrain the adoption of greater WUE.

Costs: the cost of change is always a potential barrier to action. To improve WUE and to move toward sustainable

water use is, for the irrigator, neither a short-term or certain low-cost process. This is evident when we consider what is involved in any of the following:

- lasering, installation of drip and tap systems;
- pipelining and pressuring;
- changing varieties;
- building storage and recycling systems; and
- responding to tailored ‘carrots’ and ‘sticks’ implemented through regulatory and market-based instruments and programs.

Generic incentives to primary producers via the tax system help those at the frontier of best practice but do little to ‘pull up the tail’. Tax incentives to undertake particular investments do not provide adequate incentives to change behaviour using existing technologies or infrastructure.

Analysis of the dairy sector suggests that the investment required to reduce water consumption (through eg. laser levelling of perennial pasture) would not be recouped through any additional revenues. This is in contrast to wine grapes where investment in greater WUE can be justified by the clear commercial and quality benefits that result.

Other constraints include:

- **inertia and risk aversion** – change inevitably involves risk. This is particularly true if the change is from one enterprise type to another. It is necessary to analyse the wider contextual drivers of behaviour when assessing programs to promote WUE;
- **lack of skills** – changing from flood and furrow to drip irrigation involves acquiring a substantial suite of new skills — and a quantum shift from a labour-based sector to one reliant on automation and IT control systems. This may constrain change until there is a generation change in the farm ownership;
- **uncertainty in policy environment** – the continuing uncertainty about future environmental flows and property rights over water act to constrain any initiatives to reduce the water entitlement at the property level;
- **tariffs** – a high fixed charge, which is common in larger irrigation companies, limits the incentives on individual landholders to conserve water;
- **water trading** – limits on the right to own water and trade it constrain the incentives to invest in water savings; and
- **delivery issues** – operational constraints such as channel delivery capacity and rostered supply will limit the development of higher-value, low-water-use enterprises which rely on water on demand.

¹⁴ UNE (2002). *Managing irrigation for grape production: a market segmentation study conducted as a component of the CRCV–MDBC project on development and adoption of best management practice for improved water use efficiency and effectiveness for irrigated vines*. G. Kaine and D. Bewsell, School of Marketing and Management, University of New England, Armidale, New South Wales, p. 3.

¹⁵ Brian Peardon, National Water Exchange, pers comm.

¹⁶ Dr Henning Bjornlund, pers. comm.

3.3 Drought, the cap, environmental flows and trade

A further major driver to improve WUE since the 1994–95 season has been a tightening of water availability across the MDB as a result of drought and stricter environmental flow controls introduced either in parallel with or as a result of the introduction of the cap on diversions within the MDB.

The security of supply has also been eroded as ‘sleepers’ have been activated following the introduction of water trading.

Before water trading, large users could rely on the fact that there were significant volumes of unused or little-used entitlement in most years, which were, in essence, reallocated to the active users. With the introduction of water trading, some of that sleeper or dozer component has been activated and is now sold on the temporary water markets. As a result, larger users now have to purchase additional capacity each year rather than being able to rely on accessing that water through annual allocation procedures.

Water scarcity and the need to do more with less has been a major driver in all States. Box 1 describes the key actions taken in each of the three south-eastern states.

Box 1. State actions on environmental flows

NSW Murray and Murrumbidgee

In NSW, a series of measures was implemented in the mid 1990s to achieve minimum environmental flows. Their effect was to reduce the general availability and security of supply:

- the Murray cap was reduced to 1,877 GL, down from 2,200 GL before the cap — with the average allocation now 87% with a foreshadowed further reduction to 83%;
- the maximum allocation in the Murrumbidgee was down from 2,700 GL pre cap to 2,521 GL; off-allocation volumetric limits were roughly halved, ie. on the Murray set at a 327 GL limit, down from 500 GL before the cap, and for the Murrumbidgee a limit of 220 GL, down from 480 GL pre cap; and finally, high security licences were denied access to off-allocation flows.

The most recent drought has had profound effects on the availability of water within the southern MDB, with irrigators in Murray Irrigation faced with a mere 8% allocation against their formal entitlement in late November 2002. This has meant that many have planted no rice this season and have instead used their allocation to provide for a minimum watering of a crop of wheat. This has led to the closure or mothballing of rice mills in Echuca and Deniliquin.

Victoria

In Victoria, as a result of the cap and policy reform, a suite of measures was implemented which tightened availability of supply:

- a moratorium on diversions;
- limiting high security entitlement access to sales water;
- cut back in availability of sales water to general security entitlement; and
- limited access to off-quota flows.

In Victoria, this position has been exacerbated by drought conditions which have led to very low or zero availability of ‘sales water’ since 1996. This has created considerable pressures for those growers who had previously relied on an expectation of receiving 140% of their water right again in sales water, with many dairy farmers substituting irrigated pasture with bought-in feed.

South Australia

Announcement of the cap had little impact on existing water-management procedures and practice, as SA has had 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.

SA also renounced any future access to above-allocation flows as part of the negotiation over the cap.

The overall effect of this suite of factors (drought, the cap, higher environmental flow requirements and water trading) has been to constrain the availability of water entitlements and allocations. WUE is one of the portfolio of approaches which landholders have adopted to respond to water scarcity.

Greenfields and property turnover

Improved WUE is most readily achieved where product prices are high, and there is substantial new greenfields investment and restructuring. This situation describes the wine grape expansion of the late 1990s, which saw new application technologies adopted as a matter of course by investors.

Rates of property turnover and restructuring in the irrigation sector are significantly above rates observed in dryland agriculture. MIL reports that around 7–8% of properties within their boundaries turnover annually. This compares with perhaps 1–2% for dryland properties. *Prima facie*, this suggests a more favourable prospect for changes in on-farm behaviour than the traditional understanding would suggest.

3.4 Instruments

As the experience with agricultural extension, catchment management, and land and water management plans in NSW, Victoria and other States has demonstrated, the adoption of better practices is often slow, and traditional reliance on “information, encouragement and exhortation” can rarely ensure rapid take-up of new or better practices. While subsidies and incentives have long been recognised as essential items in the tool kit of instruments, there is also a need to demonstrate performance and achievement.

The prime instruments for achieving any change in WUE, and indeed farm behaviour generally, include:

- information provision and attitude changes;
- the price mechanism, including the level and structure of water tariffs, subsidy, incentive and penalty mechanisms, salinity credits and other market-based instruments;
- self regulation to achieve common purposes at the industry or district level; and
- regulation and licensing, including the conditions attached to water licences, EPA licences and site use licences.

These instruments can be applied singly to individual irrigators, but they can also be applied as a package and collectively.

Since WUE improvement aims to facilitate several fundamental objectives, and faces multiple constraints, a package of instruments can be expected to be superior, indeed essential, in achieving the objectives. Moreover, the

ability to capture local externalities suggests that collective responses will be supported and be effective in many cases.

3.5 Industry approaches to water-use efficiency

In assessing the factors that drive or constrain adoption of greater WUE, it is useful to assess the progress achieved by different sectors, as this helps identify a number of significant variables. The following sections provide an analysis of these factors for the rice, dairy, and wine-grape sectors.

A major lesson from these industry case studies is that where industries are under pressure — whether from threats to sustainability or adverse public perception — they are much more likely to introduce self-regulatory approaches to WUE and wider NRM issues than are industry sectors that are believed to be good environmental citizens.

Thus, the strongest self-regulatory models are observed in the two irrigation industries with the worst public image in terms of environmental responsibility (whether justified or not), ie. rice and cotton. Meanwhile, the dairy sector, which has a much better environmental image, has not shown significant improvements in WUE in recent years and will be seen as failing to promote an industry-based program to drive adoption of greater WUE.

The following section confirms the high-profile initiatives taken by the rice industry to establish a Rice Policy Control Program. The cotton industry has been equally concerned at its poor press coverage regarding water consumption, and has been active in developing and promoting best-management practice in water application. This has seen a reduction in average application rates to an industry standard of 8 ML/ha, wide use of recycling systems from tailwater drains, and further research into shorter season varieties and use of low-level drip irrigation systems. Even so, more work remains to be done to reduce evaporation losses from local storages.

In Queensland, both the dairy industry and the fruit and vegetable growers are actively engaged in programs to promote greater WUE — even if the major objective is to encourage commercial development. The irrigation industry itself is promoting advice on best practice in irrigation through the publication of an “Australian Code of Practice for On-Farm Irrigation”, the main aim of which is “to encourage more efficient and cost effective use of irrigation resources”.

It is recognised that the effectiveness of these industry-based programs to promote greater WUE depends on a number of factors including the cohesiveness of the sector. These issues are discussed further in the following sections.

Rice

In the Murray and Murrumbidgee valleys of NSW, rice is the dominant monoculture, traditionally representing 80% of water used in Coleambally Irrigation, around 60% in Murrumbidgee Irrigation and between 50–60% in Murray Irrigation.

Water usage in rice growing has dropped substantially over the past 10 years, due to industry-wide initiatives. Average application rates of 20 ML/ha were common in the early 1990s, whereas the large majority of growers now operate around the industry target of 12 ML/ha. This is a case where pressure from an industry association has been successful in driving greater WUE. Box 2 reports on the Rice Environmental Policy which was established in the early 1990s and is currently being revised to ensure compliance with best practice in environmental-management systems.

The two major drivers of this policy were a recognition of threats to the sustainability of the region, and concern as to the poor public image of the industry.

The next major reduction in water application rates depends on the success of work currently under way at the Cooperative Research Centre (CRC) for Sustainable Rice Production. At present, flooding of paddocks is necessary to provide frost protection for the developing plants. By lowering the point at which the rice plant suffers damage from cold by 10°C, the industry would be able to save more than 70,000 ML on a baseline cropping area of 130,000 ha. Rice CRC director, Dr Laurie Lewin said:

Water use efficiency gain is a principal objective of rice industry environment policy ... By downgrading the threat of cold damage we can lift growers' per megalitre profit significantly, better positioning them for further investment in environmental initiatives.¹⁷

The sector has the advantage that the large majority of that rice is grown in a small number of large irrigation corporations which have the ability to police the policy.

The NSW irrigation businesses are seeking ways to diversify, to reduce their level of dependence on rice, although there are significant barriers to that process. The major one is that rice is a low capital sector where a large area and water entitlement can be managed by a family enterprise, with low labour costs. Thus, although the gross margin return, in terms of \$/ML applied, may be low, the total gross product which can be generated by a single family unit is high.

Rice is also a relatively low risk business activity with low intervention requirements during the major part of the irrigation season, in comparison with the more detailed and critical watering requirements for other, higher-value crops.

Dairy

The dairy sector is the second largest user of water across the southern MDB after rice, representing some 24% of total water diversions and 54% of diversions within the Victorian Murray and Goulburn systems (see Annex A).

There is a wide spread in the reported levels of WUE of dairy farms, with a factor of between three and four, between the top and bottom 10% of the farms surveyed, in the relative returns generated per ML of water applied in Victoria.¹⁸

However, it is important to distinguish between WUE in terms of application rates as opposed to economic value. The top 10% of the most-productive farms, in terms of \$/ML, apply roughly the same levels of irrigation water (ML/ha) as the mean of the sector as a whole. The difference in the gross margin per ML is driven by the general level of capital intensiveness seen in such variables as stocking rates, fertiliser application rates etc.

Farms earning low returns per ML include:

- low capital intensity farms whose gross margins are low as a result of low investment and stocking rates etc., combined with
- those with excessively high water application rates — where the return/ML declines after an application rate of 10 ML/ha has been reached.

In this regard, the dairy sector differs from the wine grape sector. In the latter, there is a closer alignment between the two variables, as vineyards with the most efficient water application rates (in terms of ML/ha) are also the most productive in terms of \$/ML return.

The past 10 years has seen a significant increase in the overall productivity of the dairy sector, driven by genetic improvement, pasture improvement, increased grain feeding and livestock management (Table 5). Milk production increased 7% in 1999–2000 — reflecting 4% more cows in milk and a 4% increase in yield per cow. The dairy industry has been deregulated since 1 July 2000, although with a staged implementation program of grants and adjustment factors in different States.

¹⁷ Cooperative Research Centre for Sustainable Rice Production, at <www.ricecrc.org>.

¹⁸ DNRE (1998). *Water use efficiency on irrigated dairy farms*; and DNRE (2001). *Changes in water use efficiency on irrigated dairy farms in northern Victoria*.

Box 2. Rice sector industry controls over water use

Rice growing in the Murrumbidgee and Murray valleys has been subject to environmental controls for 10 years:

- in 1995, policy guidelines were proposed by the Rice Environmental Policy Advisory Group and adopted by the Department of Land and Water Conservation (DLWC);
- in 1997, responsibility for implementing the policy was transferred to the newly formed irrigation corporations;
- compliance with the rice environmental policy is now a condition of the operating licence issued to the irrigation corporations under the *Water Management Act 2000*; and
- the licence requires an annual environment report with details about breaches of the policy and actions taken.

This initiative was driven by a combination of factors:

- awareness of the significant risks to future sustainability from adverse effects on local watertables from excess recharge; and
- concern as to the poor public image of the environmental performance of the rice industry.

These factors led to the development of a coordinated program involving all the key players, ie. the rice industry association, the DLWC, the NSW Environment Protection Authority, local irrigators and the irrigation corporations.

Rice policy controls

The rice policy:

- places limitations on the lands where rice can be grown, to ensure suitable soils are used;
- stipulates a maximum rice area that can be grown on each farm; and
- sets maximum water-use levels.

The objective is to minimise risks of excess recharge. Rice growing is restricted to either 'suitable' or 'marginal' lands. Marginal land can be used for rice only one year in four. On every farm, a maximum of 30% of the suitable and marginal areas combined, or 69 ha, whichever is the greater, can be grown each year.

This policy is currently being reviewed to ensure it meets best practice in environmental management systems.

Implementation and monitoring of the rice environmental policy

The irrigation corporations take an active role in monitoring implementation and enforcement of this policy.

For example, the rice area on every farm is measured by aerial photography each year, to check for compliance with total area restrictions and the appropriateness of land planted for rice. Landholders are also required to identify the crop they intend to irrigate. At the end of the season, water use for each crop is calculated. Farms where the rice water use exceeds the standard are deemed to be in breach of the rice water-use restriction. The corporations are also developing supporting data bases such as soil sodicity mapping and a modelling package (being developed with CSIRO) to identify the optimal return for an estimated net recharge.

Penalties

If a corporation's monitoring identifies a breach of any condition in the rice policy, the landholder is invited to discuss the issue. If it is found that the breach has occurred, penalties are applied. Penalties include reductions in the future area approved for rice growing via the water supply contract and/or refusal to supply water to specified areas of the farm. Financial and other penalties can also be imposed through referral to DLWC for prosecution (see Annex C for records of breaches and penalties within Coleambally Irrigation).

Table 5. Dairy industry productivity indicators

Characteristic	1990	2000
Number of farms	16,000	13,150
Cows per farm	77	160
Yield per cow (L/cow)	3,772	4,867
Milk per week labour (L)	3,950	7,021

Source: Australian Dairy and Products Annual 2000, USDA 2000, *Dairy industry overview, developments over the last 10 years and issues for the future*, P. Fitzgerald, ANCID Conference 2000.

The combination of industry deregulation, the Dairy Structural Adjustment Package and increased pressure on costs and water usage rates is likely to see continuing changes over the next five years:

1. There will be fewer dairy farms, but those remaining will be larger operations.
2. Milk production and cow numbers are expected to continue to increase.
3. Perennial pasture will be maintained as the base feedstuff for dairy farms, with considerable move to higher stocking rates and bought-in supplementary feeding (grain/hay/silage/byproduct etc).
4. Modest WUE gains are expected within the dairy industry primarily as poor operators leave the industry.¹⁹

Overall, water-use efficiency has changed little in the dairy sector since 1994. Certainly, there has not been the same concerted initiative to promote greater WUE as has been seen in the rice or cotton sectors.

In practice, the dairy industry involves two, separate sectors:

- a highly capital-intensive sector which already generates a high return and which is continuing to drive improvements in WUE. Research by DNRE indicates that these farms are meeting best practice in terms of the production frontier and WUE,²⁰ and
- a low-capital sector, with poor economic returns that demonstrate continuing low WUE. DNRE identifies that 19% of farms in northern Victoria fall into this category.²¹ This sector faces difficulties in moving to higher levels of technical efficiency in terms of WUE, as any such transition involves a substantial increase in either labour or capital costs (from the introduction of tighter controls over existing infrastructure or investment in centre pivot irrigation or other higher efficiency technology). Many farms could not

generate sufficient additional income to offset the higher costs involved.²²

The dairy sector in Victoria has reduced its dependence on irrigation in recent seasons. While dairy farms have always relied on access to bought-in feed to supplement irrigated pasture, the lower availability of 'sales water' in Victoria in the past five years has led to an increase in the use of bought-in fodder in place of irrigated permanent pasture. There has been a decline in the area under irrigation by some 10–15% since 1999.²³ This development has been mirrored in an increase in the area set aside to grow fodder crops both in Victoria and NSW, with only some being grown on irrigated land.

There will be growing pressure for the dairy sector to demonstrate greater efficiency in its water use. This may result in the form of industry-wide targets in the same way as the rice industry has driven water-use policy across the sector. There is already the basis for an accreditation scheme in place, with milk-processing companies such as Murray–Goulburn and Bonlac requiring auditing of critical production factors, such as levels of herbicides in milk, which could be extended to NRM parameters, such as WUE. However, there is a broad consensus that there are few drivers for the adoption of such a scheme, in the absence of political or media pressure.²⁴

Wine grape

The total area under wine-grape vines more than doubled across Australia in the past decade, from 62,000 ha in 1995 to more than 143,000 ha in 2002. The rate of growth has checked in the last few seasons, with a peak in the rate of new plantings reached in 1999.

The wine industry itself is undergoing a major shakeout, with a growth in market share for the four largest players who now control 80% of the market. This market dominance has been seen in approaches to managing current and future contracts with growers. Fewer new contracts have been let and many old ones renegotiated.

... a lot of contracts for fruit were written five years ago in the flush of expansion. They are now expiring, leaving owners exposed to lower grape prices and more selective fruit buyers.²⁵

Plantings have been made in anticipation of new export markets. For bulk wine, the recent rise in the value of the

¹⁹ Stuart Brown & Rob Rendell (2000). *Water savings in the irrigated dairy industry*.

²⁰ DNRE (2001). *Changes in water use efficiency on irrigated dairy farms in northern Victoria*. p. v.

²¹ Ibid.

²² Stuart Brown & Rob Rendell (2000). *Water savings in the irrigated dairy industry*.

²³ Stuart Brown, Farmanco, pers. comm.

²⁴ Chris Linehan, DPI/DSE, Tatura, Victoria, pers. comm., March 2003.

²⁵ Financial Review (2003). *Wine blight withers vineyards*, 4 March.

Australian dollar has increased competition, while profit margins have been eroded for production of high-value wine. However, despite this current hiatus, most industry commentators predict continued growth over the next 10 years. The Australian Wine and Brandy Corporation, for example, estimates international wine sales will continue to grow by 10% per year, with new plantings re-establishing an annual growth rate of 3–4%.

The wine-grape sector has seen a significant reduction in water application rates over the past 25 years. The sector traditionally applied 8–10 ML/ha when using flood and furrow, depending on the characteristics of the soil and slope. Conversion to trickle irrigation has reduced this application rate to 5–6 ML/ha.²⁶

The use of furrow irrigation in SA declined from 50% of the total area in 1976 to 20% by the mid 1990s. By contrast, along the Murray in the Sunraysia district, 70% was still irrigated by furrow and flood methods in the mid-1990s and, in New South Wales, 84%.²⁷ However, there has been a rapid catchup in Sunraysia as conversion of existing properties has matched the spread of new development. As a result, the area under flood and furrow has dropped from 75% of the district to 40%, over the past 10 years.²⁸

A development with major potential to further increase WUE will be to implement the partial root-zone drying techniques being developed by CSIRO.

The scientists have found that watering only one side at a time causes biochemical changes in the vine, which reduces the amount of water the plant needs. Because only half the plant's rootzone is wetted, each watering uses only about half as much water without any loss in terms of yield.²⁹

Reduced watering increases the concentration of sugar in the grape and so improves the quality of the crush. The approach also reduces foliage growth and so reduces labour costs in pruning. This and other similar demand-side management initiatives have the potential to halve water use again. On the other hand, there is now some concern as to the longer term sustainability of this approach in low rainfall areas where the application rates may prove insufficient to leach salt from the root zone.

Wine-grape production provides an example of an industry sector where significant improvements in WUE have been achieved. However, the achievements of the sector are not necessarily directly applicable to other sectors, as a number of sector-specific drivers and parameters have been significant in their adoption:

- in wine grape, reduced water usage has been driven mainly by the objective to reduce operating costs and improve quality;
- there has been a direct alignment between these commercial drivers and NRM objectives of reduced water use. That same alignment does not exist in all sectors;
- partial root-zone drying is not directly applicable to other sectors such as citrus, where fruit size and condition is critical;
- the wine-grape sector has seen a substantial increase in production and so the opportunity to implement cutting-edge arrangements as part of greenfields development; and
- the wine-grape sector has been highly profitable and so has been able to absorb higher operating costs associated with the introduction of more sophisticated equipment and scheduling.

It is also worth recognising that wine grapes still consume only some 5% of total irrigation water diversions within the southern Murray–Darling Basin. So, expansion at 3–4% pa is unlikely to create a major increase in demand, while continuing conversion of existing properties to higher efficiency application and the introduction of innovative technologies will not, by themselves, generate a sufficient quantum of savings to meet the additional environmental-flow requirements of the system.

3.6 Favourable conditions for concerted action on water-use efficiency

The previous sections looked at three very different irrigated sectors and identified other drivers of greater WUE. It is evident that different approaches have been adopted and different strategies been successful in different sectors. This section confirms those factors which appear to be most significant in driving the adoption of greater WUE.

The primary driver is the **commercial imperative**. Industry sectors will not adopt initiatives by themselves, without external incentives, unless they are aligned with the interests of the business and are capable of being funded by the sector, given current levels of profitability. This may include a recognition that adverse environmental outcomes threaten business profitability. In some sectors, commercial imperatives have driven actions which also generate NRM benefits — that is,

²⁶ DNRE (2000). *Horticultural gross margins for the Loddon Murray region*, p. 18.

²⁷ Crabb, P. (1997). Impacts of anthropogenic activities, water use and consumption on water resources and flooding, *Australia: State of the Environment Technical Paper Series* (Inland Waters), Department of the Environment: Canberra.

²⁸ Mallee CMA, *Second generation irrigation salinity management plan*, in draft November 2002.

²⁹ Dr Brian Loveys, CSIRO Plant Industry, Glen Osmond, SA 5064.

there were good business reasons to improve WUE in order to improve quality, increase flexibility and reduce costs. That coincidence of interests appears to be the exception rather than the rule.

Adoption of improved NRM outcomes will always be easier to promote in a sector where there is adequate disposable income to fund investment and when the sector is experiencing **growth and high output prices**. It is also easier to achieve change when a sector is involved in greenfields expansion, with the opportunity to plan and implement a new layout and cutting-edge technology, than it is within a sector with established layout constrained by existing infrastructure.

Similar drivers are present in sectors undergoing significant change either from generational change or following recapitalisation by new entrants/acquirers. The reverse of this is that change is difficult to promote in an industry with an ageing population that is reluctant to spend when nearing retirement. These factors are one of the explanations for the significant improvements seen in the wine-grape sector as against the relatively poor performance seen in the dairy sector.

Well founded and supported **natural-resource-management plans** linked to the licensing of IWPs, with clear conditionality, are a powerful means to promote greater WUE. However, their effectiveness depends on the licensing structure in place (see Section 4.3). They are also more effective where the local community recognises the direct threats to sustainability from current practices.

Industry targets and self-regulation provide a focused and effective way to promote greater WUE. They are a politically astute approach, as they challenge members of a sector to meet best practice. It is notable that those sectors which have been subject to concerted media criticism have implemented more effective WUE campaigns. MDBC confirms that rice and cotton both demonstrate far less dispersion in performance on WUE than other sectors, such as dairy.³⁰

Certain factors will act to promote the effectiveness of an industry-based approach:

- similarity in enterprise type and size. This allows the application of standard targets across the sector;
- a dominant monoculture in a geographically constrained area. This provides a commonality of focus;
- single supplier of key inputs, such as water;

- strong industry association/group. This is essential if the initiative is to be driven on an industry basis;
- processing companies with negotiating strength. We anticipate that ‘green marketing’ will increasingly be a determinant of NRM initiatives. This will be more effective where the processing companies hold a strong negotiating position;
- ease of monitoring and enforcement. This will be facilitated where there is a small number of IWPs involved; and
- a clear pathway to better practice. No industry is going to adopt unproven changes. Any program will be strongly aided where there is an industry research body to develop and demonstrate the practicability of changed practice.

Figure 5 provides an illustration of the relative position of different industry sectors against the two variables of ‘industry cohesiveness’ and ‘scope for improved WUE’. This confirms that dairy is clearly the next sector which merits an industry-based approach. But the above analysis would caution that this approach will be dependent on community acceptance of the importance of the program, a clear pathway to better practice and a coordinated approach between all stakeholders. Ultimately, the initiative may be triggered only in the face of a perceived threat to the media standing of the sector.

Improving WUE on farm is a long-term commitment for the individual farm, the IWP regional community and governments. As a result, the perceived inability or unwillingness of governments to make a financial commitment beyond one or a few years is also seen as a major hurdle. This is particularly the case where, under land and water management plans, local communities have entered into contracts of up to 15 years to make comprehensive changes to improve natural-resource outcomes, including reducing irrigation losses. WUE and sustainable water use within irrigation areas and districts is also now in competition for funding with the broader catchment plans and priority setting processes.

3.7 Summary comment

It is critical to recognise, and to reflect in policy development, the distinction between technical efficiency and financial viability. Adoption of greater WUE does not come free of charge. Any change is likely to involve greater levels of capital, labour, skills and risk. A particular option may be technically feasible but not realistic for a particular enterprise in specific circumstances.

There is a further critical distinction between the calculus, at an individual property level, of what is financially worthwhile, and a judgment of what is economically efficient, taking account of the wider public benefit won through control of externalities.

³⁰ Don Blackmore, MDBC, pers. comm., 2003.

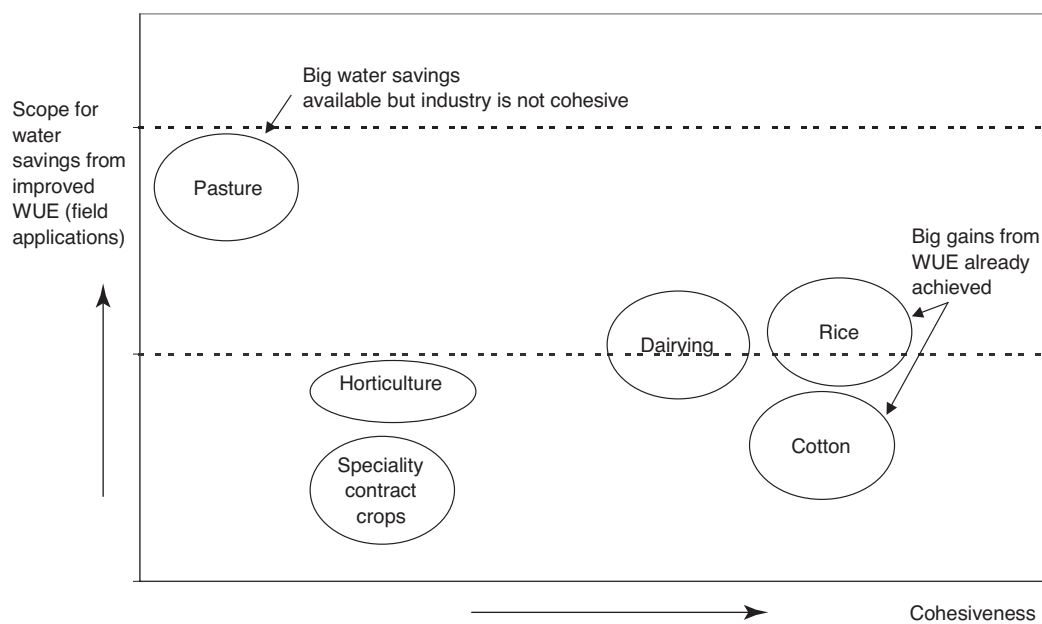


Figure 5. Scope for water savings plotted against cohesiveness in different industry sectors

4 Policy, legal and institutional framework

4.1 Introduction

The terms of reference for this study include investigation of the policy, legal and other institutional factors under which IWPs are established, and which operate to promote or impede greater efficiency and sustainable use.

IWPs are established and licensed under State legislation with significant differences in:

- ownership, choice of legal form and degree of local control; and
- powers, functions, licence obligations and responsibilities, eg. for
 - natural-resource outcomes, including sustainable water use,
 - setting of rules and conditions for water trading in the local area.

Operationally, the IWP must also work within the ‘macro’ frameworks such as:

- the Australian Tax Act and practicalities of tax equivalent regimes;
- the strategic framework for water reform which forms part of national competition policy as endorsed by COAG;
- State and Commonwealth NRM initiatives and funding programs, particularly the long-term initiatives such as the National Action Plan for Salinity and Water Quality; and
- the State legislation governing the definition of water licences and access rights and associated planning frameworks and registry arrangements.

This chapter reviews how these factors apply in each State. Annex A provides more detailed case studies for four representative IWPs: Murray Irrigation Ltd in NSW; Goulburn–Murray Water in Victoria; the Central Irrigation Trust in South Australia; and the Ord Irrigation Co-operative in Western Australia.

4.2 Legal form and structure

The COAG strategic framework for water reform agreed in 1994, and subsequently incorporated into national

competition policy, requires implementation of a suite of measures, the key ones being:

- charges that achieve full cost recovery;
- introduction of water trading;
- separation of ownership of land and water;
- devolution of the management of irrigation areas; and
- separation of resource management and regulatory roles of government from water service provision.

The requirement for separation of service provision from resource management means that retail delivery functions have been progressively separated from the State government departments responsible for water policy, through the processes of corporatisation and privatisation. The form and extent of devolution varies substantially across the States.

At one end of the spectrum, **New South Wales** privatised all areas and districts previously under departmental control. The initial model adopted, in the case of Murray Irrigation, was one of a private company owned by its shareholder members. Later privatisations have followed a co-operative structure, although Murray Irrigation subsequently moved closer to the co-operative model by becoming a company limited by guarantee. Directors are generally elected by the shareholder members.

Victoria has retained its four IWPs in public ownership following a commercialised model, with its directors appointed by the minister. As Rural Water Authorities under the *Water Act (1989)* the IWPs combine bulk and retail functions as well as undertaking licensing and regulatory functions for the Department of Sustainability and Environment.

South Australia has converted the majority of the previous government irrigation districts into irrigation trusts under the *Irrigation Act (1994)* and then facilitated the establishment of regional bodies such as the Central Irrigation Trust to ensure economies of scale, scope and critical mass in the day-to-day operation of the trusts. Landholders vote for election of key officers. The major remaining government irrigation districts in the Lower

Murray Reclaimed Irrigation Area are currently in the process of restructuring and reform.

The **Western Australian** privatisations have directly benefited from the early NSW experience, with South West Irrigation Co-operative (now Harvey Water) pioneering the two-stage co-operative structure and the other, previously government-administered irrigation areas, at Gascoyne and Ord Irrigation, following.

The key lessons from the devolution to local ownership and the separation of service provision from policy and resource management, are:

- the importance of **clarifying the entity's objectives**. Once clarified, directors and management can then focus on the achievement of these objectives and the management of business risk. The public interest is reflected in the objectives and condition of the licences; and
- the importance of a **comprehensive set of explicit contracts** between parties on all material issues and risks. The primary risks relate to environmental and infrastructural sustainability.

In some cases these processes and outcomes have been only partly followed and achieved. For instance, the directors of GMW believed in 2001 that the organisation was then at a 'halfway house'.³¹

4.3 Forms of legal structure

There is a spectrum of legal structures under which the irrigation-water providers have been established. These include:

- government or State-owned corporation;
- privatised corporation;
- private irrigation district;
- trust; and
- co-operative.

4.3.1 Government or state-owned corporation

Irrigation schemes in Victoria and Queensland remain under public ownership. In Victoria, the schemes are operated by four corporatised entities, plus First Mildura Irrigation Trust. In contrast, all Queensland schemes remain under the management of a single, corporatised, State-owned entity.

State-owned corporations are statutory bodies normally constituted under generic legislation related to such bodies, with their powers and functions specified in sector-specific legislation. So, in Victoria, for instance, the IWPs are constituted under the *State Owned*

Enterprises Act 1992 with their powers and functions identified in the *Water Act 1989*.

State-owned corporations are required to operate on a commercial basis to meet business-focused aims, albeit with the objectives set by government, normally through an annual statement of corporate intent. Members of the board of directors are selected on the basis of their skills, but are appointed by and accountable to the minister. The portfolio minister is, typically, also empowered to give a state-owned corporation board direction to undertake non-commercial activities in the public interest.

4.3.2 Privatised irrigation corporations

The major IWPs in NSW are private entities, owned and controlled by the landholders in the irrigation district concerned. Murray Irrigation Limited, Murrumbidgee Irrigation Limited, Jemalong Irrigation Limited and Western Murray Irrigation Limited are all privately owned by their shareholder members, while Coleambally Irrigation is a co-operative owned by the landholders within the district.

The corporations were originally established under the *NSW Irrigation Corporations Act 1994*, which provided for different classes of corporations. However, all such entities are now licensed under the *NSW Water Management Act 2000*. They are also subject to Commonwealth corporations law.

Generally speaking, private irrigation corporations have structured their articles of association to broadly reflect the attributes found within a co-operative, particularly with respect to voting rights, relationship between shareholding, and access to water allocations and recognition of customer interests.

It is notable that the landholders in MIL do not hold individual water entitlements but instead have a shareholding in the corporation which is equivalent to the relative size of their water entitlement.

4.3.3 Private irrigation districts

In NSW there are several smaller IWPs which exist as private irrigation districts (PID).³² These are subject to greater legal controls under the Water Management Act than the privatised irrigation corporations described above. The bulk water entitlement is held by the PID at a collective level and is not split into individual entitlements at the landholder level.

PIDs are not a significant model for the structure of IWPs.

³¹ Marsden Jacob Associates (2001). *Financial review of irrigation areas – Goulburn Murray Water*, report for DSE.

³² *Water Management Act 1994*, Ss 139–196.

4.3.4 Trusts

A further form for IWPs is that of a statutory trust. This approach is particularly prevalent in South Australia, where the irrigation entities are generally established as a trust structure operating under State legislation (*Irrigation Act 1994*).

An irrigation trust is a legal entity that holds irrigation distribution infrastructure on behalf of irrigators in a trust district. It has the standing of a body corporate. Irrigators in the district are voting members of the trust. In SA, the value of votes is generally in proportion to the irrigator's water entitlement. The presiding officers of the trust are elected, and resolutions on the policy of the trust passed, by vote. The trust may delegate its powers to a board of management to carry out the day-to-day operations of the trust.

The trust structure has various non-tax and tax advantages including limited liability and income streaming (for example, in SA, irrigation trusts are exempt from income tax and from corporations law³³). However, the trusts have a duty to provide annual reports on financial and non-financial matters equivalent to those imposed under the *Commonwealth Companies Act 1981*.

Typically, the legislation contains provisions over the structure of many of the activities undertaken by the trust including:

- the constitution and membership of the trust eg. voting rights;
- the functions exercisable by the trust eg. supply of water, borrowing of money, employment of staff etc.;
- rating powers eg. charges for water, rating of land etc., and
- provisions for the minister to remove elected members of the trust or to dissolve the trust.

The irrigation trusts in SA are akin to a hybrid between a State-owned corporation and a private company. Although day-to-day operation and direction of the trust is clearly delegated to local management, in SA the minister retains the power to abolish a trust, dispose of its property or reallocate its assets to another trust or, in the last resort, accept any residual rights or liabilities for the Crown.³⁴

4.3.5 Co-operatives

Co-operative now appear to be the preferred structure for devolved local control of irrigation areas.

After the initial round of irrigation privatisations in NSW, subsequent privatisations have chosen a co-operative structure (such as in the Coleambally Irrigation Area). In Western Australia, the first two privatised irrigation schemes, the South West scheme and the Preston scheme, were both established under a co-operative structure, with the South West operating under a dual structure. The Ord Irrigation and Carnarvon schemes have also recently adopted a dual co-operative structure.

A co-operative is an organisation comprised of members who agree to co-operate to achieve a mutual purpose, according to agreed rules. In a co-operative structure, customer interests are recognised through the co-operative rules and voting mechanisms based on a per person basis or shareholding. Co-operatives are managed by a board of directors elected by their members.

The main beneficial attributes of a co-operative over a company relate to the governance and voting arrangement, the ability to specify specific and restrictive objectives and cultural identification of the members with the irrigation entity. In this regard, co-operatives provide greater flexibility in terms of business rules and processes than companies.

The dual co-operative approach separates ownership of the assets from their management and operation. This enhances robust governance, limits the risks to the irrigation business from fluctuations in revenues and offers some tax advantages.

A comprehensive review of the optimal legal form for corporatised irrigation supply entities concluded that the dual co-operative structure provided the best model in areas of governance, prudential management of assets, taxation, financing and bankability, and flexibility in developing locally appropriate management rules.³⁵

4.3.6 Implications of structure of legal form for water-use efficiency

The corporatisation of IWPs over the past 10 years has had major impacts on the way that those IWPs are managed. In particular, there is greater focus and clarity on commercial objectives and a separation of these from other, wider government aims and programs.

This initiative has achieved significant benefits in terms of the efficiency of investment and management of resources within the sector. It has also generated significant benefits for a range of parties:

³³ Central Irrigation Trust, Annual Report 1998–1999

³⁴ *Irrigation Act 1994*, Ss 14 and 14A.

³⁵ Corrs Chambers Westgarth & Marsden Jacob Associates (1997). *Local management: legal form and related issues*, for Department of Natural Resources, Queensland, October.

- **irrigators** have gained from the greater focus on customer service, transparency and attention to cost efficiencies, and also from a change in the local entity's culture and dynamics,
- **State governments** have gained from the severing of ongoing liabilities, the change in political dynamics, and the opportunity to introduce a substantially improved and comprehensive licensing framework to meet environmental and NRM objectives, and
- **local communities** benefit because giving responsibility to the local entity facilitates regional development.

Overall, the different forms of legal standing and organisation do not appear to have major implications for the promotion or adoption of greater WUE. Different aspects of the various forms create different benefits in different circumstances.

Two distinctions are worth identifying:

- in principle, the relevant portfolio minister can direct a State-owned corporation to undertake activities that are in the wider public interest and which could include investments or operations to promote greater WUE; by comparison
- any such initiative with regard to a licensed privatised entity can be implemented only through a change to one of the formal licences of the relevant IWP or through negotiated conditions in the LWMPs, if relevant. Although the minister usually has some discretion in statute to impose and change these licence or plan conditions, the specified terms for licences and plans, and discipline of due process, results in slower changes, but more certain directions.

Full devolution of ownership and control (whether to a private company, a co-operative or trust) is associated with a close identification between the individual landholders and the objectives and interests of the IWP. This alignment has several implications for WUE:

- the IWP will often act to promote the collective interests of the group. A good example of this is a recent initiative from Murrumbidgee Irrigation which has developed a coordinated program to seek funding from government to promote the introduction of greater WUE;
- landholders within such entities appear more willing to accept strict enforcement of natural-resource conditions of licences than are private diverters or irrigators in government-owned districts when enforcement is seen as an external function.³⁶ That should help promote greater WUE; however,
- this collective identity may also result in constraints on external trade of water which may impede wider

opportunities to move water to higher-value uses (see Section 6.4); equally

- it is possible that an IWP with a more traditional management structure, and less devolved authority, such as Goulburn–Murray Water, may retain greater ability to promote investment decisions that will benefit only a minority of the customer base.

One of the conclusions of the overall study has been to confirm the value of a robust licensing regime in ensuring effective integration between the commercial imperatives of the IWP and NRM objectives.

The extent of the formality of that licensing appears to be directly correlated with the extent of corporatisation. That is, where an IWP is still effectively within the bounds of government ownership and activity, it is less likely that the obligations and duties which apply have been made explicit. At the other end of the spectrum, where an IWP is fully privatised, then the due-diligence exercise required before ownership and control can be transferred to local irrigators, by necessity requires identification of accountability across the full range of outcomes, both commercial and performance related. The clear specification of authorities and accountabilities then makes licensing both easier to specify and to monitor.

There is, however, no strong reason why corporatisation should not involve due diligence and careful specification of authorities and accountability and effective licensing.

4.4 Licensing regime for IWPs

Licensing is a primary tool through which governments can influence the policies, performance, and day-to-day operations of utilities such as IWPs. Licence compliance for the IWP is typically dependent upon the behaviour of its irrigators. Conversely, licence conditions also affect the activities of individual landholders and irrigators. These arrangements and the differences between States are significant for the promotion of greater WUE.

The licences for the IWPs cover three major aspects of their irrigation operations:

- the right to operate an irrigation system;
- the right to divert water on behalf of water users; and
- the right to discharge drainage flows to the environment.

³⁶ Graham R. Marshall (2002). *From words to deeds: a study of collective action by irrigators in enforcing their commitments to adopt conservation practices*, Conference of the Australian New Zealand Society for Ecological Economics, 2–4 December.

The key issues for WUE related to licensing are:

- the extent to which those licences are applied and integrated;
- whether the licences require achievement of NRM outcomes;
- whether there is separate licensing for site use of water at the property level; and
- how far the IWP has duties and powers to require achievement of NRM inside farm boundaries.

4.4.1 Operating licences

IWPs are required to meet a regulated set of standards, sometimes within a licensing framework and in other cases as a general services agreement or statement of obligation subject to independent regulation. For example:

- **in NSW**, irrigation corporations are required to hold an operating licence under s122 of the *Water Management Act 1994*. This provides a corporation with the authority to carry out its functions. The licence is subject to a range of conditions, in particular the obligation to hold and comply with a suite of other NRM licences and plans;
- **in Victoria**, there is no formal licensing requirement under the *Water Act 1989*, and the IWPs obtain their rights and powers as statutory authorities. However, the IWPs will be subject to some form of regulatory oversight on pricing and service levels from the newly established Essential Services Commission in terms of operating standards, tariffs etc.;
- **in SA**, the IWPs are statutory appointees, under the *Irrigation Act 1994*, in the form of independent irrigation trusts. The Act creates the procedural arrangements for the powers and authority of those trusts, but without an explicit licensing system;
- **in Queensland**, a resource operating licence is required under Section 107 of the *Water Act 2000* for the management of irrigation infrastructure and the management of water, although at present all such functions are still undertaken by SunWater; and
- **in WA**, IWPs are licensed by the Office of Water Regulation under the *Water Services Coordination Act 1995*. Licences set specifications for performance standards etc.

The primary objective of these licences is to ensure that IWPs operate their business in an efficient manner to meet the reasonable needs of their customers. It is not their general aim to promote NRM outcomes. Having an explicit licensing system creates transparency in the obligations of the IWP. This provides clearer objectives for the IWP itself and stronger arrangements for requiring compliance with external standards.

In NSW, the operating licence requires that an irrigation corporation implement any relevant LWMP. This model

ensures effective integration between commercial imperatives and wider NRM objectives.

A further measure of the role of the IWP can be seen in the extent to which it actively seeks to promote on-farm WUE by landholders. Again, there is systematic variation between States and entities in this area as reported in an Australian National Council for Irrigation and Drainage (ANCID) benchmarking report from 2000:

- 40% of IWPs reported providing advisory services on WUE to landholders;
- almost 60% of IWPs monitored irrigated crop areas to ensure compliance with NRM controls; but
- less than 40% monitored irrigation intensity by crop.

One notable feature was that, in Queensland, the IWP does not provide advisory services on WUE and, with one exception, does not monitor irrigated crop areas and irrigation intensity per crop. However, the Queensland Government addresses these objectives by means of a substantial separate initiative on WUE across all major sectors, promoted by the Department of Natural Resources and Mines.

4.4.2 Water licences

IWPs variously hold licences or bulk entitlements to take water on behalf of their customers. The licensing is a State-government responsibility, managed by the relevant government agency under water-resource legislation.

The bulk entitlement gives the IWP authority to divert water from a river or dam. It specifies the volume of water allocated to the IWP and the security of supply.

The terms and conditions of the licence in NSW, Qld and SA are subject to a local or regional water-management or allocation plan which will determine the volume, security and timing of the diversion. The volume of the licence normally represents the aggregate of the individual entitlements held by the landholders within the irrigation district, plus an allowance for losses in distribution. Therefore, any change in these components of the bulk licence will flow through to the conditions of the individual irrigator's licence and entitlement, and vice versa.

The bulk-water licences are generally issued in perpetuity (as in Vic., Qld and SA), but in NSW are for a period of 15 years and in WA for 5 years. Even where the licence is in perpetuity, its terms may be amended in line with any change to the relevant water management or allocation plan. These plans normally have a life of 10 years.

There is a significant difference in the form of water licences held by the various IWPs.

The Victorian IWPs hold one or more bulk-entitlement orders. Thus, GMW holds separate bulk entitlements for the Murray Valley and the Goulburn Valley. Although the *Water Act 1989* refers to the ability to trade bulk entitlements, a bulk entitlement is the summation of the individually held rights and entitlements which must be serviced by a Victorian rural water authority. The bulk-entitlement order therefore provides a summation of obligations. Moreover, the existence of the bulk entitlement does not itself cancel or compromise the rights or entitlements held by individual irrigators.

In contrast, the NSW Irrigation Corporations hold a single (bulk) licence which has the same status as the licences previously held by individual irrigators. Thus, Murray Irrigation holds a (bulk) licence from DLWC in the same way as does the operator of a river pump outside Hay. For the irrigation corporations, their licences replace the individual licences.

The distinction between a bulk licence and a bulk entitlement has two major implications:

- NSW irrigators served by the irrigation corporations no longer hold entitlements;
- rules in trade between irrigators with an IC are rules on internal matters so far as DLWC is concerned and are equivalent to internal rules within a co-operative for the trading of share. Both NSW and SA IWPs have agreed internally on rules that are potentially restrictive of outward trade; and
- where conditions are imposed on water licences, the licensing authority must deal directly with individual irrigators in the case of bulk entitlement, but with the IC only in the case of a NSW bulk licence.

A significant issue for the promotion of WUE on farm is the extent to which the bulk water licence itself explicitly refers to NRM outcomes — as opposed to any obligations imposed on individual landholders. This varies between the States:

- **in NSW**, the access licence is subject to mandatory conditions as set by the relevant water-management plan and may be subject to discretionary conditions imposed by the minister. In addition, the operating licence includes an explicit obligation to implement LWMPs which, typically, include hydraulic-loading maximums, farm plans, recycling storage etc.;
- **in Victoria**, the bulk entitlements (BEs) held by existing IWPs, under Section 223 of the Water Act, are solely a control on the volume which the IWP is licensed to divert. For these licences, there is currently no conditionality or reference to NRM outcomes, although there is provision for such controls for any new BEs issued under Section 43 of the Act.

Instead, NRM initiatives are promoted through a range of LWMPs and catchment strategies, supported by a number of agencies including the Department of Sustainability and Environment and the regional catchment management authority as well as the IWP itself. Here, the IWP may act as an agent, on contract, to deliver outcomes for the State government rather than as an obligation in its own licence;

- **in SA**, the water licence is held by the IWP rather than the individual landholder within a trust. The licence may be made subject to conditions by the minister, primarily through the relevant water allocation plan or water management plan,³⁷ although there is, currently, no formal linkage between the water licence and local LWMPs;
- **in WA**, the surface water licence requires the IWP to obtain formal approval from the licensing authority for both an operating strategy and water-management-improvement plan, which set targets for improvement in water distribution efficiency.

The NSW model has advantages, as it creates explicit links between the right of access to the resource and the controls required to manage and protect that resource. In this way it integrates environmental and commercial objectives. On the other hand, the NSW and SA models can result in binding restrictions on trade of water out of the districts.

Importantly, under the NSW licensing model, the EPA licence contains critical requirements which demand that the behaviour of individual irrigators be brought to account by the IWP. The critical EPA clauses state that:

P4.2 The licensee must ensure that any arrangement (contractual or otherwise) it enters into with an irrigator during the licence period contains essential terms to the following effect.

- (a) that the irrigator must comply with any reasonable direction of the licensee for the purpose of reducing the impact of chemicals and nutrients on receiving waters;
- (c) that the irrigator will grant the licensee all reasonable access to the irrigator's premises and provide the licensee with all reasonable assistance for the purposes of the licensee determining whether the irrigator is complying with (a) and (b) above; and
- (d) that if the irrigator fails to comply with the requirements set out in paragraphs (a), (b) or (c) above, the licensee may deny the irrigator any drainage services provided by the licensee.

³⁷ For example, the River Murray Catchment Water Management Board (2002), *Water allocation plan for the River Murray prescribed watercourse*.

P4.3 The licensee must monitor compliance by each irrigator with the terms of the contract or other arrangement entered into with the licensee in relation to meeting its obligations under this licence.

P4.4 The licensee must produce to the EPA a copy of any contract it enters into with an irrigator or details of any arrangement with an irrigator in relation to any supply of drainage services within 7 days of the EPA requesting it to do so.

Discontinuation of the provision of services

P5.1 In the event that an irrigator fails to comply with any of the contractual obligations which are required to be imposed as a condition of this licence that has caused, is causing or is likely to cause harm to the environment, whether on or off the premises, the licensee must discontinue the provision of the services to which the contract relates within seven days.³⁸

4.4.3 EPA drainage licences

A parallel requirement on IWPs is to ensure adequate control over drainage flows from surface and subsurface drains. These exist to collect irrigation run-off, intercept saline groundwater flows and prevent waterlogging from rainfall. There are, potentially, strong links between drainage controls and WUE because, where strict limits are imposed on bulk drainage disposal by the EPA, this creates powerful incentives for the IWP to require greater WUE by landholders.

Once again, the approach to licensing of drainage flows differs between States:

- **in NSW**, the operating licence requires the IWP to hold and comply with any subsidiary licences such as from the EPA. In the case of MIL this is in the form of a single licence covering multiple discharges. This explicit linkage integrates business objectives and NRM functions;
- **in SA**, the restructuring of the previous government irrigation areas has been matched by the development and future application of explicit licensing of drainage flows. The most significant is for the Lower Murray Reclaimed Irrigation Area, where the rehabilitation and reform of the region is being driven partly by the recognition that landholders will be faced with a future requirement to meet much stricter discharge licensing standards. The SA EPA is now examining how the outcomes of the NSW approach can be obtained in SA; and
- in Victoria, no such discharge licences apply to the IWPs, and control of drainage flows relies on coordinated contributions from a range of parties and mechanisms. A recent study identified and examined

the strengths and weaknesses of the current approach which is described as depending on personal professionalism, goodwill and co-operation for its effective operation.³⁹

The Nolan–ITU report on Victoria’s drainage programs confirms that there is no clear causal link between the formal, legal and institutional framework and achievement of NRM outcomes in practice. The report commends the operation of the drains as representing ‘best practice’, and demonstrating a high degree of innovation and continual improvement. However, the report also identifies that:

... there appears to be a lack of clarity over respective roles and responsibilities ... Ownership, authorisation to discharge and standards of management are not clear for most Community Surface Drains ... A partnership approach underpinned by good will and cooperation is fundamental to achieving broad scale catchment water quality benefits. This, however, needs to be supported by a more formalised, transparent and unambiguous regulatory approach to ensure independence, accountability, and continued commitment.⁴⁰

An explicit licensing regime that clearly identifies the obligations placed on IWPs appears a more robust model. It also has the advantage that it employs the IWP as an agent to coordinate the achievement of NRM obligations which otherwise would require licensing of multiple individual landholders, and create a major enforcement role for government.

As Nolan recommends:

Building water quality, land management and environmental goals into irrigation and drainage licences, as in the NSW L&WMPs and Murray Irrigation licences, would [facilitate] monitoring the performance of on-farm programs and incentives.⁴¹

On the other hand, land management and environmental goals do not always coincide with the boundaries of the IWPs.

4.4.4 Land and water management plans and licensing

Background to land and water management plans

Irrigation exhibits classic characteristics of market failure, as individual irrigators, on a property-by-property basis, could not take the decisions required to protect the sustainable productive capacity of the wider regional

³⁸ EPA, *NSW Pollution Control Act, 1970*.

³⁹ Nolan-ITU (2001) *Independent review of environmental aspects of northern Victoria’s surface drainage programs in irrigation areas*, prepared for DNRE & MDBC.

⁴⁰ *Ibid*, p. iii.

⁴¹ *Ibid*, p. iv.

community. Licensing and community management plans are devices to deal with these market failures.

Land and water management plans (LWMPs), and their equivalents, provide a mechanism to ensure a consistent and equitable contribution from all members who contribute to a regional problem and who will benefit from a regional solution. This should minimise risks of free-loading, where individuals benefit from the investments of other parties without an equal contribution on their own part.

Examples are:

- LWMPs in irrigation corporations in NSW;
- salinity management plans in Victoria; and
- water allocation and water management plans in South Australia.

This framework is explored further below.

NSW: LWMPs

In NSW, a major driver for adoption of greater WUE has been the development and implementation of LWMPs. The plans provide a robust and effective mechanism to promote environmental outcomes through a set of staged duties imposed on the irrigation entity and, through that, on individual landholders.

This formal structure and its enforcement by the IWPs has led to significant improvements in WUE, especially in the rice sector, where average water application rates have fallen from around 18 ML/ha in the 1980s to 12 ML/ha under the rice environmental policy.

The NSW Department of Agriculture has also played a key role in promoting the adoption of greater WUE through a package of measures and incentives including:

- training courses;
- funding for the development of irrigation and drainage management plans (IDMPs); and
- subsidies for adoption and monitoring of more sophisticated irrigation equipment.⁴²

The department stresses the multiple benefits which training generates:

Training has contributed to wide adoption of high tech scheduling tools, a greater understanding of irrigation issues, and IDMPs becoming standard practice before developing or redeveloping irrigation farms. More than 100 farms have completed IDMPs [in the Lower Murray Region], and the buoyant wine grape industry has helped irrigators update their practices.⁴³

⁴² NSW Agriculture, *Irrigated agriculture, water use efficiency incentive scheme*.

The LWMPs provide a solid base for the consistent application and monitoring of these initiatives.

Victoria: salinity management plans

In Victoria, similar achievements have been made through the implementation of salinity management plans, most of which were based on significant community engagement. A primary objective has been to establish robust controls on new developers to ensure, at a minimum, a salt neutral outcome from the introduction of new water for irrigation into the region.

Existing irrigators have also been the target of programs to improve on-farm WUE. Several incentives have been provided to promote this adoption including:

- a 25% subsidy for the cost of system audit, scheduling equipment and soil surveys;
- loans for scheduling equipment; and
- provision of extension advice.

Since the implementation of the suite of salinity management plans in Sunraysia there has been a dramatic improvement in WUE in the region:⁴⁴

- approximately 60% of growers in Sunraysia have received training and subsequently have improved water-management infrastructure on farm;
- the area under pressurised irrigation compared with flood/furrow has increased from 25% to 60%; and
- collected irrigation drainage flows have fallen by 40%, achieving an estimated 3.8 EC reduction in salinity contribution to the Murray.

However, it has to be acknowledged that the success of this program has been significantly enhanced by the commercial growth and profitability of the wine-grape sector over this period, which has provided major incentives for growers to convert older systems and invest in greater WUE. There has also been a happy coincidence between commercial drivers to reduce water usage to promote production outcomes and NRM objectives in the wine-grape sector. This same alignment has not occurred in other sectors such as dairy.

SA: Water allocation and water management plans

In South Australia, the catchment water management boards are developing water allocation plans and water management plans to identify and formalise the sustainable extractive volume for different activities and to set the terms of those diversions.

⁴³ Jeremy Giddings, NSW Department of Agriculture, www.agric.nsw.gov.au/reader/15643.

⁴⁴ Mallee CMA (2002). *Second generation salinity and water quality management plan* (in draft).

A primary objective is to promote greater WUE:

15. From 30 June 2005 water shall only be taken and used for irrigation so that water achieves a water-use efficiency of no less than 85%.⁴⁵

These plans have a statutory authority as they are approved by the minister under the *Water Resources Act 1997*. That gives their requirements and targets the standing of regulations under the Act. They therefore become relevant in defining the terms and conditions under which water diversion licences are issued. However, there is currently no explicit linkage between those plans and local LWMPs that direct local programs, or between those LWMPs and the water diversion licences held by the irrigation trusts.

The SA Government is currently exploring the optimal approach to the use of LWMPs within the SA Murray area and how to integrate those plans with the licensing regime.

4.4.5 Licensing of landholders

Licensing also applies at the level of the individual property. One of the key differences between the States is the extent to which the licensing of the IWP is integrated with and drives the licensing of landholders.

New South Wales

A common feature of all privatised IWPs in NSW (and WA) is that the water licence from the department is held by the IWP, with irrigators then holding shares in the company/co-operative. Thus, the relevant department deals with the privatised IWP rather than the irrigators within the IWPs boundaries. Irrigators outside the areas and districts served by the privatised IWPs still generally hold licences issued directly by, or on behalf of, the department.

In NSW, the IWP is required to implement the relevant local LWMP and statutory water management plan as a condition of the operating licence and water licence. The LWMP places duties on the IWP to ensure that individual landholders implement certain actions, and the water management plan provides for a wide range of relevant conditions including water efficiency and conservation (S24).

In this way the IWP is acting as an agent of the licensing body and there is a direct linkage between the licensing of the IWP and the duties placed on landholders. Figure and Table 6 provide examples of IWPs implementing an active compliance program to support NRM outcomes including improved WUE. Compliance with the licensing

framework is reported on through an annual environmental report from each IWP, as required in the operating licence. This creates clarity and transparency in the actions taken and progress towards explicit targets.

This integration is reinforced through the contractual relations between the IWP and the individual landholder. This maximises the incentives and pressures on end users to meet NRM objectives such as greater WUE, as the IWP is a knowledgeable and so highly effective agency to progress these issues.

Another positive aspect of the NSW regime is that landholders appear more ready to accept enforcement of licence conditions from their own shareholder company than from an external government agency. Recent research has looked at arrangements to ensure that LWMPs within MIL are adopted by irrigators on the ground.

The case involves a group of Australian farmers attempting to overcome their irrigation salinity and waterlogging problems by agreeing to, among other things, grant to their jointly owned company powers to sanction them individually if they fail to comply with a conservation strategy to which they have collectively committed themselves. It was found that the farmers are more prepared to accept sanctioning from their company than they would be from government.⁴⁶

One weakness of the NSW approach is the difficulty of reconciling a model based around the licensing of irrigation corporations with a catchment-based planning approach, where priorities and plans are set and monitored by community groups and catchment boards. There is evidence of competition and conflict between these two models and a risk to the funding and completion of the LWMPs from broader catchment strategies.

In NSW, the Water Management Act also makes a distinction between the right of an individual to own water (through an access licence) and the right to use it at a location (which requires a water-use approval). This makes it explicit that property-specific controls need to be in place before water may be applied to a property. Any such approval has a 10-year life span (S104). This provides a clear and robust framework to require appropriate controls at the level of the individual property. It should also free-up trade as an individual will be able to purchase water without having to have prior approval for its use at a particular location.

⁴⁵ River Murray Catchment Water Management Board (2002). *Water allocation plan for the River Murray prescribed watercourse*.

⁴⁶ Graham R. Marshall (2002). *From words to deeds: a study of collective action by irrigators in enforcing their commitments to adopt conservation practices*. Conference of the Australian New Zealand Society for Ecological Economics, 2–4 December.

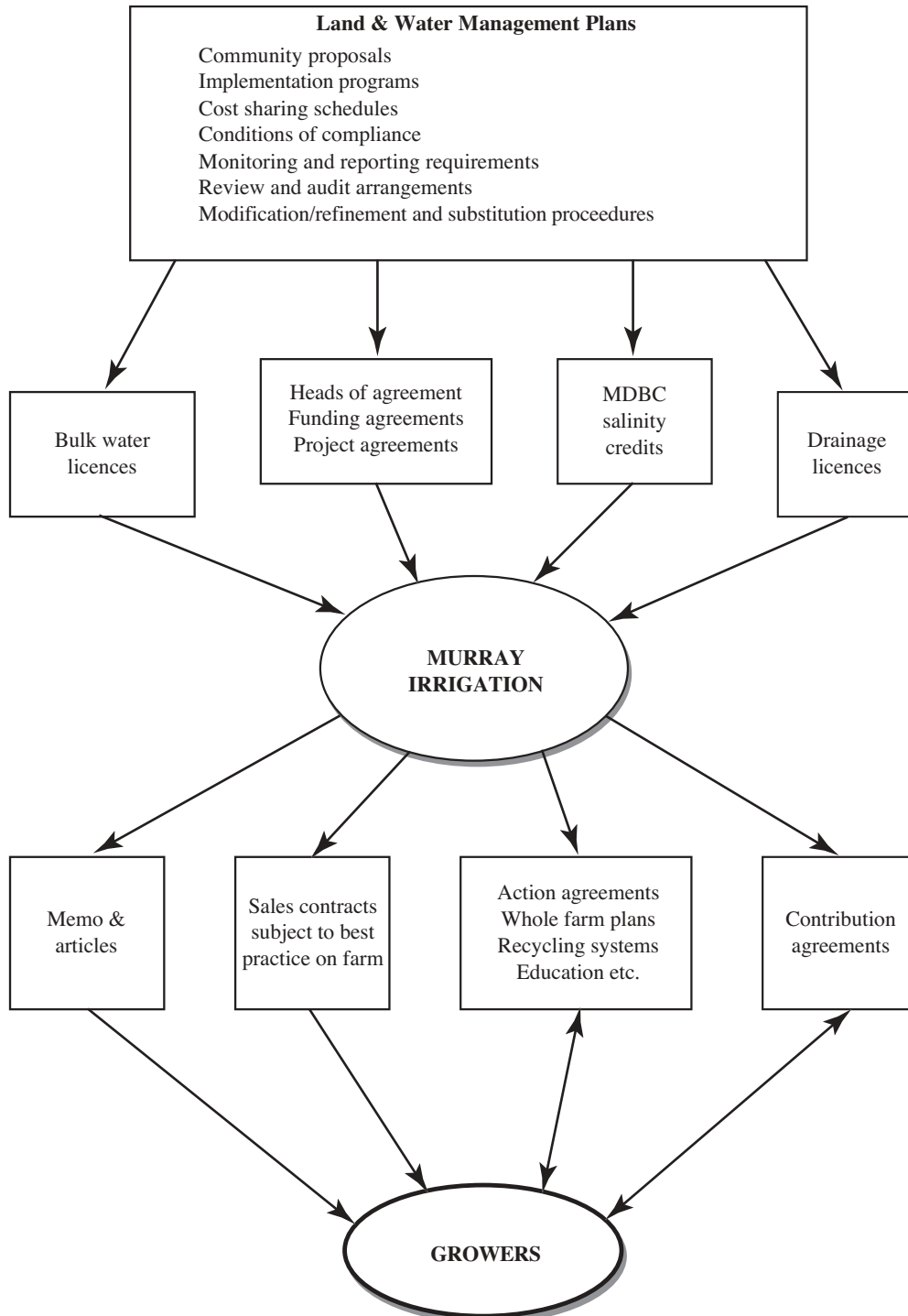


Figure 6. Licensing framework at Murray Irrigation. Source: updated from Marsden Jacob Associates (1994), *Institutional Arrangements for Land and Water Management Plans*, report prepared for the NSW Department of Water Resources.

Table 6. Summary of rice policy enforcement in the CIA and Kerarbury area

Policy	No. of breaches	Range	Actions taken
High rice water use (HRWU)	8	15–17 ML/ha	Letters sent out to farms with no history of HRWU, requesting a letter of reply with explanation for breach.
			Outcome: EM-31 surveying and drilling made priority to be completed.
			Letters sent and interviews held with landholders of farms with history of HRWU.
	16	17–19 ML/ha	Outcomes: EM-31 surveying and drilling made priority to complete; rice growing suspended on offending paddocks until EM-31 surveying and drilling complete; some areas of offending paddocks taken out in accordance to EN-31 survey and drill results; compaction works; water use testing.
			Letters sent and interviews held with landholders.
			Outcomes: EM-31 surveying and drilling made priority to complete; rice growing suspended on offending paddocks until EM-31 surveying and drilling complete; rice suitability map changed in accordance with EM-31 survey and drill results; compaction works; flowmeter checks; agreements to implement NRM; transferring of rice area.
7	>19 ML/ha	Letters sent and interviews held with landholders	
		Outcome: EM-31 surveying and drilling made priority to complete; rice growing suspended from offending paddocks until EM-31 survey and drilling complete; some areas of paddocks taken out in accordance with EN-31 survey and drill results; compaction works; flowmeter checks; agreement to implement NRM.	
Area exceedance	12	0–5 ha	Letters sent and interviews held with landholders
	5	5–10 ha	5–10 ha outcomes; late transfers of rice area between related holdings; late forward transfers of rice area; following seasons rice area reduced by the amount exceeded in 2000–2001.
	3	10.1–20 ha	
	1	20.1–30ha	
	2	> 30 ha	
Out of rotation	8		Letters sent and interviews held with landholders
			Outcomes: agreement to implement NRM; placed on a 2 in 8 rotation (from a 1 in 4 rotation); land to be reclassified with EM-31 surveying and drilling.
Unsuitable ground	2	0–5 ha	Letters sent and interviews held with landholders.
	0	5.1–10 ha	Outcomes: EM-31 survey and drilling to be carried out on this area at landholders expense; compaction works; water-use testing.
	1	> 10.1 ha	

Within the NSW irrigation corporations the cancellations of the individually held water licence which occurred with privatisation means that water-use approvals are not applied to irrigation activity within their boundaries. Rather, this discipline is provided by the LWMP.

Victoria

In Victoria, the bulk entitlements held by the individual rural water authority create no explicit obligation on the IWP to require actions by individual landholders. The Victorian model is based on the IWP acting on a collegiate basis with a range of regional agencies.

More broadly, the ability to apply conditions on individual irrigators depends on whether they are located within an irrigation district or are private diverters:

- Irrigators within districts hold water rights. Under the Water Act the authority has a duty to supply that water

right without any conditionality, under S222(1b). The only occasions on which the authority can apply conditions are when additional water is brought onto the property as a result of trade. In these circumstances, the IWP may apply limits on the maximum water rights to be attached to each holding;⁴⁷ and

- Irrigators outside districts hold diversion licences. The minister can impose conditions on those licences under S56 of the Water Act. These can include “the efficient use of water resources” (S56(1)(vii)). The IWP normally acts as the licensing body for the minister. However, those terms cannot be amended

⁴⁷ Water (Permanent Transfer of Water Rights) Regulations 1991, Regulation 7 (Victoria). IWPs will also require compliance with a suite of controls including provision of IDMPs.

within the term of the licence. Therefore, these provisions are effective to promote greater WUE only when applied to new developments, when trade takes place or at licence renewal.

The engagement of the IWPs in NRM issues is promoted more actively through the salinity management and related LWMPs of the regional catchment management authorities. In this mode, the IWP acts in concert with other regional agencies, under contract to the State government through a government services contract with the DSE.

This approach sees the IWP as one of a series of regional players with an interest in these issues. This maximises coordination between agencies and entities, and ensures integration of the IWPs priorities and those of the catchment boards. However, the approach lacks the powerful discipline of a formal, statutory obligation with equivalent weight to the commercial imperatives of the business.

Some measure of this relative weight can be seen in the business plans for the Shepparton and Central Goulburn Irrigation areas of Goulburn–Murray Water which make only passing reference to WUE in their priorities.⁴⁸ There is no program or target to drive down water usage in the dairy sector equivalent to the commitments on rice WUE in the licences or LWMPs of the irrigation corporations in NSW.

South Australia

In SA, the water licence is held by the irrigation trust not by the individual landholder. As noted, that licence has conditions set by reference to the relevant water allocation plan. In the case of the Murray, this will include an obligation to meet WUE targets of 85% or 65%, depending on location (see the case study on CIT in Annex A).

The responsibility for meeting this target rests with the IWP, as the holder of the water licence. That creates an obligation on the IWP to apply equivalent conditions to individual landholders for the supply of any water for irrigation. IWPs have the authority to apply such conditions under S30 of the *Irrigation Act 1994*. Compliance with these licence conditions is reported through a system of annual reports.

The same dynamic applies in the case of local LWMPs where funding from the Natural Heritage Trust or the catchment board has been used to promote greater WUE. However, unlike NSW, there is no explicit integration

between the licence held by the IWP and an obligation to implement the local LWMP. A review is currently being launched to assess the optimal approach to the role of LWMPs and their integration with licensing.

4.4.6 Institutional framework

In NSW there is, therefore, the mechanism for an effective integration between the water licence and the LWMPs and EPA licences, ie. there is an explicit obligation on the part of the irrigation corporation to meet NRM outcomes as part of the terms of the licence to take water. In addition, there are clear links between the obligations placed on the irrigation business and the flow-on obligations which are placed on the individual landholders within the area served by that business. Figure 6 illustrates the interaction and integration between these elements.

That integration and those links are far less certain in either Victoria or South Australia. The case study of GMW in particular confirms that the authority has few powers to require irrigators holding ‘water right’ to implement improved NRM actions. This limits the ability of the water business to promote the adoption of greater WUE other than as it relates to new developments or properties purchasing water.

The parallel issue of licensing for drainage flows confirms the same picture in Victoria; of a system performing at a high level but reliant on the goodwill and co-operation between agencies and with ambiguity as to relative roles and formal accountabilities.

This alternative model promotes regional co-ordination between agencies over strict compliance within a corporatised business framework.

4.5 Taxation

Taxation affects IWPs, individual irrigators and water-use efficiency in several distinct ways.

Taxation of reserve funds

IWPs typically face the liability of refurbishing, replacing and renewing substantial infrastructure. For privatised IWPs especially, loan funding is limited by the nature of the assets, and sinking funds must be accumulated. In the NSW irrigation corporations, the accumulation of reserve funds is an obligation of their operating licences.

In sharp contrast to the UK, contributions to renewal sinking funds by water companies are not deductible from taxable income in Australia, as the renewals annuity approach is not recognised under Australian tax law. This reduces funds available for asset renewal or requires higher prices to be charged to irrigators to achieve the same end point.

⁴⁸ GMW (2001). *Business plans for 2001/2 to 2005/6 for Central Goulburn and Shepparton irrigation areas*.

The two stage co-operative structures, adopted for South-West Irrigation and by Coleambally Irrigation, can reduce these tax impacts, as does the adoption of not-for-profit status by some Victorian rural water authorities.

Nonetheless, by comparison with the UK, the prudent accumulation of reserve funds to maintain asset condition and performance is discouraged.

Taxation of capital contributions from government

Most privatised IWPs have received capital contributions from the State governments to pay for the backlog of accumulated maintenance, ie. to bring the infrastructure up to reasonable condition, either before privatisation or to allow the IWP to do so after privatisation.

While the legal structures and transaction paths used in the later privatisations have generally avoided these tax impacts, the IWPs which privatised early in the process (eg. Murray Irrigation and Murrumbidgee) have large potential tax liabilities relating to monies paid to them from the NSW State Government.

The impact of these tax liabilities is to reduce funds available for asset renewal and upgrading, or to raise the prices paid by irrigators for delivery of water.

Income Tax Assessment Act 1997

The *Income Tax Assessment Act 1997* provides incentives to promote investment in WUE.

Subdivision 40-F allows for deduction of amounts for capital expenditure on certain depreciating assets used in carrying on a primary production business, including water facilities. A water facility is defined as “a plant or structural improvement, or an alteration, addition or

extension to a plant or a structural improvement that is primarily and principally for the purpose of conserving or conveying water”.

This provision provides an incentive for individual irrigators with the capacity to absorb increased deductions to invest in WUEs. The provision does not extend to water facilities for the purpose of draining water or to collective irrigation businesses (such as the NSW irrigation corporations) conveying or distributing water.

Thus, while subdivision 40-F may encourage investment by individual irrigators and partnerships in WUE, the provision does not appear to extend to entities (other than partnerships) formed to invest in eligible water facilities jointly or to invest in WUE in irrigation infrastructure, plant, and structures servicing individual irrigators.

Finally, Section 120(1)(A) provides for a specific benefit to co-operatives servicing primary producers. However, this provision is limited to marketing co-operatives and does not extend to other co-operatives, such as the irrigation co-operatives, supplying services to primary producers. The rationale for this asymmetric treatment is unclear. However, the impact of this asymmetry is to reduce the viability of irrigation co-operatives.

In summary, subdivision 40F provides incentives for individuals and partnerships to invest in WUE but the provision does not extend to joint action by incorporated entities. Other asymmetries contribute to the concern that irrigation water providers are not generously treated in terms of the tax-based incentives for investing in WUE.

5 Internal policies, capacity and influence

The terms of reference for the study cover how the internal policies, capacity and influence of water agencies operate to drive improvements in WUE and sustainable water use or, alternatively, impede such improvements.

Internal policies of the IWPs with the potential to impact on irrigator behaviour and WUE include policies on price levels and tariff structures:

- service and delivery standards and conventions, infrastructure upgrade and delivery/application;
- customer obligations, responsibilities and conditions for water delivery and water use;
- conditions and responsibilities for drainage;
- the acceptance and support for NRM and LWMP roles and responsibilities;
- attitudes and policies for diversification and regional development;
- regional and internal trading rules;
- promotion and facilitation of trade in water;
- policies, attitudes and perspectives on transmission or mitigation of external pressures and vice versa; and
- arrangements and acceptance of irrigator involvement in the management of the IWP including customer committees, interface and delegation.

5.1 Service delivery, infrastructure upgrades and application

The nature of the delivery system and service standards such as the frequency of guaranteed supply have an important and direct bearing on the efficiency of the on-farm systems for supplying water.

5.1.1 Water-delivery service standards

As an illustration, water-delivery service standards in gravity-fed channel irrigation schemes are specified in terms of:

- method of water delivery;
- the lead time to order water;
- the flow rate or channel head provided; and
- the ease of ordering and monitoring of flow rates.

All of these dimensions of service affect on-farm behaviour and WUE.

Most irrigation districts have greatly improved service standards in recent years through the introduction of improved operating procedures and enhanced technologies for ordering water. Goulburn–Murray Water, for example, has undertaken the following initiatives to improve customer services:

- water-delivery methods have been upgraded from a roster-based system where irrigators were supplied at fixed dates, to a system of on-demand ordering;
- the lead time between water delivery and the placement of an order is currently four days, but the objective is to reduce this to six hours;
- to maximise the benefits of laser-graded irrigation bays on farms, flow rates higher than those supplied under the original channel design conditions are required. GMW has modified its operating procedures to provide these higher flow rates; and
- customers can order water seven days a week and at any time, using a computer-based ordering system.

Channel systems are designed for flood irrigation, and pressurised, piped delivery systems are required for cost efficient use of tapes and drippers — although it is certainly possible for the irrigator to pump from a channel.

Introduction of more efficient technologies and practices by the end user, through conversion from flood/furrow to drip feed, places increased demands on the delivery infrastructure and operations of the water authority. The conversion involves a change from:

- infrequent, high flows, delivered to a rostered schedule and over a large irrigation season; to
- frequent, low flows, delivered on demand, over fewer months.

These changes place considerable pressure on the supply infrastructure and systems of the water authority. Channel capacity is often inadequate to deliver the water required within the time frame required and the delivery co-ordination systems are not sufficiently sophisticated to service on-demand orders.

Existing infrastructure may be able to operate as a mix of delivery standards (supplying both a standard product to the old requirements and also meeting new demands) for so long as those new requirements represent only a small percentage of total demand. For example, GMW provides a near ‘on-demand’ supply for its small percentage of high-value users. However, it will not be able to continue to do so if that percentage increases beyond 15% of demand, without extensive investment in new control equipment.⁴⁹

This limitation will constrain the extent to which landholders will be able to adopt or invest in drip or other highly efficient water systems. This constraint is likely to be far more influential on enterprise and technology choice than other internal policies or the institutional form of the entity itself. This change also has implications for distribution losses, as pressures for on-demand supply from open-channel systems require channels to be run at a higher level with consequential higher levels of outfalls. There is therefore a trade-off between levels of service to irrigators and efficiency of the delivery system.

In the absence of offsetting factors, IWPs might be deterred from promoting adoption of more water-use-efficient technologies on farm if this required significant change and investment in their own distribution systems. In practice, the larger and more innovative IWCs have taken the alternative view.

Nonetheless, one way to offset this constraint would be to introduce differential tariffs that would allow the IWP to charge the beneficiaries of these changes higher tariffs to match any increased delivery costs. At present, most IWPs still retain a simple two-part tariff (related solely to the entitlement and the aggregate volume consumed) which takes no account of the number of orders or deliveries required in a season or the sensitivity of their timing.

Differential charges could be used to signal the relative value of water and its timing for different sectors. It is noted that Coleambally Irrigation has introduced a range of tariffs to match the service levels provided, and that Goulburn–Murray Water is considering introducing such an approach.

A further approach would involve the unbundling of the component elements of the water entitlement and the creation of explicit title over delivery rights. This would then allow a market-based approach to the financing and trading in delivery capacity. This will be more feasible where the relevant infrastructure is relatively simple, such

as a new pipeline system. It is far more problematic where there is a complex network system, as there is with most of the larger, gravity-fed IWPs.

Policy on changes and upgrades in infrastructure is therefore linked with policy and attitudes on crop and enterprise mix in the area — and therefore to regional development.

In most regions, irrigation plays a crucial role in the economic fabric of communities through the nexus between irrigation and regional industry. For example, in the irrigation areas of northern Victoria, the \$85 million of annual expenditure on irrigation infrastructure operations supports production of crops worth \$1.4 billion at the farm gate. Crop output in turn supports industries in the region with an estimated turnover of \$8 billion.⁵⁰

Irrigation delivery businesses have an important role in jointly pursuing irrigation savings and at the same time promoting the development of irrigated agriculture.

Harvey Water co-operative in the south-west of WA is moving in steps to introduce piped delivery to better serve irrigated horticulture, leaving channels to serve the needs of irrigated pasture for dairying. These changes are not driven by water shortage, or by the pursuit of WUE *per se*, but rather by the desire to serve the evolving needs of its customers and district — where it is profitable to do so.

On a possibly much larger scale, Murrumbidgee Irrigation is investigating the potential to achieve large water savings by replacing open channels with pressurised pipe delivery which will allow consequential efficiencies, cost savings and quality upgrades to be achieved along the supply chain.

A strong example of an innovative approach adopted by irrigation businesses is the “Horticultural Vision 2010” program in the Murrumbidgee Irrigation Area. Horticultural Vision 2010 (see Box 3) is a joint project between Murrumbidgee Irrigation and the Murrumbidgee Horticulture Council Inc. The scheme proposes to replace existing horticulture supply infrastructure with pressurised, piped supplies. The on-demand pressurised supply will provide farmers with the opportunity to upgrade their on-farm irrigation to high-tech pressurised systems. This will provide water savings on farm and is expected to lead to increased yields and improved product quality.

⁴⁹ Geoff Earl, Manager, Water Reform Development, Goulburn–Murray Water, pers. comm., June 2002.

⁵⁰ Goulburn Murray Water (2001). *Regional water infrastructure supporting northern Victoria*, submission to the Infrastructure Planning Council.

Box 3. Water savings: the vision of Murrumbidgee Irrigation

Water savings, sound management, and river health

Dick Thompson, Chairman Murrumbidgee Irrigation,¹

Murrumbidgee Irrigation is fortunate to be in a position where we can envisage a strong contribution to river health from water efficiency savings and sound water management.

First, on-farm water savings through efficient field delivery systems have been demonstrated on horticultural farms within the MIA, through our Vision 2010 program and our EnviroWise program (which is aimed at improving on-farm water budgeting and management). Second, we are starting to rebuild our off-farm irrigation supply and drainage system with something of similar efficiency.²

The combination of these programs has helped to identify areas of potential water saving from improved capital and management efficiency, especially through integration of off and on-farm delivery systems. For instance, estimates from the company suggest that water saving of about 100,000 ML per year from the MIA and Districts could be delivered through an investment program involving:

- the piping of channels;
- the piping of on-farm delivery systems;
- the integration of on and off-farm irrigation systems (eg. pressurisation);
- installation of on-route storages within the system; and
- improvements to the management of water arriving at Barren Box Swamp.³

This program may require additional annual infrastructure expenditure of around \$170m, and, say, \$30m in improved management and management systems. In other words, we could be able to save water at an economic cost of about \$2,000 per ML⁴ or around half what it would cost to recover the same amount of water through reductions in irrigator entitlements or allocations. That said, the opportunity for least cost investment in system integration rapidly diminishes the further we go along the path of replacing existing assets.

Cost sharing

Common sense would suggest that such water saving options be pursued as a first resort. The financial cost of such projects could be shared equitably, ie., in accordance with the distribution of benefits from the water saved. If society receives the benefits directly, through water recovered for river health, the Government would meet the costs. If the benefits are substantially privatised (either to an individual or particular group), the direct beneficiaries should meet the costs.

If Government were to finance the investment costs, 100,000 ML per year could be returned to the river as environmental water for use in improving the health of the Snowy and/or Murray Rivers. If managed effectively, at the same time it may provide significant environmental flows in the Murrumbidgee while decreasing high flow problems in the Tumut River.

Notes:

¹ Paper presented to 50th ANCID Conference, Griffith, September 2002.

² Vision 2010, EnviroWise, and the system refurbishment are expected to cost about \$380m over the next 10 to 15 years.

³ Barren Box Swamp is soon to become Barren Box Storage, at about 25% of the swamp's current land area; and Barren Box Wetland which will comprise the remaining 75% of the swamp's current land area.

⁴ 1,100,000 ML saved at a total cost of \$2 billion means a total cost per ML of \$2,000.

The key principle emerging here is that the close link between delivery and application technologies and practices, means that change in WUE based on changing application technologies and practice on farm on any large scale requires consideration of the ISP role in delivery.

5.2 Tariffs and charges

One potential driver to promote the adoption of greater WUE is the impact of the tariffs and charges of the various IWPs. Three separate factors need to be assessed:

- the size of the overall charge; including
- the use of charges to cover environmental costs; and
- the structure of the tariff.

5.2.1 Charges as drivers

Economic theory would normally perceive price as the primary determinant of the level of consumption. This section provides an analysis of the relative significance of water charges to the running of an existing enterprise. This helps assess whether charges are likely to be a major driver of decisions relating to WUE. Two main methods of assessment have been undertaken:⁵¹

- a) **Operating expenditure:** to assess the percentage which water charges represent of the total annual operating expenditure of the enterprise. In the case of wine grapes and citrus, 'total variable costs' are also available to indicate the relative importance of water, while for dairy it is 'total enterprise operating expenditure' (Table 7).

Table 7. Water charges as a proportion (%) of operating expenditure

	Grape	Citrus	Dairy/Vic.
Water charges as a percentage of total variable costs	6.38	5.76	–
Water charges as a percentage of total enterprise operating expenditure	5.18	4.80	7.61

Total water charges represent between 5% and 8% of total annual operating expenditure.

- b) **Gross margin:** the other analysis is to assess the percentage of the gross margin of the business that water charges represent. This provides a feel for the relative revenues of the different sectors. In the case of wine grapes and citrus, figures for gross margin are available. In the case of the dairy sector, the analysis is based on enterprise operating surplus (Table 8).

Table 8. Water charges as a proportion (%) of gross margin and operating surplus

	Grape	Citrus	Dairy
Water charges as a percentage of gross margin	1.82	6.62	–
Water charges as a percentage of enterprise operating surplus	1.95	11.64	13

Water charges are clearly of little significance for the wine-grape sector, given the returns that are available. However, for dairy, higher water charges may well provide a major impetus for the adoption of greater WUE. A recent survey of dairy farmers in Queensland identified that:

... the main factor likely to encourage irrigators to become more efficient is the cost of water & application.⁵²

Citrus sits much closer to dairying in this measure.

This analysis would suggest that water charges are more likely to be a significant driver of decisions within lower-value sectors such as rice and dairy than in higher-value sectors such as horticulture or wine grapes. This suggests that it is worth further assessing the impacts of tariff design on adoption of greater WUE.

5.2.2 COAG/NCP pricing principles

COAG requires compliance with a suite of pricing reforms, in particular that charges should meet requirements for full cost recovery. That recovery ought to include, at a minimum, those sums necessary to promote business viability and also the identified costs of externalities. The term externalities is defined to mean:

... environmental and natural resource management costs attributable to and incurred by the water business.⁵³

Clearly, this requirement could be used as a tool to create powerful incentives to drive adoption of greater WUE if irrigators had to bear the real costs of meeting the adverse effects of diversions on the environment, and these costs were known.

In practice, this requirement has been adopted in only a partial way by the States. Examples of different approaches adopted by the States include:

- **NSW** includes the NRM costs of DLWC in the bulk water prices charged by State Water and subject to oversight by the Independent Pricing and Review Tribunal (IPART). NSW also has levies for LWMPs which are imposed at the property level and are related to the volume of water applied, and raise funds to complete NRM projects at the regional level;
- **Victoria** does not impose an element for the equivalent costs of DSE in its headworks charges. New development within Sunraysia is subject to a one-off salinity levy on the water transferred, which varies between \$26 and \$260/ML depending on the location of the development and the risks of increasing saline flows to the river. These funds go towards the costs of additional salt-interception schemes; and
- **in SA**, all irrigators are subject to an annual environmental levy (eg. \$3.00/ML in the Murray). This forms part of the funding for the catchment

⁵¹ Marsden Jacob Associates (1999). *Pilot inter-state water trading: cost recovery project*, report for the MDBC, February.

⁵² Barraclough & Co (2000). *Audit of water and irrigation use efficiencies on farms within the Queensland dairy industry*, Fig. 13, p. 29.

⁵³ NCC (1998), *Compendium of NCP & related reforms*, p. 113.

water management boards and regional riverine and aquatic environmental programs.

So, although there is a requirement to include costs of externalities in water charges, in practice this is implemented to only a limited extent. Given the size of the levies in place, it seems unlikely that these will have a marked effect on decisions by landholders about adoption of greater WUE.

The National Competition Council (NCC) has recently raised the profile of this requirement in its framework for the next round of the National Competition Policy (NCP) compliance assessment.⁵⁴ This confirms that its main test will be that water businesses are able to demonstrate that:

... prices faced by water users transparently reflect externalities that are attributable to and incurred by water service providers.⁵⁵

Given the existing commitment of State governments to compliance with NCP/COAG and the effective monitoring program in place managed by the NCC through the competition payments, there would be strong arguments for governments to use this program to drive the maximum outcomes available as an early element of any initiative to promote greater WUE.

Price elasticities are likely to be particularly effective in driving water usage from lower-value activities, such as pasture, to higher-value outcomes, and in promoting greater WUE in medium-value sectors such as dairy and rice where large volumes of water are currently used.

5.2.3 Structure of water tariffs

The typical approach taken by IWPs to water charges involves a two-part tariff, comprising a fixed element, related to the size of the entitlement held, and a variable element based on water usage (either the total volume or any volume above entitlement). The volumetric component may be static, or vary with the volume use with either an increasing or decreasing rate.

A key issue for IWPs is to ensure stability in revenue to match their high fixed and continuing costs, which do not vary with the volume of water supplied. This is particularly true for open-channel systems. This is the rationale for the high fixed component in many irrigation tariffs.

The significance of tariff structure and design for the promotion of greater WUE is not a simple or one-way effect. It will depend both on the structure of the tariff

and on the relative percentage of the water entitlement that is taken by an individual irrigator.

Different tariff designs will create a range of different incentives, eg.:

- a **high fixed and low variable charge** will send few signals to promote the adoption of greater WUE;
 - ... the pricing policies of irrigation water delivered by SunWater mean there is little financial incentive to use less water as there is a fixed price component to regulated water.⁵⁶
- Before water trading, this tariff encouraged a 'use it or lose it' approach to water use and led to inappropriate watering late in the season;
- on the other hand, a **high fixed charge** may generate positive outcomes for WUE as:
 - with the development of water trading, it will create incentives for landholders to dispose of any excess water they hold, rather than apply it wastefully;
 - it may also create incentives for a landholder to invest in greater WUE to create a surplus that can then be employed to expand the area under irrigation.

However, a secondary effect may be that a larger percentage of the total entitlement is thereby activated, reducing flows to the environment; by contrast,

- a **high volumetric element**, with a low fixed charge, will encourage conservation, as landholders can obtain an immediate benefit from using water carefully. This should promote greater WUE. On the other hand, this form of tariff creates few incentives for landholders to sell surplus water within their entitlement as they face little cost in holding more than their annual requirement. This may constrain the movement of water to higher-value uses.

It is notable that the Central Irrigation Trust (CIT) in SA has a low fixed charge and a high volumetric charge, which is different from most other IWPs that rely on high fixed charges to cover their fixed costs.

CIT's approach should promote stronger water-conservation signals than a tariff where the fixed component is high. However, CIT's approach cannot be automatically applied to all other irrigation areas for several powerful reasons:

- CIT faces relative certainty of demand across seasons. Wine-grape cultivation in SA is highly dependent on irrigated supply and relies very little on rainfall. The normal variation in demand between seasons is

⁵⁴ NCC (2003). *The 2003 NCP assessment framework for water reform*, February.

⁵⁵ *Ibid.*, p. 14.

⁵⁶ Queensland Fruit and Vegetable Growers (2001). *Rural water use efficiency initiative – 2001 Milestone report*, p. 21.

usually less than $\pm 10\%$.⁵⁷ This is far less than the variation in demand in the dairy sector in north-eastern Victoria where rainfall can comprise an important part of the overall water need;

- CIT's fixed costs are relatively low and comprise management of 340 km of pressurised pipe supply. By contrast, Goulburn–Murray Water is responsible for managing 7,500 km of open earthen channels with multiple infrastructure elements. These involve much higher, continuing fixed costs;
- a higher percentage of CIT's operating costs are variable with demand, eg. the electricity required for pumping. In the event of low demand, then those costs would also be reduced. By comparison most of GMW's costs are not demand driven and will be incurred irrespective of the level of sales.

At first sight there appears to be an incentive for water businesses to encourage greater use of water rather than its conservation, as the business is judged by its corporate measure of bottom line profitability. However, in practice, that driver is not clear cut:

- there is a difference between the aggregate water usage and the level of WUE at the individual property level. It is acknowledged that there are few incentives on water entities to promote a reduction in the aggregate demand across the area as a whole. However, it is in the interest of all water businesses to promote greater WUE at the farm level as this will allow the potential area of land under irrigation to be increased and boost overall revenues for the irrigation area; alternatively
- adoption of greater WUE by individual landholders will increase the security of supply for the remaining properties within the area served by the irrigation entity.

A matrix pricing system, as used by the Coleambally and Murrumbidgee irrigation companies, also reduces any incentive the IWP may have to encourage additional consumption. Under this approach, the unit tariff is calculated at the end of the season using the known volume of water deliveries, so the unit price varies inversely with the actual level of water deliveries in each season thus ensuring full cost recovery each year.

IWPs can also protect themselves, to some extent, from revenue volatility that occurs under extreme weather conditions, eg. CIT has 'insured' itself against risks of revenue inadequacy through establishing a reserve fund of \$1 million, while Murray Irrigation has adopted a supply variation levy and related fund in specific recognition of the impact of supply/demand variation on

revenue. This fund is supplemented in years of high deliveries and drawn down in years of low deliveries.

In summary, alternative tariff structures need to be designed to reduce or eliminate revenue volatility, better match the services provided, be more reflective of the costs of service provision and provide a signal of the cost of water as a stimulus to improve WUE.

As an example, particular issues that need to be reflected in an efficient tariff structure for a large, gravity-fed irrigation system include:

- the foreshadowed formal separation of water entitlement from land;
- the separation of high and low security water rights under retail entitlement reform (RER);
- the contrast between the high level of fixed costs and the seasonal volatility;
- the increasing recognition that channel capacity, rather than water availability, is often the limiting constraint; and
- the different levels of service between and within districts.

To reflect the business situation and risks faced by an IWP retail business, an efficient tariff would include:

- a **bulk water charge**. This would essentially be a straight transfer to irrigators of the bulk water charges paid by the individual areas to the headworks/bulk water business;
- an **asset/delivery capacity charge**. This charge would cover fixed maintenance costs and asset renewal/refurbishment costs, ie. an asset levy;
- a **service charge** to recover elements of operational and administrative costs; and
- a **volumetric charge** based on every ML used to reflect remaining costs and to provide a signal for WUE.

As occurred with the introduction of two-part tariffs, the simple action of unbundling the tariff structure itself provides a major signal to water users to re-assess current behaviour. For example, the separating out of an asset/delivery capacity charge would be a useful precursor to establishing tradeable entitlements to delivery capacity.

5.3 Policies on water trading

Trade provides a highly valuable and effective approach to promote movement to higher value uses of water and greater WUE. It will also provide an adjustment mechanism to minimise the potential impact of any reduction in licensed diversions, and could provide a mechanism to allow government to purchase additional water for the environment.

⁵⁷ Jeff Parish, CEO, CIT, pers. comm., June 2002.

Two major policy attitudes can be observed across the IWPs:

- the largest IWPs in the southern MDB, (GMW, MIL and CIT) have actively promoted trade by establishing and underwriting the costs of water exchanges; and
- restrictions are common on the export of water to outside the area of the IWP.

5.3.1 Water exchanges promote trade

The efficiency of the temporary market in annual allocations has been greatly increased by the establishment of formal exchange mechanisms as the primary vehicle for that trade. These increase price disclosure and confidence in transaction integrity.

Several water-exchange schemes have developed over the past five years in the southern systems:

- within MIL, approximately 30% of trade goes through the Southern Riverina Irrigators District Council (SRIDC) Exchange with the remainder split equally between brokers and bilateral deals;
- within GMW over the past three years, the North East Victoria Water Exchange/ Watermove has doubled the amount of trade for which it is responsible, as a percentage of total trade, from 15% to 30%; and
- within SA, CIT plays a role to facilitate and authorise trade for the eight individual trusts. However, the overall rate of trade is lower than in Victoria and NSW.

These exchanges have played an important role in promoting a culture supportive of trade and in ensuring robust and transparent arrangements. It is recommended that government supports and enhances the provision of formal water exchanges.

5.3.2 Constraints on outward trade

The IWPs have developed several sets of rules which constrain outward trade of water on a permanent basis. None of these restrictions applies to temporary trade in annual allocations. The restrictions include:

- direct restrictions on inward trade;
- direct restrictions on outward trade;
- requirements that specified amounts (or percentages) of water be retained on the property;
- cost-retention rules or exit fees to reduce the impact of asset stranding; and
- checking and clearance procedures to reduce third-party impacts.

Direct restrictions on inward trade have been imposed to limit further environmental damage. For example, there are restrictions imposed by Sunraysia Rural Water on the import of water into the high impact zone.

Direct restrictions on outward trade take several forms. The most common of these are that:

- outward trade is permitted so long as the net direction of trade does not reduce the bulk licence below a specified percentage of its base level. This percentage is 25% for CIT where outward trade has now stopped.

Most of the irrigation corporations and private irrigation districts in NSW have imposed similar restrictions on the 'export' of water from their districts. As an example, article 29 of the Articles of Association of Murray Irrigation Limited, states that:

The Member may not Permanently Transfer Externally where the effect of the Transfer would be that either:

- (a) the water allocation (as that term is defined in Division 4C of Part 2 of the Water Act); or
- (b) the Basic Entitlement (as that term is defined in the Irrigation Corporation Licence), of the Corporation, under the Irrigation Corporation Licence, will be less than 1.4472 million Megalitres.

The intention here is that no individual shareholder in the company should be able to reduce the major asset of the business. This is understandable within the terms of the individual business and the duties on directors to protect the interests of all shareholders. In practice, MIL has been an overall importer of water and so has been able to allow a small volume of water to be exported and yet remain above its bulk licence. However, the outcome of the approach, which is also followed widely in equivalent corporations, has been to restrict the movement of trade.

This form of restriction will prevent outward trade where the net direction of trade is outward. In the specific case of Murray Irrigation, this restriction has not been binding, since the area has been a net importer of water since the privatisation. MIL states that, as a result, no application to export water has ever been refused. Murrumbidgee Irrigation has applied a similar (but binding) set of restrictions (see Box 4); and

- the volume of outward trades in any one year cannot exceed 2% of the base. This restriction, which is in place in GMW (and also in CIT), slows — but does not prevent — outward trade.

Of the variants of direct restrictions on outward trade, the Victorian form is the least constraining in principle, while the NSW and CIT form is more constraining.

Volume retention

Requirements for certain volumes to be retained on the property — as distinct from the area serviced by the IWP — constitute a second set of restrictions. However, these restrictions are area and therefore IWP specific:

- In South Australia, these restrictions are in fact imposed by the water allocation plan for the Murray

Box 4. Permanent transfer rules – Murrumbidgee Irrigation

Murrumbidgee Irrigation applies three types of trading rules. These are:

- **volume retention rules** which mandate a minimum volume of water that must be maintained on a property;
- **cost retention rule** by which the seller must continue to pay district delivery charges for the water sold — in perpetuity; and
- **the district cap** on the volume of water that can be transferred out of a district in a specified period.

Permanent transfer trading rules: Murrumbidgee Irrigation

Entitlement Type
Volume Retention Rules
District Caps
Cost Retention Rule

High security

6 ML/ha or 25% of the irrigation entitlement on a property

No more than 1% of the district's entitlement in a year

District delivery charges apply to all exported water, with the exception of water sold to the Snowy joint venture.

Low security

25% of the irrigation entitlement on a property

The export of water entitlement out of the district is not permitted.

on the Lower Murray Reclaimed Irrigation Areas (LMRIA) rather than by the emerging IWP for the 'swamps'. Under this model there are tradeable and non-tradeable elements in the water licence.

The rationale for preventing water being traded off, is that retention volumes need to be applied to counteract the up-thrust of saline water as a result of groundwater pressures; and

- In the NSW IWPs, a similar rationale is cited as the basis of the need to retain 4 ML/ha on the property. This retention volume is higher than the level required in the SA Lower Murray and therefore more restrictive.

The in-principle argument for amounts to be retained to offset rising groundwater pressures appears sensible, but the scientific/hydrological basis of these retention levels needs to be documented and independently tested.

Protection of third-party interests

The reforms to water legislation since 1989 have sought to jointly promote trade in water and the protection of the environment and other third-party interests.

The benefits and costs of trade, and the direction and magnitude of third-party impacts, differ according to the boundaries and perspective of the observer.

In this area, the regional perspectives and calculus can differ substantially from national perspectives. Particular

concerns voiced by water sharing plans (WSPs) in the Southern Basin include:

- trade has provided a strong incentive for the activation of sleepers and dozers, with a resultant increase in the level of overall diversions;
- trade may not always see a movement to higher-value uses, as the major purchasers are typically those engaged in the predominant monoculture in the region. This means that surplus water from wine-grape production in SA, may well have moved through the temporary market to the watering of rice in NSW;
- trade has seen the movement of water to areas where increased salinity may occur, such as along the Murray in SA;
- trade may lead to increased salinity in the selling area, if the previous water use had contributed to dilution flows in surface waters;
- trade may also lead to the stranding of assets within irrigation districts, leaving the remaining irrigators with higher unit maintenance costs. Exit fees need to be developed to limit trade out of areas where there are significant sunk costs in existing irrigation infrastructure. On the other hand, there will be some areas where government will need to step in to facilitate structural adjustment to assist the withdrawal of water from an area; and
- ultimately, export of water may reduce the productive capacity of a region with the attendant social and economic impacts — these may include negative outcomes for salinity from abandoned properties and evaporation basins on floodplains. Consistent, effective measures need to be introduced to ensure

that trade does not lead to adverse environmental outcomes. The current disparity between the controls over high impact zones in Sunraysia and the (lack of) equivalent controls in SA act to constrain the further extension of interstate trade.

There is also a need to protect the interests of secured lenders when water is transferred permanently. The quality of the title registries is of critical importance in promoting trade and investment in water. In Victoria, these registries are the responsibility of the rural water authorities.

In NSW, the share registries of the irrigation corporations are the relevant registry for the majority of the water held by irrigators in the State.

Since trade is a critical tool in promoting WUE, the role and policies of the WSPs in the type and efficiency of the registries is a critical factor and influence.

The binding nature of restriction on outward trade from some IWPs has constrained greater trade according to market participants, including other IWPs within NSW, and is one of the factors cited as limiting the development of the interstate water-trading project due to the political and commercial perceptions in other States.

Water trade is a critical mechanism in minimising the overall economic costs of implementing higher environmental flows. A key priority will therefore be to develop approaches to reduce these restrictions and this requires dealing with a range of concerns including the protection of third-party interests and stranded assets.

The need to reduce these constraints has been identified in the recent publications from the NCC, which set the framework for the compliance assessment with NCP.⁵⁸

5.4 Irrigator involvement in management of irrigation water providers

In most States, there are mechanisms for irrigators/customers to be involved with, and influence management policies and decisions in, the IWPs. This implements the principle in clause 6(g) of the COAG Agreement that:

... constituents be given a greater degree of responsibility in the management of the irrigation areas, for example, through operational responsibility being devolved to local bodies.⁵⁹

For example:

- **in NSW**, most of the IWPs are privatised entities owned by the irrigators within the particular district. This provides an intimate and complete engagement of the local irrigators in the management of the business;
- **in Victoria**, GMW has introduced 'water service committees', which have a measure of responsibility for decisions on the trade-off between costs and quality at a district level. The strength of these committees is much reduced in the other Victorian IWPs;
- **in SA**, the previous government irrigation districts in the Riverlands area are now run as a series of separate, privately owned trusts, supported and serviced by the CIT. Once again this devolves control of the irrigation business to the local landholders. A parallel path to devolved management control is being developed for the LMRIA;
- **in Queensland**, SunWater still manages the entire irrigation infrastructure, despite a number of initiatives to promote devolution of control to local irrigation districts at, say, Burdekin or Mareeba; and
- **in WA**, the final stages are being completed for the full privatisation of the remaining irrigation areas previously developed and owned by the WA Water Corporation, on the Ord and at Carnarvon.

Experience from the range of models adopted is that devolution of responsibility drives the development and adoption of greater innovation and change in the design and operation of irrigation systems. A local management body is more likely to respond positively to a proposal from a group of local irrigators seeking new arrangements than is a single irrigation entity. This is particularly the case when that management body can implement differential charging, as this will create incentives for higher-value users of water to seek higher standards of supply. This will drive greater WUE.

On the other hand, this outcome is not simple or inevitable. For example, where an irrigation system is operated to service a regional monoculture, a local management body may decide to retain the *status quo* rather than invest in infrastructure to service higher demand and value uses for a small number of growers. There are also questions of critical core skills and ability to secure government support.

⁵⁸ NCC (2003). *Restrictions on water trading between irrigation districts*.

⁵⁹ NCC (1998). *Compendium of NCP agreements*, Strategic Framework for Water Reform, p. 107.

6 Principles, options and strategic directions

This chapter pulls together the lessons and insights gained in the previous review and analysis. It sets out a number of high-level principles to inform the development of future policy on the promotion of greater WUE, then identifies a series of measures which could be taken regarding both the framework within which the IWPs operate and their internal policies and practices, to achieve this end.

6.1 Core principles

1. Government policies and actions need to be developed and implemented with reference to clear objectives. WUE is a means to achieve other objectives. It is not an end in itself.
2. As a result, a blanket promotion of greater WUE, on its own, may not achieve the desired objective of increasing environmental flows. On the contrary, it may, in practice, lead to an increase in net diversions over time. Policies on WUE must be assessed and tailored to particular circumstances. This is an uncomfortable conclusion because it means that policy prescriptions that WUE should be pursued in all situations may be simplistic.
3. It is critical to recognise, and to reflect in policy development, the distinction between technical efficiency and financial viability. Adoption of greater WUE does not come free of charge. Any change is likely to involve greater levels of capital, labour, skills and risk. A particular option may be technically feasible but not realistic for a particular enterprise in specific circumstances.
4. There is a further critical distinction between the calculus, at an individual property level, of what is financially worthwhile, and a judgment of what is economically efficient, taking account of the wider public benefit won through control of externalities.
5. If government promotes initiatives which do not prove viable at the enterprise level, or attempts to generate wider public goods, then this is likely to require investment of public funds.
6. Governments have a suite of instruments available to promote changed behaviour or performance by IWPs or individual irrigators. These include, at a minimum:
 - information, education and extension;
 - pricing, penalties and taxation;
 - self-regulation; and
 - formal regulation.

The presence of multiple instruments allows the promotion of multiple objectives. Cumulative and synergistic approaches should be fostered where these impact on adoption of greater WUE.
7. Across Australia, there is a considerable variation between States in terms of the external frameworks and internal policies of IWPs. Governments should seek to capture the potential benefits available from adoption of best practice implemented elsewhere.
8. The presence of IWPs provides government with agencies to promote adoption of policies. The intermediary position of IWPs between government and individual irrigators reduces the transaction costs of implementing government policies and enhances their effectiveness. Initiatives should seek to harness these advantages by the creation of incentives for IWPs to promote optimal WUE from their members.

6.2 Priorities by sector

The first and most important message is the considerable dispersion in performance that currently exists both within and between sectors on all measures of WUE. This gives confidence that there is the potential to generate substantial savings if that dispersion were to be narrowed. A first, conceptual analysis suggests that raising the average level of WUE in each sector by one standard deviation would generate 1,000 GL in savings. That sets a first estimate of what we may expect to achieve.

It should be possible to aim for a more ambitious target, as the above value has dairy meeting an average application efficiency of only 50%, and the approach does not provide for the transfer of water between sectors.

Analysis of current usage identifies that the priorities required to drive adoption of greater WUE differ by sector. That effort should focus on four key sectors:

- **with rice**, there is currently fairly tight control over WUE within the sector, so the priority should be to seek alternative, higher-value and lower-volume uses for that water and to promote research into innovative approaches, such as new strains of rice that require less frost protection and hence lower water application rates;
- **in dairy**, there is still significant dispersion in WUE across the sector. The priority should be to narrow that range of performance. This requires a concerted program involving all stakeholders in the sector. The dairy-processing companies have a major role to play in helping drive adoption of higher standards through an accreditation scheme;
- **in cotton**, there is a narrow dispersion in WUE in field application, but there are continuing high evaporation losses from local, property-based storages. The tightly knit industry should help promote the development of innovative approaches to this issue;
- **in pasture**, there is little value in looking for major improvements in WUE as the returns are not available to merit the investment. Equally, the sector lacks the cohesive identity to drive development and implementation of innovative approaches. Here the focus should be on promoting the transfer of that water to higher-value uses that involve lower rates of watering. One way to promote this outcome will be through charging policy, where raising the level of water charges would provide the most effective stimulus to shift water to higher-value sectors.

6.3 Measures to promote adoption of greater water-use efficiency

As noted from the above analysis, a suite of approaches will need to be progressed if the aim of promoting greater WUE is to be achieved. Different strategies need to be pursued to achieve equivalent outcomes in different groups and sectors.

Those approaches will include factors related to the external framework ie.:

- legal form;
- commercial drivers;
- property rights;
- self-regulation;
- licensing; and
- taxation policy.

Supporting changes are also required in the internal policies of the IWPs covering, for example:

- service conditions and infrastructure;

- water trading; and
- prices and tariffs.

6.4 Legal form

The legal form of the IWP does not appear to be overly significant in driving adoption of greater WUE. There are offsetting factors at play:

- ministers may be able to instruct State-owned corporations (SOC) to implement WUE as part of their obligations;
- a SOC may also work alongside other government agencies more readily in a collaborative framework which provides for flexibility and professional judgment; on the other hand
- the due diligence required when an IWP is privatised has forced greater clarity of accountability for delivery of the full suite of the IWP's corporate objectives;
- this has led to creation of explicit licensing requirements; and
- a closer identification between individual landholders and the IWP, which allows for stronger enforcement of NRM programs by that IWP.

6.5 Commercial drivers

The study has confirmed the central importance of commercial drivers in determining the adoption of greater WUE. The primary incentives for the adoption of greater WUE are to reduce labour costs and time, improve quality, expand the area under cultivation and so increase the return to the enterprise. Equally, the greatest constraint to the adoption of greater WUE is the cost of implementation.

The wine-grape sector provides the classic example of the successful integration and alignment of commercial imperatives and NRM objectives. A growth industry, expanding into greenfield areas, with high returns from major new capitalisation, the sector was easily able to afford to meet the additional costs of adopting best practice WUE when setting up new vineyards or converting existing properties.

There was also a happy coincidence between commercial drivers (for reduced costs and improved quality) and NRM objectives which sought to reduce the levels of water application. There is also a high degree of technical and entrepreneurial innovation evident in the sector as competitive advantage is sought by improving quality and production. Finally, the industry processors are increasingly seeking to promote a clean and green image and preferentially select producers who meet those criteria.

This combination of factors will not always be present. It is much harder to promote WUE in an established sector

with dedicated infrastructure, where revenues are barely adequate to support a reasonable living and where industry restructure and generational shift are looming.

If we seek greater WUE in these circumstances, then we will need to develop explicit mechanisms, either through licensing or by industry-based initiatives to promote these outcomes. These initiatives will require funding to match the public-good benefits sought.

6.6 Property rights over losses

Currently, the water licences/allocations to IWPs have been set to include allowances for conveyance losses, and the volumetric water entitlements held by individual growers make no reference to WUE. Consequently, the property right to losses, whether in conveyance or on farm, currently rests either with the IWP or the individual irrigator. As a result, any savings generated through the adoption of greater on-farm WUE become available to the landholder, either to expand the area under irrigation or to be sold in the water market.

However, in some circumstances those losses provide beneficial external outcomes for the environment and/or other users. In these cases, promotion of greater WUE may itself generate adverse outcomes, unless the ownership of those losses is redefined through either policy or purchase.

Relevant policy observations are that:

- improved science and changing situations can lead to different property-right regimes being optimal compared with the past;
- the assignment of transmission losses to the NSW irrigation corporations under their bulk-water licenses and to the Victorian rural water authorities under their bulk-entitlement orders has made it more difficult to generate wider environmental outcomes from reductions in those losses;
- proposals for ‘externality’ taxes and subsidies to encourage trade out of certain areas and into others may not be achievable without very strong simplifying assumptions; and
- in order to improve water quality and the volumes of environmental flows, the uniform application of public subsidies for WUE initiatives and reduction of transmission losses is likely to be inefficient, and a more tailored, discretionary approach may be warranted.

In the context of the River Murray, this suggests bigger subsidies to reduce losses in downstream reaches (eg. South Australia), but no subsidies to reduce losses in most reaches upstream.

6.7 Industry self regulation

The rice sector provides a convincing example of industry-based regulation as an approach to drive the adoption of greater WUE. The effectiveness of this approach depended on several factors, including community acceptance of the need for action, a cohesive industry sector, a strong industry association, a negative media image, a clear pathway to better practice, engagement of government agencies and a leadership role from the relevant IWP.

These factors will not always apply to other sectors. Cotton demonstrates many of the same features. By contrast, the dairy sector has failed to engage in a concerted program to promote greater WUE. There appear to be several reasons for that failure:

- there is less acceptance across the sector of the need for change;
- the industry is less cohesive than are the rice or cotton sectors, with larger numbers of small players;
- there is, at present, little public or media attention or concern at the current levels of WUE across the sector, which has a generally positive and benign image;
- the industry appears to be two sectors in practice, with a highly capitalised intensive sector operating to different commercial and business practices than a less intensive sector. Moving to a higher level of WUE involves making a step-change in investment, in comparison with the rice sector where it has proved possible to make incremental improvements over time; and
- that investment is unlikely to yield an adequate return to merit the sums required.

However, the potential benefits of an industry-based program merit significant attention to this approach. There is a particular role for the IWPs to act as the central driving agent for the program, and for the dairy-food processing companies to promote greater WUE through an accreditation scheme, in line with a ‘clean and green’ marketing campaign.

6.8 Licensing

Licensing plays a central role in the promotion of a wide range of NRM outcomes in irrigation districts. It applies both to the individual property and to the IWP.

At the **property level**, there is a critical distinction between licensing the right to take water, as opposed to the right to apply that water at a specified property. Here the model being introduced in NSW and South Australia is superior to the current model in Victoria, where, within districts, there is no such separation, and irrigators have unconditional rights to water.

Individual landholders should be required to hold property-specific, site-use licences, such as irrigation and drainage management plans. These demonstrate that adequate controls are in place to ensure that water usage will not create adverse outcomes and that landholders are meeting best practice. Any such licence should also refer to the constraints and terms set out in a local water management plan, should be time-limited with an adequate lifespan to provide for certainty of investment, and be endorsed through a process of independent audit.

At the **IWP level**, the above analysis identifies two main models:

- the NSW model, which is based on explicit licensing, with the IWP carrying specific obligations to coordinate and promote actions by landholders within its region; and
- the Victorian model, where these roles are more implicit and outcomes are promoted through professionalism and co-operation between agencies.

It is recognised that the outcome of this comparison will depend on whether the assessment is at a theoretical level or takes account of performance in practice.

On balance, the model developed in the NSW irrigation corporations appears more robust and effective in providing a clear accountability for promoting WUE on farm. Various elements of that model merit wider application. Their strength though, is in their integration through:

- explicit licensing of the IWP as the manager of an irrigation business. This provides an outer envelope to integrate the various subsidiary obligations and duties;
- explicit recognition, at the level of the operating licence, of the importance of integrating commercial imperatives and NRM outcomes. This process ensures that any appropriate LWMP is given equivalent weight in the corporate objectives of the IWP as to the promotion of financial and commercial aims;
- the licensing of the IWP to take a water supply, on behalf of its landholders, is conditional on the IWP meeting the terms of a relevant water-management plan;
- the terms of the IWP's licence ensure effective linkage between the obligations on the IWP and the obligations on the individual landholder; and
- explicit licensing for drainage flows through a single unitary licence treats the IWP as an agency for the licensing authority.

Any such framework will need to ensure adequate integration with the catchment-based planning processes.

6.9 Taxation

Taxation can help promote investment in infrastructure to promote greater WUE by the IWP and on farm. At present, taxation policy contains certain aspects and anomalies that not only limit these incentives but also may actually constrain adoption of such investments. Areas where reform should be promoted include:

- the treatment of contributions to reserve funds to cover future costs of infrastructure renewal and replacement;
- the related issue of the treatment of capital contributions to IWPs from State governments to pay for the backlog of accumulated maintenance; and
- the application of the *Income Tax Assessment Act 1997* to cover investments by IWPs in infrastructure that promotes WUE.

6.10 Water trading

Water trading has an important role to play both to promote the movement of water to higher-value uses and to mitigate the potential economic costs of any proposal to increase environmental flows.

At present there is a suite of constraints to the free movement of water both within valleys, between valleys and between States. Actions that would promote greater and easier trade include:

- establishing a common currency in water entitlement to permit easier movement between valleys and States;
- developing more sophisticated exchanges that will generate confidence amongst irrigators, and facilitate swifter and easier trade;
- extending the range of tradeable water-based products to include options and futures to allow enterprises to treat water as just another factor input;
- reducing barriers to outward trade from IWPs, through a series of actions including the introduction of exit fees where appropriate *in lieu* of prohibition;
- developing adequate and equivalent controls on new developments across the basin, to ensure that adverse effects such as salinity are minimised; and
- extending the market to include other parallel products, such as salt credits, to direct irrigation development to low-risk sites.

6.11 Price and tariff design

Price clearly has a role to play in promoting adoption of greater WUE. The elasticity of demand varies with a number of variables:

- sectors generating higher returns (in terms of gross margins in \$/ML) will generally prove less sensitive to increases in charges from the IWP. For example, water charges represented only 2% of enterprise

operating surplus for wine grape production as opposed to 13% for dairy;

- some sectors have proven relatively price elastic, ie. they have had the ability to respond at the margin and reduce application rates incrementally. Other sectors, such as dairy, appear to face a step-change in investment and practice to move to higher WUE; and
- the nature of the tariff will affect the response of landholders to increases in charges. Where the tariff is heavily loaded towards the formal entitlement, then the landholder has no way to reduce his costs other than through the sale of that entitlement. Where the tariff is loaded to the volumetric element, then increased charges will tend to promote reduced consumption.

This avenue merits early adoption as a strategic framework for the water sector forming part of National Competition Policy, which already requires full cost pricing to generate adequate funds to ensure business viability and to cover the costs of externalities. Most IWPs do not meet this standard.

Adoption of greater WUE on farm may be constrained by the limitations of the IWP's existing delivery infrastructure, either total volume constraints or the ability to deliver water on demand to meet the requirements of high-value horticulture. Tariffs have an important role to play in encouraging investment in distribution infrastructure, which would in turn promote adoption of greater WUE on farm.

Summary of principles and strategic options

Principles	Strategic options
<ul style="list-style-type: none"> • Target beneficial savings, not savings <i>per se</i> 	<ul style="list-style-type: none"> • Blanket requirements on IWPs not optimal <ul style="list-style-type: none"> – zoning approach → district strategies – the water or the WUE
<ul style="list-style-type: none"> • WUE is an on-farm issue, therefore tailor policies to farm situation <ul style="list-style-type: none"> – regional plans, incentives and licensing must drill down to farm level 	<ul style="list-style-type: none"> • IWP licences must contain drill-down provisions (as in NSW EPA licences) to demonstrate cross-compliance • Require site-use licences for irrigation in all States
<ul style="list-style-type: none"> • Build on achievements in WUE frameworks over past 15 years <ul style="list-style-type: none"> – ensure existing mechanisms are fully applied; and – transpose strong lessons to other jurisdictions 	<ul style="list-style-type: none"> • Support the multiple-good outcomes at State, district and catchment level <ul style="list-style-type: none"> – provide firm, realistic guidance
<ul style="list-style-type: none"> • Recognise that ownership of losses is already determined 	<ul style="list-style-type: none"> • Reallocation of losses requires purchase or clawback
<ul style="list-style-type: none"> • Do not be bound by incremental thinking <ul style="list-style-type: none"> – reform vs fatigue/rural anger exogenous structural pressures are severe (commodity prices vs breakeven); and – opportunity for radical solutions 	<ul style="list-style-type: none"> • Build up positive elements eg. recognition of the need for environmental flows by substantial number of irrigators • Use opportunities to rationalise systems • Strengthen State legislation
<ul style="list-style-type: none"> • Support and disseminate positive policies and experience 	<ul style="list-style-type: none"> • eg. rice industry, Victorian surface drainage, better LWMPs

Annex A: Case studies

In assessing the significance of the institutional forms and policies of the IWPs, lengthy discussions were held with staff from a wide range of water companies and natural resource departments in State governments. The outcomes of those discussions and assessments have been recorded in a series of case studies which sought to capture the detail of the policies, procedures and arrangements at the individual company level.

These relate to:

- Murray Irrigation in NSW;
- Goulburn–Murray Water in Victoria; and
- The Central Irrigation Trust in South Australia.

In drawing out the lessons from these case studies, we have also considered evidence and factors relating to irrigation entities and forms in Western Australia, Queensland and Tasmania. We have provided a brief note, in conclusion, on the current state of play in licensing of the Ord Irrigation Co-operative in Western Australia.

1. Murray Irrigation Limited: New South Wales

Background

Murray Irrigation Limited (MIL) is the largest privately owned irrigation supply and drainage company in Australia. It provides irrigation water to over 2,400 farms owned by 1,800 family farm businesses in southern NSW, through 3,600 km of earthen channels. The Mulwala Canal is a substantial channel with an average flow of 10 GL/day. MIL's area stretches over 716,000 hectares of farmland north of the Murray River, covering 180 km to the west of Deniliquin and 120 km to the east.

Key features of the MIL region are:⁶⁰

- annual farm-gate production of \$300 million;
- diverse irrigated agriculture produced on family farms, dominated by rice production, normally using 60% of total water delivered;
- 50% of Australia's rice crop production;

- 10% of NSW milk production;
- water supply to Berrigan, Finley and Wakool;
- population of 25,000; and
- area of 715,693 ha.

Legal form and devolved control

MIL is a private, non-profit company, established in 1995 through the privatisation of the previously State-owned Murray Irrigation Area and Districts. MIL is wholly owned by the irrigated farm businesses within the area, each of which is a shareholder in the company.

The board of MIL has 10 elected company directors; eight of whom are irrigator members (elected on a geographical representational basis) and two directors with special skills in engineering and finance. Under this model, the interests of landholders are clearly and centrally represented in the decisions of the company.

One positive outcome of this identity of interest is that the board has unequivocally authorised the staff of the business to strictly enforce the rules and procedures of the company regarding water ordering and use, as wastage is perceived as reducing the security of supply for other irrigators. As an example, landholders who take lesser volumes than they order are subject to close scrutiny and discipline, as the excess is normally lost to the system through escape flows at the end of channels.

Recent research confirms the strength of this model with landholders clearly accepting a level of enforcement from their own business that they would find intolerable from the State Government.

Water ownership

MIL holds a bulk licence from DLWC for an entitlement of almost 1,500 GL (67% of the NSW share of Murray River irrigation entitlements). This will be converted to an access licence under Section 56 of the *NSW Water Management Act 2000* when this part of the Act is fully implemented.

The access licence will be subject to conditions under Section 66 of the Act, in particular those imposed by the relevant water management plan. In MIL's case, the plan

⁶⁰ From www.murrayirrigation.com.au.

is still under development. The NSW Murray–Lower Darling Regulated River Water Source Draft Water Sharing Plan was drafted by a community reference committee on which MIL was represented by its general manager, George Warne. This draft plan is currently with the minister for consideration. It will set total consumptive diversions, as well as trading and operating rules for the river.

Individual irrigators within the company own shareholdings in the company *in lieu* of individual water entitlements. A large majority of those entitlements are equivalent to general rather than high security and they are therefore liable to significant variation in allocation in any season.

Tariffs

MIL charges its irrigators separately for water, drainage and contributions to its land and water management plans.

A uniform water delivery price applies across MIL, comprising a fixed and a variable element.

Irrigators are also subject to a LWMP levy which includes surface and subsurface drainage charges, related to total water use. These charges differ between and within each area. Much of the Wakool District is serviced by the Wakool Tullakool subsurface drainage scheme. Drainage charges within the area are cost reflective and depend on the degree of services received.

Licensing

MIL is appointed as an irrigation corporation under Part 1 of Chapter 4 of the *NSW Water Management Act 2000*, which supersedes the former *Irrigation Corporations Act 1994*.

The primary licensing control is the requirement for MIL to hold an operating licence under Section 122. This provides MIL with authority to carry on its business functions. On the other hand, it places significant obligations on MIL, the most important being to:

- provide, construct, maintain, manage and operate water supply and drainage infrastructure;
- hold all relevant licences or authorities; and
- comply with the provisions of any applicable management program.

This approach ensures integration between the commercial imperatives of the business and the external constraints and obligations on the company created through the discharge licences managed by the EPA or the LWMPs overseen by DLWC. Under this model, a failure to meet the requirements of these subsidiary licensing mechanisms involves a direct contravention of the primary operating licence itself.

This integration is reinforced through the series of formal interactions between MIL and the irrigators within its area, such as:

- sales contracts;
- the memorandum and articles of association and related company policies which impose requirements regarding operating procedures; and
- action agreements from the LWMPs etc.

These arrangements translate the legal obligations and requirements from MIL down to the level of the individual property. In this way, MIL can more easily enforce requirements on landholders, as it has a clear legal obligation to do so and is at risk of losing its licence in the event of non-compliance by a landholder.

The strength of this integration between commercial and NRM drivers is seen in the declared aims and objectives of MIL which are to:

- draw water from the Murray and Edward Rivers to supply irrigators at an acceptable level of service;
- promote the efficient use of water;
- maintain and manage the infrastructure needed to supply water efficiently;
- administer the allocation of water to irrigators and the running of the business;
- comply with specific drainage requirements for the region;
- manage the environmental needs of the region; and
- involve the community in all aspects of proper water management.

Land and water management plans

The primary mechanism to direct the actions and investments of MIL in terms of NRM priorities are a series of four LWMPs.

These comprise integrated NRM plans developed as a collaborative exercise involving the local community, MIL, Murray Shire and the NSW State Government. The priorities of the plans are to maintain the economic and environmental sustainability of the region through the implementation of controls to reverse the rising water tables and consequent land and water salinisation that had become increasingly evident during the 1980s and early 1990s.

The original plans were drawn up in parallel with the privatisation process in 1995 and have recently been revised and re-endorsed as part of a five-year review in 2001. Over the past six years, the Murray community has invested \$153 million in on-ground works and incentive payments, supplemented by \$28 million in government support.

Asset refurbishment

As part of the privatisation process, the State Government agreed to provide funds to enable the refurbishment of certain infrastructure assets to reflect inadequate asset maintenance in the past. This involves 15 annual payments to a total of \$82.5 million in 1995 prices, indexed for inflation, to cover the costs of infrastructure refurbishment in accordance with approved works programs. These levels of payment are not out of line with parallel arrangements adopted in other States to inject capital into irrigation entities to create viable, sustainable businesses.⁶¹

The other side of the funding agreement with the NSW Government was that MIL was required to return 30,000 ML to DLWC, representing the savings from the channel leakage and wastage that were the intended outcomes of the infrastructure investment. Much of this saving has been achieved through the introduction of remote sensing and control of water supply structures. These moves have reduced escape flows at the end of channels.⁶²

Environment protection licence

The other critical control is the integrated Environment Protection Licence (EP Licence) which controls discharges from drainage outfalls within MIL's area. As noted above, the Water Management Act requires MIL to hold and comply with this licence as part of the terms for its operating licence.

One of the other positive attributes of the licensing system is that the EP Licence covers 13 separate key sites within a single licence. In this way, MIL is seen to act as an agent for the EPA, coordinating the control, monitoring and reporting of discharges within its area of operation. This is a far more efficient approach in terms of monitoring and enforcement than an arrangement whereby each individual discharge is separately licensed. These advantages are highlighted in that a number of additional outfalls are subject to independent licences causing multiple workload.

Water trading

There is an active water market within MIL and between MIL and other areas. Even though individual irrigators do not hold explicit water entitlements, they are able to trade the notional water that is equivalent to their shareholding in the company.

Temporary trade is co-ordinated mainly through the SRIDC Water Exchange.⁶³ This provides a continuous, and thus discriminatory bulletin board type of market.

The exchange originally employed a uniform price auction but found that having a couple of weeks between each auction meant that it was unable to meet water users' demands for 'real time' delivery, resulting in a relatively low participation rate and increased price volatility.

In an effort to overcome this, the exchange introduced several major innovations in the 1998–99 season:

- it moved from a uniform price auction to a standard auction mechanism (ie. trade takes place whenever a buyer and seller can be matched on the bulletin board);
- a prior approval process — sellers have to transfer that portion of their licence onto the MIL bulk licence, before posting on the bulletin board; and
- lodgement of payments by buyers — the exchange requires full payment from parties wishing to lodge bids.

In this way, once the two parties have been matched, purchased water may be transferred onto the buyer's licence almost instantaneously. More recently, MIL has taken over the running of the exchange for the SRIDC and supports the process as a service to its members. It also helps enforce the disciplines around the exchange. The exchange exhibits the following positive characteristics:

- 'real-time' trading reduces market-induced price volatility and price discovery is continuous;
- negligible transaction costs associated with settlement/delivery encourage higher rates of participation, again reducing price volatility by adding to liquidity and enhancing price discovery; and
- bulletin boards provide timely information as to market direction.

Negative characteristics include:

- buyers and sellers lose the anonymity that characterises uniform price auctions; and
- the benchmark function of a single clearing price is lost as a guide to informal bilateral trade.

Data on the history of trading indicate a growth in the volume of trade, although an easing in value in 2000–01 when there was a higher level of allocation (Table A1). It is worth noting that the average price for temporary water as at November 2002 is \$312.00, a factor of ten times the average price of the previous four years.

⁶¹ Marsden Jacob Associates (1999). *Pilot interstate water trading project: cost recovery*, report for MDBC.

⁶² *MIL Annual Report* (2001), p. 8.

⁶³ SRIDC is the Southern Riverina Irrigators District Council and represents the interests of shareholder members of MIL.

Table A1. Trade on the SRIDC Water Exchange

Season	1998–99	1999–00	2000–01	2001–02
No. of trades	780	1,294	1,181	1,077
Volume (ML)	51,689	60,109	71,583	69,397
Value of trades	\$826,208	\$2,237,078	\$1,121,497	\$2,845,835
Average price	\$15.33	\$37.68	\$15.49	\$40.82

MIL provides a contact service bulletin board to link buyers and sellers in the permanent market. However, the trade itself is entirely a matter between the two irrigators. Any trade needs MIL's approval, based on the supply capacity of the relevant channels and the hydrological capacity of the land in question. Once a trade is complete then the share register is amended to reflect the change.

There are formal constraints on the export of water from MIL to other areas. All permanent trades have to obtain the formal approval of the board and there is a prohibition on permanent trade out of the region where this would result in the volume of the bulk licence falling below 1,447 GL. This last restriction is defined in article 29 of the Articles of Association of Murray Irrigation Limited, which states that:

The Member may not Permanently Transfer Externally where the effect of the Transfer would be that either:

- (a) the water allocation (as that term is defined in Division 4C of Part 2 of the Water Act); or
- (b) the Basic Entitlement (as that term is defined in the Irrigation Corporation Licence), of the Corporation, under the Irrigation Corporation Licence,

will be less than 1.4472 million Megalitres.

This constraint is understandable at the level of the company where the bulk water licence represents the major asset of the business and it is the duty of the directors to protect and enhance that value.

On the other hand, this control and equivalent constraints on the export of water from other irrigation corporations and private irrigation districts within NSW have a combined effect to restrict the free trade of water within the southern Murray–Darling Basin. This may act to impede the possible adjustment effects needed to drive water to higher-value uses.

2. Goulburn–Murray Water: Victoria

Goulburn–Murray Water is responsible for the provision of bulk water supplies to urban water authorities, other rural water authorities, industry and agriculture, and for the delivery of irrigation water, domestic and stock supplies and drainage services to 24,892 properties within its 68,000 square kilometre region. Its core business as an IWP is to service some 15,000 customers

within its direct irrigation districts. This makes it by far the largest single IWP in Australia.

GMW maintains approximately 7,000 km of channels for irrigation, domestic and stock purposes, and, on average, 2.1 million ML is delivered each year.

GMW also undertakes a number of NRM activities closely related to its core business for government, on a cost-recovery basis. These activities are predominantly related to salinity, water quality and water resource management.⁶⁴

Legal form

GMW is a statutory authority under the *Water Act 1989* and a statutory corporation under the State Owned Enterprises Act. It has a skills-based board which is appointed by and reports to the Minister for Sustainability and Environment.

GMW operates as a fully integrated business covering a range of functions including:

- headworks, with responsibility for harvesting and storages;
- distribution, covering the management of the irrigation infrastructure;
- service company, providing customer services to landholders; and
- NRM manager, acting on behalf of DSE in certain defined roles under the Water Act, with especial focus on flood mitigation.

GMW was set up as a successor body to the Rural Water Corporation and Rural Water Commission. In this process, government assumed considerable debt inherited from the predecessors, including unfunded superannuation liabilities. A condition of this transfer of liabilities is that GMW is required to implement full cost recovery without further recourse to government for funding.

Devolution

GMW covers seven discrete irrigation areas:

- Shepparton
- Central Goulburn

⁶⁴ See www.g-mwater.com.au for further base data.

- Rochester
- Campaspe
- Pyramid–Boort
- Murray Valley
- Torrumbarry.

A measure of devolution to local management and control has been implemented. However, this is still relatively informal with little explicit underpinning through eg. service contracts or agreements. Water service committees (WSCs) have been established for each area and those committees are invited to contribute to decisions on future investment and prices in the relevant area. However, the specification and modelling of options is still undertaken in advance by head office and there is no memorandum of understanding to specify the extent of the accountability held by the WSC.

Discussions with directors and management of GMW confirm that this process of devolution is currently still at a halfway house, midway between a public sector body and a fully privatised entity.⁶⁵

Ownership of water

Allocation of water entitlement occurs at both bulk and individual levels.

Landholders are allocated one of a variety of water entitlements:

- landholders in irrigation districts are allocated water rights which are recorded in the authority's register. This is a high-security right with a high degree of certainty of supply. There is nearly 2,000 GL of water-right entitlement across Victoria, the large majority of which is controlled and delivered by GMW;
- landholders outside irrigation districts have rights to take and use water (S51), subject to conditions (S56). These diversion licences are also of high security and are issued for 15 years;
- both may have access to sales water, which constitutes a lower security entitlement and which is allocated only once the first two rights have been fully met and there are sufficient reserves to guarantee the next year's supply. The level of sales right is tied to the size of the other entitlement. Holders of diversion licences generally have lower sales rights than holders of water right. Due to drought, very little sales water has been made available over the past five years;
- off-quota water is less commonly available in times of high flows; and
- finally, irrigators have rights to an allowance to cover stock and domestic needs.

GMW is finalising proposals to introduce a medium-security right that would provide irrigators with a suite of alternative products to match their risk profile.

GMW is allocated a bulk entitlement (BE), under Part 4 of the Water Act. However, in practice, this represents the aggregate of the entitlements issued to individuals, as GMW has a duty to supply. This is recognised as the BE is amended whenever an individual landholder trades water in or out of the GMW area.

This BE is not a recognised asset of the company and is not, therefore, recorded on its balance sheet. GMW owns the transmission losses within the irrigation district and therefore has the right to trade this entitlement on the water market provided it is surplus to its supply obligations (S46A (3C)).

Separation of water and land

Water may be traded between properties, subject to conditions. To this extent, ownership of water has been separated from the ownership of land. However, individuals still need to own land to enter the market and any sale is assessed only against a specified property.

Operational issues

GMW operates primarily through well-established and complex open-channel systems.

Introduction of greater WUE by the end user, through conversion from flood/furrow to drip feed, places increased demands on the delivery infrastructure and operations of the water authority. The conversion involves a change from:

- infrequent, high flows, delivered to a rostered schedule and over a long irrigation season; to
- frequent, low flows, delivered on-demand, within a smaller number of months.

These changes place considerable pressure on the supply infrastructure and systems of the water authority. Channel capacity is often inadequate to deliver the water needed within the time frame required, and the delivery coordination systems are not sufficiently sophisticated to service on-demand orders.

Existing infrastructure may be able to operate as a hybrid scheme (supplying both a standard product to the old requirements and also meeting new demands) for so long as those new requirements represent only a small percentage of total demand. For example, GMW provides a near 'on-demand' supply for its small percentage of high-value users. However, it will not be able to continue to do so if that percentage increases beyond 15% of demand, without extensive investment in new control equipment.⁶⁶

⁶⁵ See Marsden Jacob Associates report (2001) *Financial review of Shepparton & Central Goulburn Irrigation Areas: Goulburn–Murray Water*, for DSE, November.

⁶⁶ Geoff Earl, Goulburn–Murray Water, pers. comm., June 2002.

This limitation will constrain the extent to which landholders will be able to adopt or invest in drip or other highly efficient water systems. This constraint will be far more influential than other aspects of the institutional form of the entity itself.

This change also has implications for distribution losses, as pressures for on-demand supply from open-channel systems require channels to be run at a higher level with consequential higher levels of outfalls. There is, therefore, a trade-off between levels of service to irrigators and distribution efficiency.

More sophisticated operational systems based on SCADA are being developed with the objective of managing the infrastructure to deliver water on a shorter order cycle and with lower outfall losses.

Tariffs

A two-part tariff applies across GMW, with

- a fixed element based on water right; and
- a variable component based on water usage from access to sales water above the water right.

There is no direct correlation between charges and the costs that an individual property places on the system. GMW is considering reform to its tariffs to allow the introduction of charges related to number of orders, standard of service etc. This would help promote the introduction of higher-value horticulture with its dependence on water on-demand.

Water trading

Victoria led the introduction of effective water trading, especially in the temporary market. The major vehicle for this has been the Northern Victoria Water Exchange (NVWE) which was established by GMW in September 1998. The exchange operates as a discontinuous (weekly), uniform price, double auction.

This was re-formulated as 'Watermove' in October 2002. This extended its coverage beyond the boundaries of GMW both to temporary trade elsewhere in Victoria and to permanent and leased trade.⁶⁷ The new exchange covers four Victorian rural water authorities: First Mildura Irrigation Trust (FMIT), GMW, Southern Rural Water (SRW) and Sunraysia Rural Water Authority (SRWA).

The provision of the water exchange and supporting arrangements to establish trading rules have been highly effective in promoting the growth in temporary trade. The introduction of Watermove is likely to stimulate greater volumes of sales and lead to a more mature and better

informed market. Data on trade in northern Victoria indicate a continuing growth in the percentage of trade which is conducted through the exchange (Table A2).

Table A2. Temporary water trade in Goulburn–Murray Water (GMW)/Northern Victoria Water Exchange (NVWE)

Year	Total volume of trade in GMW (ML)	Volume of trade through NVWE (ML)	Percentage of trade through NVWE
1998–1999	208,069	30,852	15
1999/–000	215,824	53,439	26
2000–2001	193,335	60,117	31

The level of trade has been driven by a number of factors:

- the introduction of the MDBC cap on diversions within the basin;
- the policy on recognition of rights of sleepers and dozers, which has activated volumes of previously little used water;
- reliance on 'sales water' in the dairy sector; and
- drought, with very low or zero sales water availability over the period from 1996–97 to the present.

There are some limits on the transfer of water, based predominantly on the physical limitations of interconnection between systems across the region. There is also a 2% per annum limit on the rate at which water may be permanently transferred from a district, although this restriction has never been implemented in practice.⁶⁸

Unlike NSW, no carryover is allowed. A carryover enables irrigators to hold water for use in the following season. Victoria follows a highly conservative and socialised approach to water management to ensure the high security required for the high-security water right which comprises the majority of its deliveries.

There are also some restrictions on the right to lease water for extended periods.

There is evidence of high levels of entitlement not being used in many periods. Clearly, there are still significant incentives to retain water rights and to rely on selling that entitlement in the temporary market as:

- there is uncertainty on the future policy environment regarding property rights;
- landholders are able to obtain benefits in season without losing long-term access; and
- there is some evidence of landholders holding onto entitlements in anticipation of structural adjustment as a generational shift plays out.

⁶⁷ DNRE (2001). *Improving water markets – preliminary design for Watermove Pty Ltd*, 15 June.

⁶⁸ *Water (Permanent Transfer of Water Rights) Regulations 1991*, Regulation 8.

Licensing and natural-resource-management objectives

The Department of Sustainability and Environment and GMW promote a suite of LWMPs and salinity management plans across the irrigated sector. These have some statutory authority having been endorsed by the minister. However, they are not integrated into a formal structure of licensing which ensures their implementation by GMW; indeed in this area GMW is acting on contract to the State Government. Nor is there any obligation by GMW to enforce the application of NRM plans by individual landholders.

On the contrary, irrigators within irrigation districts have an entitlement to water rights. Those rights are in perpetuity and are not subject to terms and conditions regarding their use, except when water is traded, when a suite of measures can be required including the provision of an irrigation and drainage management plan to cover eg. a soil survey and irrigation scheduling, and also allow GMW to limit the water application rate.

In this regard, water right differs from the diversion licences where the minister can impose appropriate terms and conditions to protect the environment and promote conservation. However, even with the diversion licences, there is no formal provision to amend the terms of the licence midway through its life. This means that:

- the LWMPs rely primarily on extension and incentives rather than on enforcement; and
- their impact is far greater on new developments, where the terms and conditions of the new licences can be set to meet the best-management practice outlined in the LWMPs.

The failure of the dairy sector to drive forward a co-ordinated plan to improve WUE across the industry must partly be a result of the weaknesses of this model.

GMW operates within an informal model which places greater emphasis on coordination and goodwill than on formal accountability, formalised through its environmental management system. This promotes highly effective outcomes across a range of outcomes. However, it is dependent on personal professionalism, individual commitment and communication.

A recent review of the framework for maintaining surface water drainage indicates the strengths and weaknesses of this approach, commending the levels of performance achieved but highlighting the weaknesses in the model.⁶⁹

⁶⁹ Nolan-ITU (2001). *Independent review of environmental aspects of northern Victoria's surface drainage programs in irrigation areas*, prepared for DNRE & MDBC.

3. Central Irrigation Trust: South Australia

The Central Irrigation Trust (CIT) is a service organisation that provides a range of functions on contract to nine local irrigation trusts in the SA Riverland district.⁷⁰ Together this set of trusts represents more than 50% of total irrigation diversion across the State. The CIT region covers about 16,000 ha and produces some 25% of Australia's wine grapes and 30% of its citrus.

Legal form

The trusts are statutory bodies set up under Sections 18 to 25 of the *Irrigation Act 1994*. This provides a simple and flexible structure based on private irrigation districts. The trusts are obliged in the legislation to meet certain requirements such as:

- appointing officers;
- holding meetings;
- keeping and auditing financial records; and
- reporting to an AGM.

Beyond this, however, there is considerable discretion for the trust to determine its own procedures (S21(5)). The trusts are exempt from the provisions of the corporations law (S18(4)), but are required to report annually on the financial accounts of the company and its operations (Ss 24 & 25). The legal form of the trusts has some advantages for taxation purposes, as a private Australian Tax Office ruling determined that the trusts were similar in purpose to a local authority.

Individual irrigators vote to elect the presiding officers of the trust and to pass resolutions on key policies. The votes of irrigators are proportionate to their water holding. The trust can delegate day-to-day operations to a board of management, and, in practice, there is one board of management which oversees the operations of all of the trusts, with one representative from each trust. The directors (and shareholders) of CIT are the nine irrigator members on the boards of management (ie. the presiding officers) for the nine trusts along with the chief executive officer of CIT.

In theory, the individual trusts have the freedom to choose whether to contract with CIT for the suite of services provided. However, the trusts are currently closely bound to each other in legal and operational terms. There is also the potential for individual trusts to appoint their own boards and this approach is starting to materialise.

⁷⁰ The eight traditional members have recently been joined by Loxton Irrigation District.

The irrigation trusts characterise a midway position between a State-owned corporation and a private company. Although day-to-day operation and direction of the trust is clearly delegated to local management, the minister retains the power to abolish a trust, dispose of its property or reallocate its assets to another trust or, in the last resort, accept any residual rights or liabilities for the Crown.⁷¹

Devolution

The trusts are based on individual irrigation districts which are defined by separate and distinct supply systems. The trust comprises all the individual landowners in that specific district. To that extent, the approach involves full devolution of control and accountability to the individual landholder. CIT is then a service company owned and controlled by the nine irrigation trusts which it services.

Operational issues

The large majority of the infrastructure is located in and owned by the individual trusts rather than forming part of the assets of the CIT. In practice, therefore the trusts exist as a series of semi-autonomous irrigation districts rather than as parts of a single integrated entity as in the case of GMW or MI.

The large majority of that infrastructure is new or recently renovated, as part of the terms of the handover of the former government irrigation areas to local control. They rely entirely on pressurised pipeline systems with a high degree of automation and control so that, for instance, individual landholders can now place orders through the Internet with most pumps now controlled through SCADA-based systems.

Licensing

Each trust is allocated a separate licence to take water, under S29 of the Water Resources Act, although, in practice, these licences are managed by CIT on behalf of the individual trusts. Ownership of the water is a separable property right independent of the ownership of land as 29(5) of the Water Resources Act makes it clear that a licence to take water “is personal property ... in accordance with any other law for the passing of property”.

The licence may be made subject to such conditions as are endorsed by the minister on the licence. Currently, the licences held by the trusts do not refer to explicit NRM objectives. However, the trusts are subject to other controls which impose requirements relating to these objectives.

In particular, all diversions from the Murray are subject to the structured allocation and controls set out in the water allocation plan for the River Murray.⁷² This plan has the status of a regulation under the Water Resources Act.

The objectives of the plan include to:

3. provide for the sustainable use of water
6. provide for the allocation of water to prevent adverse impacts
7. provide for the efficient use of water

The plan seeks to achieve these aims through a number of controls, the most significant for CIT being the requirements that:

15. From 30 June 2005 water shall only be taken and used for irrigation so that water achieves a water-use efficiency of no less than 85%. and
19. From 30 June 2010, water initially allocated prior to 1 January 1988 ... shall only be taken and used for irrigation where the use will not detrimentally affect ... the quality of water in the River Murray ...

The trusts allocate a volumetric entitlement to each grower. Each trust has the power to impose “such terms and conditions as it thinks fit”⁷³ on that supply, which may include “a requirement relating to the regeneration of the land or its protection from degradation in the future”. This provides the trust with authority to require individuals to meet NRM outcomes.

At present, CIT implements these requirements through a set of LWMPs and policies, and by a requirement that any inward water trade is supported by an approved irrigation and drainage management plan. These mechanisms provide the main mechanisms to allow the trusts to achieve the targets for WUE in the water allocation plan, and so link the licensing of the trust to the actions of individual landholders.

Evidence from CIT’s annual reports indicates a significant increase in investment in this area over the past five years. In due course it is expected that the LWMPs will become part of the terms of the licences under which water is allowed to be diverted. This approach would then link:

- the objectives of the catchment plan, with
- the bulk diversion licence under S29 of the Water Resources Act, with
- the obligations on individual growers through LWMPs, as imposed by Section 30 of the Irrigation Act.

⁷¹ *Irrigation Act 1994*, Sections 14 and 14A.

⁷² River Murray Catchment Water Management Board (2002). *Water allocation plan for the River Murray prescribed watercourse*.

⁷³ *Irrigation Act 1994*, S30(1)(a).

Water trading

Individual landholders have the right to trade water on permanent, temporary or leased terms. CIT has provided a water exchange to facilitate that trade. Figure A1 shows the trade, aggregated across the eight trusts for the period from 1997–98 to 2000–01.

The terms of that trade are subject to rules which are set by the individual trusts to protect the interests of the members as a group, ie. to minimise risks of stranded assets and to maintain the productive capability of the region. All inward trades have to be supported by the development of an approved irrigation and drainage management plan (IDMP).

The trusts are able also to trade their bulk licence with the support of their members, where there is surplus, unused capacity. An example in 2001 involved Barossa Infrastructure approaching each of the trusts seeking to purchase water. In most cases that trade was declined at the level of the trust, even though 50% of the requirement was later sourced directly from individual landholders within those same trusts.⁷⁴

⁷⁴ Jeff Parish, CIT, pers. comm., June 2002.

The outcome of this approach is that there is a percentage of the total bulk licence which is not used in most years. This figure has varied over the last four seasons (Table A3).

This surplus reflects a number of factors:

- drought-proofing insurance held by irrigators against severe years;
- a conservative approach to property rights over water;
- pleasure in seeing additional flows down the Murray where these are not needed in a particular year; and
- concern not to promote the commercial advantage of a potential competitor.

Tariffs

The tariffs charged by CIT are distinctive for two reasons:

- they are averaged across the nine irrigation trusts; and
- they are heavily weighted to the volumetric component.

As identified above, the large majority of the irrigation delivery infrastructure is located in, and owned by, the individual trusts rather than by CIT. There are differences in the extent and condition of those assets between the various trusts, and therefore in the costs which those individuals trusts face.

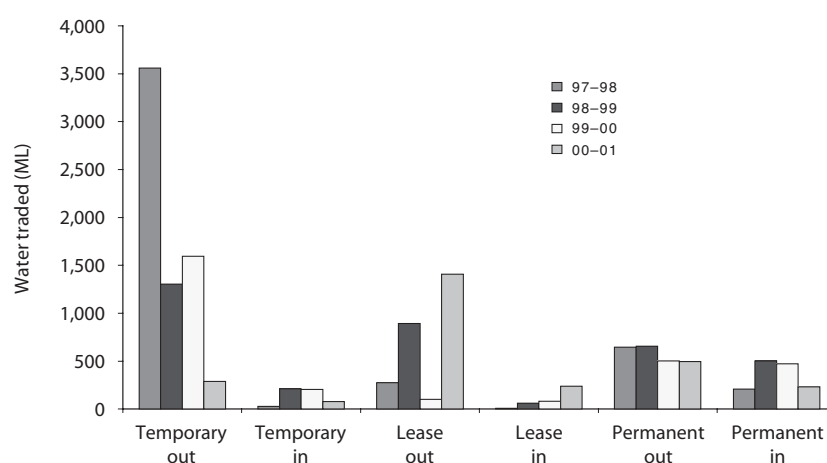


Figure A1. Aggregate water trade within the Central Irrigation Trust, SA. Source: CIT Annual Report, 2001–2002.

Table A3. Water usage in the Central Irrigation Trust, SA.

	97–98	%	98–99	%	99–00	%	00–01	%
Used	87,126	68	95,753	77	86,652	71	98,946	82
Unused	37,042	29	26,255	21	34,200	28	20,625	17
Traded	4,235	3	2,078	2	1,437	1	1,642	1
Total	128,403		124,086		122,289		121,213	

However, the trusts have, to date, followed a policy of socialising those costs across the nine trusts to create a standard delivery charge irrespective of location. This approach reflects the prior history of the trusts as part of the same government irrigation district and also a sense of identity at the regional rather than trust level. This may change as the next generation of growers takes responsibility for the properties and the commercial imperatives of the individual trusts start to diverge.

Hence, the requirement for 'full cost recovery' is met when assessed at the level of the nine trusts when taken as a unit, even though there is some sharing of those costs between the different trusts. If full cost recovery were to be met at the level of each trust then this would lead to some transfers between areas — indeed users in Berri might see a halving of their water charges. However, given the relatively modest level of those charges and their low contribution to the overall costs of the enterprises it is unlikely that this change would have any marked effect on the level of WUE at the farm level.

The other significant factor related to CIT's tariffs is the relative weighting given to the volumetric element of the tariff. The tariff consists of:

- an access charge of \$5/ML; and
- a volumetric charge of \$35/ML.

This is a far greater weight to the volumetric element than is evident in any of the other irrigation businesses in the southern MDB. CIT adopted this approach explicitly to provide incentives for growers to conserve water. Clearly, it places CIT at risk of revenue inadequacy in wet years and, as a result, the trust has built up a reserve of \$1 million to provide some protection against this risk. The CIT is protected to some extent from this risk by the stability of the level of irrigation demand between seasons with a forecast variability of $\pm 10\%$ given the low rainfall and high dependence on irrigated supply of the wine-grape sector.

4. Ord Irrigation Co-operative: Western Australia

The Ord Irrigation Co-operative (OIC) was formed in 1996 in the first step of devolution to local management.⁷⁵ The momentum to full privatisation was halted by uncertainty on native title issues. The area was, however, privatised as of 2 July 2002. Between 1996 and 2002, OIC operated the area under an operations and maintenance contract to the Water Corporation, WA.

A draft operating licence under the *Water Services Coordination Act (1995)* has been tabled. This draft

operating licence, which is valid for 25 years, requires the co-operative to make written submissions annually on prices to be charged and to establish customer councils.

The diversion licence to be issued to the OIC by the Waters and Rivers Commission requires adherence to specific conditions including:

- an operating strategy agreed between the OIC and the Commission; and
- a water-use improvement plan (WUIP). This plan is currently being prepared by OIC.

The strategy and plan will specify targets and methods for achieving improved irrigation efficiency, drainage-water quality, groundwater management and reduced irrigation return flows. The WUIP nests within the broader LWMP which includes these objectives, plus river management, vegetation, species protection and so on. However, the LWMP is not a licence condition.

To date, no formal diversion licence has been issued, but the draft operating strategy⁷⁶ and draft WUIP provide firm indications of key points. These include:

- groundwater levels have risen steadily since irrigation commenced, with more than 10% of the Ord River irrigation area now having groundwater within two metres of the surface. The efficiency of water deliveries and use is, therefore, an important issue;
- the area has predominantly heavy cracking clay soils most suited to furrow irrigation. This suggests that simple technology fixes, ie. shifting away from furrow/flood irrigation, are not immediately relevant;
- a water-distribution efficiency target of 85% will be set by the WUIP;
- on-farm watering efficiency of 65% will also be set by the WUIP;
- overall water use from the total of individual farm figures aggregated into total farm usage figures will be reported to the commission, including wet and dry season totals, but it appears that OIC will not be required to report water usage bands;
- recognition that "while education, research and extension are central to achieving best irrigation practices on-farm, discouragement of and penalties for unacceptable practices are also required to improve overall water use management."⁷⁷

⁷⁵ Kinhill/Marsden Jacob Associates (1995). *Business strategy plan, Water Authority of Western Australia*, April.

⁷⁶ Operating strategy for the diversion, distribution and on-farm management of water supplied via the Stage 1 channel systems of the Ord Irrigation District, prepared by Waters and Rivers Commission in conjunction with Ord Irrigation Co-operative, draft after 31 May Working Session (region and OIC).

⁷⁷ Operating strategy for the diversion, distribution and on-farm management of water supplied via the Stage 1 channel systems of the Ord Irrigation District, prepared by Waters and Rivers Commission in conjunction with Ord Irrigation Co-operative, draft after 31 May Working Session (region and OIC), p.20

- recognition that “The OIC need to have the legal capacity to pass their responsibility for meeting the conditions of [the] Licence... onto individual irrigator, where the conditions relate directly to on-farm practices. Sanctions become essential when the actions (or lack of action) of a few threaten the licensee’s ability to comply with their licence conditions.”⁷⁸

At the current time, it is envisaged that three specific clauses should be required to be included between the irrigator and the OIC.

⁷⁸ Ibid, p. 20.

These three specific clauses are narrower in their application than the generic approach adopted in the EPA licences for the NSW irrigation corporations. However, the Commission can support the OIC in implementing these contractual obligations by issuing a directive to the OIC to meet a condition if it has failed to do so and could direct OIC to “no longer supply water to the customer concerned”⁷⁹; and at the time of the licence review (2007) the respective trends in the on-farm implementation and water management indices will be compared and used as input to reassessing licence conditions at the time.

⁷⁹ Ibid, p. 21.

Annex B: Sources

Gross margins

Crop gross margin budgets – various reports	NSW Department of Land & Water Conservation, 1999
NSW Agriculture – website	Towards efficient water use on irrigated dairy pastures, W. Douglass & D. Poulton, ANCID 1999 Conference
North Central – Cropping Gross Margins Handbook	Economic sustainability with reduced irrigation water: a preliminary study of the Murray Irrigation Limited shareholders capacity to manage NSW water reforms, Crase, L., Jackson, J., & Toohey, D., ANCID 1999
Department of Natural Resources & Environment (Victoria) 1999	Conference, Vision 2045 A strategy for the sustainable and economic management of water resources in the Barossa Region, Rust PPK 1999
Horticultural Gross Margins for the Loddon Murray Regions 1999–2000	Sunraysia Horticultural Gross Margins, Sunraysia Herald 2000
Department of Natural Resources & Environment (Victoria) 2000	
Draft NSW Water Conservation Strategy	